
Specification For The Dalles Fruit Company Holding Pond



Prepared by:



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**The Dalles Fruit
Holding Pond**

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SECTION 01100 - SUMMARY**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 WORK COVERED BY CONTRACT DOCUMENTS

- A. Project Identification: Project consists of the installation of a 10.43 acre-feet hdpe lined holding pond. The pond will require inlet plumbing and outlet piping with control and monitoring devices.
 - 1. Project Location: Please see site map on Sheet C 1.0.
 - 2. Owner: The Dalles Fruit Company, 111 Parallel Ave, Dallesport, WA 98617
- B. Engineer Identification: The Contract Documents were prepared and copyrighted by Bell Design Company, 1000 E Steuben, P.O. Box 308, Bingen, WA 98605.

1.3 CONTRACTS

- A. This project will be constructed under a single contract.

1.4 USE OF PREMISES

- A. General: The Contractor shall have full use of construction easements and public rights-of-way for construction operations, including use of Project site, during construction period. The Contractor's use of premises is limited only by Owner's right to perform work or to retain other contractors on portions of Project.

1.5 SPECIFICATION FORMATS AND CONVENTIONS

- A. Specification Format: The Specifications are organized into Divisions and Sections using the 16-division format and CSI/CSC's "MasterFormat" numbering system.
 - 1. Section Identification: The Specifications use section numbers and titles to help cross-referencing in the Contract Documents. Sections in the Project Manual are in numeric sequence; however, the sequence is incomplete. Consult the table of contents at the beginning of the Project Manual to determine numbers and names of sections in the Contract Documents.
- B. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
 - 1. Abbreviated Language: Language used in the Specifications and other Contract Documents is abbreviated. Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be inferred as the sense requires. Singular words shall be interpreted as plural, and

plural words shall be interpreted as singular where applicable as the context of the Contract Documents indicates.

2. Imperative mood and streamlined language are generally used in the Specifications. Requirements expressed in the imperative mood are to be performed by Contractor. Occasionally, the indicative or subjunctive mood may be used in the Section Text for clarity to describe responsibilities that must be fulfilled indirectly by Contractor or by others when so noted.
 - a. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

PART 4 - PAYMENT

4.1 GENERAL

- A. Payment for the work incurred due to the requirements of this section shall be considered incidental. Any reimbursement for work created by this section shall be absorbed within the other unit prices stated in the Proposal.

END OF SECTION 01100

SECTION 01250 - CONTRACT MODIFICATION PROCEDURES**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

This Section specifies administrative and procedural requirements for handling and processing Contract modifications.

Related Sections include the following:

1. Division 1 Section "Unit Prices" for administrative requirements for using unit prices.
2. Division 1 Section "Product Requirements" for administrative procedures for handling requests for substitutions made after Contract award.

1.3 MINOR CHANGES IN THE WORK

Engineer will issue supplemental instructions authorizing Minor Changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on form included at end of this section.

1.4 PROPOSAL REQUESTS

Owner-Initiated Proposal Requests: Engineer will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.

1. Proposal Requests issued by Engineer are for information only. Do not consider them instructions either to stop work in progress or to execute the proposed change.
2. Within time specified in Proposal Request after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
 - a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
 - b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 - c. Include an updated Contractor's Construction Schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.

Contractor-Initiated Proposals: If latent or unforeseen conditions require modifications to the Contract, Contractor may propose changes by submitting a request for a change to the Engineer.

3. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
4. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
5. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
6. Include an updated Contractor's Construction Schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
7. Comply with requirements in Division 1 Section "Product Requirements" if the proposed change requires substitution of one product or system for product or system specified.

Proposal Request Form: For Change Order proposals, use forms provided by Owner. Sample copies are included at the end of Division 01781.

1.5 CHANGE ORDER PROCEDURES

On Owner's approval of a Proposal Request, Engineer will issue a Change Order for signatures of Owner and Contractor on form included at the end of Division 01781.

1.6 CONSTRUCTION CHANGE DIRECTIVE

Construction Change Directive: Engineer may issue a Construction Change Directive on form included at the end of Division 01781. Construction Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.

1. Construction Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.

Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive.

2. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

PART 4 - PAYMENT

4.1 GENERAL

A. Payment for the work incurred do to the requirements of this section shall be considered incidental. Any reimbursement for work created by this section shall be absorbed within the other unit prices stated in the Proposal.

END OF SECTION 01250

SECTION 01270 - UNIT PRICES**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for unit prices.
- B. Related Sections include the following:
 - 1. Division 1 Section "Contract Modification Procedures" for procedures for submitting and handling Change Orders.
 - 2. Division 1 Section "Quality Requirements" for general testing and inspecting requirements.
 - 3. See each division for specific section items.

1.3 DEFINITIONS

- A. Unit prices shall be submitted for all items of work set forth in the Proposal. All items required to complete the work specified or shown on the Drawings, but not included in the Proposal, shall be considered incidental to those set forth in the Proposal. Unit prices shall include all administrative, overhead, markup, and insurance costs associated with the item. The Bidder shall thoroughly familiarize himself with the project and make his own estimates for costs associated with the methods of construction, constructability, safety, and the need to protect his work and any equipment in connection with the project. The Bidder's unit prices stated in the proposal shall reflect these considerations.
 - 1. The estimate of quantities of work to be done is tabulated in the Proposal and, although stated with as much accuracy as possible, is approximate only. Unit prices shall either apply to plan quantities or bid quantities. The type of quantity to which the unit price is to be applied is stated in the proposal. The type of quantities listed in the proposal are defined as follows:
 - a. Plan Quantities:
Plan quantities shall be fixed and shall not vary regardless of the actual quantity required or found in the field. The bidder shall familiarize himself with the bid item and make his own estimate as to the actual quantity involved with the unit price and shall adjust his unit price to reflect any differences between his estimate of the actual field quantity and that shown in the proposal as a plan quantity. If the bidder feels that the actual quantity varies enough from the plan quantity to cause his unit prices to be unreasonable when evaluated in the bidding process, the Bidder shall inform the ENGINEER in writing no later than 6 days before the bid opening and, if in the opinion of the ENGINEER the plan quantity is in error, a correction to the plan quantity shall be made in the form of a written addendum. Unit prices are established for plan quantities for the purpose of determining compensation if the OWBER should choose to increase or decrease the scope of work as delineated by the drawings or as stated in the specifications. Payment to the Contractor will be made on the measurement of the work performed by the Contractor as specified in the Contract Documents unless otherwise specifically stated in the item's "Payment" section.
 - b. Bid Quantity:

Bid quantities are assumed solely for the basis of calculation upon which the award of the Contract shall be made. Payment to the Contractor will be made on field measurement of the work performed by the Contractor as specified in the Contract Documents unless otherwise specifically stated in the Item's "Payment" section.

c. Non -Guaranteed Quantities or Items

Quantities or items specified as non-guaranteed in their related "Payment" section may be deleted at the OWNER's or ENGINEER's discretion. No payment for work or damages due to loss of anticipated profits and overhead shall be made for these items if deleted from the contract or deducted from the Contract Sum by appropriate modification, if estimated quantities of Work required by the Contract Documents are increased or decreased.

1.4 PROCEDURES

- A. Unit prices include all necessary material, plus cost for delivery, installation, insurance, overhead, and profit.
- B. Measurement and Payment: Refer to individual Specification Sections for work that requires establishment of unit prices. Methods of measurement and payment for unit prices are specified in those Sections.
- C. Owner reserves the right to reject Contractor's measurement of work-in-place that involves use of established unit prices and to have this work measured, at Owner's expense, by an independent surveyor acceptable to Contractor.
- D. List of Unit Prices: A list of unit prices is included in the Bidder's Proposal. Specification Sections referenced in the schedule contain requirements for materials described under each unit price.
- E. Applicable taxes shall be added to totals of all unit prices and included with proposal quantities.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 LIST OF UNIT PRICES

- A. See Proposal for list of unit prices.

PART 4 - PAYMENT

4.1 GENERAL

- A. Payment for all unit price items are defined in each specific section. Any work defined by specific sections but not included as a specific UNIT PRICE BID ITEM shall be considered incidental and shall be absorbed within the other unit prices stated in the proposal.

END OF SECTION 01270

SECTION 01290 - PAYMENT PROCEDURES**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

This Section specifies administrative and procedural requirements necessary to prepare and process Applications for Payment.

Related Sections include the following:

1. Division 1 Section "Unit Prices" for administrative requirements governing use of unit prices.
2. Division 1 Section "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.
3. Division 1 Section "Construction Progress Documentation" for administrative requirements governing preparation and submittal of Contractor's Construction Schedule and Submittals Schedule.

1.3 DEFINITIONS

Schedule of Values: A statement furnished by Contractor allocating portions of the Contract Sum to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

1.4 SCHEDULE OF VALUES

Coordination: Coordinate preparation of the Schedule of Values with preparation of Contractor's Construction Schedule.

1. Correlate line items in the Schedule of Values with other required administrative forms and schedules, including the following:
 - a. Application for Payment forms with Continuation Sheets.
 - b. Submittals Schedule.
2. Submit the Schedule of Values to Engineer at earliest possible date but no later than 14 days before the date scheduled for submittal of initial Applications for Payment.

Format and Content: Use the Project Manual table of contents as a guide to establish line items for the Schedule of Values. Provide at least one line item for each Specification Section.

1. Identification: Include the following Project identification on the Schedule of Values:
 - a. Project name and location.
 - b. Name of Engineer.

- c. Engineer's project number.
 - d. Contractor's name and address.
 - e. Date of submittal.
2. Arrange the Schedule of Values in tabular form with separate columns to indicate the following for each item listed:
 - a. Related Specification Section or Division.
 - b. Description of the Work.
 - c. Name of subcontractor.
 - d. Name of manufacturer or fabricator.
 - e. Name of supplier.
 - f. Change Orders (numbers) that affect value.
 - g. Dollar value.
 - 1) Percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.
3. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with the Project Manual table of contents. Provide several line items for principal subcontract amounts, where appropriate.
4. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
5. Provide a separate line item in the Schedule of Values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
 - a. Differentiate between items stored on-site and items stored off-site. Include evidence of insurance or bonded warehousing if required.
6. Provide separate line items in the Schedule of Values for initial cost of materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
7. Each item in the Schedule of Values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.
 - a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the Schedule of Values or distributed as general overhead expense, at Contractor's option.
8. Schedule Updating: Update and resubmit the Schedule of Values before the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.

1.5 APPLICATIONS FOR PAYMENT

Each Application for Payment shall be consistent with previous applications and payments as certified by Engineer and paid for by Owner.

1. Initial Application for Payment, Application for Payment at time of Substantial Completion, and final Application for Payment involve additional requirements.

Payment Application Times: The date for each progress payment is indicated in the Agreement between Owner and Contractor. The period of construction Work covered by each Application for Payment is the period indicated in the Agreement.

Payment Application Times: The date for each progress payment is the 1st Wednesday of each month. The period covered by each Application for Payment starts on the day following the end of the preceding period and ends 15 days before the date for each progress payment.

Applications for payment must be submitted to the Engineer at least 15 days prior to the 1st Monday of each month.

Payment Application Forms: Use forms provided by Owner for Applications for Payment. Sample copies are included at end of this Section.

Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Engineer will return incomplete applications without action.

1. Entries shall match data on the Schedule of Values and Contractor's Construction Schedule. Use updated schedules if revisions were made.
2. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

Transmittal: Submit 3 signed and notarized original copies of each Application for Payment to Engineer by a method ensuring receipt within 24 hours. One copy shall include waivers of lien and similar attachments if required.

1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.

Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's lien from every entity who is lawfully entitled to file a mechanic's lien arising out of the Contract and related to the Work covered by the payment.

Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's liens from subcontractors, sub-subcontractors, and suppliers for construction period covered by the previous application.

1. Submit partial waivers on each item for amount requested, before deduction for retainage, on each item.
2. When an application shows completion of an item, submit final or full waivers.
3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
4. Submit final Application for Payment with or preceded by final waivers from every entity involved with performance of the Work covered by the application who is lawfully entitled to a lien.
5. **Waiver Forms:** Submit waivers of lien on forms, executed in a manner acceptable to Owner.

Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:

1. List of subcontractors.
2. Schedule of Values.
3. Contractor's Construction Schedule (preliminary if not final).
4. Submittals Schedule (preliminary if not final).
5. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
6. Certificates of insurance and insurance policies.

Application for Payment at Substantial Completion: After issuing the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.

1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
2. This application shall reflect Certificates of Partial Substantial Completion issued previously for Owner occupancy of designated portions of the Work.

Final Payment Application: Submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:

1. Evidence of completion of Project closeout requirements.
2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
3. Updated final statement, accounting for final changes to the Contract Sum.
4. Contractor's Affidavit of Release of Liens.
5. Evidence that claims have been settled.
6. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
7. Final, liquidated damages settlement statement.
8. Removal of temporary facilities and services.
9. Removal of surplus materials, rubbish, and similar elements.
10. Change of door locks to Owner's access.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

PART 4 - PAYMENT

4.1 GENERAL

Payment for the work incurred do to the requirements of this section shall be considered incidental. Any reimbursement for work created by this section shall be absorbed within the other unit prices stated in the Proposal.

END OF SECTION 01290

SECTION 01300 - SUBMITTALS**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section specifies administrative and procedural requirements for submittals required for performance of the Work, including:
 - 1. Daily Construction Reports.
 - 2. Product Data.

1.3 SUBMITTAL PROCEDURES

- A. Within 10 days of the notice to proceed, the Contractor shall submit a schedule by which all identified submittals shall be submitted for approval. The schedule will be discussed at the pre-construction meeting.
- B. Contractors shall submit shop drawings, material lists, manufacturer samples and other required information within sixty (60) calendar days after his receipt of the contract, permit proper consideration and action on same before materials or items, which such shop drawings, information and samples represent, are ordered. Allow sufficient time so that no delay occurs due to required lead-time in ordering or delivery to the job site.
 - 1. No Pay Application beyond 60 days time limit will be processed until all outstanding shop drawings have been submitted.
 - 2. More than three (3) failed submittals will result in charges for review paid to the Engineer in advance.
- C. Coordination: Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.
 - 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals and related activities that require sequential activity.
 - 2. Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination.
 - a. The Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
 - 3. Processing: Allow sufficient review time so that installation will not be delayed as a result of the time required to process submittals, including time for re-submittals.

- a. Allow two weeks for initial review. Allow additional time if processing must be delayed to permit coordination with subsequent submittals. The Engineer will promptly advise the Contractor when a submittal being process must be delayed for coordination.
 - b. If an intermediate submittal is necessary, process the same as the initial submittals.
 - c. Allow two weeks for reprocessing each submittal.
 - d. The contractor will be held responsible for any delay in progress of the work due to his failure to observe these requirements. Time for completion of the Contract will not be extended on account of his failure to promptly submit shop drawings, product data and samples.
 - D. Submittal Preparation: Place a permanent label or title block on each submittal for identification. Indicate the name of the entity that prepared each submittal on the label or title block.
 1. Provide a space approximately 4" x 5" on the label or beside the title block on Shop Drawings to record the Engineer's and Subcontractor's review and approval markings and the action taken.
 2. Include the following information on the label for processing and recording action taken.
 - a. Number of Submittals.
 - b. Project name.
 - c. Date.
 - d. Name of Engineer.
 - e. Name of Subcontractor.
 - f. Name of Supplier.
 - g. Name of Manufacturer.
 - h. Number and title of appropriate Specification Section.
 - i. Drawing number and detail references, as appropriate.
 - E. Submittal Transmittal: Package each submittal appropriately for transmittal and handling. Transmit each submittal for Subcontractor to Engineer using a transmittal form. Submittals received from sources other than the Subcontractor will be returned without action.
 1. On a transmittal, record relevant information and requests for data. On the form, or separate sheet, record deviations for Contract Document requirements, including minor variations and limitations. Include Contractor's certification that information complies with Contract Document requirements.
 - a. All submittals including shop drawings shall be numbered in consecutive order on each submittal and on the transmittal.
 2. Transmittal Form: Use CSI Form 12.1A or equivalent.
- 1.4 DAILY CONSTRUCTION REPORTS
- A. Prepare a daily construction report, recording the following information concerning events at the site; and submit duplicate copies to the Engineer at weekly intervals:
 1. List of Subcontractors at the site.
 2. Approximate counter top of personnel at the site.
 3. High and low temperatures, general weather conditions.
 4. Accidents and unusual events.
 5. Meetings and significant decisions.
 6. Stoppages, delays, shortages, losses.
 7. Meter readings and similar recordings.

8. Emergency procedures.
9. Orders and requests of governing authorities.
10. Change Orders received, implemented.
11. Services connected, disconnected.
12. Equipment or system tests and start-ups.
13. Partial Completions, occupancies.
14. Substantial Completions authorized.

1.5 PRODUCT DATA

- A. Collect Product Data into a single submittal for each element of construction or system. Product Data includes printed information such as manufacturer's installation instructions, catalog cuts, standard color charts, roughing-in diagrams and templates, standard wiring diagrams and performance curves. Where Product Data must be specially prepared because standard printed data is not suitable for use, submit as "Shop Drawings".
1. Mark each copy to show applicable choices and options. Where printed Product Data includes information on several products, some of which are not required, mark copies to indicate the applicable information. Include the following information:
 - a. Manufacturer's printed recommendations.
 - b. Compliance with recognized trade association standards.
 - c. Compliance with recognized testing agency standards.
 - d. Application of testing agency labels and seals.
 - e. Notation of dimensions verified by field measurement.
 - f. Notation of coordination requirements.
 2. Do not submit Product Data until compliance with requirements of the Contract Documents has been confirmed.
 3. Preliminary Submittal: Submit a preliminary single-copy of Product Data only where selection of options is required.
 4. Submittals; Submit five copies of each required submittal; submit seven copies where required for maintenance manuals. The Engineer will retain two, and will return the others marked with action taken and corrections or modifications required.
 - a. Unless noncompliance with Contract Document provisions is observed, the submittal may serve as the final submittal.
 5. Distribution: Furnish copies of final submittal to installers, subcontractors, suppliers, manufacturers, fabricators, and others required for performance of construction activities. Show distribution on transmittal forms.
 - a. Do not proceed with installation until an applicable copy of Product Data applicable is in the installer's possession.
 - b. Do not permit use of unmarked copies of Product Data in connection with construction.

1.6 ENGINEER'S ACTION

- A. Except for submittals for record, information or similar purposed, where action and return is required or requested, the Engineer will review each submittal, mark to indicate action taken, and return promptly.
1. Compliance with specified characteristics is the Contractor's responsibility.

- B. The submittal review by the Engineer will be general in nature. It shall not relieve the Contractor of responsibility for accuracy of such submittals, not proper fitting, construction of work, furnishing of materials, or work required by Contract Documents and not indicated on submittals. Submittal approval shall not be construed as approving departures from Contract Documents. Approval of a specific item shall not imply approval of an assembly in which this item is a component.
 - 1. Review of submittals and schedules shall not relieve the Contractor from responsibility for any violation indicated on such submittals or schedules of local, county, state or federal laws, rules, ordinances, or rules and regulations of commissions, boards or other authorities or utilities having jurisdiction.
- C. Action Stamp: The Engineer will stamp each submittal with a uniform, self-explanatory action stamp. The stamp will be appropriately marked, as follows, to indicate the action taken:
 - 1. Final Unrestricted Release: Where submittals are marked "No Exceptions Taken", (NET) that part of the Work covered by the submittal may proceed provided it complies with requirements of the Contract Documents; final acceptance will depend upon that compliance.
 - 2. Final-But-Restricted Release: When submittals are marked "Note Markings", (NM) that part of the Work covered by the submittal may proceed provided it complies with notations or corrections on the submittal and requirements of the Contract Documents; final acceptance will depend on that compliance.
 - 3. Returned for Resubmittal: When submittal is marked "Rejected", (Contractor to confirm or resubmit) do not proceed with that part of the Work covered by the submittal, including purchasing, fabrication, delivery, or other activity. Revise or prepare a new submittal in accordance with the notations; resubmit without delay. Repeat if necessary to obtain a different action mark.
 - a. Do not permit submittals marked "Rejected" (Confirm or Resubmit) to be used at the Project site, or elsewhere where Work is in progress.
 - 4. Other Action: Where a submittal is primarily for information or record purposes, special processing or other activity, the submittal will be returned, marked "Action Not Required".

1.7 NONCOMPLIANCE

- A. In the event that work is completed before a required submittal is either provided to the Engineer, or is approved by the Engineer, the Contractor will be responsible for any expenses due to an incorrect or unacceptable product.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

PART 4 - PAYMENT

4.1 GENERAL

- A. Payment for the work incurred do to the requirements of this section shall be considered incidental. Any reimbursement for work created by this section shall be absorbed within the other unit prices stated in the Proposal.

END OF SECTION 01300

SECTION 01310 - PROJECT MANAGEMENT AND COORDINATION**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
 - 1. General project coordination procedures.
 - 2. Conservation.
 - 3. Coordination Drawings.
 - 4. Administrative and supervisory personnel.
 - 5. Project meetings.
- B. Each contractor shall participate in coordination requirements. Certain areas of responsibility will be assigned to a specific contractor.

1.3 COORDINATION

- A. Coordination: Coordinate construction operations included in various Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections, that depend on each other for proper installation, connection, and operation.
- B. Coordination: Each contractor shall coordinate its construction operations with those of other contractors and entities to ensure efficient and orderly installation of each part of the Work. Each contractor shall coordinate its operations with operations, included in different Sections, that depend on each other for proper installation, connection, and operation.
 - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 - 2. Coordinate installation of different components with other contractors to ensure maximum accessibility for required maintenance, service, and repair.
 - 3. Make adequate provisions to accommodate items scheduled for later installation.
- C. If necessary, prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
 - 1. Prepare similar memoranda for Owner and separate contractors if coordination of their Work is required.

- D. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other contractors to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
 - 1. Preparation of Contractor's Construction Schedule.
 - 2. Preparation of the Schedule of Values.
 - 3. Installation and removal of temporary facilities and controls.
 - 4. Delivery and processing of submittals.
 - 5. Progress meetings.
 - 6. Preinstallation conferences.
 - 7. Project closeout activities.
- E. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials.
 - 1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work.

1.4 SUBMITTALS

- A. Coordination Drawings: Prepare Coordination Drawings if limited space availability necessitates maximum utilization of space for efficient installation of different components or if coordination is required for installation of products and materials fabricated by separate entities.
 - 1. Indicate required installation sequences.
 - 2. Comply with requirements of Section "Submittals".
- B. Staff Names: Within 15 days of starting construction operations, submit a list of principal staff assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home and office telephone numbers. Provide names, addresses, and telephone numbers of individuals assigned as standbys in the absence of individuals assigned to Project.
 - 1. Post copies of list in Project meeting room, in temporary field office, and by each temporary telephone.

1.5 ADMINISTRATIVE AND SUPERVISORY PERSONNEL

- A. General: In addition to Project superintendent, provide other administrative and supervisory personnel as required for proper performance of the Work.
 - 1. Include special personnel required for coordination of operations with other contractors.

1.6 PROJECT MEETINGS

- A. General: Schedule and conduct meetings and conferences at Project site, unless otherwise indicated.
 - 1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Engineer of scheduled meeting dates and times.
 - 2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.

3. Minutes: Record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Engineer, within 3 days of the meeting.
- B. Preconstruction Conference: Schedule a preconstruction conference before starting construction, at a time convenient to Owner and Engineer, but no later than 10 days after execution of the Agreement. Hold the conference at Project site or another convenient location. Conduct the meeting to review responsibilities and personnel assignments.
1. Attendees: Authorized representatives of Owner, Engineer; Contractor and its superintendent; major subcontractors; manufacturers; suppliers; and other concerned parties shall attend the conference. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 2. Agenda: Discuss items of significance that could affect progress, including the following:
 - a. Tentative construction schedule.
 - b. Phasing.
 - c. Critical work sequencing.
 - d. Designation of responsible personnel.
 - e. Procedures for processing field decisions and Change Orders.
 - f. Procedures for processing Applications for Payment.
 - g. Distribution of the Contract Documents.
 - h. Submittal procedures.
 - i. Preparation of Record Documents.
 - j. Use of the premises.
 - k. Responsibility for temporary facilities and controls.
 - l. Parking availability.
 - m. Office, work, and storage areas.
 - n. Equipment deliveries and priorities.
 - o. First aid.
 - p. Security.
 - q. Progress cleaning.
 - r. Working hours.
- C. Progress Meetings: Conduct progress meetings at intervals as determined by the Owner and Engineer. Coordinate dates of meetings with preparation of payment requests.
1. Attendees: In addition to representatives of Owner and Engineer, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 2. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's Construction Schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - b. Review present and future needs of each entity present, including the following:
 - 1) Interface requirements.
 - 2) Sequence of operations.
 - 3) Status of submittals.
 - 4) Deliveries.

- 5) Off-site fabrication.
 - 6) Access.
 - 7) Site utilization.
 - 8) Temporary facilities and controls.
 - 9) Work hours.
 - 10) Hazards and risks.
 - 11) Progress cleaning.
 - 12) Quality and work standards.
 - 13) Change Orders.
 - 14) Documentation of information for payment requests.
3. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present. Include a brief summary, in narrative form, of progress since the previous meeting and report.
 - a. Schedule Updating: Revise Contractor's Construction Schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

PART 2 - PRODUCTS (Not Used)**PART 3 - EXECUTION (Not Used)****PART 4 - PAYMENT****4.1 GENERAL**

- A. Payment for the work incurred do to the requirements of this section shall be considered incidental. Any reimbursement for work created by this section shall be absorbed within the other unit prices stated in the Proposal.

END OF SECTION 01310

SECTION 01322 - PHOTOGRAPHIC DOCUMENTATION**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for the following:
 - 1. Preconstruction photographs.
 - 2. Periodic construction photographs.
 - 3. Final Completion construction photographs.
- B. Related Sections include the following:
 - 1. Division 1 Section "Unit Prices" for procedures for unit prices for extra photographs.
 - 2. Division 1 Section "Submittal Procedures" for submitting construction photographs.
 - 3. Division 1 Section "Closeout Procedures" for submitting photographic negatives as Project Record Documents at Project closeout.

1.3 LEVEL OF EFFORT

- A. Level of Effort: The number of construction photographs on average should be 12 photographs per week over the duration of Project. More photos per week may be necessary depending on level of activity during the specific week.

1.4 SUBMITTALS

- A. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- B. Construction Photographs: Submit 1 print of each photographic view within 14 days of taking photographs.
 - 1. Format: 3 ½ x 5 inch enclosed back to back in clear plastic sleeves that are punched for standard 3-ring binder.
 - 2. Identification: On back of each print provide an applied label or rubber-stamped impression with the following information:
 - a. Name of Project.
 - b. Name and address of photographer.
 - c. Name of Engineer.
 - d. Name of Contractor.
 - e. Date photograph was taken.

- f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
- 3. Negatives: Submit a complete set of photographic negatives in protective envelopes with each submittal of prints. Identify date photographs were taken.

PART 2 - PRODUCTS

2.1 PHOTOGRAPHIC MEDIA

- A. Photographic Film: Medium-format, quality color, high quality film.

PART 3 - EXECUTION

3.1 PHOTOGRAPHS, GENERAL

- A. Date Stamp: Unless otherwise indicated, date and time stamp each photograph as it is being taken so stamp is integral to photograph.

3.2 CONSTRUCTION PHOTOGRAPHS

- A. Preconstruction Photographs: Before starting construction, take color photographs of Project site and surrounding properties from different vantage points, as directed by Engineer.
- B. Periodic Construction Photographs: Take 12 color photographs weekly with the cutoff date associated with each Application for Payment. Photographer shall select vantage points to best show status of construction and progress since the last photographs were taken.

PART 4 - PAYMENT

4.1 GENERAL

- A. Payment for the work incurred do to the requirements of this section shall be considered incidental. Any reimbursement for work created by this section shall be absorbed within the other unit prices stated in the Proposal.

END OF SECTION 01322

SECTION 01400 - QUALITY REQUIREMENTS**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
 - 1. Specific quality-control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
 - 2. Specified tests, inspections, and related actions do not limit Contractor's quality-control procedures that facilitate compliance with the Contract Document requirements.
 - 3. Requirements for Contractor to provide quality-control services required by Engineer, Owner, or authorities having jurisdiction are not limited by provisions of this Section.
- C. Related Sections include the following:
 - 1. Division 1 Section "Construction Progress Documentation" for developing a schedule of required tests and inspections.
 - 2. Divisions 2 through 16 Sections for specific test and inspection requirements.

1.3 DEFINITIONS

- A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and ensure that proposed construction complies with requirements.
- B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that completed construction complies with requirements. Services do not include contract enforcement activities performed by Engineer.
- C. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

1.4 DELEGATED DESIGN

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Engineer.

1.5 REGULATORY REQUIREMENTS

- A. Copies of Regulations: Obtain copies of the following regulations and retain at Project site to be available for reference by parties who have a reasonable need:

1. 2012 IBC
2. 2012 IPC
3. 2012 IMC
4. 2012 IFC
5. Washington Amendments to Building, Mechanical and Plumbing Codes
6. Most current DOH Drinking Water Standards
7. Most current AWWA Water Standards

1.6 SUBMITTALS

- A. Qualification Data: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

- B. Reports: Prepare and submit certified written reports that include the following:

1. Date of issue.
2. Project title and number.
3. Name, address, and telephone number of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.
7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Ambient conditions at time of sample taking and testing and inspecting.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and reinspecting.

- C. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.7 QUALITY ASSURANCE

- A. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- B. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- C. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- D. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance.
- E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar to those indicated for this Project in material, design, and extent.
- F. Specialists: Certain sections of the Specifications require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
 - 1. Requirement for specialists shall not supersede building codes and similar regulations governing the Work, nor interfere with local trade-union jurisdictional settlements and similar conventions.
- G. Testing Agency Qualifications: An agency with the experience and capability to conduct testing and inspecting indicated, as documented by ASTM E 548, and that specializes in types of tests and inspections to be performed.
- H. Preconstruction Testing: Testing agency shall perform preconstruction testing for compliance with specified requirements for performance and test methods.
 - 1. Contractor responsibilities include the following:
 - a. Provide test specimens and assemblies representative of proposed materials and construction. Provide sizes and configurations of assemblies to adequately demonstrate capability of product to comply with performance requirements.
 - b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
 - c. Fabricate and install test assemblies using installers who will perform the same tasks for Project.
 - d. When testing is complete, remove assemblies; do not reuse materials on Project.
 - 2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Engineer with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.

1.8 QUALITY CONTROL

- A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.

1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of the types of testing and inspecting they are engaged to perform.
 2. Payment for these services will be made from testing and inspecting allowances, as authorized by Change Orders.
 3. Costs for retesting and reinspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor.
- B. Contractor Responsibilities: Unless otherwise indicated, provide quality-control services specified and required by authorities having jurisdiction.
1. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.
 - a. Contractor shall not employ the same entity engaged by Owner, unless agreed to in writing by Owner.
 2. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
 3. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
 4. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
 5. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- C. Special Tests and Inspections: Owner will engage a testing agency to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner.
1. Testing agency will notify Engineer and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
 2. Testing agency will submit a certified written report of each test, inspection, and similar quality-control service to Engineer with copy to Contractor and to authorities having jurisdiction.
 3. Testing agency will retest and reinspect corrected work.
- D. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing.
- E. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that revised or replaced Work that failed to comply with requirements established by the Contract Documents.
- F. Testing Agency Responsibilities: Cooperate with Engineer and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
1. Notify Engineer and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 2. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
 3. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
 4. Do not release, revoke, alter, or increase requirements of the Contract Documents or approve or accept any portion of the Work.
 5. Do not perform any duties of Contractor.

- G. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
1. Access to the Work.
 2. Incidental labor and facilities necessary to facilitate tests and inspections.
 3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
 4. Facilities for storage and field-curing of test samples.
 5. Delivery of samples to testing agencies.
 6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
 7. Security and protection for samples and for testing and inspecting equipment at Project site.
- H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
1. Schedule times for tests, inspections, obtaining samples, and similar activities.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 REPAIR AND PROTECTION

- A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
- B. Protect construction exposed by or for quality-control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

PART 4 - PAYMENT

4.1 GENERAL

- A. Payment for the work incurred do to the requirements of this section shall be considered incidental. Any reimbursement for work created by this section shall be absorbed within the other unit prices stated in the Proposal.

END OF SECTION 01400

SECTION 01420 - REFERENCES**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 DEFINITIONS

- A. General: Basic Contract definitions are included in the Conditions of the Contract.
- B. "Approved": The term "approved," when used in conjunction with Architect's action on Contractor's submittals, applications, and requests, is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.
- C. "Directed": Terms such as "directed," "requested," "authorized," "selected," "approved," "required," and "permitted" mean directed by Architect, requested by Architect, and similar phrases.
- D. "Indicated": The term "indicated" refers to graphic representations, notes, or schedules on Drawings; or to other paragraphs or schedules in Specifications and similar requirements in the Contract Documents. Terms such as "shown," "noted," "scheduled," and "specified" are used to help the user locate the reference.
- E. "Regulations": The term "regulations" includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.
- F. "Furnish": The term "furnish" means to supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- G. "Install": The term "install" describes operations at Project site including unloading, temporary storage, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
- H. "Provide": The term "provide" means to furnish and install, complete and ready for the intended use.
- I. "Installer": An installer is Contractor or another entity engaged by Contractor, as an employee, subcontractor, or contractor of lower tier, to perform a particular construction operation, including installation, erection, application, and similar operations.
- J. The term "experienced," when used with the term "installer," means having successfully completed a minimum of five previous projects similar in size and scope to this Project; being familiar with the special requirements indicated; and having complied with requirements of authorities having jurisdiction.
 - 1. Using a term such as "carpentry" does not imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as "carpenter." It also does not imply that requirements specified apply exclusively to tradespeople of the corresponding generic name.

- K. "Project site" is the space available for performing construction activities, either exclusively or in conjunction with others performing other work as part of Project. The extent of Project site is shown on the Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.3 INDUSTRY STANDARDS

- A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.
- B. Publication Dates: Comply with standards in effect as of the date of the Contract Documents, unless otherwise indicated.
- C. Conflicting Requirements: Where compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to Architect for a decision before proceeding.
1. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of the requirements. Refer uncertainties to Architect for a decision before proceeding.
- D. Copies of Standards: Each entity engaged in construction on Project must be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.
1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from the publication source and make them available on request.
- E. Abbreviations and Names: Abbreviations and acronyms are frequently used in the Specifications and other Contract Documents to represent the name of a trade association, standards-developing organization, authorities having jurisdiction, or other entity in the context of referencing a standard or publication. Where abbreviations and acronyms are used in the Specifications or other Contract Documents, they mean the recognized name of these entities. Refer to Gale Research's "Encyclopedia of Associations" or Columbia Books' "National Trade & Professional Associations of the U.S.," which are available in most libraries.
- F. Abbreviations and Names: Abbreviations and acronyms are frequently used in the Specifications and other Contract Documents to represent the name of a trade association, standards-developing organization, authorities having jurisdiction, or other entity in the context of referencing a standard or publication. The following abbreviations and acronyms, as referenced in the Contract Documents, mean the associated names. Names and addresses are subject to change and are believed, but are not assured, to be accurate and up-to-date as of the date of the Contract Documents.

AA	Aluminum Association	(202) 862-5100
	900 19th St., NW, Suite 300	
	Washington, DC 20006	
	Www.aluminum.org	

AAMA	American Architectural Manufacturers Association 1827 Walden Office Sq., Suite 104 Schaumburg, IL 60173-4268 www.aamanet.org	(847) 303-5664
AAN	American Association of Nurserymen (See ANLA)	
AASHTO	American Association of State Highway and Transportation Officials 444 North Capitol St., NW, Suite 249 Washington, DC 20001 www.aashto.org	(202) 624-5800
ABMA	American Bearing Manufacturers Association (Formerly: Anti-Friction Bearing Manufacturers Association) 1200 19th St., NW, Suite 300 Washington, DC 20036-2401 www.abma-dc.org	(202) 429-5155
ACI	American Concrete Institute P.O. Box 9094 Farmington Hills, MI 48333-9094 www.aci-int.org	(248) 848-3700
AFBMA	Anti-Friction Bearing Manufacturers Association (See ABMA)	
AFPA	American Forest and Paper Association (Formerly: National Forest Products Association) 1111 19th St., NW, Suite 800 Washington, DC 20036 www.afandpa.org	(800) 878-8878 (202) 463-2700
AGA	American Gas Association 1515 Wilson Blvd. Arlington, VA 22209 www.aga.com	(703) 841-8400
AHA	American Hardboard Association 1210 W. Northwest Hwy Palatine, IL 60067-1897	(847) 934-8800
AI	Asphalt Institute P.O. Box 14052 Lexington, KY 40512-4052 www.asphaltinstitute.org	(606) 288-4960
AIA	The American Institute of Architects 1735 New York Ave., NW Washington, DC 20006-5292 www.aia.org	(202) 626-7300
AISC	American Institute of Steel Construction One East Wacker Dr., Suite 3100 Chicago, IL 60601-2001	(800) 644-2400 (312) 670-2400

	www.aisc.web.com	
AISI	American Iron and Steel Institute 1101 17th St., NW, Suite 1300 Washington, DC 20036-4700 www.steel.org	(202) 452-7100
AITC	American Institute of Timber Construction 7012 S. Revere Pkwy, Suite 140 Englewood, CO 80112 www.aitc-glulam.org	(303) 792-9559
ALCA	Associated Landscape Contractors of America 150 Elden St., Suite 270 Herndon, VA 20170-4831 www.alca.org	(800) 395-2522 (703) 736-9666
ALI	Associated Laboratories, Inc. P.O. Box 152837 Dallas, TX 75315 www.assoc-labs.com	(214) 565-0593
ALSC	American Lumber Standards Committee P.O. Box 210 Germantown, MD 20875	(301) 972-1700
AMCA	Air Movement and Control Association International, Inc. 30 W. University Dr. Arlington Heights, IL 60004-1893 www.amca.org	(847) 394-0150
ANLA	American Nursery and Landscape Association (Formerly: American Association of Nurserymen) 1250 Eye St., NW, Suite 500 Washington, DC 20005 www.anla.org	(202) 789-2900
ANSI	American National Standards Institute 11 West 42nd St., 13th Floor New York, NY 10036-8002 www.ansi.org	(888) 267-4783 (212) 642-4900
APA	APA-The Engineered Wood Association (Formerly: American Plywood Association) P.O. Box 11700 Tacoma, WA 98411-0700 www.apawood.org	(253) 565-6600
ARI	Air-Conditioning and Refrigeration Institute 4301 Fairfax Dr., Suite 425 Arlington, VA 22203 www.ari.org	(703) 524-8800
ARMA	Asphalt Roofing Manufacturers Association Center Park 4041 Powder Mill Rd., Suite 404	(301) 348-2002

	Calverton, MD 20705 www.asphaltroofing.org	
ASA	Acoustical Society of America 500 Sunnyside Blvd. Woodbury, NY 11797 //asa.aip.org	(516) 576-2360
ASC	Adhesive and Sealant Council 1627 K St., NW, Suite 1000 Washington, DC 20006-1707 www.ascouncil.org	(202) 452-1500
ASCE	American Society of Civil Engineers World Headquarters 1801 Alexander Graham Bell Dr. Reston, VA 20191-4400 www.asce.org	(800) 548-2723 (703) 295-6000
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers 1791 Tullie Circle, NE Atlanta, GA 30329-2305 www.ashrae.org	(800) 527-4723 (404) 636-8400
ASLA	American Society of Landscape Architects 636 Eye St., NW Washington, DC 20001-3736 www.asla.org	(202) 898-2444
ASME	American Society of Mechanical Engineers 345 East 47th St. New York, NY 10017-2392 www.asme.org	(800) 843-2763 (212) 705-7722
ASTM	American Society for Testing and Materials 100 Barr Harbor Dr. West Conshohocken, PA 19428-2959 www.astm.org	(610) 832-9500
AWPA	American Wood-Preservers' Association P.O. Box 5690 Granbury, TX 76049 www.awpa.com	(817) 326-6300
AWPB	American Wood Preservers' Bureau (This organization is now defunct.)	
AWS	American Welding Society 550 NW LeJeune Rd. Miami, FL 33126 www.amweld.org	(800) 443-9353 (305) 443-9353
AWWA	American Water Works Association 6666 W. Quincy Ave.	(800) 926-7337 (303) 794-7711

	Denver, CO 80235 www.awwa.org	
CLFMI	Chain Link Fence Manufacturers Institute 9891 Broken Land Pkwy, Suite 300 Columbia, MD 21046 www.baileadership.com	(301) 596-2584
CPA	Composite Panel Association (Formerly: National Particleboard Association) 18928 Premiere Ct. Gaithersburg, MD 20879-1569 www.pbmdf.com	(301) 670-0604
CPPA	Corrugated Polyethylene Pipe Association 3621 Secor Rd., Suite 320 Toledo, OH 436046 www.cppa-info.org	(800) 510-2772 (419) 241-2221
CRSI	Concrete Reinforcing Steel Institute 933 N. Plum Grove Rd. Schaumburg, IL 60173-4758 www.crsi.org	(847) 517-1200
DHI	Door and Hardware Institute (Formerly: National Builders Hardware Association) 14170 Newbrook Dr. Chantilly, VA 20151-2223 www.dhi.org	(703) 222-2010
DIPRA	Ductile Iron Pipe Research Association 245 Riverchase Pkwy East, Suite O Birmingham, AL 35244 www.dipra.org	(205) 402-8702
IEEE	Institute of Electrical and Electronics Engineers 345 E. 47th St. New York, NY 10017-2394 www.ieee.org	(800) 678-4333 (212) 705-7900
INCE	Institute of Noise Control Engineering P.O. Box 3206, Arlington Branch Poughkeepsie, NY 12603 www.ince.org	(914) 462-4006
MIA	Masonry Institute of America 2550 Beverly Blvd. Los Angeles, CA 90057 www.masonryinstitute.org	(213) 388-0472
NAA	National Arborist Association P.O. Box 1094 Amherst, NH 03031-1094 www.natlarb.com	(800) 733-2622 (603) 673-3311
NACE	NACE International	(281) 492-0535

	(Formerly: National Association of Corrosion Engineers) P.O. Box 218340 Houston, TX 77218-8340	(281) 492-8254
NAGDM	National Association of Garage Door Manufacturers (See DASMA)	
NAIMA	North American Insulation Manufacturers Association (Formerly: Thermal Insulation Manufacturers Association) 44 Canal Center Plaza, Suite 310 Alexandria, VA 22314 www.naima.org	(703) 684-0084
NAPA	National Asphalt Pavement Association NAPA Building 5100 Forbes Blvd. Lanham, MD 20706-4413 www.hotmix.org	(888) 468-6499 (301) 731-4748
NBHA	National Builders Hardware Association (See DHI)	
NCAC	National Council of Acoustical Consultants 66 Morris Ave., Suite 1A Springfield, NJ 07081 www.ncac.com	(973) 564-5859
NCMA	National Concrete Masonry Association 2302 Horse Pen Rd. Herndon, VA 20171-3499 www.ncma.org	(703) 713-1900
NECA	National Electrical Contractors Association 3 Bethesda Metro Center, Suite 1100 Bethesda, MD 20814-3299 www.necanet.org	(301) 657-3110
NEMA	National Electrical Manufacturers Association 1300 N 17th St., Suite 1847 Rosslyn, VA 22209 www.nema.org	(703) 841-3200
NFPA	National Fire Protection Association One Batterymarch Park P.O. Box 9101 Quincy, MA 02269-9101 www.nfpa.org	(800) 344-3555 (617) 770-3000
NFPA	National Forest Products Association (See AFPA)	
NGA	National Glass Association 8200 Greensboro Drive, 3rd Floor McLean, VA 22102-3881	(703) 442-4890
NIA	National Insulation Association	(703) 683-6422

	(Formerly: National Insulation and Abatement Contractors Association) 99 Canal Center Plaza, Suite 222 Alexandria, VA 22314 www.insulation.org	
NPCA	National Paint and Coatings Association 1500 Rhode Island Ave., NW Washington, DC 20005-5597 www.paint.org	(202) 462-6272
NRCA	National Roofing Contractors Association O'Hare International Center 10255 W. Higgins Rd., Suite 600 Rosemont, IL 60018-5607 www.roofonline.org	(800) 323-9545 (847) 299-9070
NRMCA	National Ready Mixed Concrete Association 900 Spring St. Silver Spring, MD 20910 www.nrmca.org	(301) 587-1400
NSF	National Sanitation Foundation PO Box 130140 Ann Arbor, MI 48113-0140 www.nsf.org	(800) 673-6275
PCA	Portland Cement Association 5420 Old Orchard Rd. Skokie, IL 60077-1083 www.portcement.org	(847) 966-6200
PDCA	Painting and Decorating Contractors of America 3913 Old Lee Hwy, Suite 33-B Fairfax, VA 22030 www.pdca.com	(800) 332-7322 (703) 359-0826
PGI	PVC Geomembrane Institute/Technology Program University of Illinois-Urbana Champaign 205 N. Mathews Ave. 2215 Newmark Civil Engineering Lab Urbana, IL 61801 //pgi-tp.ce.vivc.edu	(217) 333-3929
PPFA	Plastic Pipe and Fittings Association 800 Roosevelt Rd., Building C, Suite 20 Glen Ellyn, IL 60137-5833	(888) 314-6774 (630) 858-6540
PPI	Plastics Pipe Institute (The Society of the Plastics Industry, Inc.) 1801 K St., NW, Suite 600K Washington, DC 20006 www.plasticpipe.org	(202) 974-5306
RCSC	Research Council on Structural Connections Sargent & Lundy	(312) 269-2424

	55 E. Monroe St. Chicago, IL 60603	
SAE	SAE International 400 Commonwealth Dr. Warrendale, PA 15096-0001 For publications: Call (724) 776-4970 www.sae.org	(724) 776-4841
SDI	Steel Door Institute 30200 Detroit Rd. Cleveland, OH 44145-1967 www.steeldoor.org	(440) 899-0010
SGCC	Safety Glazing Certification Council P.O. Box 9 Henderson Harbor, NY 13651	(315) 938-7444
SIGMA	Sealed Insulating Glass Manufacturers Association 401 N. Michigan Ave. Chicago, IL 60611-4267 www.sigmaonline.org/sigma	(312) 644-6610 x3279
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association 4201 Lafayette Center Dr. P.O. Box 221230 Chantilly, VA 20151-1209 www.smacna.org	(703) 803-2980
STI	Steel Tank Institute 570 Oakwood Rd. Lake Zurich, IL 60047-1559 www.steeltank.com	(847) 438-8265
SWPA	Submersible Wastewater Pump Association 1806 Johns Dr. Glenview, IL 60025-1657	(847) 729-7972
SWRI	Sealant, Waterproofing and Restoration Institute 2841 Main St. Kansas City, MO 64108 www.swrionline.org	(816) 472-7974
TPI	Truss Plate Institute 583 D'Onofrio Dr., Suite 200 Madison, WI 53719	(608) 833-5900
UL	Underwriters Laboratories Inc. 333 Pfingsten Rd. Northbrook, IL 60062 www.ul.com	(800) 704-4050 (847) 272-8800
UNI	Uni-Bell PVC Pipe Association 2655 Villa Creek Dr., Suite 155 Dallas, TX 75234	(972) 243-3902

members.aol.com/unibell

WCLIB	West Coast Lumber Inspection Bureau P.O. Box 23145 Portland, OR 97281-3145	(800) 283-1486 (503) 639-0651
WRI	Wire Reinforcement Institute 301 E. Sandusky St. Findlay, OH 45840 www.bright.net/~rreiter	(419) 425-9473
WSC	Water Systems Council Building C, Suite 20 800 Roosevelt Rd. Glen Ellyn, IL 60137	(630) 545-1762
WWPA	Western Wood Products Association Yeon Building 522 SW 5th Ave. Portland, OR 97204-2122 www.wwpa.org	(503) 224-3930

- G. Federal Government Agencies: Names and titles of Federal Government standards- or specification-developing agencies are often abbreviated. The following abbreviations and acronyms referenced in the Contract Documents indicate names of standards- or specification-developing agencies of the Federal Government. Names and addresses are subject to change and are believed, but are not assured, to be accurate and up-to-date as of the date of the Contract Documents.

EPA	Environmental Protection Agency 401 M St., SW Washington, DC 20460 www.epa.gov	(202) 260-2090
FCC	Federal Communications Commission 1919 M St., NW Washington, DC 20554 www.fcc.gov	(202) 418-0126
FHA	Federal Housing Administration (U.S. Department of Housing and Urban Development) 451 Seventh St., SW Washington, DC 20410 www.hud.gov	(202) 401-0388
OSHA	Occupational Safety and Health Administration (U.S. Department of Labor) 200 Constitution Ave., NW Washington, DC 20210 www.osha.gov	(202) 219-8148
USPS	U.S. Postal Service 475 L'Enfant Plaza, SW Washington, DC 20260-0010 www.usps.gov	(202) 268-2000

- H. State Government Agencies: The following state government agencies develop standards referenced in the Contract Documents:

Washington

CTED	Community, Trade & Economic Development Dan Riebli P.O. Box 48300 Olympia, WA 98504	(360) 586-0871 fax (360) 586-4162
DOE	Department of Ecology 15 W Yakima, Suite 200 Yakima, WA 98902	(509) 575-2490
DOH	Department of Health 1500 W 4th Avenue, Suite 305 Spokane, WA 99204	
DOR	Department of Revenue P.O. Box 47474 Olympia, WA 98504-7474	
ESD	Employment Security Department P.O. Box 9046 Olympia, WA 98507-9046	
L&I	Labor & Industries P.O. Box 44835 Olympia, WA 98504-4835	
WSDOT	Washington State Department of Transportation Southwest Region P.O. Box 1709 Vancouver, WA 98668-1709	(360) 905-2000 Fax (360) 905-2222

- I. Local Government Agencies: The following local agencies develop standards referenced in the Contract Documents:

Klickitat County Building Department 228 W Main Goldendale, WA 98620	(509) 773-3706
Klickitat County Engineer Department 228 W Main Goldendale, WA 98620	(509) 773-4616
Klickitat County Planning Department 228 W Main Goldendale, WA 98620	(509) 773-5703

1.4 GOVERNING REGULATIONS AND AUTHORITIES

- A. The Engineer has contracted authorities having jurisdiction where necessary to obtain information necessary for preparation of Contract Documents; that information may or may not be of significance to the Contractor. Contact authorities having jurisdiction directly for information and decisions having a bearing on the Work.
- B. Copies of Regulations: Obtain copies of the following regulations and retain at the Project Site to be available for reference by parties who have a reasonable need.
 - 1. International Building Code
 - 2. International Plumbing Code
 - 3. International Mechanical Code
 - 4. National Electric Code
 - 5. International Fire Code
 - 6. Underwriters Laboratories Fire Resistance Directory

1.5 SUBMITTALS

- A. Permits, Licenses, and Certificates: For the Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established in conjunction with compliance with standards and regulations bearing upon performance of the Work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01420

SECTION 01421 – TOLERANCES**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and General Provisions of the Contract. When other documents provide specific tolerances, those tolerances shall prevail.

1.2 SUMMARY

- A. This Section provides general tolerances for dimensions that are not specified elsewhere.
- B. Tolerance applications include the following:
 - 1. Linear measurements.
 - 2. Angular measurements.
 - 3. Machined surfaces.
 - 4. Implied dimensions.
 - a. Angles
 - b. Centerlines
 - c. Equal Spacing
 - d. Parallelism
 - e. Flatness
 - f. Level
 - g. Concentricity

PART 2 - PRODUCTS (NOT USED)**PART 3 - EXECUTION****3.1 MEASUREMENTS**

- A. Concrete Work
 - 1. Linear Measurements $\pm 1/8''$
 - 2. Angular Measurements $\pm 1^\circ$
 - 3. Implied Dimensions
 - a. Angles $\pm 1^\circ$
 - b. Centerlines $\pm 1/8''$
 - c. Equal Spacing $\pm 1/8''$
 - d. Parallelism $\pm 1/4''$
 - e. Flatness $1/4''$ TIR
 - f. Level $1/8''$ / 20-foot lineal dimension
- B. Structural Steel Work
 - 1. Linear Dimensions

- a. Greater than 20-feet $\pm 1/8''$
- b. 6-feet through 20-feet $\pm 1/16''$
- c. 5-feet or less $\pm 1/32''$
- 2. Angular Measurement $\pm 1/2^\circ$
- 3. Machined Elements
 - a. Finish $\sqrt[1.6]{}$ or 63μ inches
 - b. Flat ± 0.001 TIR
 - c. Diameter ± 0.002
 - d. Lineal Dimensions ± 0.004
- 4. Implied Dimensions – Non Machined Elements
 - a. Angles $\pm 1/2^\circ$
 - b. Same Plane $\pm 1/8''$
 - c. Equal Spacing $1/32$ true dimension location
 - d. Parallelism $\pm 1/8''$
 - e. Flatness $\pm 1/16''$
 - f. Level $\pm 1/8''$ / 20-feet lineal dimension
 - g. Concentricity $\pm 1/32''$ TIR
- 5. Implied Dimensions – Machined Elements
 - a. Angles $\pm 0.1^\circ$
 - b. Equal Spacing $\pm 0.010''$
 - c. Parallelism $\pm 0.010/12''$
 - d. Flatness $\pm 0.010/\text{ft}^2$
 - e. Concentricity ± 0.004 TIR

3.2 QUALITY ASSURANCE

- A. Where no other documentation, drawings, or sections contain applicable tolerance criteria, this section will be used by the inspecting engineer to determine the acceptable accuracy.

PART 4 - PAYMENT (NOT APPLICABLE)

END OF SECTION 01421

SECTION 01600 - PRODUCT REQUIREMENTS**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following administrative and procedural requirements: selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; product substitutions; and comparable products.
- B. Related Sections include the following:
 - 1. Division 1 Section "References" for applicable industry standards for products specified.
 - 2. Division 1 Section "Closeout Procedures" for submitting warranties for contract closeout.
 - 3. Divisions 2 through 16 Sections for specific requirements for warranties on products and installations specified to be warranted.

1.3 DEFINITIONS

- A. Products: Items purchased for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
 - 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation, shown or listed in manufacturer's published product literature, that is current as of date of the Contract Documents.
 - 2. New Products: Items that have not previously been incorporated into another project or facility, except that products consisting of recycled-content materials are allowed, unless explicitly stated otherwise. Products salvaged or recycled from other projects are not considered new products.
 - 3. Comparable Product: Product that is demonstrated and approved through submittal process, or where indicated as a product substitution, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
- C. Basis-of-Design Product Specification: Where a specific manufacturer's product is named and accompanied by the words "basis of design," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of other named manufacturers.
- D. Manufacturer's Warranty: Preprinted written warranty published by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.

- E. Special Warranty: Written warranty required by or incorporated into the Contract Documents, either to extend time limit provided by manufacturer's warranty or to provide more rights for Owner.

1.4 SUBMITTALS

- A. See Division 1 Section "Submittals".
- B. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. Substitution Request Form: Use CSI Form 13.1A.
 - 2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
 - a. Statement indicating why specified material or product cannot be provided.
 - b. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by Owner and separate contractors, that will be necessary to accommodate proposed substitution.
 - c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
 - d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
 - e. Samples, where applicable or requested.
 - f. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
 - g. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
 - h. Research/evaluation reports evidencing compliance with building code in effect for Project, from a model code organization acceptable to authorities having jurisdiction.
 - i. Detailed comparison of Contractor's Construction Schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating lack of availability or delays in delivery.
 - j. Cost information, including a proposal of change, if any, in the Contract Sum.
 - k. Contractor's certification that proposed substitution complies with requirements in the Contract Documents and is appropriate for applications indicated.
 - l. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
 - 3. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within one week of receipt of a request for substitution. Engineer will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or 7 days of receipt of additional information or documentation, whichever is later.
 - a. Form of Acceptance: Change Order.
 - b. Use product specified if Engineer cannot make a decision on use of a proposed substitution within time allocated.
- C. Basis-of-Design Product Specification Submittal: Comply with requirements in Division 1 Section "Submittal Procedures." Show compliance with requirements.

1.5 QUALITY ASSURANCE

- A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.
 - 1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.
 - 2. If a dispute arises between contractors over concurrently selectable but incompatible products, Engineer will determine which products shall be used.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written instructions.
 - 1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
 - 2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
 - 3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
 - 4. Inspect products on delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.
 - 5. Store products to allow for inspection and measurement of quantity or counting of units.
 - 6. Store materials in a manner that will not endanger Project structure.
 - 7. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
 - 8. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
 - 9. Protect stored products from damage.
- B. Storage: Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

1.7 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution. Submit a draft for approval before final execution.
 - 1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
 - 2. Specified Form: Forms are included with the Specifications. Prepare a written document using appropriate form properly executed.
 - 3. Refer to Divisions 2 through 16 Sections for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements in Division 1 Section "Closeout Procedures."

PART 2 - PRODUCTS**2.1 PRODUCT OPTIONS**

- A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged, and unless otherwise indicated, that are new at time of installation.
1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
 2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
 3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
 4. Where products are accompanied by the term "as selected," Engineer will make selection.
 5. Where products are accompanied by the term "match sample," sample to be matched is Engineer's.
 6. Descriptive, performance, and reference standard requirements in the Specifications establish "salient characteristics" of products.
 7. Or Equal: Where products are specified by name and accompanied by the term "or equal" or "or approved equal" or "or approved," comply with provisions in "Comparable Products" Article to obtain approval for use of an unnamed product.
- B. Product Selection Procedures: Procedures for product selection include the following:
1. Product: Where Specification paragraphs or subparagraphs titled "Product" name a single product and manufacturer, provide the product named.
 - a. Substitutions may be considered, unless otherwise indicated.
 2. Manufacturer/Source: Where Specification paragraphs or subparagraphs titled "Manufacturer" or "Source" name single manufacturers or sources, provide a product by the manufacturer or from the source named that complies with requirements.
 - a. Substitutions may be considered, unless otherwise indicated.
 3. Products: Where Specification paragraphs or subparagraphs titled "Products" introduce a list of names of both products and manufacturers, provide one of the products listed that complies with requirements.
 - a. Substitutions may be considered, unless otherwise indicated.
 4. Manufacturers: Where Specification paragraphs or subparagraphs titled "Manufacturers" introduce a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements.
 - a. Substitutions may be considered, unless otherwise indicated.
 5. Available Products: Where Specification paragraphs or subparagraphs titled "Available Products" introduce a list of names of both products and manufacturers, provide one of the products listed or another product that complies with requirements. Comply with provisions in "Comparable Products" Article to obtain approval for use of an unnamed product.
 6. Available Manufacturers: Where Specification paragraphs or subparagraphs titled "Available Manufacturers" introduce a list of manufacturers' names, provide a product by one of the

- manufacturers listed or another manufacturer that complies with requirements. Comply with provisions in "Comparable Products" Article to obtain approval for use of an unnamed product.
7. Product Options: Where Specification paragraphs titled "Product Options" indicate that size, profiles, and dimensional requirements on Drawings are based on a specific product or system, provide either the specific product or system indicated or a comparable product or system by another manufacturer. Comply with provisions in "Product Substitutions" Article.
 8. Basis-of-Design Products: Where Specification paragraphs or subparagraphs titled "Basis-of-Design Product[s]" are included and also introduce or refer to a list of manufacturers' names, provide either the specified product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with provisions in "Comparable Products" Article to obtain approval for use of an unnamed product.
 - a. Substitutions may be considered, unless otherwise indicated.
 9. Visual Matching Specification: Where Specifications require matching an established Sample, select a product (and manufacturer) that complies with requirements and matches Engineer's sample. Engineer's decision will be final on whether a proposed product matches satisfactorily.
 - a. If no product available within specified category matches satisfactorily and complies with other specified requirements, comply with provisions of the Contract Documents on "substitutions" for selection of a matching product.
 10. Visual Selection Specification: Where Specifications include the phrase "as selected from manufacturer's colors, patterns, textures" or a similar phrase, select a product (and manufacturer) that complies with other specified requirements.
 - a. Standard Range: Where Specifications include the phrase "standard range of colors, patterns, textures" or similar phrase, Engineer will select color, pattern, or texture from manufacturer's product line that does not include premium items.
 - b. Full Range: Where Specifications include the phrase "full range of colors, patterns, textures" or similar phrase, Engineer will select color, pattern, or texture from manufacturer's product line that includes both standard and premium items.
 11. Allowances: Refer to individual Specification Sections and "Allowance" provisions in Division 1 for allowances that control product selection and for procedures required for processing such selections.

2.2 PRODUCT SUBSTITUTIONS

- A. Timing: Engineer will consider requests for substitution if received within 60 days after commencement of the Work. Requests received after that time may be considered or rejected at discretion of Engineer.
- B. Conditions: Engineer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Engineer will return requests without action, except to record noncompliance with these requirements:
 1. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Engineer for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
 2. Requested substitution does not require extensive revisions to the Contract Documents.
 3. Requested substitution is consistent with the Contract Documents and will produce indicated results.

4. Substitution request is fully documented and properly submitted.
5. Requested substitution will not adversely affect Contractor's Construction Schedule.
6. Requested substitution has received necessary approvals of authorities having jurisdiction.
7. Requested substitution is compatible with other portions of the Work.
8. Requested substitution has been coordinated with other portions of the Work.
9. Requested substitution provides specified warranty.
10. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

2.3 COMPARABLE PRODUCTS

- A. Where products or manufacturers are specified by name, submit the following, in addition to other required submittals, to obtain approval of an unnamed product:
 1. Evidence that the proposed product does not require extensive revisions to the Contract Documents, that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
 2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
 3. Evidence that proposed product provides specified warranty.
 4. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
 5. Samples, if requested.

PART 3 - EXECUTION (Not Used)

PART 4 - PAYMENT

4.1 GENERAL

- A. Payment for the work incurred do to the requirements of this section shall be considered incidental. Any reimbursement for work created by this section shall be absorbed within the other unit prices stated in the Proposal.

END OF SECTION 01600

SECTION 01700 - EXECUTION REQUIREMENTS**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes general procedural requirements governing execution of the Work including, but not limited to, the following:
 - 1. Construction layout.
 - 2. Field engineering and surveying.
 - 3. General installation of products.
 - 4. Coordination of Owner-installed products.
 - 5. Progress cleaning.
 - 6. Starting and adjusting.
 - 7. Protection of installed construction.
 - 8. Correction of the Work.
- B. Related Sections include the following:
 - 1. Division 1 Section "Project Management and Coordination" for procedures for coordinating field engineering with other construction activities.
 - 2. Division 1 Section "Submittal Procedures" for submitting surveys.
 - 3. Division 1 Section "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, and final cleaning.

1.3 QUALITY ASSURANCE

- A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.

PART 2 - PRODUCTS (Not Used)**PART 3 - EXECUTION****3.1 EXAMINATION**

- A. Existing Conditions: The existence and location of site improvements, utilities, and other construction indicated as existing are not guaranteed. Before beginning work, investigate and verify the existence and location of mechanical and electrical systems and other construction affecting the Work.

1. Before construction, verify the location and points of connection of utility services.
- B. Existing Utilities: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities and other construction affecting the Work.
 1. Before construction, verify the location and invert elevation at points of connection of water-service piping; and underground electrical services.
 2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
- C. Acceptance of Conditions: Examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
 1. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
 - a. Description of the Work.
 - b. List of detrimental conditions, including substrates.
 - c. List of unacceptable installation tolerances.
 - d. Recommended corrections.
 2. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
 3. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
 4. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
 5. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Existing Utility Information: Furnish information to Engineer that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction. Call 1 (800) 332-2344 before you dig.
- B. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 1. Notify Engineer not less than two days in advance of proposed utility interruptions.
 2. Do not proceed with utility interruptions without Engineer's written permission.
- C. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- D. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.

- E. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Engineer. Include a detailed description of problem encountered, together with recommendations for changing the Contract Documents. Submit requests on CSI Form 13.2 A "Request for Interpretation" .

3.3 CONSTRUCTION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Engineer promptly.
- B. General: Use qualified personnel to lay out the Work using accepted surveying practices.
 - 1. Protect benchmarks established by Engineer. Use these to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
 - 2. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
 - 3. Inform installers of lines and levels to which they must comply.
 - 4. Check the location, level and plumb, of every major element as the Work progresses.
 - 5. Notify Engineer when deviations from required lines and levels exceed allowable tolerances.
- C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and invert elevations. Initial layout of building outlines and pipeline centerlines will be done by Engineer.
- D. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.

3.4 FIELD ENGINEERING

- A. Identification: Owner will identify existing benchmarks, control points, and property corners.
- B. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.
 - 1. Do not change or relocate existing benchmarks or control points without prior written approval of Engineer. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Engineer before proceeding.
 - 2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.
- C. Benchmarks: Establish and maintain a minimum of two permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.
 - 1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
 - 2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
 - 3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.

- D. Property Corners: The Contractor shall be responsible to replace all destroyed or damaged property corners at no cost to the Owner.

3.5 INSTALLATION

- A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
 - 1. Make vertical work plumb and make horizontal work level.
 - 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 - 3. Conceal pipes, ducts, and wiring in finished areas, unless otherwise indicated.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- E. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.
- F. Anchors and Fasteners: Provide anchors and fasteners as required to anchor each component securely in place, accurately located and aligned with other portions of the Work.
 - 1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Engineer.
 - 2. Allow for building movement, including thermal expansion and contraction.
- G. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.
- H. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.6 OWNER-INSTALLED PRODUCTS

- A. Site Access: Provide access to Project site for Owner's construction forces.
- B. Coordination: Coordinate construction and operations of the Work with work performed by Owner's construction forces.
 - 1. Construction Schedule: Inform Owner of Contractor's preferred construction schedule for Owner's portion of the Work. Adjust construction schedule based on a mutually agreeable timetable. Notify Owner if changes to schedule are required due to differences in actual construction progress.
 - 2. Preinstallation Conferences: Include Owner's construction forces at preinstallation conferences covering portions of the Work that are to receive Owner's work. Attend preinstallation conferences conducted by Owner's construction forces if portions of the Work depend on Owner's construction.

3.7 PROGRESS CLEANING

- A. General: Clean Project site and work areas daily, including common areas. Coordinate progress cleaning for joint-use areas where more than one installer has worked. Enforce requirements strictly. Dispose of materials lawfully.
 - 1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
 - 2. Do not hold materials more than 7 days during normal weather or 3 days if the temperature is expected to rise above 80 deg F.
 - 3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
- B. Site: Maintain Project site free of waste materials and debris.
- C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
 - 1. Remove liquid spills promptly.
 - 2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
- E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
- F. Exposed Surfaces: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- G. Cutting and Patching: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.
 - 1. Thoroughly clean piping, conduit, and similar features before applying paint or other finishing materials. Restore damaged pipe covering to its original condition.
- H. Waste Disposal: Burying or burning waste materials on-site will not be permitted. Washing waste materials down sewers or into waterways will not be permitted.
- I. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- J. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- K. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.8 STARTING AND ADJUSTING

- A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- B. Adjust operating components for proper operation without binding. Adjust equipment for proper operation.
- C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Manufacturer's Field Service: If a factory-authorized service representative is required to inspect field-assembled components and equipment installation, comply with qualification requirements in Division 1 Section "Quality Requirements."

3.9 PROTECTION OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Comply with manufacturer's written instructions for temperature and relative humidity.

3.10 CORRECTION OF THE WORK

- A. Repair or remove and replace defective construction. Restore damaged substrates and finishes.
 - 1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.
- B. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.
- C. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.
- D. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

PART 4 - PAYMENT

4.1 GENERAL

- A. Payment for the work incurred do to the requirements of this section shall be considered incidental. Any reimbursement for work created by this section shall be absorbed within the other unit prices stated in the Proposal.

END OF SECTION 01700

SECTION 01781 - PROJECT RECORD DOCUMENTS**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for Project Record Documents, including the following:
 - 1. Record Drawings.
 - 2. Record Specifications.
 - 3. Record Product Data.
- B. Related Sections include the following:
 - 1. Division 1 Section "Closeout Procedures" for general closeout procedures and maintenance manual requirements.
 - 2. Divisions 2 through 16 Sections for specific requirements for Project Record Documents of products in those Sections.

1.3 SUBMITTALS

- A. Record Drawings: Comply with the following:
 - 1. Number of Copies: Submit one set of marked-up Record Prints.
- B. Record Specifications: Submit one copy of Project's Specifications, including addenda and contract modifications.
- C. Record Product Data: Submit one copy of each Product Data submittal.
 - 1. Where Record Product Data is required as part of operation and maintenance manuals, submit marked-up Product Data as an insert in the manual instead of submittal as Record Product Data.

PART 2 - PRODUCTS**2.1 RECORD DRAWINGS**

- A. Record Prints: Maintain one set of blue- or black-line white prints of the Contract Drawings and Shop Drawings.

1. Preparation: Mark Record Prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to prepare the marked-up Record Prints.
 - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Accurately record information in an understandable drawing technique.
 - c. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
2. Content: Types of items requiring marking include, but are not limited to, the following:
 - a. Dimensional changes to Drawings.
 - b. Revisions to details shown on Drawings.
 - c. Depths of foundations below first floor.
 - d. Locations and depths of underground utilities.
 - e. Revisions to routing of piping and conduits.
 - f. Revisions to electrical circuitry.
 - g. Actual equipment locations.
 - h. Conduit size and routing.
 - i. Locations of concealed internal utilities.
 - j. Changes made by Change Order or Construction Change Directive.
 - k. Changes made following Engineer's written orders.
 - l. Details not on the original Contract Drawings.
 - m. Field records for variable and concealed conditions.
 - n. Record information on the Work that is shown only schematically.
3. Mark the Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. If Shop Drawings are marked, show cross-reference on the Contract Drawings.
4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at the same location.
5. Mark important additional information that was either shown schematically or omitted from original Drawings.
6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

2.2 RECORD SPECIFICATIONS

- A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
 3. Record the name of the manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
 4. For each principal product, indicate whether Record Product Data has been submitted in operation and maintenance manuals instead of submitted as Record Product Data.
 5. Note related Change Orders, Record Drawings, and Product Data where applicable.

2.3 RECORD PRODUCT DATA

- A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
 - 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 - 2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
 - 3. Note related Change Orders, Record Drawings, and Product Data where applicable.

2.4 MISCELLANEOUS RECORD SUBMITTALS

- A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

- A. Recording: Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and modifications to Project Record Documents as they occur; **do not wait until the end of Project.**
- B. Maintenance of Record Documents and Samples: Store Record Documents and Samples in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to Project Record Documents for Engineer's reference during normal working hours.

PART 4 - PAYMENT

4.1 GENERAL

- A. Payment for the work incurred do to the requirements of this section shall be considered incidental. Any reimbursement for work created by this section shall be absorbed within the other unit prices stated in the Proposal.

END OF SECTION 01781



SUBMITTAL TRANSMITTAL

Project: _____ Date: _____
A/E Project Number: _____

TRANSMITTAL To (Contractor): _____ Date: _____ Submittal No. _____
A From (Subcontractor): _____ By: _____ ☐ Resubmission

Qty.	Reference / Number	Title / Description / Manufacturer	Spec. Section Title and Paragraph / Drawing Detail Reference

- ☐ Submitted for review and approval
☐ Resubmitted for review and approval
☐ Complies with contract requirements
☐ Will be available to meet construction schedule
☐ A/E review time included in construction schedule

- ☐ Substitution involved - Substitution request attached
☐ If substitution involved, submission includes point-by-point comparative data or preliminary details
☐ Items included in submission will be ordered immediately upon receipt of approval

Other remarks on above submission: _____

☐ One copy retained by sender

TRANSMITTAL To (A/E): _____ Attn: _____ Date Rec'd by Contractor: _____
B From (Contractor): _____ By: _____ Date Trnsmt'd by Contractor: _____

- ☐ Approved
☐ Approved as noted

- ☐ Revise / Resubmit
☐ Rejected / Resubmit

Other remarks on above submission: _____

☐ One copy retained by sender

TRANSMITTAL To (Contractor): _____ Attn: _____ Date Rec'd by A/E: _____
C From (A/E): _____ ☐ Other By: _____ Date Trnsmt'd by A/E: _____

- ☐ Approved
☐ Approved as noted
☐ Not subject to review
☐ No action required
☐ Revise / Resubmit
☐ Rejected / Resubmit
☐ Approved as noted / Resubmit

- ☐ Provide file copy with corrections identified
☐ Sepia copies only returned
☐ Point-by-point comparative data required to complete approval process
☐ Submission Incomplete / Resubmit

Other remarks on above submission: _____

☐ One copy retained by sender

TRANSMITTAL To (Subcontractor): _____ Attn: _____ Date Rec'd by Contractor: _____
D From (Contractor): _____ By: _____ Date Trnsmt'd by Contractor: _____

Copies: ☐ Owner ☐ Consultants ☐ _____ ☐ _____ ☐ _____ ☐ One copy retained by sender



Advancement
of Construction
Technology

SUBCONTRACTORS AND MAJOR MATERIAL SUPPLIERS LIST

Project: _____

To (A/E): _____

From (Contractor): _____
Date: _____
A/E Project Number: _____
Contract For: _____

List Subcontractors and Major Material Suppliers proposed for use on this Project as required by the Construction Documents. Attach supplemental sheets if necessary.

Section Number	Section Title	Firm	Address	Phone Number (Fax Number)	Contact
-------------------	------------------	------	---------	------------------------------	---------

☐ Attachments

Signed by: _____ Date: _____

Copies: ☐ Owner ☐ Consultants ☐ _____ ☐ _____ ☐ _____ ☐ _____ ☐ _____ ☐ _____ ☐ _____ ☐ File



SUBSTITUTION REQUEST (After the Bidding Phase)

Project: _____ Substitution Request Number: _____

From: _____
To: _____ Date: _____

A/E Project Number: _____
Re: _____ Contract For: _____

Specification Title: _____ Description: _____
Section: _____ Page: _____ Article/Paragraph: _____

Proposed Substitution: _____

Manufacturer: _____ Address: _____ Phone: _____

Trade Name: _____ Model No.: _____

Installer: _____ Address: _____ Phone: _____

History: ☐ New product ☐ 2-5 years old ☐ 5-10 yrs old ☐ More than 10 years old

Differences between proposed substitution and specified product: _____

☐ Point-by-point comparative data attached - REQUIRED BY A/E

Reason for not providing specified item: _____

Similar Installation:

Project: _____ Architect: _____

Address: _____ Owner: _____

_____ Date Installed: _____

Proposed substitution affects other parts of Work: ☐ No ☐ Yes; explain _____

Savings to Owner for accepting substitution: _____ (\$ _____).

Proposed substitution changes Contract Time: ☐ No ☐ Yes [Add] [Deduct] _____ days.

Supporting Data Attached: ☐ Drawings ☐ Product Data ☐ Samples ☐ Tests ☐ Reports ☐ _____

SUBSTITUTION REQUEST (Continued)

The Undersigned certifies:

- Proposed substitution has been fully investigated and determined to be equal or superior in all respects to specified product.
- Same warranty will be furnished for proposed substitution as for specified product.
- Same maintenance service and source of replacement parts, as applicable, is available.
- Proposed substitution will have no adverse effect on other trades and will not affect or delay progress schedule.
- Cost data as stated above is complete. Claims for additional costs related to accepted substitution which may subsequently become apparent are to be waived.
- Proposed substitution does not affect dimensions and functional clearances.
- Payment will be made for changes to building design, including A/E design, detailing, and construction costs caused by the substitution.
- Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

Submitted by: _____

Signed by: _____

Firm: _____

Address: _____

Telephone: _____

Attachments: _____

A/E's REVIEW AND ACTION

- ☐ Substitution approved - Make submittals in accordance with Specification Section 01330.
☐ Substitution approved as noted - Make submittals in accordance with Specification Section 01330.
☐ Substitution rejected - Use specified materials.
☐ Substitution Request received too late - Use specified materials.

Signed by: _____

Date: _____

Additional Comments: ☐ Contractor ☐ Subcontractor ☐ Supplier ☐ Manufacturer ☐ A/E ☐ _____



REQUEST FOR INTERPRETATION

Project:	_____	R.F.I. Number:	_____
	_____	From:	_____
To:	_____	Date:	_____
	_____	A/E Project Number:	_____
Re:	_____	Contract For:	_____

Specification Section:	Paragraph:	Drawing Reference:	Detail:
------------------------	------------	--------------------	---------

Request:

Signed by:	Date:
------------	-------

Response:

☐ Attachments

Response From:	To:	Date Rec'd:	Date Ret'd:
----------------	-----	-------------	-------------

Signed by:	Date:
------------	-------

Copies: ☐ Owner ☐ Consultants ☐ _____ ☐ _____ ☐ _____ ☐ _____ ☐ File



Project: _____

To (Contractor): _____

From (A/E): _____
Site Visit Date: _____
A/E Project Number: _____
Contract For: _____

The following items require the attention of the Contractor for completion or correction. This list may not be all-inclusive, and the failure to include any items on this list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract Documents.

Item Number	Room Number	Location (Area)	Description	Correction/Completion Date	Verification A/E Check
----------------	----------------	--------------------	-------------	-------------------------------	---------------------------

☐ Attachments

Signed by: _____ Date: _____

Copies: ☐ Owner ☐ Consultants ☐ _____ ☐ _____ ☐ _____ ☐ _____ ☐ _____ ☐ _____ ☐ _____ ☐ File

The Dalles Fruit Company

COPIES DISTRIBUTED TO: CONTRACTOR ENGINEER/ARCHITECT CITY OF BINGEN
 PROJ. INSPECTOR OTHER _____

CONSTRUCTION CHANGE DIRECTIVE

The Dalles Fruit Company

=====

PROJECT:	<u>Holding Pond</u>	DIRECTIVE NO.	_____
Location:	<u>111 Parallel Ave</u>	INITIATION DATE:	_____
City/State:	<u>Dallesport, WA 98617</u>	CONTRACT NO.	_____
		CONTRACT DATE:	_____

DIRECTED TO CONTRACTOR:

YOU ARE HEREBY DIRECTED TO MAKE THE FOLLOWING CHANGE(S) IN THIS CONTRACT:

PROPOSED ADJUSTMENTS

1. The proposed basis of adjustment to the Contract Sum of Guaranteed Maximum Price is:

- ☐ Lump Sum (increase) (decrease) of \$ _____
☐ Unit Price of \$ _____ per _____
☐ As provided in Subparagraph 7.3.6 of AIA Document A201, 1987 edition.
☐ As follows:

2. The Contract Time is proposed to (be adjusted) (remain unchanged). The proposed adjustment, if any is (an increase of _____ days) (a decrease of _____ days).

When signed by the Owner and Engineer and received by the Contractor, this document becomes effective IMMEDIATELY as a Construction Change Directive (CCD), and the Contractor shall proceed with the change(s) described above. Signature by the Contractor indicates the Contractor's agreement in Contract Sum and Contract Time set forth in this Construction Change Directive.

SIGNED AUTHORIZATION

ENGINEER	OWNER	CONTRACTOR
Bell Design Company	The Dalles Fruit Company	_____
P.O. Box 308		
1000 E. Steuben	111 Parallel Ave	
Bingen, WA 98605	Dallesport, WA 98617	
By: _____	By: _____	By: _____
Date: _____	Date: _____	Date: _____

=====

The Dalles Fruit Company

DIRECTED TO CONTRACTOR: _____

DESCRIPTION:

<u>Contractor</u>	<u>Bell Design Company</u>
-------------------	----------------------------

The Dalles Fruit Company

Bell Design Company

SECTION 02221 - TRENCH EXCAVATION AND BACKFILL**PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. This section covers the work necessary for the trench excavation and backfill, complete, except for pipe base and pipe zone backfill which are included under the specification for the pipe.

1.2 TYPE OF BACKFILL

- A. For bidding purposes, the class of backfill to be used above the pipe zone is indicated on the Drawings. The right is reserved to modify the use, location, and quantities of the various types of backfill during construction as the Engineer considers being to the best interest of the Owner. Payment will be made based on the class of backfill installed. During construction, the Engineer will designate the type of backfill to be used in each location throughout the project.
- B. Trench backfill above the pipe zone will be divided into the following classifications for the purpose of payment:
 - 1. Class A Backfill: In general, Class A backfill will be used in unsurfaced areas where subsequent trench settlement must be held to a minimum.
 - 2. Class C Backfill: Class C backfill will, generally, be limited to use in unsurfaced or unimproved areas.
 - 3. Class D Backfill:
 - a. Class D backfill will, generally, be limited to traveled roadways and crossings where final surfacing replacement will be made shortly after backfilling and subsequent trench settlement must be held to a minimum.
 - b. When directed by the Engineer, Class D backfill shall also be used under all culverts, water, gas, irrigation, and sewerlines, buried telephone, power and television cable, and any other miscellaneous buried pipelines or cables that cross the excavated trench. The Contractor will be paid for 10 feet of Class D backfill under each crossing so constructed.
 - 4. Depth: Unless specifically stated otherwise all depth measurements noted on the plans or within the specifications refer to finished compacted depth of material. Not loose dumped depth.
 - 5. Concrete Backfill: Concrete backfill will be used where, in the opinion of the Engineer, there is insufficient cover over the pipe for proper cover and protection.

1.3 EXCAVATION AND BACKFILL FOR FIRE HYDRANTS AND SIMILAR APPURTENANCES AND SERVICE CONNECTIONS

- A. Excavation and backfill for these items will be included for payment under the applicable section.

1.4 TRENCH EXCAVATION

- A. Excavation is unclassified. Complete all excavation regardless of the type of materials encountered. The Contractor shall make own estimate of the kind and extent of the various materials, which will be encountered in the excavation.

PART 2 - PRODUCTS

2.1 FOUNDATION STABILIZATION

- A. Foundation stabilization shall be 6-inch to 2-inch crushed rock with 100 percent by weight passing a 6-” screen and less than 10% passing the 2” screen, and free from excessive dirt or other organic material.

2.2 TRENCH BACKFILL

- A. Granular Backfill: Granular backfill shall be clean, bank- or pit-run gravel or crushed rock, having reasonably well gradation from coarse to fine. The maximum size shall be 3 inches. If required by the Engineer, the Contractor shall screen pit or bank run materials and maintain a separate approved stockpile for quality control. Under such conditions, the Contractor shall be required to utilize trench backfill materials from the approved stockpile only.
- B. Crushed Rock Backfill: Crushed rock backfill shall be as specified for ROCK FOR SURFACING AND BASE in Section SURFACE RESTORATION. Submit samples to the Engineer for approval, if requested. Provide 1-1/4-inch minus as shown or as approved.
- C. Concrete for Trench Backfill: Conform to ASTM C94, Alternate 3. Proportion to obtain a 28-day compressive strength of 2,500 pounds per square inch. Use a minimum of five sacks of cement per cubic yard of concrete.

2.3 CONTROLLED DENSITY FILL (CDF)

- A. CDF shall be low strength, highly flowable mixture of Portland cement, Pozzolan (fly ash), fine aggregates, water and admixtures, if necessary, which will results in a hardened, dense, non-settling, hand excavatable fill.
- B. Portland cement shall be type I-II or II.
- C. The Contractor shall furnish a mix design for approval. The mixture shall be designed to insure that the material placed has a 7-day compressive strength of between 50 psi and 150 psi. The compressive strength shall be tested using 4-inch mortar cubes per ASTM C 109.
- D. Within 24 hours the material shall be capable of supporting vehicular traffic without rutting.

2.4 IMPORTED TOPSOIL

- A. Imported topsoil shall be suitable sandy loam from an approved source, which possesses friability and a high degree of fertility. It shall be free of clods, roots, gravel, and other inert material. It shall be free of quack grass, horsetail, and other noxious vegetation and seed. Should such regenerative material be present in the soil, the Contractor shall remove, at his expense, all such growth, both surface and root, which may appear in the imported topsoil within 1 year following acceptance of the

2.5 COMPACTION EQUIPMENT

- A. Compaction equipment shall be of suitable type and adequate to obtain the amount of compaction specified. Compaction equipment shall be operated in strict accordance with the manufacturer's instructions and recommendations and shall be maintained in such condition that it will deliver the manufacturer's rated compactive effort.

- B. If in the event that the manufacturers recommendations are unavailable or incomplete to determine expected standard densities in specified lifts, the Engineer will required a field test of the equipment and soil densities to be tested by a qualified testing agency.

2.6 GUARD POSTS

- A. Guard posts, if required, shall be as shown on the Drawings.

2.7 NON WOVEN GEOFABRIC

- A. When foundation stabilization is required geofabric shall be provided above and below the foundation stabilization the full width of the trench. The geofabric shall conform to AASHTO M288 class 2 specifications.

PART 3 - EXECUTION

3.1 PREPARATION OF RIGHT-OF-WAY

- A. Where clearing or partial clearing of the right-of-way is necessary, complete prior to the start of trenching. Cut trees and brush as near to the surface of the ground as practicable, remove all stumps, and pile for disposal. Do not permit excavated materials to cover brush or trees prior to disposal or burning.
- B. Do not remove existing trees or tree limbs over 2 inches in diameter on public property unless they are within 4 feet of the pipe centerline, without permission from the Engineer. Protect from damage, unless otherwise marked by the Engineer, all trees, shrubs, or plants within the limits of the easement on private property. Those that interfere with trenching may be removed intact with their root system. Ball the root system of the trees, shrubs, or plants, bind in burlap, heel into the stockpiled topsoil from the trench excavation, and keep watered as required. Upon completion of the pipe laying and backfilling of the trench, replant the trees, shrubs, or plants in their original position. The Contractor shall record the location of any plant prior to its removal. Should any tree, shrub, or plant that has been disturbed as a result of its removal, or otherwise damaged by the Contractor, die within 6 months from the time that it was disturbed or damaged, it shall be replaced in kind and size by the Contractor at own expense.

3.2 DISPOSAL OF CLEARED MATERIAL

- A. The Contractor shall bear all costs of disposing of stumps, brush, roots, limbs, and other waste materials from the clearing operation. Material shall be disposed of in such a manner as to meet all requirements of state, county, and local regulations regarding health, safety, and public welfare. Nonflammable material, and flammable material, shall be disposed of off the construction site in an approved location at the Contractor's expense.
- B. In no case shall any material be left on the project, shoved onto abutting private properties, or be buried in embankments or trenches on the project.

3.3 OBSTRUCTIONS

- A. This item refers to obstructions which may be removed and do not require replacement. Remove obstructions within the trench area or adjacent thereto such as tree roots, stumps, abandoned piling, buildings and concrete structures, logs, and debris of all types without additional compensation. The

Engineer may, if requested, make changes in the trench alignment to avoid major obstructions, if such alignment changes can be made within the easement or right-of-way without adversely affecting the intended function of the facility. The Contractor shall pay all additional costs or credit the Owner for any savings resulting from such alignment changes.

- B. Dispose of obstructions removed from the excavation in accordance with Paragraph DISPOSAL OF CLEARED MATERIAL.
- C. Coordinate with power company for the removal and replacement of power pole guy anchors. Power company will furnish plate type anchors to be installed in trench by Contractor. Power company will install guy wires to anchors.

3.4 REMOVAL AND REPLACEMENT OF TOPSOIL

- A. Attention is directed to Division 1, GENERAL REQUIREMENTS for additional trench surfacing and/or seeding requirements. Where trenches cross lawns, garden areas, pasturelands, cultivated fields, or other areas on which reasonable topsoil conditions exist, remove the topsoil for a depth of 12 inches for the full width of the trench to be excavated. Stockpile this topsoil to one side of the right-of-way and do not mix with the remaining excavated material. Replace the topsoil in the top 12 inches of the backfilled trench. Minimum finished depth of topsoil over all trenches shall be 10 inches.
- B. In lieu of stockpiling and replacing the topsoil, imported topsoil from borrow pits may be substituted in the top 10 inches.
- C. Maintain the finished grade of the topsoil level with the area adjacent to the trench until final acceptance by the Engineer. Repair damage to adjacent topsoil caused by work operations. Remove all rock, gravel, clay, and any other foreign materials from the surface, regrade, and add topsoil as required.

3.5 RESEEDING AND FERTILIZING

- A. Originally seeded areas shall be fertilized and reseeded with first-quality seed or planted with new sod as approved by the property owner. All ground preparation, reseeded, and sodding shall be done in accordance with the best-accepted practices for lawn planting. The Contractor shall be responsible for obtaining a satisfactory grass turf acceptable to the property owner.
- B. All disturbed pastureland shall be hydroseeded with grass.

3.6 PAVEMENT REMOVAL

- A. Cut all bituminous and concrete pavements, regardless of the thickness, prior to excavation of the trenches with an approved pavement saw, hydrohammer, or approved pavement cutter. Width of the pavement cut shall be at least equal to the required width of the trench at ground surface. Pavement and concrete materials removed shall be hauled from the site and not used for trench backfill.

3.7 TRENCH WIDTH

- A. Minimum width of unsheeted trenches in which pipe is to be laid shall be 18 inches greater than the outside diameter of the pipe, or as approved. Double pipe trenches shall be 36 inches greater than the sum of the diameters of the two pipes to be placed in the trench, or as approved. Sheet piling requirements shall be independent of trench widths.

- B. The maximum width at the top of the trench will not be limited, except where excess width of excavation would cause damage to adjacent structures or property.
- C. Confine trench widths to dedicated rights-of-way or construction easements, unless special written agreements have been made with the affected property owner.

3.8 GRADE

- A. Excavate the trench to the lines and grades shown or as established by the Engineer with proper allowance for pipe thickness and for pipe base or special bedding when required. If the trench is excavated below the required grade, correct any part of the trench excavated below the grade at no additional cost to the Owner, with gravel of the type specified for pipe base in Section PIPE AND FITTINGS or GRAVITY SEWER PIPE whichever is applicable. Place the gravel over the full width of trench in compacted layers not exceeding 6 inches deep to the established grade with allowance for the pipe base.

3.9 SHORING, SHEETING, AND BRACING OF TRENCHES

- A. Sheet and brace the trench when necessary to prevent caving during excavation in unstable material, or to protect adjacent structures, property, workers, and the public. Increase trench widths accordingly by the thickness of the sheeting. Maintain sheeting in place until the pipe has been placed and backfilled at the pipe zone. Shoring and sheeting shall be removed, as the backfilling is done, in a manner that will not damage the pipe or permit voids in the backfill. All sheeting, shoring, and bracing of trenches shall conform to the safety requirements of the federal, state, or local public agency having jurisdiction. The most stringent of these requirements shall apply.

3.10 LOCATION OF EXCAVATED MATERIALS

- A. During trench excavation, place the excavated material only within the construction easement, right-of-way, or approved working area. Do not obstruct any private- or public-traveled roadways or streets. Conform to all federal, state, and local codes governing the safe loading of all trenches with excavated material.

3.11 REMOVAL OF WATER

- A. At all times provide and maintain ample means and devices to promptly remove and dispose of all water entering the trench excavation during the time the trench is being prepared for the pipe laying, during the laying of the pipe, and until the backfill at the pipe zone has been completed. These provisions shall apply during the noon hour as well as overnight.
- B. Dispose of the water in a manner to prevent damage to adjacent property. Drainage of trench water through the pipeline under construction is prohibited.
- C. Provide all materials, equipment, and labor as necessary to dewater trenches. Excavate sumps or install well heads upstream of trenching to dewater area ahead of trench construction. Provide all pumps, power, and piping necessary to dewater and dispose of water in a manner that will not damage property or the environment.

3.12 FOUNDATION STABILIZATION

- A. When, in the opinion of the Engineer, the existing material in the bottom of the trench is unsuitable for supporting the pipe, excavate below the flow line of the pipe, as directed by the Engineer. Place geofabric in the bottom of the trench and backfill the trench to subgrade of pipe base with foundation stabilization material specified hereinbefore. Place the foundation stabilization material over the full width of the trench and compact in layers not exceeding 6 inches deep to the required grade. Place geofabric over the top of the foundation stabilization before installing the pipe bedding.

3.13 PIPE BASE AND PIPE ZONE BACKFILL

- A. Pipe base and pipe zone backfill are included in specification for pipe.

3.14 TRENCH BACKFILL ABOVE PIPE ZONE

- A. When backfill is placed mechanically, push the backfill material onto the slope of the backfill previously placed and allow to slide down into the trench. Do not push backfill into the trench in such a way as to permit free fall of the material until at least 2 feet of cover is provided over the top of the pipe. Under no circumstances allow sharp, heavy pieces of material to drop directly onto the pipe or the tamped material around the pipe. Do not use backfill material of consolidated masses larger than 1/2 cubic foot.
1. Class A Backfill:
 - a. Backfill the trench above the pipe zone with excavated trench materials. Compact the backfill in suitable lifts with mechanical vibratory or impact tampers. Determine the type of compaction equipment, method to use, and amount of compaction required to prevent subsequent settlement.
 - b. Remove all boulders and stones 2 inches in diameter and larger from material used for backfill in the upper 12 inches of Class A backfilled trenches.
 - c. Where Class A backfill is specified in areas where topsoil conditions exist, place imported topsoil in the top 12 inches of the trench. Compact and rake to match the ground surface adjacent to the trench.
 - d. Maintain the surface of the backfilled trench level with the existing grade until the entire project is accepted by the Owner. Any subsequent settlement of the finished surface during the warranty period shall be considered to be a result of improper or insufficient compaction and shall be promptly repaired by the Contractor at no cost to the Owner.
 2. Class C Backfill:
 - a. Backfill the trench above the pipe zone with excavated trench materials.
 - b. In untraveled areas on private or public street or road rights-of-way, leave the trench with the backfill material neatly mounded not more than 6 inches above the existing ground for the entire width of the trench. In lawn or garden areas, backfill the trench and maintain it level with the existing adjacent grade. In all other locations, estimate and provide the amount of backfill material required so that after normal settlement, the finished surface will meet the existing grade. Neatly windrow the material over the trench, and remove all excess. Any excess or deficiency of backfill material which becomes apparent after settlement and within the warranty period shall be corrected by regrading, disposal of excess material, and adding additional material where required. Remove rocks larger than 2 inches from the upper 12 inches of the backfill.
 3. Class D Backfill:
 - a. Backfill the trench above the pipe zone with approved granular backfill material in lifts not exceeding 8-inch loose depth. Compact each lift with mechanical vibrating or impact tampers. Determine the type of equipment and method to use and amount of compaction required to prevent subsequent settlement.
 - b. Where Class D backfill is in graveled areas or road shoulders, backfill the trench to a compacted depth of 9 inches below the original ground surface and place a minimum of 9 inches of 1-1/4-Inch approved crushed rock backfill over the entire trench surface.

- c. Where Class D backfill is in pavement, maintain the surface of the backfilled trench level with the existing grade with 3/4-inch minus crushed rock backfill material until pavement replacement is completed or the entire project is accepted by the Owner.
 - d. Any subsequent settlement of the finished surfacing during the warranty period shall be considered to be a result of improper or insufficient compaction and shall be promptly repaired by the Contractor at no cost to the Owner.
- 4. Concrete Backfill: Place concrete backfill in such a manner that no dirt or foreign material becomes mixed with the concrete. Minimum thickness of concrete protection shall be 6 inches on the top and sides of the pipe. Concrete shall have sufficient time to reach initial set before any additional backfill material is placed in the trench. Place pipe base in all trenches requiring concrete backfill.
- 5. Control Density Backfill (CDF): Place CDF backfill in such a manner that no dirt or foreign material becomes mixed with the concrete. Minimum thickness of CDF protection shall be 12-inches on the top of pipe to bottom of surface restoration, 6-inches below bottom of pipe, and 9-inches on sides of the pipe. CDF shall have sufficient time to reach initial set before any additional backfill material is placed in the trench. Protect special fittings; drain holes or other items from CDF as directed by Engineer. Use 6-mil poly vapor barrier as protection when directed by the Engineer. Use concrete or masonry blocks to support pipe from any movement during CDF placement.

3.15 MAINTENANCE OF TRENCH BACKFILL

- A. Maintain the backfilled trench surface between any valved sections of pipeline until the following operations have been completed and approved by the Engineer:
 - 1. Service connections installed and backfilled.
 - 2. Valves, valve boxes, and hydrants installed.
 - 3. Testing and disinfection.
 - 4. Cleanup and restoration of all physical features.
 - 5. Utilities restored to their original condition or better.
 - 6. And, in general, all work required between the line valves accomplished with the exception of repaving.
- B. This maintenance shall include, but not be limited to, the addition of crushed rock backfill material to keep the surface of backfilled trenches reasonably smooth, free from ruts and potholes, and suitable for normal traffic flow.
- C. No additional payment will be made for the maintenance of the trench backfill prior to completion of the work outlined above.
- D. No pavement replacement shall be undertaken until all items outlined above been completed and approved by the Engineer.
- E. Maintenance of Class D backfilled trenches is considered as incidental to this item of work and payment for such maintenance will be considered as included in payment for Class D backfill.

3.16 DISPOSAL OF EXCESS EXCAVATED MATERIAL

- A. Dispose of all excess excavated materials. Make arrangements for the disposal and bear all costs or retain any profit incidental to such disposal.

3.17 STORM SEWERS AND DRAINAGE CULVERTS

- A. Every attempt has been made to identify and show on the drawings all utility conflicts. However, no guarantee can be made that all buried utilities have been identified. It is the contractor's sole responsibility to identify all utility conflicts before excavation begins. Replace in kind storm sewers and drainage culverts which are removed. If the pipe is damaged during removal, dispose of it and furnish and install new pipe at no additional cost to the City.

3.18 SANITARY SEWERS AND SEPTIC DRAIN LINES

- A. Every attempt has been made to identify and show on the drawings all utility conflicts. However, no guarantee can be made that all buried utilities have been identified. It is the contractor's sole responsibility to identify all utility conflicts before excavation begins. All sewer crossings shall conform to Washington State Department of Ecology's Criteria for Sewage Works Design August 2008, Section C1. Replace sanitary sewers and septic drain lines which are removed or are in conflict with Section C1. If the pipe is damaged during removal, dispose of it and furnish and install new pipe at no additional cost to the City.

3.19 SETTLEMENT

- A. Any settlement noted in backfill, fill, or in structures built over the backfill or fill within the 1-year warranty period in accordance with the General Conditions will be considered to be caused by improper compaction methods and shall be corrected at no cost to the Owner. Structures damaged by settlement shall be restored to their original condition by the Contractor at no cost to the Owner.

PART 4 - PAYMENT

4.1 GENERAL

- A. Payment for work specified in this section will be made at the unit prices stated in the Proposal and shall be included under the following items. Computation of quantities will be as indicated for each item and will be based upon measurements made by the Engineer.
- B. Payment for trench excavation and backfill for service connection pipe will be included under that section.

4.2 TRENCH EXCAVATION AND BACKFILL (SINGLE & DOUBLE PIPE TRENCH)

- A. Payment for trench excavation and backfill will be made at the respective unit prices per linear foot stated in the Proposal for the trench excavation, and the class of backfill used. Payment for all surface restoration, including tree, shrub, and plant removal and replacement, reseeding, power pole anchor plate installation and all other incidental work shall also be included in this item.
- B. The length of trench for which payment will be made shall be the field measured distance along the centerline of the pipe, valves, and fittings, in place.
- C. Payment for trench excavation and the respective backfill shall constitute full compensation for all work specified under this item.
- D. The price bid per linear foot shall include all extra excavation required to provide space for pipe base where specified or ordered by the Engineer. The bid price shall also include any incidental excavation and backfill necessary to widen the trench for installation of branch-line fittings. Pipe base and pipe zone

backfill will be paid for under Section PIPE AND FITTINGS or GRAVITY SEWER PIPE whichever is applicable.

4.3 FOUNDATION STABILIZATION

- A. This item is a plan quantity therefore no measurement will be made, but payment will be based on the unit price stated on the unit price bid sheet multiplied by the bid sheet quantity regardless of the amount used in the field. Payment for this item shall constitute full compensation for all materials, labor, equipment, and incidentals necessary to furnish materials at trench side and for placing and compacting it in the trench and for the extra depth of trench excavation required below the pipe base grade to provide for a stable base for the pipe as shown in the plans.
- B. Payment for this item shall include providing and installing geotextile fabric above and below the foundation stabilization rock.

4.4 CONCRETE BACKFILL

- A. Payment for this item will be based on the unit price per linear foot as stated in the Proposal. Payment will be in addition to the linear foot payment for trench excavation and backfill. Pipe base will be paid for under Section PIPE AND FITTINGS or GRAVITY SEWER PIPE whichever is applicable.

4.5 CONTROLLED DENSITY FILL (CDF)

- A. This item is a plan quantity therefore no measurement will be made, but payment will be based on the unit price stated on the unit price bid sheet multiplied by the bid sheet quantity regardless of the amount used in the field. Payment for this item shall constitute full compensation for all materials, labor, equipment, and incidentals necessary to furnish materials at trench side and for placing CDF a minimum of 6-inches below the pipe and up to the spring line of the pipe the full width of the trench.
- B. Payment for trench excavation and the respective CDF shall constitute full compensation for all work specified under this item.

4.6 UTILITY TRENCHES

- A. Utility trench excavation and backfill shall be considered incidental and shall be absorbed in other bid items. All costs associated with drains, underground power lines, wires, phone/telemetry, and process water piping or chemical feed line trenches shall include excavation, the class of backfill used, tree, shrub, and plant removal and replacement, reseeding, power pole anchor plate installation, and all other incidental work.

4.7 TRENCH DEWATERING

- A. Trench dewatering shall be paid as a lump sum item and shall cover all materials, labor, excavation, equipment, and work necessary to dewater the trench. Payment shall also cover the operation of pumps and installation and maintenance of discharge piping during construction.

END OF SECTION 02221

SECTION 02222 – ROCK EXCAVATION

PART 1 - GENERAL

1.0 ROCK EXCAVATION

- A. Rock excavation is defined as the removal of all material which by actual demonstration, cannot, in the Engineer's judgement, be reasonably excavated with equipment comparable to types listed in TABLE 1 and equipped with rippers or similar approved equipment and which is, in fact, systematically drilled and blasted or broken by power-operated tools designed for rock excavation. Engineer may waive the demonstration if material encountered is well-defined rock. The term Rock Excavation shall be understood to indicate a method of removal and not a geological formation.

TABLE 1

Manufacturer	Model	Minimum Net Horse Power	Type of Excavation
Caterpillar	225	125	Trench
John Deere	690	125	Trench
Case	125B/980B	125	Trench

PART 2 - PRODUCTS

This part not used.

PART 3 - EXECUTION

3.0 ROCK EXCAVATION

- A. Engineer will make determination of "Rock Excavation".
- B. Solid Rock is defined as follows:
1. Solid rock shall comprise and included all rock material which is in ledges, bedded deposits and unstratified masses and which cannot be removed without drilling and blasting, and conglomerate deposits which are so firmly cemented as to present all the characteristics of solid rock and which cannot be removed without drilling and blasting.
 2. When solid rock layers have an overburden of material of common classification which cannot practically be stripped and handled separately from the solid rock and/or are interspersed with a material of common classification, the entire mass will be classified as solid rock if the solid rock constitutes not less than 85 percent of the entire mass.
 3. Broken and fractured rock will not be classified as rock nor will so-called "hard pan" or cemented gravel, even though it may be advantageous to use explosives in its removal.
 4. Boulders measuring larger than 1 cubic yard in volume will be classified as rock if drilling and blasting or other approved methods are actually used for their removal from the trench. If material which would be classified as rock by the above definition is mechanically removed without

blasting, breaking, or splitting, it will not be considered as rock excavation. If equipment larger than that previously identified is specifically brought in for the sole purpose of rock removal, as defined above, then such removal will be considered rock excavation and will be paid for as such at the unit price bid.

- C. Before rock removal by systematic drilling and blasting or other methods will be permitted, notify Engineer who, with Contractor or its representative, will determine the amount of material to be removed as rock excavation and will record the information. Then drill, blast, or break with power-operated tools specially designed for rock excavation, and excavate the material.
- D. Use of explosives shall be avoided as far as practicable, and in no case shall tunnel blasting methods be used. Such blasting as must be done shall be controlled in a manner which will avoid possible shattering of loosening of materials back of lines to which the excavations are to be made. The Contractor shall be responsible for any and all damages to property or injury to persons resulting from blasting, or accidental or premature explosions that may occur in connection with the use of explosives. Give adequate warning to all affected persons and adjacent property owners prior to blasting.
- E. When blasting rock in trenches, cover area to be shot with blasting mats or other approved type of protective material that will prevent scattering of rock fragments outside of the excavation.
- F. The blasting must be performed by workers certified to do such work according to any local, state or federal regulations, The Contractor must provide the Engineer documentation of the workers certification for blasting 48 hours prior to any blasting.
- G. Rock excavation shall included removal of the rock. Where blasting is resorted to, it shall be carried on in accordance with local, county, state and federal requirements governing this class of work. All necessary precautions shall be taken for protection of the work, persons, or property.
- H. Rock excavated, if any, shall become the property of the Contractor and must be removed from the site and disposed of by the Contractor.
- I. Overexcavation resulting from rock excavation or blasting shall be restored at the Contractor's expense.

3.1 BLASTING REQUIREMENTS

- A. The use of explosives will be allowed provided that the Contractor meets the following requirements.
 - 1. A permit from the White Salmon Fire Department is obtained for blasting operations.
 - 2. In accordance with UFC 7701.4 the minimum bond or public liability insurance policy for all blasting operations shall be \$1,000,000.
 - 3. Two sets of plans and specifications must be provided to the Fire Department showing the blasting operation complies with the Uniform Fire Code (1997 Edition), the NFPA 495- Explosive Materials Code (1996 Edition), and the WAC 296-52 Safety Standards for the Possession and Handling of Explosives (9-15-98)
 - 4. The documentation shall include but not be limited to:
 - a. Current Washington State Blasters License.
 - b. Blasting Plan that shows compliance with Chapter 8 of the NFPA 495 for ground vibration, air blast, and flyrock.
 - c. Bond or insurance policy with a minimum amount of \$1,000,000.
- B. Depending on the size and scope of the blasting operation, "technical assistance" as specified in UFC 103.1.1 may be required
 - 1. Prior to a permit being issued, an inspection of the "blast area" (as defined in WAC 296-52-417) by a Fire Department Official and the Fire Department's technical assistant, if technical

assistance was required for the project, shall be performed to determine compliance with the approved plans and specifications.

2. If there are conflicts in requirements between the UFC, the NFPA, or the WAC, the most restrictive requirement shall apply.

PART 4 PAYMENT

4.1 GENERAL

- A. Payment for work specified in this section will be made at the unit prices stated in the Proposal and shall be included under the following items. Computation of quantities will be as indicated for each item and will be based upon measurements made by the Engineer.

4.2 ROCK EXCAVATION

- A. Payment for rock excavation will be made at the respective unit prices per cubic foot stated in the Proposal for the rock excavation, and all other incidental work.
- B. Payment for rock excavation shall constitute full compensation for all work specified under this item.
- E. The price bid per cubic foot shall include all extra rock excavation required to provide space for pipe base or structures where specified or ordered by the Engineer. The bid price shall also include any incidental rock excavation necessary to widen the trench for installation of branch-line fittings.
- F. Rock Measurement: Volume of rock actually removed, measured in original position, but not to exceed the following:
 1. 12 inches (300 mm) outside of concrete forms at footings.
 2. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
 3. 6 inches (150 mm) beneath bottom of concrete slabs on grade.
 4. 6 inches (150 mm) beneath pipe in trenches, and the greater of 24 inches (600 mm) wider than pipe or 42 inches (1065 mm) wide.
- G. Unit prices for rock excavation include replacement with approved materials.

END OF SECTION 02222

SECTION 02300 - EARTHWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:

1. Preparing subgrades for slabs-on-grade, walks, pavements, lawns, and plantings.
2. Excavating and backfilling for buildings and structures.
3. Bedding Course for Foundations course for slabs-on-grade, and structures.
4. Base course for concrete walks, driveways, and pavements.
5. Surface course for driveways, asphalt paving.
6. Drainage Course for foundations drains.
7. Structural Backfill for walls and platforms.
8. Excavating and backfilling trenches within building lines.
9. Excavating and backfilling trenches for buried mechanical and electrical utilities and pits for buried utility structures.

- B. Related Sections include the following:

1. Division 1 Section "Unit Prices" for a schedule of unit prices.
2. Division 2 Section "Site Clearing" for site stripping, grubbing, removing topsoil, and protecting trees to remain.
3. Division 2 Section "Trench Excavation and Backfill"
4. Division 2 Section "Surface Restoration"
5. Division 2 Section "Rock Excavation"
6. Division 2 Section "Tree Protection, Removal and Trimming" for protecting and trimming trees to remain. Also for removal of merchantable timber.
7. Division 2 Section "Subdrainage" for drainage of footings, slabs-on-grade, and walls.
8. Division 2 Section "Landscaping" for finish grading, including placing and preparing topsoil for lawns and plantings.
9. Division 3 Section "Cast-in-Place Concrete" for granular course over vapor retarder.
10. Division 15 and 16 Sections for excavating and backfilling buried mechanical and electrical utilities and buried utility structures.

1.3 DEFINITIONS

- A. Backfill: Soil materials used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

- B. Surface Course: Layer placed between the subbase and asphalt paving.

- C. Bedding Course for foundations: Layer of rock placed over the excavated subgrade below a structure.
- D. Borrow: Satisfactory soil imported from off-site for use as fill or backfill.
- E. Drainage Course: Drainage fill used around foundations drain system.
- F. Excavation: Removal of material encountered above subgrade elevations.
 - 1. Additional Excavation: Excavation below subgrade elevations as directed by Engineer. Additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
 - 2. Bulk Excavation: Excavations more than 10 feet (3 m) in width and pits more than 30 feet (9 m) in either length or width.
 - 3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated dimensions without direction by Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be without additional compensation.
- G. Fill: Soil materials used to raise existing grades.
- H. Structural Backfill: Engineered or Engineer approved structural backfill material used around and behind structural walls and masses. Use Class D trench backfill material unless specified otherwise.
- I. Rip Rap: 18-inch to 6-inch angular open graded basalt or granite rock used for energy dissipation or erosion control.
- J. Rock: Rock material in beds, ledges, unstratified masses, and conglomerate deposits and boulders of rock material exceeding 1 cu. yd. (0.76 cu. m) for bulk excavation or 3/4 cu. yd. (0.57 cu. m) for footing, trench, and pit excavation that cannot be removed by rock excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:
 - 1. Excavation of Footings, Trenches, and Pits: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch- (1065-mm-) wide, short-tip-radius rock bucket; rated at not less than 120-hp (89-kW) flywheel power with bucket-curling force of not less than 25,000 lbf (111 kN) and stick-crowd force of not less than 18,700 lbf (83 kN); measured according to SAE J-1179.
 - 2. Bulk Excavation: Late-model, track-mounted loader; rated at not less than 210-hp (157-kW) flywheel power and developing a minimum of 45,000-lbf (200-kN) breakout force; measured according to SAE J-732.
- K. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- L. Base Course: Layer placed between the subgrade and surface course for asphalt paving, or layer placed between the subgrade and a concrete pavement or walk.
- M. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.
- N. Utilities include on-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings or adjacent to buildings.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Each type of plastic warning tape.
 - 2. Drainage fabric.
 - 3. Separation fabric.
- B. Samples: For the following:
 - 1. 30-lb (14-kg) samples, sealed in airtight containers, of each proposed soil material from on-site or borrow sources.
 - 2. 12-by-12-inch (300-by-300-mm) sample of drainage fabric.
 - 3. 12-by-12-inch (300-by-300-mm) sample of separation fabric.
- C. Material Test Reports: When specifically requested by the Engineer supply written test reports from a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:
 - 1. Classification according to ASTM D 2487 of each on-site or borrow soil material proposed for fill and backfill.
 - 2. Laboratory compaction curve according to ASTM D 1557 for each on-site or borrow soil material proposed for fill and backfill.
- D. Blasting plan approved by authorities having jurisdiction, for record purposes. See "Rock Excavation for blasting requirements.

1.5 QUALITY ASSURANCE

- A. Comply with applicable requirements of NFPA 495, "Explosive Materials Code."
- B. Pre-excavation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Meetings."
- C. The contractor shall be required to hire the services of a qualified inspection agency to provide any required earthwork inspections. An inspections program and schedule shall be developed by the inspection agency and the contractor and provided to the Engineer prior to any phase of earthwork progress. See Division 1, Section "Quality Requirements" for additional requirements.

1.6 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Engineer and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Engineer not less than two days in advance of proposed utility interruptions.
 - 2. Contact utility-locator service for area where Project is located before excavating. Call 1 (800) 332-2344.
- B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.
- C. In the event that foundation stabilization is required beneath the generator pad, the specification found in Section 02221 "Trench Excavation and Backfill", page 2, sub-section "Foundation Stabilization" will be

used. The foundation stabilization will be paid for under the above referenced section. The Engineer will determine whether the foundation stabilization is required and will also determine the payment quantity.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Satisfactory Soils: ASTM D 2487 soil classification groups GW, GP, GM, SW, SP, and SM, or a combination of these group symbols; free of rock or gravel larger than 3 inches (75 mm) in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
- C. Unsatisfactory Soils: ASTM D 2487 soil classification groups GC, SC, ML, MH, CL, CH, OL, OH, and PT, or a combination of these group symbols.
 - 1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
- D. Backfill and Fill: Satisfactory soil materials.
- E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch (38-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.
- F. Surface Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 3/4-inch (19-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve or see Surface Restoration Leveling Course 3/4-minus specification.
- G. Structural Backfill/Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch (38-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.
- H. Bedding: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch (25-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.
- I. Bedding for Foundations: See "Bedding" for specifications.
- J. Drainage Fill: Washed, narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch (38-mm) sieve and 0 to 5 percent passing a No. 8 (2.36-mm) sieve.
- K. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch (25-mm) sieve and 0 to 5 percent passing a No. 4 (4.75-mm) sieve.
- L. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.
- M. Rip Rap: Washed 18-inch to 6-inch angular open graded basalt or granite rock.

2.2 ACCESSORIES

- A. Detectable Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, minimum 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored as follows:
 - 1. Red: Electric.
 - 2. Yellow: Gas, oil, steam, and dangerous materials.
 - 3. Orange: Telephone and other communications.
 - 4. Blue: Water systems.
 - 5. Green: Sewer systems.
- B. Drainage Fabric: Nonwoven geotextile, specifically manufactured as a drainage geotextile; made from polyolefins, polyesters, or polyamides; and with the following minimum properties determined according to ASTM D 4759 and referenced standard test methods:
 - 1. Grab Tensile Strength: 110 lbf (490 N); ASTM D 4632.
 - 2. Tear Strength: 40 lbf (178 N); ASTM D 4533.
 - 3. Puncture Resistance: 50 lbf (222 N); ASTM D 4833.
 - 4. Water Flow Rate: 150 gpm per sq. ft. (100 L/s per sq. m); ASTM D 4491.
 - 5. Apparent Opening Size: No. 50 (0.3 mm); ASTM D 4751.
- C. Separation Fabric: Woven geotextile, specifically manufactured for use as a separation geotextile; made from polyolefins, polyesters, or polyamides; and with the following minimum properties determined according to ASTM D 4759 and referenced standard test methods:
 - 1. Grab Tensile Strength: 200 lbf (890 N); ASTM D 4632.
 - 2. Tear Strength: 75 lbf (333 N); ASTM D 4533.
 - 3. Puncture Resistance: 90 lbf (400 N); ASTM D 4833.
 - 4. Water Flow Rate: 4 gpm per sq. ft. (2.7 L/s per sq. m); ASTM D 4491.
 - 5. Apparent Opening Size: No. 30 (0.6 mm); ASTM D 4751.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
- B. Protect subgrades and foundation soils against freezing temperatures or frost. Provide protective insulating materials as necessary.
- C. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.2 DEWATERING

- A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

- B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
2. Install a dewatering system to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.

3.3 EXPLOSIVES

- A. Explosives: Obtain written permission from authorities having jurisdiction before bringing explosives to Project site or using explosives on Project site. See Rock Excavation for blasting requirements

1. Do not damage adjacent structures, property, or site improvements or weaken the bearing capacity of rock subgrade when using explosives.

3.4 EXCAVATION, GENERAL

- A. Unclassified Excavation: Excavation to subgrade elevations regardless of the character of surface and subsurface conditions encountered, including rock, soil materials, and obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

- B. Classified Excavation: Excavation to subgrade elevations classified as earth and rock. Rock excavation will be paid for by adjusting the Contract Sum according to unit prices included in the Contract Documents.

1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation.

- a. Intermittent drilling; blasting, if permitted; ram hammering; or ripping of material not classified as rock excavation is earth excavation.

2. Rock excavation includes removal and disposal of rock.

- a. Do not excavate rock until it has been classified and cross-sectioned by Engineer.

3.5 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch (25 mm). Extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
2. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch (25 mm). Do not disturb bottom of excavations intended for bearing surface.

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Excavate surfaces under walks and pavements to indicated cross sections, elevations, and grades.

3.7 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated gradients, lines, depths, and elevations.
 - 1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.
- B. Excavate trenches to uniform widths to provide a working clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches (300 mm) higher than top of pipe or conduit, unless otherwise indicated.
 - 1. Clearance: 12 inches (300 mm) on each side of pipe or conduit or,
 - 2. Clearance: As indicated.
- C. Trench Bottoms: Excavate trenches at least 4 inches (100 mm) deeper than bottom of pipe elevation to allow for bedding course. Hand excavate for bell of pipe.
 - 1. Excavate trenches at least 6 inches (150 mm) deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

3.8 APPROVAL OF SUBGRADE

- A. Notify Engineer when excavations have reached required subgrade.
- B. If Engineer determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
 - 1. Additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
- C. Proof roll subgrade with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof roll wet or saturated subgrades.
- D. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Engineer.

3.9 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill may be used when approved by Engineer.
 - 1. Fill unauthorized excavations under other construction or utility pipe as directed by Engineer.

3.10 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow materials and satisfactory excavated soil materials. Stockpile soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.11 BACKFILL

- A. Place and compact backfill in excavations promptly, but not before completing the following:
 1. Construction below finish grade including, where applicable, dampproofing, waterproofing, and perimeter insulation.
 2. Surveying locations of underground utilities for record documents.
 3. Inspecting and testing underground utilities.
 4. Removing concrete formwork.
 5. Removing trash and debris.
 6. Removing temporary shoring and bracing, and sheeting.
 7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

3.12 UTILITY TRENCH BACKFILL

- A. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- B. Backfill trenches excavated under footings and within 18 inches (450 mm) of bottom of footings; fill with concrete to elevation of bottom of footings.
- C. Provide 4-inch- (100-mm-) thick, concrete-base slab support for piping or conduit less than 30 inches (750 mm) below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches (100 mm) of concrete before backfilling or placing roadway subbase.
- D. Place and compact initial backfill of subbase material, free of particles larger than 1 inch (25 mm), to a height of 12 inches (300 mm) over the utility pipe or conduit.
 1. Carefully compact material under pipe haunches and bring backfill evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of utility system.
- E. Coordinate backfilling with utilities testing.
- F. Fill voids with approved backfill materials while shoring and bracing, and as sheeting is removed.
- G. Place and compact final backfill of satisfactory soil material to final subgrade.
- H. Install warning tape directly above utilities, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

3.13 FILL

- A. Preparation: Remove vegetation, topsoil, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface before placing fills.
- B. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

C. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use satisfactory soil material.
2. Under walks and pavements, use satisfactory soil material.
3. Under steps and ramps, use engineered fill.
4. Under building slabs, use engineered fill.
5. Under footings and foundations, use Bedding Course for foundations.

3.14 MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air-dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.15 COMPACTION OF BACKFILLS AND FILLS

A. Place backfill and fill materials in layers not more than 8 inches (200 mm) in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.

B. Compact soil to not less than the following percentages of maximum dry unit weight according to ASTM D 1557:

1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches (300 mm) of existing subgrade and each layer of backfill or fill material at 95 percent.
2. Under walkways, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill material at 92 percent.
3. Under lawn or unpaved areas, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill material at 85 percent.

3.16 GRADING

A. General: Uniformly grade areas to a smooth surface, free from irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Lawn or Unpaved Areas: Plus or minus 1 inch (25 mm).
2. Walks: Plus or minus 1 inch (25 mm).
3. Pavements: Plus or minus 1/2 inch (13 mm).

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch (13 mm) when tested with a 10-foot (3-m) straightedge.

3.17 FOUNDATIONS DRAINAGE WITH DRAINAGE COURSE

- A. Drainage Piping: Drainage pipe is specified in Division 2 Section "SUBDRAINAGE."
- B. Foundation Drain: Place a layer of drainage fabric around perimeter foundation drains and other foundation drains . Place a 6-inch (150-mm) course of filter material on drainage fabric to support drainage pipe. Encase drainage pipe in a minimum of 12 inches (300 mm) of filter material and wrap in drainage fabric, overlapping sides and ends at least 6 inches (150 mm).
 - 1. Compact each course of filter material to 95 percent of maximum dry unit weight according to ASTM D 1557.
- C. Drainage Course: Place and compact Drainage Course material over subsurface foundation drain, in width indicated, to within 12 inches (300 mm) of final subgrade. Use 2 cubic foot per linear of drainage course along all foundation drains. Overlay drainage backfill with one layer of drainage fabric, overlapping sides and ends at least 6 inches (150 mm).
 - 1. Compact each course of Drainage Course to using machine compaction acceptable to the Engineer.

3.18 BASE AND SURFACE COURSES

- A. Where necessary due to wet or moist subgrade conditions, install separation fabric on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
- B. Under pavements and walks, when moist conditions exist, place base course on separation fabric according to fabric manufacturer's written instructions.

3.19 BEDDING COURSE FOR FOUNDATIONS

- A. Under slabs-on-grade and structural footings, install drainage fabric on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends. Place bedding course on drainage fabric.

3.20 FIELD QUALITY CONTROL

- A. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.
- B. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Engineer.
- C. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:
 - 1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. (186 sq. m) or less of paved area or building slab, but in no case fewer than three tests.
 - 2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for each 100 feet (30 m) or less of wall length, but no fewer than two tests.

3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for each 150 feet (46 m) or less of trench length, but no fewer than two tests.

- D. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

3.21 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
 1. Scarify or remove and replace soil material to depth as directed by Engineer; reshape and recompact.
- C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to the greatest extent possible.

3.22 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Disposal: Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Engineer.
 1. Remove waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

PART 4 PAYMENT

4.1 GENERAL

- A. Payment for work specified in this section will be made at the unit prices stated in the Proposal and shall be included under the following items. Computation of quantities will be as indicated for each item and will be based upon measurements made by the Engineer.
- B. Payment for trench excavation and backfill for service waterline and connection pipe will be included under that section.

4.2 COMMON EXCAVATION (UNCLASSIFIED)

- A. Payment for common excavation will be made at the respective unit prices per cubic yard stated in the Proposal for the common excavation and all other incidental work.
- B. Payment for common excavation and the respective backfill shall constitute full compensation for all work specified under this item.
- C. Measurement for common excavation shall be determined by the Engineer based on topographic surveys prior to construction. No adjustments shall be made for variations to the quantity stated in the proposal for improvements indicated on the Drawings.

4.3 DRAINAGE COURSE

- A. Payment for Drainage Course will be made at the respective unit prices per TON stated in the Proposal for the Drainage Course and all other incidental work.
- B. Payment for Drainage Course backfill shall constitute full compensation for all work specified under this item.
- C. Measurement for structural backfill shall be the actual number of tons used, but limited to 2 cf/lf along each foundation drainpipe, and shall be based on weight tickets from state certified weigh stations. Trip tickets shall be presented to the Engineer for his signature on the date of use. No payment will be allowed on trip tickets not so validated by the Engineer. The unit price for the rock shall include payment for excavating to provide space for the rock if necessary and disposal of all excess excavated material. Payment for over-excavation shall not be made.

4.4 BASE COURSE

- A. Payment for Base Course will be made at the respective unit prices per TON stated in the Proposal for the Base Course and all other incidental work.
- B. Payment for Base Course shall constitute full compensation for all work specified under this item.
- C. Measurement for structural backfill shall be the actual number of tons used, and shall be based on weight tickets from state certified weigh stations. Trip tickets shall be presented to the Engineer for his signature on the date of use. No payment will be allowed on trip tickets not so validated by the Engineer. The unit price for the rock shall include payment for excavating to provide space for the rock if necessary and disposal of all excess excavated material. Payment for over-excavation shall not be made. Nominal depth shall be as indicated on the Drawings.

4.6 SURFACE COURSE

- A. Payment for surface Course will be made at the respective unit prices per TON stated in the Proposal for the surface Course and all other incidental work. See Surface Restoration for Payment requirements for Rock Surfacing.

4.6 BEDDING COURSE FOR FOUNDATIONS

- A. Payment for bedding course for foundations will be made at the respective unit prices per TON stated in the Proposal for the bedding course for foundations and all other incidental work.
- B. Payment for bedding course for foundations shall constitute full compensation for all work specified under this item.
- C. Measurement for structural backfill shall be the actual number of tons used, and shall be based on weight tickets from state certified weigh stations. Trip tickets shall be presented to the Engineer for his signature on the date of use. No payment will be allowed on trip tickets not so validated by the Engineer. The unit price for the rock shall include payment for excavating to provide space for the rock if necessary and disposal of all excess excavated material. Payment for over-excavation shall not be made. Compacted depth shall be 4-inches below slabs and foundations.

4.7 RIP RAP

- A. Payment for rip rap will be made at the respective unit prices per cubic yard stated in the Proposal for the rip rap and all other incidental work.
- B. Payment for rip rap shall constitute full compensation for all work specified under this item.
- C. Measurement for rip rap for foundations shall be determined by the Engineer based on measurement of actual materials placed in the field and based on requirements of the Drawings.

4.8 STRUCTURAL BACKFILL

- A. Payment for structural backfill will be made at the respective unit prices per TON stated in the Proposal for the structural backfill and all other incidental work.

- B. Payment for structural backfill shall constitute full compensation for all work specified under this item.
- C. Measurement for structural backfill shall be the actual number of tons used, and shall be based on weight tickets from state certified weigh stations. Trip tickets shall be presented to the Engineer for his signature on the date of use. No payment will be allowed on trip tickets not so validated by the Engineer. The unit price for the rock shall include payment for excavating to provide space for the rock if necessary and disposal of all excess excavated material. Payment for over-excavation shall not be made.

.END OF SECTION 02300

SECTION 02575 - SURFACE RESTORATION**PART 1 - GENERAL****4.1 SECTION INCLUDES**

- A. This section covers the work necessary to replace all pavement, rock surfacing, drainage facilities, and other street features damaged either directly or indirectly by the operations incidental to the construction of the water system, complete.

PART 2 - PRODUCTS**2.1 ROCK FOR SURFACING, LEVELING COURSE, AND CRUSHED ROCK BACKFILL**

- A. Rock shall be crushed gravel or rock meeting the following quality standards:

Abrasion (AASHTO T 96)	Maximum wear	35 percent
Fractured face	Minimum particles	75 percent
Liquid limit (AASHTO T 89)	Not greater than	30 percent
Plasticity index (AASHTO T 91)	Not greater than	6 percent

- B. The aggregate shall consist of uniform quality, clean, tough, durable fragments of rock or gravel, free from flat, elongated, soft or disintegrated pieces, and other objectionable matter occurring either free or as a coating on the stone.
- C. Based on U.S. standard sieves, the gradation of the aggregates to be furnished shall be as indicated below:

- 1) 3/4-inch minus:

GRADATION	
Sieve Designation (Square Opening)	Percent Passing by Weight 3/4" Minus Leveling Course
3/4"	100
1/4"	55-75
U.S. No. 40	8-12
U.S. No. 200	10.0 max
% Fractured	75 min.
Sand Equivalent	35 min.

- 2) 1-1/4-inch minus:

GRADATION	
Sieve Designation (Square Opening)	Percent Passing by Weight 1-1/4" Minus Leveling Course
1-1/4"	100
5/8"	50-80
1/4"	30-50
U.S. No. 40	3-18
U.S. No. 200	7.5 max
% Fractured	75 min.
Sand Equivalent	35 min.

- D. Submit proof in the form of test results from a commercial testing laboratory or other evidence satisfactory to the Engineer to show that the materials meet the quality and gradation requirements.

2.2 ASPHALT CONCRETE

- A. Asphalt concrete mix conforming to the Standard Specifications For Highway Construction of the Washington State Department of Transportation, Class B.

2.4 ASPHALT PRIME

- A. Liquid asphalt for use as a tack coat for asphalt edges and manhole casting shall be RC-70 or MC-70 liquid asphalt conforming to AASHTO M 81 or M 82.

2.5 CONCRETE

- A. Concrete for miscellaneous construction shall conform to ASTM C94, Alternate 3 and shall have a design mix proportioned for 3,000 pounds square inch compressive strength at 28 days. Concrete mix shall contain no less than 5-1/2 sacks of cement per cubic yard.

2.6 PIPE FOR STORM SEWER AND CULVERT REPLACEMENT

- A. Pipe 15 inches and under shall be Class 2, conforming to ASTM C14 or as indicated on the drawings. Pipe 18 inches and over shall conform to ASTM C76, Class III.

PART 3 - EXECUTION

3.1 CONSTRUCTION PROCEDURE

- A. Replace all bituminous pavement damaged under this Contract with asphalt concrete regardless of original type.

3.2 REMOVAL OF PAVEMENT

- A. Removal of all pavement shall conform to Section TRENCH EXCAVATION AND BACKFILL and payment for removal shall be included in that section.

3.3 STREET MAINTENANCE

- A. Maintain all trenches as specified under Section TRENCH EXCAVATION AND BACKFILL.

3.4 ASPHALT CONCRETE PAVEMENT REPLACEMENT

- A. Subgrade:

1. Bring the trench to a smooth, even grade at the correct distance below the top of the existing pavement surface so as to provide adequate space for the leveling course and pavement. Trim existing pavement to a straight line to remove any pavement which has been damaged or which is broken and unsound to provide a smooth, sound edge joining the new pavement. Trim pavement back a distance of 12 inches from the trench edge on both sides of the trench.
 2. Compact the subgrade with mechanical vibratory or impact tampers. Determine the amount and method of compaction necessary to prevent subsequent settlement. Any subsequent settlement of the finished surfacing during the warranty period shall be promptly repaired by the Contractor, at the Contractor's sole expense.
- B. Leveling Course:
1. Place sufficient leveling course material to obtain a thickness of 6 inches after compaction, and for proper matching with the adjacent existing pavement. Place the leveling course for the full width of the trench where pavement was disturbed, including bituminous surfaced shoulders.
 2. Compact the leveling course with mechanical vibratory or impact tampers. Determine the amount and method of compaction necessary to Prevent subsequent settlement. Any subsequent settlement of the finished surfacing during the warranty period shall be promptly repaired by the Contractor, at the Contractor's sole expense.
- C. Prime Coat: After leveling course has been compacted and just prior to placing asphalt concrete, apply an asphalt prime coat to the edges of existing pavement. Also tack coat cast iron manhole frames, cleanouts, and valve boxes below grade.
- D. Asphalt Concrete:
1. Place the asphalt concrete on the prepared subgrade over the trench to a depth of not less than 4 inches or the depth of the adjacent pavement, whichever is greater, but not for more than 6 inches. If the thickness is greater than 6 inches, place the surfacing in two lifts. Spread and level the asphalt concrete with hand tools or by use of a mechanical spreader, depending upon the area to be paved. Bring the asphalt concrete to the proper grade and compact by rolling or the use of hand tampers where rolling is impossible or impractical.
 2. Roll with power rollers capable of providing compression of 200 to 300 pounds per linear inch. Begin the rolling from the outside edge of the replacement progressing toward the existing surfacing, lapping the existing surface at least 1/2 the width of the roller. If existing surfacing bounds both edges of the replacement, begin rolling at the edges of the replacement, lapping the existing surface at least 1/2 the width of the roller, and progress toward the center of the replacement area. Overlap each preceding track by at least 1/2 the width of the roller and make sufficient passes over the entire area to remove all roller marks and to produce the desired result, as determined by the Engineer.
 3. The finished surface of the new compacted paving shall be flush with the existing surface and shall conform to the grade and crown of the adjacent pavement.
 4. Immediately after the new paving is compacted, all joints between new and original asphalt pavement shall be painted with hot asphalt or asphalt emulsion and be covered with dry paving sand before the asphalt solidifies.
- E. Surface Smoothness: The surface smoothness of the replaced pavement shall be such that when a straightedge is laid across the patched area between the edges of the old surfacing and the surface of the new pavement, the new pavement shall not deviate from the straightedge more than 1/4 inch.
- 3.5 CONCRETE PAVEMENT
- A. Concrete pavement replaced shall be the same thickness as that removed, except that in no instance shall it be less than a minimum of 6 inches. Protect the newly placed concrete from traffic for a period of 7 days and cure by covering with burlap, sand, earth, or sawdust, which is kept continuously wet.

3.6 WEATHER CONDITIONS

- A. Asphalt shall not be applied to wet material. Asphalt shall not be applied during rainfall, sand or dust storms, or any imminent storms that might adversely affect the construction. The Engineer will determine when surfaces and material are dry enough to proceed with construction. Asphalt concrete shall not be placed (1) when the atmospheric temperature is lower than 40 degrees F, (2) during heavy rainfall, or (3) when the surface upon which it is to be placed is frozen or wet. Exceptions will be permitted only in special cases and only with prior written approval of the Engineer.

3.7 PROTECTION OF STRUCTURES

- A. Provide whatever protective coverings may be necessary to protect the exposed portions of bridges, culverts, curbs, gutters, posts, guard fences, road signs, and any other structures from splashing oil and asphalt from the paving operations. Remove any oil, asphalt, dirt, or any other undesirable matter that may come upon these structures by reason of the paving operations.
- B. Where water valve boxes, manholes, catch basins, or other underground utility appurtenances are within the area to be surfaced, the resurfacing shall be level with the top of the existing finished elevation of these facilities. If it is evident that these facilities are not in accordance with the proposed finished surface, notify the Engineer to have the proper authority contacted in order to have the facility altered before proceeding with the resurfacing around the obstruction. Consider any delays experienced from such obstructions as incidental to the paving operation. No additional payment will be made. Protect all covers during asphalt application.

3.8 EXCESS MATERIALS

- A. Dispose of all excess materials. Make arrangements for the disposal and bear all costs or retain any profit incidental to such disposal.

3.9 CONTRACTOR'S RESPONSIBILITY

- A. Settlement of replaced pavement over trenches within the warranty period shall be considered the result of improper or inadequate compaction of the subbase or base materials. The Contractor shall promptly repair all pavement deficiencies noted during the warranty period at the Contractor's sole expense.

3.10 ASPHALT DRIVEWAYS AND WALKS

- A. Replace asphalt driveways and walks in accordance with ASPHALT CONCRETE PAVEMENT REPLACEMENT.

3.11 STORM SEWER AND CULVERT REPLACEMENT

- A. Install storm sewers and culverts at original locations. Storm sewers and culverts shall be carefully bedded to provide uniform bearing. Backfill with 3/4-inch minus base course material. Place backfill in 6-inch lifts uniformly on both sides of pipe simultaneously, and thoroughly compact each lift with mechanical tampers before placing the next lift.
- B. Replace storm sewers and culverts to the original lines and grades. Pipe 15 inches and smaller shall be laid on a minimum 4-inch thick 3/4-inch minus gravel base conforming ROCK FOR SURFACING, LEVELING COURSE, AND CRUSHED ROCK BACKFILL, this section. Use a minimum 6-inch thick gravel base under pipe 18 inches and larger.

3.12 DRESSING OF SHOULDERS

- A. In addition to the preparation of the surfaced roadway, blade the entire width of the graded roadway between the outside edges of the shoulders until it presents a neat and uniform appearance. Open up all culverts under the roadway or under side roads within the right-of-way or ditches obstructed by the Contractor's operations, and remove all debris therefrom and dispose of offsite.

3.13 ROCK SURFACING

- A. Where directed by the Engineer, place crushed rock surfacing material, as specified herein, for the full width of all streets, driveways, parking areas, street shoulders, and other areas disturbed by the construction. Rock shall be 1-1/2-inch or 3/4-inch minus, and of the quality and gradation specified hereinbefore.

for surfacing and base ROCK FOR SURFACING, LEVELING COURSE, AND CRUSHED ROCK BACKFILL. Spread the rock by tailgating and supplement by hand labor where necessary. Level and grade the rock to conform to existing grades and surfaces.

3.14 EXISTING FENCING

- A. Replace all fences to their original location in a condition equal to or better than existed prior to construction. Provide and maintain temporary fences to keep livestock within pasture areas.
- B. When construction proceeds through a chain link fence, remove chain link material from nearest joint and roll back. Do not cut chain link material. If necessary, remove metal post and replace after construction is finished. Post should have base poured in place with concrete.

4.15 ROCK FACE RESETORATION

- A. In areas where rock has been excavated or blasted and is exposed above ground, all loose rock and debris shall be removed using high pressure air other method acceptable to the Engineer.

PART 4 – PAYMENT

4.1 GENERAL

- A. Payment for the work under this section shall be based on the appropriate unit prices stated in the Contractor's Proposal. Payment shall be considered full compensation for furnishing all labor, materials, and equipment to complete the work as specified under this section.

4.2 ROCK SURFACING

- A. Payment for replacement of rock surfacing shall be based on the unit price per ton as stated in the Contractor's Proposal. The quantity of rock replaced shall be the actual number of tons used, and shall be based on weight tickets from state certified weigh stations. Trip tickets shall be presented to the Engineer for his signature on the date of use. No payment will be allowed on trip tickets not so validated by the Engineer. The unit price for the rock shall include payment for excavating to provide space for the rock if necessary and disposal of all excess excavated material.

4.3 ASPHALT CONCRETE AND PORTLAND CEMENT CONCRETE PAVEMENT REPLACEMENT

- A. Payment for the asphalt concrete and portland cement concrete pavement replacement under this section shall be based on the appropriate unit price per lineal foot as stated in the Contractor's Proposal. Payment shall be considered full compensation for furnishing all labor, materials, and equipment to complete the work as specified under this section.
- B. When the pipe centerline crosses, or is under or at the edge of existing pavement, payment for asphalt concrete and portland cement concrete pavement will be based on the unit price per linear foot (for the full width of the disturbed or damaged surface) stated in the Contractor's Proposal for each. The number of linear feet will be measured by the Engineer.
- C. When the pipe centerline is 4 feet or less outside of the edge of the existing pavement, but not under or at the edge of the pavement, payment for resurfacing will be based on the unit price per square yard stated in the Contractor's Proposal for the actual area replaced. Payment will be limited to pavement replaced within 4 feet of the pipe centerline. All pavement damaged outside these limits shall be replaced at the Contractor's sole expense.
- D. The unit prices shall include payment for excavation required to provide space for the surfacing, preparation of the trench surfacing, disposal of all excess excavated materials, and all other work required to complete the resurfacing. The crushed rock-leveling course will also be considered as included in the bid

price per linear foot and in the bid price per square yard for pavement replacement as stated in the Contractor's Proposal.

- E. Should the Contractor elect to jack under certain sections of pavement, payment will be made as though removal and replacement had been accomplished.

4.4 CRUSHED ROCK BACKFILL

- A. Crushed rock backfill will be paid for under Section TRENCH EXCAVATION AND BACKFILL.

END OF SECTION 02575

SECTION 02584 - UNDERGROUND DUCTS AND UTILITY STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Ducts in direct-buried duct banks.
 - 2. Handholes and handhole accessories.
 - 3. Utility vaults, vault access doors and hardware.

1.3 SUBMITTALS

- A. Product Data: For the following:
 - 1. Handhole hardware.
 - 2. Conduit and ducts, including elbows, bell ends, bends, fittings, and solvent cement.
 - 3. Duct-bank materials, including spacers and miscellaneous components.
 - 4. Warning tape and wire.
 - 5. Utility Vaults
- B. Shop Drawings: Show fabrication and installation details for underground ducts and utility structures and include the following:
 - 1. For manholes and utility vaults:
 - a. Duct sizes and locations of duct entries.
 - b. Reinforcement details.
 - c. Utility vault doors and hardware
 - d. Step details.
 - e. Grounding details.
 - f. Dimensioned locations of cable rack inserts, pulling-in irons, and sumps.
- C. Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures. Include plans and sections drawn to scale, and show all bends and location of expansion fittings.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories (Including Ducts for Communications and Telephone Service): Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

- B. Comply with ANSI C2.
- C. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.
- B. Store precast concrete units at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.
- C. Lift and support precast concrete units only at designated lifting or supporting points.

1.6 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated.
 - 1. Notify Engineer at least two days in advance of proposed utility interruptions.

1.7 COORDINATION

- A. Coordinate layout and installation of ducts, utility vaults, and handholes with final arrangement of other utilities and site grading, as determined in the field.
- B. Coordinate elevations of ducts and duct-bank entrances into handholes with final profiles of conduits as determined by coordination with other utilities and underground obstructions. Revise locations and elevations from those indicated as required to suit field conditions and to ensure duct runs drain to manholes and handholes, and as approved by Engineer.

PART 2 - PRODUCTS

2.1 PRODUCTS AND MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Underground Precast Concrete Utility Structures:
 - a. Carder Concrete Products.
 - b. Christy Concrete Products, Inc.
 - c. Elmhurst-Chicago Stone Co.
 - d. Riverton Concrete Products.
 - e. Rotondo Precast/Old Castle.
 - f. Utility Vault Co.
 - g. Wausau Concrete Co.
 - 2. Frames and Covers:

- a. Campbell Foundry Co.
- b. East Jordan Iron Works, Inc.
- c. McKinley Iron Works, Inc.
- d. Neenah Foundry Co.
- e. Or approved equal.

3. Nonmetallic Ducts and Accessories:

- a. Aruco Corp.
- b. Beck Manufacturing Inc.
- c. Cantex, Inc.
- d. Certainteed Corp.; Pipe & Plastics Group.
- e. ElecSys, Inc.
- f. Electri-Flex Co.
- g. Ipex, Inc.
- h. Lamson & Sessions; Carlon Electrical Products.
- i. Manhattan/CDT/Cole-Flex.
- j. Spiraduct/AFC Cable Systems, Inc.
- k. Or approved equal.

2.2 CONDUIT

- A. Conduit and fittings are specified in Division 16 Section "Raceways and Boxes."

2.3 DUCTS

- A. Rigid Nonmetallic Conduit: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by the same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B. Use NEMA TC 2, Type EPC-80-PVC, UL 651 under traffic bearing areas and under load bearing foundation structures.

2.4 HANDHOLES

- A. Precast Handholes: Reinforced concrete, monolithically poured walls and bottom, with steel frame and access door assembly as the top of handhole. Duct entrances and windows shall be located near corners to facilitate racking. Pulling-in irons and other built-in items shall be installed before pouring concrete. Cover shall have nonskid finish and legend. Unit, when buried, shall be designed to support AASHTO H10 loading.
- B. Valve covers: See specific sections for Valves in Division 15.
- C. Cover Legend: "ELECTRIC", "WATER", "SIGNAL", or as indicated.

2.5 UTILITY VAULTS

- A. Base sections: Utility Vault or approved equal. 6-inch minimum thickness for floor and slab
- B. Baffles and weirs: Precast concrete.
- C. Inlet/outlet pipes: Type and size as shown on the plans.
- D. Top: Utility Vault or approved equal. 8-inch min thickness, height as required for indicated grades.

- E. Access hatch: See manhole frames and covers. Unless otherwise indicated on the drawings use a standard duty manhole frame and covers.
- F. Grade rings; As required to meet finished grades with access hatches
- G. Sealant: Butyl Resin Sealant between box sections

2.6 CAST-IN-PLACE MANHOLES

- A. Loading: AASHTO HS20, traffic load as indicated.

2.7 ACCESSORIES

- A. Duct Spacers: Rigid PVC interlocking spacers, selected to provide minimum duct spacings and cover depths indicated while supporting ducts during concreting and backfilling; produced by the same manufacturer as the ducts.
- B. Pulling Eyes in Walls: Eyebolt with reinforcing-bar fastening insert 2-inch- (50-mm-) diameter eye and 1-by-4-inch (25-by-100-mm) bolt.
 - 1. Working Load Embedded in 6-Inch (150-mm), 4000-psi (27.6-MPa) Concrete: 13,000-lbf (58-kN) minimum tension.
- C. Pulling and Lifting Irons in Floor: 7/8-inch- (22-mm-) diameter, hot-dip-galvanized, bent steel rod; stress relieved after forming; and fastened to reinforced rod. Exposed triangular opening.
 - 1. Ultimate Yield Strength: 40,000-lbf (180-kN) shear and 60,000-lbf (270-kN) tension.
- D. Bolting Inserts for Cable Stanchions: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch (13-mm) ID by 2-3/4 inches (69 mm) deep, flared to 1-1/4 inches (30 mm) minimum at base.
 - 1. Tested Ultimate Pullout Strength: 12,000 lbf minimum.
- E. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.
- F. Cable Stanchions: Hot-rolled, hot-dip-galvanized, T-section steel; 2-1/4-inch size; punched with 14 holes on 1-1/2-inch centers for cable-arm attachment.
- G. Cable Arms: 3/16-inch thick, hot-rolled, hot-dip-galvanized, steel sheet pressed to channel shape; 12 inches wide by 14 inches long and arranged for secure mounting in horizontal position at any location on cable stanchions.
- H. Cable-Support Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.
- I. Grounding Materials: Comply with Division 16 Section "Grounding and Bonding."
- J. Ladder: UL-listed, heavy-duty wood specifically designed for electrical manhole use. Minimum length equal to distance from deepest manhole floor to grade plus 36 inches (900 mm).

- K. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F (2 deg C). Capable of withstanding temperature of 300 deg F (150 deg C) without slump and of adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.
- L. Warning Tape: Underground-line warning tape specified in Division 16 Section "Electrical Identification."
- M. Warning Wire: 12 gage single stranded insulated copper wire appropriately color coded and U.L. rated for underground bury.

2.8 CONSTRUCTION MATERIALS

- A. Dampproofing: Comply with Division 7 Section "Bituminous Dampproofing."
- B. Mortar: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. (60 L) where packaged mix complying with ASTM C 387, Type M, may be used.
- C. Concrete: Use 3000-psi- (20.7-MPa-) minimum, 28-day compressive strength and 3/8-inch (10-mm) maximum aggregate size. Concrete and reinforcement are specified in Division 3 Section "Cast-in-Place Concrete."

PART 3 - EXECUTION

3.1 APPLICATION

- A. Underground Ducts for Electrical Branch Circuits: Type DB-60-PVC, direct-buried duct bank.
- B. Underground Ducts for Telephone Utility Service: Type EPC-40-PVC, direct-buried duct bank, except use Type EPC-80-PVC when crossing below roads, load bearing structures, and railroads.
- C. Underground Ducts for Communication Circuits: Type EPC-40-PVC, direct-buried duct bank.

3.2 EARTHWORK

- A. Excavation and Backfill: Comply with Division 2 Section "Earthwork" but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- C. Restore all areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 2 Section "Landscaping."
- D. Restore disturbed pavement.

3.3 CONDUIT AND DUCT INSTALLATION

- A. Slope: Pitch ducts a minimum slope of 1:300 down toward and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two utility structures to drain in both directions.
- B. Curves and Bends: Use manufactured elbows for stub-ups at equipment and at building entrances. Use manufactured long sweep bends with a minimum radius of 25 feet (7.5 m), both horizontally and vertically, at other locations.
- C. Use solvent-cement joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.
- D. Duct Entrances to Manholes and Handholes: Space end bells approximately 10 inches (250 mm) o.c. for 5-inch (125-mm) ducts and vary proportionately for other duct sizes. Change from regular spacing to end-bell spacing 10 feet (3 m) from the end bell without reducing duct line slope and without forming a trap in the line. Grout end bells into manhole walls from both sides to provide watertight entrances.
- E. Building Entrances: Make a transition from underground duct to conduit at least 10 feet (3 m) outside the building wall. Use fittings manufactured for this purpose. Follow the appropriate installation instructions below:
 - 1. Direct-Buried, Nonencased Ducts at Nonwaterproofed Wall Penetrations: Install a Schedule 40, galvanized steel pipe sleeve for each duct. Calk space between conduit and sleeve with duct-sealing compound on both sides for moisture-tight seal.
 - 2. Waterproofed Wall and Floor Penetrations: Install a watertight entrance-sealing device with sealing gland assembly on the inside. Anchor device into masonry construction with one or more integral flanges. Secure membrane waterproofing to the device to make permanently watertight.
- F. Direct-Buried Ducts: Support ducts on duct spacers, spaced as recommended by manufacturer and coordinated with duct size, duct spacing, and outdoor temperature. Install as follows:
 - 1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts.
 - 2. Install expansion fittings as shown on Shop Drawings.
 - 3. Trench Bottom: Continuous, firm, and uniform support for duct bank. Prepare trench bottoms as specified in Division 2 Section "Earthwork" for pipes less than 6 inches (150 mm) in nominal diameter.
 - 4. Backfill: Install backfill as specified in Division 2 Section "Earthwork." After installing first tier of ducts, backfill and compact. Repeat backfilling after placing each tier. After placing last tier, hand-place backfill to 4 inches (100 mm) over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, complete backfilling normally.
 - 5. Minimum Clearances between Ducts: 3 inches (75 mm) between ducts for like services and 6 inches (150 mm) between power and signal ducts.
 - 6. Depth: Install top of duct bank at least 36 inches (900 mm) below finished grade, unless otherwise indicated.
- G. Warning Tape: Bury warning tape approximately 12 inches (300 mm) above all concrete-encased duct banks. Align tape parallel to and within 3 inches (75 mm) of the centerline of duct bank.
- H. Warning Wire: See typical trench section on the drawings for wire location.
- I. Stub-ups: Use rigid steel conduit for stub-ups to equipment. For equipment mounted on outdoor concrete bases, extend steel conduit a minimum of 5 feet (1.5 m) from edge of base. Install insulated grounding bushings on terminations. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches (75 mm) of concrete.

- J. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.
- K. Pulling Cord: Install 100-lbf- (445-N-) test nylon cord in ducts, including spares.

3.4 HANDHOLE INSTALLATION

- A. Elevation: Install handholes with depth as indicated. Where indicated, cast handhole cover frame directly into roof of handhole and set roof surface 1 inch (25 mm) above grade.
- B. Drainage: Install drains in bottom of units where indicated. Coordinate with drainage provisions indicated.
- C. Access: Install cast-iron frame and cover.
 - 1. Install precast collars and rings to support frame and cover and to connect cover with roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.
 - 2. Set frames in paved areas and trafficways flush with finished grade. Set other frames 1 inch (25 mm) above finished grade.
- D. Hardware: Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.
- E. Field-Installed Bolting Anchors: Do not drill deeper than 3-7/8 inches (98 mm) for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.
- F. Grounding: Install ground rod through floor in each structure with top protruding 4 inches (100 mm) above floor. Seal floor opening against water penetration with waterproof nonshrink grout. Ground exposed metal components and hardware with bare-copper ground conductors. Train conductors neatly around corners. Use cable clamps secured with expansion anchors to attach ground conductors.
- G. Utility Vaults
 - 1. Install specified units level and plumb and with orientation and depth coordinated with connecting ducts or pipes to minimize, or eliminate bends and deflections required for proper entrances.
 - 2. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch (25-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.
 - 3. Vaults to be installed per manufacturer's recommendations.

3.5 FIELD QUALITY CONTROL

- A. Testing: Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
- B. Correct installations if possible and retest to demonstrate compliance. Remove and replace defective products and retest.

3.6 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

- B. Clean internal surfaces of manholes, including sump. Remove foreign material.

PART 4 PAYMENT

4.1 GENERAL

- A. Payment for work specified in this section will be made at the unit prices stated in the Proposal and shall be included under the following items. Computation of quantities will be as indicated for each item and will be based upon measurements made by the Engineer.
- B. Payment for trench excavation and backfill for utility pipe will be included under that section.

4.2 DUCTS AND HANDHOLES

- A. Payment for Ducts and Handholes will be included as part of the applicable unit prices stated in the Proposal.

4.3 UTILITY VAULTS

- A. Payment for Utility Vaults will be made at the respective unit price for each type and size for each Utility Vault and all other incidental work.
- B. Payment for Utility Vaults shall constitute full compensation for all work specified under this item.

END OF SECTION 02584

SECTION 02660 - HDPE AND LLDPE GEOMEMBRANE**PART 1 GENERAL****1.01 SCOPE**

This specification covers the technical requirements for the Manufacturing and Installation of the geomembrane. All materials shall meet or exceed the requirements of this specification, and all work will be performed in accordance with the procedures provided in these project specifications

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. D 638, Standard Test Method for Tensile Properties of Plastics.
2. D 751, Standard Test Methods for Coated Fabrics.
3. D 792, Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
4. D 1004, Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting.
5. D 1204, Standard Test Method for Linear Dimensional Changes of Non Rigid Thermoplastic Sheeting or Film at Elevated Temperature.
6. D 1238, Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
7. D 1505, Standard Test Method for Density of Plastics by Density-Gradient Technique.
8. D 1603, Standard Test Method for Carbon Black in Olefin Plastics.
9. D 3895, Test Method for Oxidative Induction Time of Polyolefins by Thermal Analysis.
10. D 4218, Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique.
11. D 4437, Standard Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes.
12. D 4833, Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products.
13. D 5199, Standard Test Method for Measuring Nominal Thickness of Smooth Geomembranes.
14. D 5397, Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefins using Notched Constant Tensile Load Test.
15. D 5596, Standard Practice for Microscopical Examination of Pigment Dispersion in Plastic Compounds.
16. D 5641, Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.
17. D 5721, Practice for Air-Oven Aging of Polyolefin Geomembranes.
18. D 5820, Test Method for Air Testing.
19. D 5885, Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High Pressure Differential Scanning Calorimetry.
20. D 5994, Standard Test Method for Measuring Nominal Thickness of Textured Geomembranes
21. D 6365, Standard Practice for the Nondestructive Testing of Geomembrane Seams using The Spark Test
22. D5820-95, Pressurized Air Channel Test for Dual Seamed Geomembranes

A. Geosynthetic Research Institute (GRI):

1. GRI GM 9, Cold Weather Seaming of Geomembranes
2. GRI GM 10, The Stress Crack Resistance of HDPE Geomembrane Sheet
3. GRI GM 13, Test Properties, Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes
4. GRI GM 14, Test Frequencies for Destructive Seam Testing Selecting, variable intervals for taking geomembrane destructive samples using the method of attributes.
5. GRI GM 12, Measurement of the Asperity Height of Textured Geomembranes Using a Depth Gage
6. GRI GM 17, Test Methods, Test Properties and Testing Frequency for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes
7. GRI GM 19, Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes

1.03 SUBMITTALS

A. Submit under provisions of Section 01300, Submittals.

B. Submit the following to the Engineer or Owner, for review and approval, within a reasonable time so as to expedite shipment or installation of the Geomembrane:

1. Documentation of manufacturer's qualifications as specified in subsection 1.04A of this Section.
2. Manufacturer's Quality Control program manual or descriptive documentation.
3. A material properties sheet, including at a minimum all properties specified in GRI GM 13, including test methods used.
 - a) Certification stating that the resin meets the specification requirements
 - b) Statement certifying no recycled polymer and no more than 10% rework of the same type of material is added to their resin (product run may be recycled)
4. Sample of the material.
5. Documentation of Installer's qualifications, as specified below and in subsection 1.04B of this Section.
 - a. Submit a list of at least ten completed facilities. For each installation, provide: name and type of facility; its location; the date of installation; name and telephone number of contact at the facility; type and thickness of geomembrane and; surface area of the installed geomembrane.
 - b. Submit resumes or qualifications of the Installation Supervisor, Master Seamer and Technicians to be assigned to this project.
 - c. Quality Control Program.
6. Example Material Warranty and Liner Installation Warranty

C. Shop Drawings

1. Submit copies of shop drawings for engineer's approval within a reasonable time so as not to delay the start of geomembrane installation. Shop drawings shall show the proposed panel layout identifying seams and details. Seams should generally follow the direction of the slope. Butt seams or roll-end seams should not occur on a slope unless approved by the Owner's Representative. Butt seams on a slope, if allowed, should be staggered.
2. Placement of geomembrane should not be allowed to proceed until Owner's Representative has received and approved the shop drawings.

D. Additional Submittals (In-Progress and at Completion)

1. Manufacturer's warranty (refer to subsection 1.07).
2. Geomembrane installation warranty (refer to subsection 1.08).
3. Daily written acceptance of subgrade surface (refer to subsection 3.01.C).
4. Low-temperature seaming procedures if applicable (refer to subsection 3.03.A).
5. Prequalification test seam samples (refer to subsection 3.05.A.6).
6. Field seam non-destructive test results (refer to subsection 3.05.B.1).
7. Field seam destructive test results (refer to subsection 3.05.C.6).
8. Daily field installation reports (refer to subsection 3.05.G).
9. Installation record drawing, as discussed in subsection 3.05.

1.04 QUALITY CONTROL

- A. **Manufacturer's Qualifications:** The manufacturer of geomembrane of the type specified or similar product shall have at least five years experience in the manufacture of such geomembrane. In addition, the geomembrane manufacturer shall have manufactured at least 1,000,000 M² (10,000,000 FT²) of the specified type of geomembrane or similar product during the last five years.
- B. **Installer's Qualifications**
1. The Geomembrane Installer shall be the Manufacturer, approved Manufacturer's Installer or a contractor approved by the Owner's Representative to install the geomembrane.
 2. The Geomembrane Installer shall have at least three years experience in the installation of the specified geomembrane or similar. The Geomembrane Installer shall have installed at least 10 projects involving a total of 500,000 M² (5,000,000 FT²) of the specified type of geomembrane or similar during the last three years.
 3. Installation shall be performed under the direction of a field Installation Supervisor who shall be responsible throughout the geomembrane installation, for geomembrane panel layout, seaming, patching, testing, repairs, and all other activities of the Geomembrane Installer. The Field Installation Supervisor shall have installed or supervised the installation and seaming of a minimum of 10 projects involving a total of 500,000 M² (5,000,000 FT²) of geomembrane of the type specified or similar product.
 4. Seaming shall be performed under the direction of a Master Seamer (who may also be the Field Installation Supervisor or Crew Foreman) who has seamed a minimum of 300,000 M² (3,000,000 FT²) of geomembrane of the type specified or similar product, using the same type of seaming apparatus to be used in the current project. The Field Installation Supervisor and/or Master Seamer shall be present whenever seaming is performed.
 5. All seaming, patching, other welding operations, and testing shall be performed by qualified technicians employed by the Geomembrane Installer.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Each roll of geomembrane delivered to the site shall be labeled by the manufacturer. The label shall be firmly affixed and shall clearly state the manufacturer's name, product identification, material thickness, roll number, roll dimensions and roll weight.
- B. Geomembrane shall be protected from mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions.

- C. Rolls shall be stored away from high traffic areas. Continuously and uniformly support rolls on a smooth, level prepared surface.

1.06 PROJECT CONDITIONS

- A. Geomembrane should not be installed in the presence of standing water, while precipitation is occurring, during excessive winds, or when material temperatures are outside the limits specified in Section 3.03.

1.07 MATERIAL WARRANTY AS AGREED BY PROJECT PARTICIPANTS.

- A. Materials shall be warranted for 5 years from date of installation

1.08 GEOMEMBRANE INSTALLATION WARRANTY

- A. The Geomembrane Installer shall guarantee the geomembrane installation against defects in the installation and workmanship for 1 year commencing with the date of final acceptance.

1.09 GEOMEMBRANE PRE-CONSTRUCTION MEETING

- A. Geomembrane Pre-Construction Meeting shall be held at the site prior to installation of the geomembrane. At a minimum, the meeting shall be attended by the Geomembrane Installer, Owner, Owner's representative (Engineer and/or CQA Firm), and the Earthwork Contractor.
- B. Topics for this meeting shall include:
 - 1. Health and Safety
 - 2. Lines of authority and communication. Resolution of any project document ambiguity.
 - 3. Methods for documenting, reporting and distributing documents and reports.
 - 4. Procedures for packaging and storing archive samples.
 - 5. Review of time schedule for all installation and testing.
 - 6. Review of panel layout and numbering systems for panels and seams including details for marking on geomembrane.
 - 7. Procedures and responsibilities for preparation and submission of as-built panel and seam drawings.
 - 8. Temperature and weather limitations. Installation procedures for adverse weather conditions. Defining acceptable subgrade, geomembrane, or ambient moisture and temperature conditions for working during liner installation.
 - 9. Subgrade conditions, dewatering responsibilities and subgrade maintenance plan.
 - 10. Deployment techniques including allowable subgrade for the geomembrane.
 - 11. Plan for controlling expansion/contraction and wrinkling of the geomembrane.
 - 12. Covering of the geomembrane and cover soil placement.
 - 13. Measurement and payment schedules.
 - 14. Responsibilities of each party.
- C. The meeting shall be documented by a person designated at the beginning of the meeting and minutes shall be transmitted to all parties.

PART 2 PRODUCTS**2.01 SOURCE QUALITY CONTROL****A. Manufacturing Quality Control**

1. The test methods and frequencies used by the manufacturer for quality control/quality assurance of the above geomembrane prior to delivery, shall be in accordance with GRI GM 13 for HDPE geomembrane or GRI GM 17 for LLDPE geomembrane, or modified as required for project specific conditions.
2. The manufacturer's geomembrane quality control certifications, including results of quality control testing of the products, as specified in subsection 2.01.A.3 of this Section, must be supplied to the Owner's Representative to verify that the materials supplied for the project are in compliance with all product and or project specifications in this Section. The certification shall be signed by a responsible party employed by the manufacturer, such as the QA/QC Manager, Production Manager, or Technical Services Manager. Certifications shall include lot and roll numbers and corresponding shipping information.
3. The Manufacturer will provide Certification that the geomembrane and welding rod supplied for the project are made from the same material type and are compatible.

2.02 GEOMEMBRANE

- A. The geomembrane shall consist of new, first quality products designed and manufactured specifically for the purpose of this work which shall have been satisfactorily demonstrated by prior testing to be suitable and durable for such purposes. The geomembrane rolls shall be seamless, high density polyethylene (HDPE - Formulated Sheet Density $\geq 0.94\text{g/cc}$) or linear low density polyethylene (LLDPE - Formulated Sheet Density $\leq 0.939\text{ g/cc}$) containing no plasticizers, fillers or extenders and shall be free of holes, blisters or contaminants, and leak free verified by 100% in line spark or equivalent testing. The geomembrane shall be supplied as a continuous sheet with no factory seams in rolls. The geomembrane will meet the property requirements as shown in Table 2.02A or as appropriate in Table A (GRI GM 13) or in Table B (GRI GM 17)
- B. Material conformance testing by the Owner's Representative, if required, will be conducted using in-plant sampling or as specified for the project.
- C. The geomembrane seams shall meet the property requirements as shown in Table 1 and Table 2 of Attachment A or as required by project specifications

Table 2.02A –Textured HDPE Geomembrane Properties

Properties	Test Method	Test Value							Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
Thickness mils (min. ave.) • lowest individual for 8 out of 10 values • lowest individual for any of the 10 values	D 5994	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	nom. (-5%) -10% -15%	per roll
Asperity Height mils (min. ave.) (1)	D 7466	10 mil	10 mil	10 mil	10 mil	10 mil	10 mil	10 mil	every 2nd roll (2)
Density (min. ave.)	D 1505/D 792	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	0.940 g/cc	200,000 lb
Tensile Properties (min. ave.) (3) • yield strength • break strength • yield elongation • break elongation	D 6693 Type IV	63 lb/in. 45 lb/in. 12% 100%	84 lb/in. 60 lb/in. 12% 100%	105 lb/in. 75 lb/in. 12% 100%	126 lb/in. 90 lb/in. 12% 100%	168 lb/in. 120 lb/in. 12% 100%	210 lb/in. 150 lb/in. 12% 100%	252 lb/in. 180 lb/in. 12% 100%	20,000 lb
Tear Resistance (min. ave.)	D 1004	21 lb	28 lb	35 lb	42 lb	56 lb	70 lb	84 lb	45,000 lb
Puncture Resistance (min. ave.)	D 4833	45 lb	60 lb	75 lb	90 lb	120 lb	150 lb	180 lb	45,000 lb
Stress Crack Resistance (4)	D 5397 (App.)	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	300 hr.	per GRI GM10
Carbon Black Content (range)	D 4218 (5)	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	2.0-3.0 %	20,000 lb
Carbon Black Dispersion	D 5596	note (6)	note (6)	note (6)	note (6)	note (6)	note (6)	note (6)	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) (7) (a) Standard OIT — or — (b) High Pressure OIT	D 3895 D 5885	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	100 min. 400 min.	200,000 lb
Oven Aging at 85°C (7), (8) (a) Standard OIT (min. ave.) -% retained after 90 days — or — (b) High Pressure OIT (min. ave.) -% retained after 90 days	D 5721 D 3895 D 5885	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	55% 80%	per each formulation
UV Resistance (9) (a) Standard OIT (min. ave.) — or — (b) High Pressure OIT (min. ave.) -% retained after 1600 hrs (11)	D 7238 D 3895 D 5885	N.R. (10) 50%	N.R. (10) 50%	N.R. (10) 50%	N.R. (10) 50%	N.R. (10) 50%	N.R. (10) 50%	N.R. (10) 50%	per each formulation

PART 3 EXECUTION**3.01 SUBGRADE PREPARATION**

- A. The subgrade shall be prepared in accordance with the project specifications. The geomembrane subgrade shall be uniform and free of sharp or angular objects that may damage the geomembrane prior to installation of the geomembrane.
- B. The Geomembrane Installer and Owner's Representative shall inspect the surface to be covered with the geomembrane on each day's operations prior to placement of geomembrane to verify suitability.
- C. The Geomembrane Installer and Owner's Representative shall provide daily written acceptance for the surface to be covered by the geomembrane in that day's operations. The surface shall be maintained in a manner, during geomembrane installation, to ensure subgrade suitability.
- D. All subgrade damaged by construction equipment and deemed unsuitable for geomembrane deployment shall be repaired prior to placement of the geomembrane. All repairs shall be approved by the Owner's Representative and the Geomembrane Installer. This damage, repair, and the responsibilities of the contractor and Geomembrane Installer shall be defined in the preconstruction meeting.

3.02 GEOMEMBRANE PLACEMENT

- A. No geomembrane shall be deployed until the applicable certifications and quality control certificates listed in subsection 1.03 of this Section are submitted to and approved by the Owner's Representative within the timeframe specified in the Contract Documents. If the material does not meet project specifications it shall be removed from the work area.
- B. The geomembrane shall be installed to the limits shown on the project drawings and essentially as shown on approved panel layout drawings.
- C. No geomembrane material shall be unrolled and deployed if the material temperatures are lower than 0 degrees C (32 degrees F) unless otherwise approved by the Owner's Representative. The specified minimum temperature for material deployment may be adjusted by the Owner's Representative. Temperature limitations should be defined in the preconstruction meeting. Typically, only the quantity of geomembrane that will be anchored and seamed together in one day should be deployed.
- D. No vehicular traffic shall travel on the geomembrane other than an approved low ground pressure Vehicle or equivalent.
- E. Sand bags or equivalent ballast shall be used as necessary to temporarily hold the geomembrane material in position under the foreseeable and reasonably - expected wind conditions. Sand bag material shall be sufficiently close-knit to prevent soil fines from working through the bags and discharging on the geomembrane.
- F. Geomembrane placement shall not be done if moisture prevents proper subgrade preparation, panel placement, or panel seaming. Moisture limitations should be defined in the preconstruction meeting.
- G. Damaged panels or portions of the damaged panels which have been rejected shall be marked and their removal from the work area recorded.
- H. The geomembrane shall not be allowed to "bridge over" voids or low areas in the subgrade. The geomembrane shall rest in intimate contact with the subgrade.

- I. Wrinkles caused by panel placement or thermal expansion should be minimized in accordance with section 1.09 B11.
- J. Considerations on Site Geometry: In general, seams shall be oriented parallel to the line of the maximum slope. In corners and odd shaped geometric locations, the total length of field seams shall be minimized. Seams shall not be located at low points in the subgrade unless geometry requires seaming at such locations and if approved by the Owner's Representative.
- K. Overlapping: The panels shall be overlapped prior to seaming to whatever extent is necessary to affect a good weld and allow for proper testing. In no case shall this overlap be less than 75mm (3 in.).

3.03 SEAMING PROCEDURES

- A. Cold weather installations should follow guidelines as outlined in GRI GM9.
- B. No geomembrane material shall be seamed when liner temperatures are less than 0 degrees C (32 degrees F) unless the following conditions are complied with:
 - 1. Seaming of the geomembrane at material temperatures below 0 degrees C (32 degrees F) is allowed if the Geomembrane Installer can demonstrate to the Owner's Representative, using pre-qualification test seams, that field seams comply with the project specifications, the safety of the crew is ensured, and geomembrane material can be fabricated (i.e. pipeboots, penetrations, repairs. etc.) at sub-freezing temperatures.
 - 2. The Geomembrane Installer shall submit to the Owner's Representative for approval, detailed procedures for seaming at low temperatures, possibly including the following:
 - a. Preheating of the geomembrane
 - b. The provision of a tent or other device if necessary to prevent heat losses during seaming and rapid heat losses subsequent to seaming.
 - c. Number of test welds to determine appropriate seaming parameters
- C. No geomembrane material shall be seamed when the sheet temperature is above 75 degrees C (170 degrees F) as measured by an infrared thermometer or surface thermocouple unless otherwise approved by the Owner's Representative. This approval will be based on recommendations by the manufacturer and on a field demonstration by the Geomembrane Installer using prequalification test seams to demonstrate that seams comply with the specification.
- D. Seaming shall primarily be performed using automatic fusion welding equipment and techniques. Extrusion welding shall be used where fusion welding is not possible such as at pipe penetrations, patches, repairs and short (less than a roll width) runs of seams.
- E. Fishmouths or excessive wrinkles at the seam overlaps shall be minimized and when necessary cut along the ridge of the wrinkles back into the panel so as to effect a flat overlap. The cut shall be terminated with a keyhole cut (nominal 10 mm (1/2 in) diameter hole) so as to minimize crack/tear propagation. The overlay shall subsequently be seamed. The key hole cut shall be patched with an oval or round patch of the same base geomembrane material extending a minimum of 150 mm (6 in.) beyond the cut in all directions.

3.04 PIPE AND STRUCTURE PENETRATION SEALING SYSTEM

- A. Provide penetration sealing system as shown in the Project Drawings.

- B. Penetrations shall be constructed from the base geomembrane material, flat stock, prefabricated boots and accessories as shown on the Project Drawings. The prefabricated or field fabricated assembly shall be field welded to the geomembrane as shown on the Project Drawings so as to prevent leakage. This assembly shall be tested as outlined in section 3.05.B. Alternatively, where field non destructive testing cannot be performed, attachments will be field spark tested by standard holiday leak detectors in accordance with ASTM 6365 Spark testing should be done in areas where both air pressure testing and vacuum testing are not possible.
1. Equipment for Spark testing shall be comprised of but not limited to: A hand held holiday spark tester and conductive wand that generates a high voltage.
 2. The testing activities shall be performed by the Geomembrane Installer by placing an electrically conductive tape or wire beneath the seam prior to welding. A trial seam containing a non welded segment shall be subject to a calibration test to ensure that such a defect (non welded segment) will be identified under the planned machine settings and procedures. Upon completion of the weld, enable the spark tester and hold approximately 25mm (1 in) above the weld moving slowly over the entire length of the weld in accordance with ASTM 6365. If there is no spark the weld is considered to be leak free.
 3. A spark indicates a hole in the seam. The faulty area shall be located, repaired and retested by the Geomembrane Installer.
 4. Care should be taken if flammable gases are present in the area to be tested.

3.05 FIELD QUALITY CONTROL

The Owner's Representative shall be notified prior to all pre-qualification and production welding and testing, or as agreed upon in the pre-construction meeting.

A. Prequalification Test Seams

1. Test seams shall prepare and tested by the Geomembrane Installer to verify that seaming parameters (speed, temperature and pressure of welding equipment) are adequate.
2. Test seams shall be made by each welding technician and tested in accordance with ASTM D 4437 at the beginning of each seaming period. Test seaming shall be performed under the same conditions and with the same equipment and operator combination as production seaming. The test seam shall be approximately 3.3 meters (10 feet) long for fusion welding and 1 meter (3 feet) long for extrusion welding with the seam centered lengthwise. At a minimum, tests seams should be made by each technician 1 time every 4–6 hours; additional tests may be required with changes in environmental conditions.
3. Two 25 mm (1 in) wide specimens shall be die-cut by the Geomembrane Installer from each end of the test seam. These specimens shall be tested by the Geomembrane Installer using a field tensiometer testing both tracks for peel strength and also for shear strength. Each specimen should fail in the parent material and not in the weld, "Film Tear Bond"(F.T.D. failure). Seam separation equal to or greater than 25% of the track width shall be considered a failing test.
4. The minimum acceptable seam strength values to be obtained for all specimens tested are listed in Subsection 3.05.C.4 of this Section. Four specimens shall pass for the test seam to be a passing seam.
5. If a test seam fails, an additional test seam shall be immediately conducted. If the additional test seam fails, the seaming apparatus shall be rejected and not used for production seaming until the deficiencies are corrected and a successful test seam can be produced.
6. A sample from each test seam shall be labeled. The label shall indicate the date, geomembrane temperature, number of the seaming unit, technician performing the test seam and pass or fail description. The sample shall then be given to the Owner's Representative for archiving.

B. Field Seam Non-destructive Testing

1. All field seams shall be non-destructively tested by the Geomembrane Installer over the full seam length before the seams are covered. Each seam shall be numbered or otherwise designated. The location, date, test unit, name of tester and outcome of all non-destructive testing shall be recorded and submitted to the Owner's Representative.
2. Testing should be done as the seaming work progresses, not at the completion of all field seaming, unless agreed to in advance by the Owner's Representative. All defects found during testing shall be numbered and marked immediately after detection. All defects found should be repaired, retested and remarked to indicate acceptable completion of the repair.
3. Non-destructive testing shall be performed using vacuum box, air pressure or spark testing equipment.
4. Non-destructive tests shall be performed by experienced technicians familiar with the specified test methods. The Geomembrane Installer shall demonstrate to the Owner's Representative all test methods to verify the test procedures are valid.
5. Extrusion seams shall be vacuum box tested by the Geomembrane Installer in accordance with ASTM D 4437 and ASTM D 5641 with the following equipment and procedures:
 - a. Equipment for testing extrusion seams shall be comprised of but not limited to: a vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft rubber gasket attached to the base, port hole or valve assembly and a vacuum gauge; a vacuum pump assembly equipped with a pressure controller and pipe connections; a rubber pressure/vacuum hose with fittings and connections; a plastic bucket; wide paint brush or mop; and a soapy solution.
 - b. The vacuum pump shall be charged and the tank pressure adjusted to approximately 35 kPa (5 psig).
 - c. The Geomembrane Installer shall create a leak tight seal between the gasket and geomembrane interface by wetting a strip of geomembrane approximately 0.3m (12 in) by 1.2m (48 in) (length and width of box) with a soapy solution, placing the box over the wetted area, and then compressing the box against the geomembrane. The Geomembrane Installer shall then close the bleed valve, open the vacuum valve, maintain initial pressure of approximately 35 kPa (5 psig) for approximately 5 seconds. The geomembrane should be continuously examined through the viewing window for the presence of soap bubbles, indicating a leak. If no bubbles appear after 5 seconds, the area shall be considered leak free. The box shall be depressurized and moved over the next adjoining area with an appropriate overlap and the process repeated.
 - d. All areas where soap bubbles appear shall be marked, repaired and then retested.
 - e. At locations where seams cannot be non destructively tested, such as pipe penetrations, alternate nondestructive spark testing (as outlined in section 3.04.B) or equivalent should be substituted.
 - f. All seams that are vacuum tested shall be marked with the date tested, the name of the technician performing the test and the results of the test.
6. Double Fusion seams with an enclosed channel shall be air pressure tested by the Geomembrane Installer in accordance with ASTM D 5820 and ASTM D 4437 and the following equipment and procedures:
 - a. Equipment for testing double fusion seams shall be comprised of but not limited to: an air pump equipped with a pressure gauge capable of generating and sustaining a pressure of 210 kPa (30 psig), mounted on a cushion to protect the geomembrane; and a manometer equipped with a sharp hollow needle or other approved pressure feed device.
 - b. The Testing activities shall be performed by the Geomembrane Installer. Both ends of the seam to be tested shall be sealed and a needle or other approved pressure feed device inserted into the tunnel created by the double wedge fusion weld. The air pump shall be adjusted to a pressure of

210 kPa (30 psig), and the valve closed,. Allow 2 minutes for the injected air to come to equilibrium in the channel, and sustain pressure for 5 minutes. If pressure loss does not exceed 28 kPa (4 psig) after this five minute period the seam shall be considered leak tight. Release pressure from the opposite end verifying pressure drop on needle to ensure testing of the entire seam. The needle or other approved pressure feed device shall be removed and the feed hole sealed.

- c. If loss of pressure exceeds 28 kPa (4 psig) during the testing period or pressure does not stabilize, the faulty area shall be located, repaired and retested by the Geomembrane Installer.
- d. Results of the pressure testing shall be recorded on the liner at the seam tested and on a pressure testing record.

C. Destructive Field Seam Testing

1. One destructive test sample per 150 linear m (500 linear ft) seam length or another predetermined length in accordance with GRI GM 14 shall be taken by the Geomembrane Installer from a location specified by the Owner's Representative. The Geomembrane Installer shall not be informed in advance of the sample location. In order to obtain test results prior to completion of geomembrane installation, samples shall be cut by the Geomembrane Installer as directed by the Owner's Representative as seaming progresses.
2. All field samples shall be marked with their sample number and seam number. The sample number, date, time, location, and seam number shall be recorded. The Geomembrane Installer shall repair all holes in the geomembrane resulting from obtaining the seam samples. All patches shall be vacuum box tested or spark tested. If a patch cannot be permanently installed over the test location the same day of sample collection, a temporary patch shall be tack welded or hot air welded over the opening until a permanent patch can be affixed.
3. The destructive sample size shall be 300 mm (12 in) wide by 1 m (36 in) long with the seam centered lengthwise. The sample shall be cut into three equal sections and distributed as follows: one section given to the Owner's Representative as an archive sample; one section given to the Owner's Representative for laboratory testing as specified in paragraph 5 below; and one section retained by the Geomembrane Installer for field testing as specified in paragraph 4 below.
4. For field testing, the Geomembrane Installer shall cut 10 identical 25 mm (1 in) wide replicate specimens from his sample. The Geomembrane Installer shall test five specimens for seam shear strength and five for peel strength. Peel tests will be performed on both inside and outside weld tracks. To be acceptable, 4 of 5 test specimens must pass the stated criteria in section 2.02 with less than 25% separation. If 4 of 5 specimens pass, the sample qualifies for testing by the testing laboratory if required.
5. If independent seam testing is required by the specifications it shall be conducted in accordance with ASTM 5820 or ASTM D4437.
6. Reports of the results of examinations and testing shall be prepared and submitted to the Owner's Representative.
7. For field seams, if a laboratory test fails, that shall be considered as an indicator of the possible inadequacy of the entire seamed length corresponding to the test sample. Additional destructive test portions shall then be taken by the Geomembrane Installer at locations indicated by the Engineer; typically 3 m (10 ft) on either side of the failed sample and laboratory seam tests shall be performed. Passing tests shall be an indicator of adequate seams. Failing tests shall be an indicator of non-adequate seams and all seams represented by the destructive test location shall be repaired with a cap-strip extrusion welded to all sides of the capped area. All cap-strip seams shall be non-destructively vacuum box tested until adequacy of the seams is achieved. Cap strip seams exceeding 50 M in length (150 FT) shall be destructively tested.

D. Identification of Defects

1. Panels and seams shall be inspected by the Installer and Owner's Representative during and after panel deployment to identify all defects, including holes, blisters, undispersed raw materials and

signs of contamination by foreign matter.

- E. Evaluation of Defects: Each suspect location on the liner (both in geomembrane seam and non-seam areas) shall be non-destructively tested using one of the methods described in Section 3.05.B. Each location which fails non-destructive testing shall be marked, numbered, measured and posted on the daily "installation" drawings and subsequently repaired.
1. If a destructive sample fails the field or laboratory test, the Geomembrane Installer shall repair the seam between the two nearest passed locations on both sides of the failed destructive sample location.
 2. Defective seams, tears or holes shall be repaired by reseaming or applying a extrusion welded cap strip.
 3. Reseaming may consist of either:
 - a. Removing the defective weld area and rewelding the parent material using the original welding equipment; or
 - b. Reseaming by extrusion welding along the overlap at the outside seam edge left by the fusion welding process.
 4. Blisters, larger holes, and contamination by foreign matter shall be repaired by patches and/or extrusion weld beads as required. Each patch shall extend a minimum of 150 mm (6 in) beyond all edges of the defects.
 5. All repairs shall be measured, located and recorded.
- F. Verification of Repairs on Seams: Each repair shall be non-destructively tested using either vacuum box or spark testing methods. Tests which pass the nondestructive test shall be taken as an indication of a successful repair. Failed tests shall be reseamed and retested until a passing test results. The number, date, location, technician and test outcome of each patch shall be recorded.
- G. Daily Field Installation Reports: At the beginning of each day's work, the Installer shall provide the Engineer with daily reports for all work accomplished on the previous work day. Reports shall include the following:
1. Total amount and location of geomembrane placed;
 2. Total length and location of seams completed, name of technicians doing seaming and welding unit numbers;
 3. Drawings of the previous day's installed geomembrane showing panel numbers, seam numbers and locations of non-destructive and destructive testing;
 4. Results of pre-qualification test seams;
 5. Results of non-destructive testing; and
 6. Results of vacuum testing of repairs.
- H. Destructive test results shall be reported prior to covering of liner or within 48 hours.

3.06 LINER ACCEPTANCE

- A. Geomembrane liner will be accepted by the Owner's Representative when:
1. The entire installation is finished or an agreed upon subsection of the installation is finished;
 2. All Installer's QC documentation is completed and submitted to the owner
 3. Verification of the adequacy of all field seams and repairs and associated geomembrane testing is complete.

3.07 ANCHOR TRENCH

- A. Construct as specified on the project drawings.

3.08 DISPOSAL OF SCRAP MATERIALS

- B. On completion of installation, the Geomembrane Installer shall dispose of all trash and scrap material in a location approved by the Owner, remove equipment used in connection with the work herein, and shall leave the premises in a neat acceptable manner. No scrap material shall be allowed to remain on the geomembrane surface.

PART 4 MEASUREMENT AND PAYMENT

- A. Payment for geomembrane installation will be as per contract unit price per square foot, as measured parallel to liner surface, including designed anchor trench material and is based upon net lined area.
- B. Net lined area is defined to be the true area of all surfaces to be lined plus designed burial in all anchor trenches, rubsheets, and sacrificial layers.
- C. Prices shall include full compensation for furnishing all labor, material, tools, equipment, and incidentals.
- D. Prices also include doing all the work involved in performing geomembrane installation completely as shown on the drawing, as specified herein, and as directed by the ENGINEER.

PART 5 GRI GM13 SPECIFICATION

"This section shall include the current GRI GM13 manufacturer's specification or a revision of GRI GM13 specific to the unique project requirements and/or standards, as determined by the owner or owners' agent."

ATTACHMENT A

Table 1 *Seam Strength and related Properties of Thermally Bonded Smooth and Textured Linear Low Density Polyethylene (LLDPE) Geomembrane (English Units)*

Geomembrane Nominal Thickness	20 mils	30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils
Hot Wedge Seams ⁽¹⁾								
shear strength ⁽²⁾ , lb/in.	30	45	60	75	90	120	150	180
shear elongation at break ⁽³⁾ , %	50	50	50	50	50	50	50	50
peel strength ⁽²⁾ , lb/in.	25	38	50	63	75	100	125	150
peel separation, %	25	25	25	25	25	25	25	25
Extrusion Fillet Seams ⁽¹⁾								
shear strength ⁽²⁾ , lb/in.	30	45	60	75	90	120	150	180
shear elongation at break ⁽³⁾ , %	50	50	50	50	50	50	50	50
peel strength ⁽²⁾ , lb/in.	25	34	44	57	66	88	114	136
peel separation, %	25	25	25	25	25	25	25	25

Notes for Table 1:

- 1) Also for hot air and ultrasonic seaming methods
- 2) Value listed for shear and peel strength are for 4 out of 5 test specimens; the 5th specimen can be low as 80% of the listed values
- 3) Elongation measurements should be omitted for field testing

Table 2 *Seam Strength and related Properties of Thermally Bonded Smooth and Textured Linear High Density Polyethylene (HDPE) Geomembrane (English Units)*

Geomembrane Nominal Thickness	30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils
Hot Wedge Seams ⁽¹⁾							
shear strength ⁽²⁾ , lb/in.	57	80	100	120	160	200	240
shear elongation at break ⁽³⁾ , %	50	50	50	50	50	50	50
peel strength ⁽²⁾ , lb/in.	45	60	76	91	121	151	181
peel separation, %	25	25	25	25	25	25	25
Extrusion Fillet Seams ⁽¹⁾							
shear strength ⁽²⁾ , lb/in.	57	80	100	120	160	200	240
shear elongation at break ⁽³⁾ , %	50	50	50	50	50	50	50
peel strength ⁽²⁾ , lb/in.	39	52	65	78	104	130	156
peel separation, %	25	25	25	25	25	25	25

Notes for Tables 2:

- 1) Also for hot air and ultrasonic seaming methods
- 2) Value listed for shear and peel strength are for 4 out of 5 test specimens; the 5th specimen can be low as 80% of the listed values
- 3) Elongation measurements should be omitted for field testing

END OF SECTION 02660

SECTION 02726 MANHOLE CONSTRUCTION**PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Work necessary for construction of manholes, complete. Manhole details are shown on the Drawings.

1.2 SUBMITTALS

- A. Shop Drawings: Furnish the following:
 - 1. Precast Manhole Riser Sections: Details of construction.
 - 2. Precast Base Sections: Details of construction.
 - 3. Premolded Joint Filler: Manufacturer's instructions.
 - 4. Manhole Frames and Covers: Details of construction and design data.

PART 2 PRODUCTS**2.1 BASE ROCK**

- A. Clean 1-inch minus gravel or crushed rock uniformly graded from coarse to fine conforming to Article ROCK FOR SURFACING AND BASE, Section SURFACE RESTORATION.

2.2 CONCRETE

- A. Ready-mixed, conforming to ASTM C94, Alternate 2. Compressive field strength for manhole bases shall be not less than 2,500 psi at 28 days. Maximum size of aggregate shall be 1-1/2 inches. Slump shall be between 2 and 4 inches.

2.3 PRECAST MANHOLE RISER SECTIONS

- A. Minimum 48 inches in diameter, conforming to ASTM C478 and the following:
 - 1. Minimum Wall Thickness: 4 inches.
 - 2. Provide eccentric cones for manholes. Cones shall have same wall thickness and reinforcement as riser section.
 - 3. Top and bottom of sections shall be parallel.
 - 4. Joints: Tongue-and-groove or Keylock type. The Contractor's attention is directed to specification for PREFORMED PLASTIC GASKETS hereinafter. At the option of the Contractor, joints may be confined O-ring with rubber gaskets conforming to ASTM C443. However, all manholes on the project must be of the same type.

2.4 PRECAST BASE SECTIONS

- A. Base Sections: Base slab integral with sidewalls.
- B. Base Slab: Minimum 6 inches thick with No. 4 reinforcing bars, 8-inch centers, both directions in center of slab. Tie reinforcing steel to wall steel.

2.5 MANHOLE EXTENSIONS

- A. Concrete Grade Rings for Extensions: Maximum 6 inches high with a minimum of one No. 2 reinforcing bar centered in the ring.
- B. In general, provide manhole extensions on manholes in streets or other locations where a subsequent change in existing grade may be likely. Limit extensions to maximum height of 12 inches.

2.6 PREFORMED PLASTIC GASKETS

- A. Manufacturers: Hamilton Kent Manufacturing Co., Box 178, Kent, OH PART 44240, Kent-Seal No.2. or LCT manhole adapter gaskets as manufactured by Romac Industries, INC, PO Box 3212, Seattle, WA 98114.

2.8 MANHOLE ADAPTER GASKETS FOR PLACING PVC PIPE IN MANHOLE CUT OUTS

- A. Gasket shall be designed to be used on PVC sewer pipe.
- B. Gasket material shall consist of Styrene Butadiene Rubber as per ASTM D 2000 MBA 710. Gaskets shall meet ASTM #M2AA610F13C12F17 test specification.
- C. Gaskets shall be LCT manhole adapter gaskets as manufactured by Romac Industries, INC, PO Box 3212, Seattle, WA 98114 or equivalent.

2.9 MANHOLE ADAPTER GASKETS FOR PLACING DI PIPE IN MANHOLE CUT OUTS

- A. Gasket shall be designed to be used on DI sewer pipe.
- B. Gasket material shall consist of Styrene Butadiene Rubber as per ASTM D 2000 MBA 710. Gaskets shall meet ASTM #M2AA610F13C12F17 test specification.
- C. Gaskets shall be LCT manhole adapter gaskets as manufactured by Romac Industries, INC, PO Box 3212, Seattle, WA 98114 or equivalent.

2.9 MANHOLE FRAMES AND COVERS

- A. Cast or ductile iron of size and shape shown, with the word **SEWER** in 2-inch raised letters.
- B. Castings:
 - 1. Tough, close-grained gray iron, sound, smooth, clean, free from blisters, blowholes, shrinkage, cold shuts, and defects.
 - 2. Conform to ASTM A48, Class 30B, for cast iron and ASTM A536, Grade 6T-40-12 for ductile iron.
 - 3. Plane or grind bearing surfaces to ensure flat, true surfaces.
- C. Covers: True and seat within ring at all points.

2.10 CLEANOUT FRAMES AND COVERS

- A. Cast or ductile iron of size and shape shown.
- B. Castings:
 - 1. Tough, close-grained gray iron, sound, smooth, clean, free from blisters, blowholes, shrinkage, cold shuts, and defects.
 - 2. Conform to ASTM A48, Class 30B, for cast iron and ASTM A536, Grade 65-40-12 for ductile iron.
 - 3. Plane or grind bearing surfaces to ensure flat, true surfaces.
- C. Covers: True and seat within frame at all points.

2.11 POLLUTION CONTROL MANHOLES

- A. Precast concrete sections and base. See typical detail in the Drawings
- B. Baffles, TEE's and 90's:
 - 1. Appurtenances shall be of type and size as indicated on the plans.
 - 2. Use restrained joints when indicated.
- C. Catch basin: Maintain at least 18-inch capacity below outlet invert for settling.

2.12 SPECIAL MANHOLES FOR NON-SEWER VAULT APPLICATIONS

- A. See drawings for specific details pertaining to each application.
- B. Base sections:
 - 1. Provide special brackets, saddles, pipe stands or attachments as required.
 - 2. Provide special cut-out windows as indicated on the Drawings such that manhole section will not interfere with pass-through piping.
 - 3. Refer to other sections of this specifications for moisture sealing and waterproofing penetrations of pass-through piping.
 - 4. Drainage: Install drains in bottom of units where indicated. Coordinate with drainage provisions indicated.
- C. Cover Legend: "Water", "Signal", "Electric", or as indicated.
- D. Top Section: Cone or flat section as indicated on Drawings. Hatched openings as called-out on Drawings. Unless otherwise indicated use standard duty manhole frames and covers on precast concrete cone sections.

PART 3 EXECUTION**3.1 EXCAVATION AND BACKFILL**

- A. As specified in Section TRENCH EXCAVATION AND BACKFILL.
- B. Backfill Around Manholes: Use highest class of trench backfill immediately adjacent, as shown on the Drawings.

3.2 BASE ROCK

- A. Remove water from the excavation.
- B. Place minimum of 6 inches of rock base and thoroughly compact with a mechanical vibrating or power tamper.

3.3 CONCRETE BASE

- A. Construct concrete base as shown on the Drawings.
- B. Vibrate to density concrete and screed so first precast manhole section to be placed has a level, uniform bearing for full circumference.
- C. Deposit sufficient mortar on base to assure watertight seal between base and manhole wall, or place first precast section of manhole in concrete base before concrete has set. Properly locate and plumb first section.
- D. If material in bottom of trench is unsuitable for supporting manhole, excavate below the base as directed by Engineer, and backfill to required grade with rock, as specified in Section TRENCH EXCAVATION AND BACKFILL, Article FOUNDATION STABILIZATION.

3.4 PLACING PRECAST MANHOLE SECTIONS

- A. Section Installation:
 - 1. Thoroughly clean ends of sections to be joined.
 - 2. Thoroughly wet joint with water prior to placing mortar.
 - 3. Place mortar on grove of lower section.
 - 4. Set next section in-place.
 - 5. Fill joint completely with mortar of proper consistency.
 - 6. Trowel interior and exterior surfaces smooth on standard tongue-and-groove joints.
 - 7. Prevent mortar from drying out and cure by applying an approved curing compound or comparable approved method.

8. Do not use mortar mix for longer than 30 minutes.
9. Chip out and replace cracked or defective mortar.
10. Completed Manholes: Rigid and watertight

B. Preformed Plastic Gaskets: If used in lieu of mortar joints, install in accordance with manufacture's instructions and the following:

1. Carefully inspect precast manhole sections to be joined.
2. Do not use sections with chips or cracks in the tongue.
3. Use only pipe primer furnished by gasket manufacturer.
4. Install gasket material in accordance with manufacturer's instructions.
5. Completed Manholes: Rigid and watertight.

C. Rubber Gasketed Joints: Install in accordance with manufacturer's instructions.

3.5 MANHOLE INVERT

- A. Construct as shown with smooth transitions to ensure an unobstructed flow through manhole. Remove sharp edges or rough sections which tend to obstruct flow.
- B. Where full section of pipe is laid through manhole, break out top section as shown and cover exposed edge of pipe completely with mortar. Trowel mortar surfaces smooth.
- C. When connecting into manholes, invert of pipes and sumps will be constructed as shown on drawings.

3.6 DROP ASSEMBLIES

- A. Construct drop assemblies as shown, at locations shown.
- B. Ductile Iron Drop Assembly
 1. Extend ductile iron pipe from the drop to a minimum of 3 feet beyond the manhole excavation into the trench, and connect to sewer pipe with an approved adapter.
 2. Support lower drop elbow by concrete poured monolithically with manhole base.
- B. PVC Inside Drop Assembly
 1. Provide flexible joint within 6-inches of concrete encasement.
 2. Provide rubber manhole adapter gasket at pipe entry
 2. Anchor PVC pipe flush with manhole wall. Fasten with straps with 1-1/2-inch x 10 gage stainless steel straps and 2-1/2-inch stainless steel bolts space no more than 4 foot in spacing.

3.7 RIGID PIPE FLEXIBLE JOINTS

- A. Provide joints in all rigid pipe not more than 1-1/2 feet from manhole walls. Lay pipes entering manholes on compacted base rock extending to undisturbed earth.
- B. Where last joint of the line laid up to manhole is between 1-1/2 and 6 feet from manhole wall, provide a flexible joint in the manhole wall using:
 1. "Kor-N-Seal" flexible rubber boot with stainless steel accessories as manufactured by Kor-N-Seal Co. (NPC Systems, Inc.), Milford, New Hampshire 03055.
 2. "Z-Lok XP" or "A-LOK" flexible connectors as manufactured by A-Lok Products, Inc., Tullytown, Pennsylvania 19007.
- C. Shorten pipes laid out of manhole to ensure first joint is no more than 1-1/2 feet from manhole base.

3.8 PIPE STUBOUTS FOR FUTURE SEWER CONNECTIONS

- A. Install as shown and as follows:

1. Plugs:
 - a. Install plugs in end of stubouts with gasket joints similar to sewer pipe being used.
 - b. Plugs shall withstand internal or external pressures without leakage.
 - c. Brace plugs to prevent blowoffs during testing.
2. Markers: Install markers as specified in Section SEWER SERVICE CONNECTIONS, Article SERVICE CONNECTION MARKERS.

3.9 MANHOLE EXTENSIONS

- A. Install extensions as shown, to height not exceeding 12 inches.
- B. Lay grade rings in mortar with sides plumb and tops level. Seal joints with mortar as specified for manhole sections, and make watertight.

3.10 MANHOLE FRAMES AND COVERS

- A. Install frames on top of manholes to positively prevent infiltration of surface or groundwater into manholes.
- B. Set frames on preformed plastic gaskets.
- C. Set tops of covers flush with surface of adjoining pavement or ground surface, unless otherwise shown or directed.

PART 4 PAYMENT

4.1 MANHOLES

- A. Payment for work necessary to construct manholes will be included in the price stated in the Proposal for manholes 6 feet deep, plus the unit price per foot stated in the Proposal for extra depth of manholes over 6 feet, including extensions if required. No deduction will be made from the manhole price for depths less than 6 feet.
- B. Manhole depths will be measured from top of manhole frame and cover to manhole invert at center of manhole. Depth will be to the nearest foot, as measured by Engineer. Payment will include compensation for a complete manhole including base, frame and cover, ring extensions, and for overexcavating and placing the compacted 6-inch layer of base rock under concrete base.

4.2 DROP ASSEMBLIES

- A. Payment for work necessary to construct drop assemblies as shown or as specified, regardless of size, will be included in the price stated in the Proposal for drop assemblies each.

4.3 POLLUTION CONTROL MANHOLES AND SPECIAL MANHOLES FOR NON-SEWER VAULT APPLICATIONS

- A. Payment for work necessary to construct pollution control manholes and special manholes for non-sewer vault applications as shown or as specified, regardless of size and depth, will be included in the price stated in the Proposal for each. Work will include any materials or trenching required to provide vault drains if needed, frames and lids, ladders, and extensions if required.

END OF SECTION 02726

SECTION 02731 – CHLORINE AND PH MONITOR ASSUMBLY**PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Work necessary to furnish all materials, labor, and work necessary to install and wire complete Cole Parmer Magnetic Drive Pump T-72010-10, Analytical Technology, Inc. Residual Chlorine and pH Monitor Q46H/62.

1.2 SUBMITTALS

- A. Residual chlorine and pH monitor manufactures drawings showing all critical dimensions, principal parts and principal materials.
- B. Manufacturers' installation instructions.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Ship all chlorine and pH monitor, pump and other devices with suitable packaging to protect products from damage.

PART 2 - PRODUCTS**2.1 RESIDUAL CHLORINE AND pH MONITOR**

- A. Acceptable Manufacturers:
 - 1. Analytical Technology, Inc.
 - a. Shall be Model Q46H/62 with 120 to 100 volt alternating current power source, constant head flowcell, pH sensor and adapter for overflow cell, panel with flow controls, without flow switch, NEMA 4x Junction box and 100foot sensor interconnect cable.
 - 2. The residual chlorine and pH monitor fabrication, engineering and customer support shall all be provided by the same company. Outsourcing any of these components is not acceptable.
 - 3. To assure quality control and single source accountability the same manufacturer shall fabricate and fully assemble the residual chlorine and pH monitor and all components.
 - 4. Or approved equal.

2.2 MAGNETIC DRIVE PUMP

- A. Acceptable Manufacturers:
 - 1. Cole Parmer
 - a. Shall be model T-72010-10 with 120 to 100 volt alternating current power source, maximum between 1 to 10 psi and pump to a height of 6 feet.
 - 2. The magnetic drive pump fabrication, engineering and customer support shall all be provided by the same company. Outsourcing any of these components is not acceptable.
 - 3. To assure quality control and single source accountability the same manufacturer shall fabricate and fully assemble the magnetic drive pump and all components.

2.3 TUBE, WYE AND FOOT VALVE

- A. Furnish non-reinforced flexible PVC pipe capable of:
 - Temperature Range: -30°F to +150°F
 - Hardness: 80A Durometer
 - Resin Compliance: Non Reinforced PVC, FDA for Food Contact

Suggested Fittings: Barb
Color: Clear

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Verify that dimensions are correct and project conditions are suitable for installation. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. Thoroughly clean and remove all shipping materials prior to setting.
- C. Install products in accordance with plans, general comments below and the manufacturer's instructions.
- D. Testing of tubing and fitting will be tested by visual inspection while operating. Tubing that has obvious leaks or that doesn't operate as designed will be rejected.

PART 4 - PAYMENT

4.1 GENERAL

- A. Payment for installation of chlorine and ph monitor will be at the lump sum listed in the proposal. The price shall included all labor, work, and materials necessary to install the meter complete, including supports, wiring, piping modifications and calibration.

END OF SECTION 02731

SECTION 02821 - CHAIN-LINK FENCES AND GATES**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Galvanized steel chain-link fabric.
 - 2. Gates, posts, and hardware.
- B. Related Sections include the following:
 - 1. Division 2 Section "Earthwork" for filling and for grading work.
 - 2. Division 3 Section "Cast-in-Place Concrete".
 - 3. Division 16 Sections for electrical service and connections for motor operators, controls, limit switches, and other powered devices and for system disconnect switches.

1.3 SUBMITTALS

- A. Product Data: Material descriptions, construction details, dimensions of individual components and profiles, and finishes for the following:
 - 1. Fence and gate posts, rails, and fittings.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed chain-link fences and gates similar in material, design, and extent to those indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. Source Limitations for Chain-Link Fences and Gates: Obtain each color, grade, finish, type, and variety of component for chain-link fences and gates from one source with resources to provide chain-link fences and gates of consistent quality in appearance and physical properties.

1.5 PROJECT CONDITIONS

- A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

PART 2 - PRODUCTS**2.1 CHAIN-LINK FENCE FABRIC**

1. Steel Chain-Link Fence Fabric: Provide fabric fabricated in one-piece widths for fencing in height of 12 feet (3.6 m) and less. Comply with CLFMI's "Product Manual".

- B. Selvage: Knuckled at both selvages.

2.2 INDUSTRIAL SWING GATES

- A. General: Comply with ASTM F 900 for the following swing-gate types:

1. Double gate.

- B. Metal Pipe and Tubing: Galvanized steel. Comply with ASTM F 1083 and ASTM F 1043 for materials and protective coatings.

- C. Frames and Bracing: Fabricate members from round tubing with outside dimension and weight according to ASTM F 900 for the following gate fabric height:

1. Gate Fabric Height: More than 6 feet (1.83 m).

- D. Gate Posts: Fabricate members from round galvanized steel pipe with outside dimension and weight according to ASTM F 900 for the following gate fabric heights and leaf widths:

1. Gate Fabric Height by Leaf Width: Over 6 feet (1.83 m) by over 6 feet (1.83 m) but not over 12 feet (3.66 m).

- E. Hardware: Latches permitting operation from both sides of gate, hinges, center gate stops and, for each gate leaf more than 5 feet (1.5 m) wide, keepers.

2.3 FITTINGS

- A. General: Provide fittings for a complete fence installation, including special fittings for corners. Comply with ASTM F 626.

- B. Barbed Wire Arms: Hot-dip galvanized pressed steel or hot-dip galvanized cast iron. Provide the following type, according to ASTM F 626, with clips, slots, or other means for attaching strands of barbed wire, and means for attaching to posts. Provide line posts with arms designed with opening to accommodate top rail or tension wire. Provide corner arms at fence corner posts, unless extended posts are indicated.

1. Type I, single slanted arm.

- C. Tie Wires, Clips, and Fasteners: Provide the following types according to ASTM F 626:

1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, complying with the following:

- a. Hot-Dip Galvanized Steel: 0.106-inch- (2.69-mm-) diameter wire; galvanized coating thickness matching coating thickness of chain-link fence fabric.

2.4 BARBED WIRE

- A. Zinc-Coated Steel Barbed Wire: Comply with ASTM A 121, Standard grade for the following two-strand barbed wire:
 - 1. Standard Size and Construction: 0.099-inch- (2.51-mm-) diameter line wire with 0.080-inch- (2.03-mm-) diameter, 2-point round barbs spaced not more than 5 inches (127 mm) o.c.

2.5 CAST-IN-PLACE CONCRETE

- A. General: Comply with ACI 301 for cast-in-place concrete and Section 03300 – Cast-in-Place Concrete.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for a verified survey of property lines and legal boundaries, site clearing, earthwork, pavement work, and other conditions affecting performance.
 - 1. Do not begin installation before final grading is completed, unless otherwise permitted by Engineer.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. General: Install chain-link fencing to comply with ASTM F 567 and more stringent requirements specified.
 - 1. Install fencing on established boundary lines inside property line.
- B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed or compacted soil.
- C. Post Setting: Hand-excavate holes for post foundations in firm, undisturbed or compacted soil. Set line gate posts in concrete footing. Protect portion of posts aboveground from concrete splatter. Place concrete around posts and vibrate or tamp for consolidation. Using mechanical devices to set line posts per ASTM F 567 is permitted. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during placement and finishing operations until concrete is sufficiently cured.
 - 1. Dimensions and Profile: 8-feet tall before barbed wire
 - 2. Exposed Concrete Footings: Extend concrete 2 inches (50 mm) above grade, smooth, and shape to shed water.

3.3 CHAIN-LINK FENCE INSTALLATION

- A. Bottom Rails: Install, spanning between posts, using fittings and accessories.

- B. Chain-Link Fabric: Apply fabric to inside of enclosing framework. Leave 1 inch (25.4 mm) between finish grade or surface and bottom selvage, unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.
- C. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric per ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.
 - 1. Maximum Spacing: Tie fabric to line posts 12 inches (304 mm) o.c. and to braces 24 inches (609 mm) o.c.
- D. Fasteners: Install nuts for tension bands and carriage bolts on the side of the fence opposite the fabric side. Peen ends of bolts or score threads to prevent removal of nuts.
- E. Barbed Wire: Install barbed wire uniformly spaced angled toward security side of fence. Pull wire taut and install securely to extension arms and secure to end post or terminal arms.

3.4 GATE INSTALLATION

- A. General: Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.5 ADJUSTING

- A. Gate: Adjust gate to operate smoothly, easily, and quietly, free from binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

PART 4 - PAYMENT

4.1 8-FT GATES AND HARDWARE

- A. Payment for work specified in this section will be made at the lump sum price stated in the Proposal. All necessary materials, equipment and labor shall be provided for a complete job.

4.2 8-FT. CHAIN LINK FENCE

- A. Payment for work specified in this section will be made at the unit price per linear foot stated in the Proposal. All necessary materials, equipment and labor shall be provided for a complete job. No payment will be made for loss of anticipated profits or overhead should this item be reduced.

END OF SECTION 02821

SECTION 03300 - CAST-IN-PLACE CONCRETE**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mix design, placement procedures, and finishes.
- B. Related Sections include the following:
 - 1. Division 2 Section "Earthwork" for fill under slabs-on-grade.

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume.

1.4 SUBMITTALS

- A. Product Data: For each type of manufactured material and product indicated.
- B. Design Mixes: For each concrete mix. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.
 - 1. Indicate amounts of mix water to be withheld for later addition at Project site.
- C. Steel Reinforcement Shop Drawings: Details of fabrication, bending, and placement, prepared according to ACI 315, "Details and Detailing of Concrete Reinforcement." Include material, grade, bar schedules, stirrup spacing, bent bar diagrams, arrangement, and supports of concrete reinforcement. Include special reinforcement required for openings through concrete structures.
- D. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork. Design and engineering of formwork are Contractor's responsibility.
 - 1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and installing and removing reshoring.
- E. Welding Certificates: Copies of certificates for welding procedures and personnel.
- F. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials:

- G. Material Certificates: Signed by manufacturers certifying that each of the following items complies with requirements:
1. Cementitious materials and aggregates.
 2. Form materials and form-release agents.
 3. Steel reinforcement and reinforcement accessories.
 4. Fiber reinforcement.
 5. Admixtures.
 6. Waterstops.
 7. Curing materials.
 8. Floor and slab treatments.
 9. Bonding agents.
 10. Adhesives.
 11. Vapor retarders.
 12. Epoxy joint filler.
 13. Joint-filler strips.
 14. Repair materials.
- H. Minutes of preinstallation conference.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed concrete Work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for formwork and shoring and reshoring installations that are similar to those indicated for this Project in material, design, and extent.
- C. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.
1. Manufacturer must be certified according to the National Ready Mixed Concrete Association's Certification of Ready Mixed Concrete Production Facilities.
- D. Testing Agency Qualifications: The contractor shall be required to hire the services of an independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.
1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
- E. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, each aggregate from one source, and each admixture from the same manufacturer.
- F. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code-- Reinforcing Steel."
- G. ACI Publications: Comply with the following, unless more stringent provisions are indicated:
1. ACI 301, "Specification for Structural Concrete."
 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle steel reinforcement to prevent bending and damage.
 - 1. Avoid damaging coatings on steel reinforcement.
 - 2. Repair damaged epoxy coatings on steel reinforcement according to ASTM D 3963/D 3963M.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

- A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
- B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.
- C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.
- D. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.
- E. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.
- F. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch (19 by 19 mm), minimum.
- G. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
 - 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- H. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
 - 1. Furnish ties that, when removed, will leave holes not larger than 1 inch (25 mm) in diameter in concrete surface.

2.2 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
- B. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M, and as follows:
- C. Steel Bar Mats: ASTM A 184/A 184M, assembled with clips.
 - 1. Steel Reinforcement: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed bars.

- D. Plain-Steel Wire: ASTM A 82, as drawn.
- E. Plain-Steel Welded Wire Fabric: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.
- F. Deformed-Steel Welded Wire Fabric: ASTM A 497, flat sheet.

2.3 REINFORCEMENT ACCESSORIES

- A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete or fiber-reinforced concrete of greater compressive strength than concrete, and as follows:
 - 1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected or CRSI Class 2 stainless-steel bar supports.
- B. Joint Dowel Bars: Plain-steel bars, ASTM A 615/A 615M, Grade 60 (Grade 420). Cut bars true to length with ends square and free of burrs.

2.4 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Type I/II.
- B. Portland Cement: ASTM C 150, Type II.
- C. Portland Cement: ASTM C 150, Type III.
- D. Normal-Weight Aggregate: ASTM C 33, uniformly graded, and as follows:
 - 1. Class: Severe weathering region, but not less than 3S.
 - 2. Nominal Maximum Aggregate Size: 3/4 inch (19 mm).
 - 3. Combined Aggregate Gradation: Well graded from coarsest to finest with not more than 18 percent and not less than 8 percent retained on an individual sieve, except that less than 8 percent may be retained on coarsest sieve and on No. 50 (0.3-mm) sieve, and less than 8 percent may be retained on sieves finer than No. 50 (0.3 mm).
- E. Water: Potable and complying with ASTM C 94.

2.5 ADMIXTURES

- A. General: Admixtures certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material and to be compatible with other admixtures and cementitious materials. Do not use admixtures containing calcium chloride.
- B. Air-Entraining Admixture: ASTM C 260.
- C. Water-Reducing Admixture: ASTM C 494, Type A.
- D. Water-Reducing and Accelerating Admixture: ASTM C 494, Type E.
- E. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.

2.6 WATERSTOPS

- A. Flexible Rubber Waterstops: CE CRD-C 513, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.
 - 1. Profile: Flat, dumbbell with center bulb.
 - 2. Profile: Ribbed with center bulb.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Rubber Waterstops:
 - a. Greenstreak.
 - b. Progress Unlimited Inc.
 - c. Westec Barrier Technologies; Div. of Western Textile Products, Inc.
 - d. Williams Products, Inc.
- C. Self-Expanding Strip Waterstops: Manufactured rectangular or trapezoidal strip, sodium bentonite or other hydrophylic material for adhesive bonding to concrete.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Volclay Waterstop-RX; Colloid Environmental Technologies Co.
 - b. Con Seal CS-231; Concrete Sealants Inc.
 - c. Swellseal Joint; De Neef Construction Chemicals (U.S.) Inc.
 - d. Hydrotite; Greenstreak.
 - e. Mirastop; Mirafi Moisture Protection, Div. of Royal Ten Cate (USA), Inc.
 - f. Adeka Ultra Seal; Mitsubishi International Corporation.
 - g. Superstop; Progress Unlimited Inc.

2.7 VAPOR RETARDERS

- A. Vapor Retarder: ASTM E 1745, Class C, of one of the following materials; or polyethylene sheet, ASTM D 4397, not less than 6 mils (0.25 mm) thick:
 - 1. Nonwoven, polyester-reinforced, polyethylene coated sheet; 6 mils (0.25 mm) thick.
 - 2. Three-ply, nylon- or polyester-cord-reinforced, laminated, high-density polyethylene sheet; 7.8 mils (0.18 mm) thick.
- B. Granular Fill: Clean mixture of crushed stone or crushed or uncrushed gravel; ASTM D 448, Size 57, with 100 percent passing a 1-1/2-inch (38-mm) sieve and 0 to 5 percent passing a No. 8 (2.36-mm) sieve.

2.8 FLOOR AND SLAB TREATMENTS (where specified)

- A. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery with emery aggregate containing not less than 50 percent aluminum oxide and not less than 25 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.
- B. Penetrating Liquid Floor Treatment: Chemically reactive, waterborne solution of inorganic silicate or silicate materials and proprietary components; odorless; colorless; that penetrates, hardens, and densifies concrete surfaces.

- C. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

1. Penetrating Liquid Floor Treatment:
 - a. Titan Hard; Burke Group, LLC (The).
 - b. Chemisil Plus; ChemMasters.
 - c. Intraseal; Conspec Marketing & Manufacturing Co., Inc.
 - d. Ashford Formula; Curecrete Chemical Co., Inc.
 - e. Day-Chem Sure Hard; Dayton Superior Corporation.
 - f. Euco Diamond Hard; Euclid Chemical Co.
 - g. Seal Hard; L&M Construction Chemicals, Inc.
 - h. Vexcon Starseal PS; Vexcon Chemicals, Inc.

2.9 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) dry.
- C. Water: Potable.
- D. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.
- E. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.
- F. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 1. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound:
 - a. Klear-Kote Cure-Sealer-Hardener, 30 percent solids; Burke Group, LLC (The).
 - b. Polyseal WB; ChemMasters.
 - c. UV Safe Seal; Lambert Corporation.
 - d. Lumiseal WB Plus; L&M Construction Chemicals, Inc.
 - e. Vocomp-30; W. R. Meadows, Inc.
 - f. Metcure 30; Metalcrete Industries.
 - g. Vexcon Starseal 1315; Vexcon Chemicals, Inc.

2.10 RELATED MATERIALS

- A. Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.
- B. Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber, or ASTM D 1752, cork or self-expanding cork.
- C. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- D. Reglets: Fabricate reglets of not less than 0.0217-inch- (0.55-mm-) thick galvanized steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

2.11 CONCRETE MIXES

- A. Prepare design mixes for each type and strength of concrete determined by either laboratory trial mix or field test data bases, as follows:
 - 1. Proportion normal-weight concrete according to ACI 211.1 and ACI 301.
- B. Use a qualified independent testing agency for preparing and reporting proposed mix designs for the laboratory trial mix basis.
- C. Footings and Foundation Walls: Proportion normal-weight concrete mix as follows:
 - 1. Compressive Strength (28 Days): 4000 psi (27.6 MPa).
 - 2. Maximum Slump: 4 inches (100 mm).
- D. Slab-on-Grade: Proportion normal-weight concrete mix as follows:
 - 1. Compressive Strength (28 Days): 4000 psi (27.6 MPa).
 - 2. Maximum Slump: 5 inches (125 mm).
- E. Air Content: Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content of 2 to 4 percent, unless otherwise indicated.
- F. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

2.12 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.13 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94, and furnish batch ticket information.
- B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94. Mix concrete materials in appropriate drum-type batch machine mixer.
 - 1. For mixer capacity of 1 cu. yd. (0.76 cu. m) or smaller, continue mixing at least one and one-half minutes, but not more than five minutes after ingredients are in mixer, before any part of batch is released.
 - 2. For mixer capacity larger than 1 cu. yd. (0.76 cu. m), increase mixing time by 15 seconds for each additional 1 cu. yd. (0.76 cu. m).
 - 3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mix type, mix time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION**3.1 FORMWORK**

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until concrete structure can support such loads.

- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
- C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
 - 1. Class B, 1/4 inch (6 mm).
- D. Construct forms tight enough to prevent loss of concrete mortar.
- E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical. Kerf wood inserts for forming keyways, reglets, recesses, and the like, for easy removal.
 - 1. Do not use rust-stained steel form-facing material.
- F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- H. Chamfer exterior corners and edges of permanently exposed concrete.
- I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use Setting Drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 1. Install anchor bolts, accurately located, to elevations required.

3.3 REMOVING AND REUSING FORMS

- A. General: Formwork, for sides of beams, walls, columns, and similar parts of the Work, that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 24 hours after placing concrete provided concrete is hard enough to not be damaged by form-removal operations and provided curing and protection operations are maintained.

- B. Leave formwork, for beam soffits, joists, slabs, and other structural elements, that supports weight of concrete in place until concrete has achieved the following:
 - 1. 28-day design compressive strength.
 - 2. At least 70 percent of 28-day design compressive strength.
 - 3. Determine compressive strength of in-place concrete by testing representative field- or laboratory-cured test specimens according to ACI 301.
 - 4. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- C. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
- D. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Engineer.

3.4 SHORES AND RESHORES

- A. Comply with ACI 318 (ACI 318M), ACI 301, and recommendations in ACI 347R for design, installation, and removal of shoring and reshoring.
- B. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.
- C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.5 VAPOR RETARDERS

- A. Vapor Retarder: Place, protect, and repair vapor-retarder sheets according to ASTM E 1643 and manufacturer's written instructions.
- B. Fine-Graded Granular Material: Cover vapor retarder with fine-graded granular material, moisten, and compact with mechanical equipment to elevation tolerances of plus 0 inch (0 mm) or minus 3/4 inch (19 mm).
- C. Granular Fill: Cover vapor retarder with granular fill, moisten, and compact with mechanical equipment to elevation tolerances of plus 0 inch (0 mm) or minus 3/4 inch (19 mm).
 - 1. Place and compact a 1/2-inch- (13-mm-) thick layer of fine-graded granular material over granular fill.

3.6 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
 - 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
 - 1. Shop- or field-weld reinforcement according to AWS D1.4, where indicated.
- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- E. Install welded wire fabric in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

3.7 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Engineer.
 - 1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
 - 2. Form from preformed galvanized steel, plastic keyway-section forms, or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
 - 3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
 - 4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
 - 5. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
 - 6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 - 7. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness, as follows:
 - 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch (3 mm). Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
 - 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
- D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.
2. Terminate full-width joint-filler strips not less than 1/2 inch (12 mm) or more than 1 inch (25 mm) below finished concrete surface where joint sealants, specified in Division 7 Section "Joint Sealants," are indicated.
3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

3.8 WATERSTOPS

- A. Flexible Waterstops: Install in construction joints as indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of Work. Field-fabricate joints in waterstops according to manufacturer's written instructions.
- B. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions, bonding or mechanically fastening and firmly pressing into place. Install in longest lengths practicable.

3.9 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Do not add water to concrete during delivery, at Project site, or during placement, unless approved by Engineer.
- C. Before placing concrete, water may be added at Project site, subject to limitations of ACI 301.
 1. Do not add water to concrete after adding high-range water-reducing admixtures to mix.
- D. Deposit concrete continuously or in layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as specified. Deposit concrete to avoid segregation.
- E. Deposit concrete in forms in horizontal layers no deeper than 24 inches (600 mm) and in a manner to avoid inclined construction joints. Place each layer while preceding layer is still plastic, to avoid cold joints.
 1. Consolidate placed concrete with mechanical vibrating equipment. Use equipment and procedures for consolidating concrete recommended by ACI 309R.
 2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the vibrator. Place vibrators to rapidly penetrate placed layer and at least 6 inches (150 mm) into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mix constituents to segregate.
- F. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
 1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 2. Maintain reinforcement in position on chairs during concrete placement.

3. Screed slab surfaces with a straightedge and strike off to correct elevations.
 4. Slope surfaces uniformly to drains where required.
 5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, free of humps or hollows, before excess moisture or bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
- G. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
1. When air temperature has fallen to or is expected to fall below 40 deg F (4.4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) at point of placement.
 2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators, unless otherwise specified and approved in mix designs.
- H. Hot-Weather Placement: Place concrete according to recommendations in ACI 305R and as follows, when hot-weather conditions exist:
1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
 3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.10 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defective areas repaired and patched. Remove fins and other projections exceeding ACI 347R limits for class of surface specified.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defective areas. Remove fins and other projections exceeding 1/8 inch (3 mm) in height.
1. Apply to concrete surfaces exposed to public view or to be covered with a coating or covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, or painting.
 2. Do not apply rubbed finish to smooth-formed finish.
- C. Rubbed Finish: Apply the following to smooth-formed finished concrete:
1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
 2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into

voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.

3. Cork-Float Finish: Wet concrete surfaces and apply a stiff grout. Mix one part portland cement and one part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.

- D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.11 FINISHING FLOORS AND SLABS

- A. General: Comply with recommendations in ACI 302.1R for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbled. Use stiff brushes, brooms, or rakes.
 1. Apply scratch finish to surfaces indicated and to surfaces to receive concrete floor topping or mortar setting beds for ceramic or quarry tile, portland cement terrazzo, and other bonded cementitious floor finishes.
- C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraighening until surface is left with a uniform, smooth, granular texture.
 1. Apply float finish to surfaces indicated, to surfaces to receive trowel finish, and to floor and slab surfaces to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.
- D. Trowel Finish: After applying float finish, apply first trowel finish and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
 1. Apply a trowel finish to surfaces indicated and to floor and slab surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin film-finish coating system
 2. Finish surfaces to the following tolerances, measured within 24 hours according to ASTM E 1155/E 1155M for a randomly trafficked floor surface:
 - a. Specified overall values of flatness, F(F) 25; and levelness, F(L) 20; with minimum local values of flatness, F(F) 17; and levelness, F(L) 15.
 3. Finish and measure surface so gap at any point between concrete surface and an unleveled freestanding 10-foot- (3.05-m-) long straightedge, resting on two high spots and placed anywhere on the surface, does not exceed the following:
 - a. 3/16 inch (4.8 mm).

- E. Trowel and Fine-Broom Finish: Apply a partial trowel finish, stopping after second troweling, to surfaces indicated and to surfaces where ceramic or quarry tile is to be installed by either thickset or thin-set method. Immediately after second troweling, and when concrete is still plastic, slightly scarify surface with a fine broom.
- F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
 - 1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Engineer before application.
- G. Slip-Resistive Aggregate Finish: Before final floating, apply slip-resistive aggregate finish where indicated and to concrete stair treads, platforms, and ramps. Apply according to manufacturer's written instructions and as follows:
 - 1. Uniformly spread 25 lb/100 sq. ft. (12 kg/10 sq. m) of dampened slip-resistive aggregate over surface in one or two applications. Tamp aggregate flush with surface, but do not force below surface.
 - 2. After broadcasting and tamping, apply float finish.
 - 3. After curing, lightly work surface with a steel wire brush or an abrasive stone, and water to expose slip-resistive aggregate.

3.12 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete Work.
- B. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates of manufacturer furnishing machines and equipment.
- C. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel-finish concrete surfaces.

3.13 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with recommendations in ACI 305R for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing by one or a combination of the following methods:

- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces, by one or a combination of the following methods:
1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.
 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
 - a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
 - b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
 - c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer recommends for use with floor coverings.
 3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
 4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.14 LIQUID FLOOR TREATMENTS

- A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.
1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
 2. Do not apply to concrete that is less than seven days old.
 3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.
- B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller according to manufacturer's written instructions.

3.15 JOINT FILLING

- A. Prepare, clean, and install joint filler according to manufacturer's written instructions.

1. Defer joint filling until concrete has aged at least six months. Do not fill joints until construction traffic has permanently ceased.
- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.
- C. Install semirigid epoxy joint filler full depth in saw-cut joints and at least 2 inches (50 mm) deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.16 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Engineer. Remove and replace concrete that cannot be repaired and patched to Engineer's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 (1.2-mm) sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch (13 mm) in any dimension in solid concrete but not less than 1 inch (25 mm) in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
 2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
 3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Engineer.
- D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
 1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch (0.25 mm) wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
 2. After concrete has cured at least 14 days, correct high areas by grinding.
 3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
 4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
 5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch (6 mm) to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.

6. Repair defective areas, except random cracks and single holes 1 inch (25 mm) or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least 3/4 inch (19 mm) clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mix as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
 7. Repair random cracks and single holes 1 inch (25 mm) or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.
- E. Perform structural repairs of concrete, subject to Engineer's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Engineer's approval.

3.17 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified independent testing and inspecting agency to sample materials, perform tests, and submit test reports during concrete placement according to requirements specified in this Article.
- B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mix exceeding 5 cu. yd. (4 cu. m), but less than 25 cu. yd. (19 cu. m), plus one set for each additional 50 cu. yd. (38 cu. m) or fraction thereof.
 2. Slump: ASTM C 143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.
 3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; ASTM C 173, volumetric method, for structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
 4. Unit Weight: ASTM C 567, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
 5. Compressive-Strength Tests: ASTM C 39; test two laboratory-cured specimens at 7 days and two at 28 days.
 - a. Test two field-cured specimens at 7 days and two at 28 days.
 - b. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at age indicated.
- C. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
- D. Strength of each concrete mix 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 (3.4 MPa).

- E. Test results shall be reported in writing to Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-and 28-day tests.
- F. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but will not be used as sole basis for approval or rejection of concrete.
- G. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Engineer. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42 or by other methods as directed by Engineer.

PART 4 - PAYMENT

4.1 GENERAL

- A. No payment shall be made until approved by quality control agencies. No payment shall be made for any rejected concrete. All rejected concrete shall be removed at the contractor's expense. No extensions for time lost due to rejected concrete shall be made.
- B. No payments shall be made until individual trip tickets of actual truck measure have been furnished to the Engineer for verification and approval. Trip tickets shall be presented to the Engineer for signature on the day the material is delivered. Payment for this item shall constitute full compensation for all materials, labor, equipment, forms, reinforcement, additives, sealers, vapor barriers, and incidentals necessary to furnish materials at job site and for placing and finishing it as specified
- C. Payment for the Maintenance Building slab and foundation will be included in the Maintenance Building Lump Sum Price.
- D. Payment for the Reservoir foundation will be made under its respective section.

END OF SECTION 03300

SECTION 11230 – AERATORS ASSUMBL Y**PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Work necessary to furnish all materials, labor, and work necessary to install and wire complete VaraCorp 3.0 horsepower 3 phase turbine aerator.

1.2 SUBMITTALS

- A. Manufacturers' installation instructions.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Ship all turbine aerator and other devices with suitable packaging to protect products from damage.
- B. Protect turbine aerator and accessories from damage.
- C. The turbine aerator shall be stored on a smooth flat surface, free of sharp objects, and if laid horizontally, shall be placed in such a way as to avoid structural damage.

PART 2 - PRODUCTS**2.1 TURBINE AERATOR**

- A. Motor: 480V, 3 Phase
 - 1. TECO Westinghouse or WEG 3 HP, 1200 RPM motor operating at 480 Volts, 3 Phase, 60 Hz
 - 2. Motor housing is cold-rolled steel.
 - 3. Vertical operating motor with "C" flange mounting.
 - 4. Rain cap mounted on top of motor.
 - 5. Two-part epoxy paint, marine grade.
 - 6. Power cable shall be SOOW, underwater rated, UV protected.
- B. Drive/Air Shaft
 - 1. 1 ½-inch O.D. X 3.5 feet long, 316 stainless steel air shaft, ¼-inch wall thickness.
 - 2. Machined to couple directly onto the motor shaft with supplied set screws.
 - 3. Machined to couple to the turbine using supplied pin.
- C. Turbine
 - 1. 8-inch diameter. Made of high density fiberglass resin. Has a mounting hub, supplied with SS screws, designed to couple onto the air/drive shaft using supplied pin.
 - 2. Stainless steel bottom plate, fastened to hub with supplied SS screw & neoprene washer.
- D. pontoons:
 - 1. Polyethylene shell, foam filled, and UV protected.
 - 2. Two 1"x 1" stainless steel square tubing for reinforcement under the motor deck.
 - 3. Stainless steel fasteners and 4 eye bolts for tethering.
- E. Acceptable Manufacturer

1. The unit shall be a 3.0 horsepower 3 phase turbine aerator, manufactured by VaraCorp LLC, 13501 Ranch Road 12 Suite 103, Wimberley, Texas U.S.A 78676. 1-800-801-6685. <http://www.varacorp.com/>.

2.2 TURBINE AERATOR ACCESSORIES

- A. Nema 4X rated control box with motor starter, over-load protection, through-the-door on/off switch. The optional electrical control panel must be installed per instructions and National Electrical Code.
- B. Low water legs, to protect the turbine from hitting bottom due to fluctuating water levels.
- C. 3/16-inch vinyl coated stainless steel aircraft cable to anchor the system to the bank.
- D. Wire clamps and quick connectors. (See installation instructions.)

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Verify that dimensions are correct and project conditions are suitable for installation. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. Thoroughly clean and remove all shipping materials prior to setting.
- C. Install products in accordance with plans, general comments below and the manufacturer's instructions.
- D. Care shall be taken in the handling, storage and placement of the turbine aerator in preparation for installation. The top spreaders shall be left on the turbine aerator until after installation is complete.

PART 4 - PAYMENT

4.1 GENERAL

- A. Payment will be made for each aerator furnished and installed at the unit prices stated in the Contractor's Proposal. Payment for the aerators shall constitute full compensation for the work as specified under this section.

END OF SECTION 11230

SECTION 13420 – FLOWMETER ASSUMBLY**PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Work necessary to furnish all materials, labor, and work necessary to install and wire complete Plasti-Fab 3 inch Parshall Flume, MJK 713 Flow Meter and M800 Mission Communications LLC monitoring remote terminal unit (RTU).

1.2 SUBMITTALS

- A. Parshall Flume- Approval drawings showing all critical dimensions, principal parts and principal materials.
- B. Manufacturers' installation instructions.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Ship all Parshall Flumes and other devices with suitable packaging to protect products from damage.
- B. Protect flume flanges, tabs and accessories from damage.
- C. The flume shall be stored on a smooth flat surface, free of sharp objects, and if laid horizontally, shall be placed in such a way as to avoid structural damage.

PART 2 - PRODUCTS**2.1 MATERIALS**

- A. Flume body shall be:
 - 1. Engineered composite fiberglass reinforced plastic (FRP).
 - a. Molded in one piece to create a seamless corrosion barrier impervious to moisture.
 - b. FRP resin shall be polyester.
 - 2. Flume Hardware: Type T-304L
- B. Flow Meter
 - 1. Sensor: VALOX (reg. tm of General Electric Co.)
 - 2. Wire: Shielded, oil resistant PUR insulation, length 39 ft.

2.2 PARSHALL FLUMES

- A. Acceptable Manufacturers:
 - 1. Plasti-Fab Inc.
 - a. Shall be Model 3" Parshall.
 - 2. The flume fabrication, engineering and customer support shall all be provided by the same company. Outsourcing any of these components is not acceptable.
 - 3. To assure quality control and single source accountability the same manufacturer shall fabricate and fully assemble the flume and all components.
 - 4. Or approved equal. Pre-approved by Engineer at least 10 business days prior to bid date.
 - a. Manufacturer must have a qualified Engineer on staff with at least 5 years experience with hydraulic measurement flumes.

2.3 FLOW METER

- A. Acceptable Manufacturers:
 - 1. MJK North America, Inc.
 - a. Shall be Model MJK 713 with Shuttle Ultrasonic Sensor

2. The flow meter fabrication, engineering and customer support shall all be provided by the same company. Outsourcing any of these components is not acceptable.
3. To assure quality control and single source accountability the same manufacturer shall fabricate and fully assemble the flow meter and all components.

2.4 MONITORING REMOTE TERMINAL UNIT

A. Acceptable Manufacturers:

1. Mission Communications LLC
 - a. Shall be Model M800
2. Shall have a built in battery backup capable of keeping the RTU powered for 24 hours in case of primary AC failure.
3. All terminations inside the RTU enclosure shall be low voltage AC or DC (28 volts or less). The RTU shall be supplied with a U.L. recognized 120 VAC to 12 VAC step down transformer.
4. The RTU shall have two (2) analog, 10-bit resolution, 4-20ma or 0-5 vdc inputs, with four (4) alarm thresholds per input. The analog input values shall be transmitted by the RTU to the central monitoring software at least every 2 minutes. The RTU shall have built in AC failure and low battery detection. The RTU shall have eight (8) digital inputs of which up to three (3) shall be capable of recording pump runtimes in one (1) minute resolution. Any change of the RTU digital inputs shall be transmitted to the central monitoring software within 10 seconds of occurrence.
5. The RTU shall have at least three (3) remotely controllable relay outputs that may be controlled at will by the customer. The RTU shall have up to two (2) optional pulse counting totalizers of which one can be programmed to report every two (2) minutes. The RTU shall have a built in electronic key or card reader, which can be used to securely put the RTU in/out of alarm reporting mode and/or to accept in progress, alarms. The RTU shall produce an audible noise to indict to the operator that the key or card has been successfully read.
6. The RTU unit fabrication, engineering and customer support shall all be provided by the same company. Outsourcing any of these components is not acceptable.
7. To assure quality control and single source accountability the same manufacturer shall fabricate and fully assemble the monitoring RTU and all components.

2.5 CONSTRUCTION

A. Flume

1. Flume throat size shall be 3" inch.
2. Parshall Flume body shall be totally manufactured of fiberglass reinforced polyester.
3. Each Flume shall be molded individually to the exact dimensions specified.
4. The thickness of the walls and floor of the flume shall be not less than 1/4" (6mm) thick.
5. Flumes shall be manufactured of reinforced thermoset plastic.
6. Flume shall have UV Stabilizing pigment in the Resin to provide longterm protection from UV.
7. Flume inside surface shall be smooth, isophthalic gelcoat of 10 – 20 mil (0.25 - 0.51mm) thickness.
8. The surface shall be free of exposed reinforcing fibers.
9. The minimum glass content shall be 30% exclusive of gelcoat surfaces.
10. The flume shall be reinforced with box section stiffeners down the sides and across the bottom.
11. The stiffeners shall be joined at the knee to form a rigid dimensionally stable flume.
12. Reinforcing shall be designed to provide structural support throughout the length and width of the flume floor.
13. Flume shall be structurally designed to maintain dimensional integrity with a full head of water while being free standing.

14. Flume shall have a molded-in head gage graduated in 100ths of a foot & centimeters.
 1. Wingwalls.
 2. Bulkheads.
 3. Sectioning.
 4. Low profile.
 5. Outlet removed.
 6. T-304 adjustable stainless steel ultrasonic mounting bracket.
 7. Pressure probe cavity with lift out bracket.
 8. Inlet and outlet adapter with 8" OD pipe stub.
 9. Neoprene boots with stainless steel bands for connection to 8" OD pipe.
 10. Stilling well 12" (305mm) diameter.
 11. Stainless steel sample pipe 3/8" (9.5mm)OD with molded side cavity.
 12. Stainless steel bubbler pipe 1/4"(6mm) OD with molded side cavity.
 13. Temperature probe bracket.
 14. pH probe cavity with stainless steel lift out bracket.
- B. Structural characteristics for a 1/8" (3mm) glass mat laminate shall meet the following minimum physical properties:

Tensile strength	15,000 psi (1034 ksc)
Flexural Modulus	1,000,000 psi (70307 ksc)
Flexural Strength	20,000 psi (1406 ksc)
Compressive Strength	22,000 psi (1547 ksc)
Impact Strength	9.0 ft-lbs/in. (1.24 kgf.m/25mm)
Water absorption	0.13% (in 24 hours)

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Verify that dimensions are correct and project conditions are suitable for installation. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. Thoroughly clean and remove all shipping materials prior to setting.
- C. Install products in accordance with plans, general comments below and the manufacturer's instructions.
- D. Care shall be taken in the handling, storage and placement of the flume in preparation for installation. The top spreaders shall be left on the flume until after installation is complete. They may be removed after the grout has cured if desired.
- E. The flume shall be installed level end-to-end and side-to-side, and must remain level throughout installation. Flume assembly should be set into a pre-poured block-out / channel.
- F. The contractor shall provide sufficient shoring and bracing of the floor and sidewalls to prevent lifting, floating, buckling or bulging of the sides and bottom during installation. The side locking clips are not intended to be used as anchorage points. Their function is to key the flume into the grout or concrete.
- G. Concrete shall be poured in successive lifts of not more than 6" - 8"(152- 203mm) per lift. Extra care shall be exercised during the first pour to insure that grout flows smoothly under the floor, and an even fill is achieved. The first lift shall be allowed to set so that excessive hydraulic forces are not transferred to the bottom of the flume by later lifts.
- H. The MJK 713 Flowmeter should be in a NEMA 4X enclosure when mounted outdoors directly on a wall or in a panel using a panel mounting kit (order no. 200105) and with a sun shield (order no. 200115).
- I. The monitoring RTU shall be enclosed in a NEMA 1 or optional NEMA 4 enclosure.
- J. The RTU shall transmit all data and alarms via the Nextel or Sprint wireless data network. Such network(s) shall have 128-bit AES encryption.
- K. The RTU shall have a 12 volts AC power supply.

- L. The Flow meter shall have a 110 - 120 volts AC power supply

3.2 FLUME ADJUSTMENT AND START UP

- A. Check flume for being level both directions, meeting dimensional requirements and cleaned per manufacture's instructions.

PART 4 - PAYMENT

4.1 GENERAL

- A. Payment for installation of flowmeter will be at the lump sum listed in the proposal. The price shall included all labor, work, and materials necessary to install the meter complete, including supports, wiring, piping modifications, saddles, plumbing, and calibration.

END OF SECTION 13420

SECTION 15000 – PIPELINE GENERAL REQUIREMENT**PART 1 - PROJECT DESCRIPTION****1.1 GENERAL**

- A. A brief description of the work is stated in the Invitation to Bid. To determine the full scope of the project or any particular part of the project, coordinate the applicable information in the several parts of these Contract Documents.

PART 2 - SEQUENCE OF OPERATIONS**2.1 SCHEDULING**

- A. Plan the work and carry it out with minimum interference to the operation of the existing facilities. Prior to starting the work, confer with the ENGINEER and OWNER's representative to develop a work schedule which will permit the facilities to function as normally as practical. It may be necessary to do certain parts of the construction work outside normal working hours in order to avoid undesirable conditions. The Contractor shall do this work at such times, and at no additional cost to the OWNER. Do not make connections between existing work and new work until necessary inspection and tests have been completed on the new work and it is found to conform in all respects to the requirements of the Contract Documents.
- B. Work on existing structures and facilities shall be performed on a schedule and in a manner that will permit the existing facility to operate continuously.

2.2 SHUTDOWN OF EXISTING OPERATIONS OR UTILITIES

- A. Continuous operation of the water purveyor's existing water system is of critical importance.
- B. Connections to existing services or utilities, or other work that requires the temporary shutdown of any existing operations or utilities shall be planned in detail with appropriate scheduling of the work and coordinated with the OWNER or ENGINEER. The approved schedule for shutdown or restart shall be indicated on the Contractor's Progress Schedule, and advance notice shall be given in order that the OWNER or ENGINEER may witness the shutdown, tie-in, and startup.
- C. All materials and equipment (including emergency equipment) necessary to expedite the tie-in shall be on hand prior to the shutdown of existing services or utilities.

2.3 OPERATION OF EXISTING SYSTEM PROHIBITED

- A. At no time undertake to close off any lines or open valves or take any other action which would affect the operation of the existing system, except as specifically required by the Drawings and Specifications and after approval is granted by the OWNER. Request approval 7 working days in advance of the time that interruption of the existing system is required.

2.4 PROGRESS OF PIPELINE CONSTRUCTION

- A. The work shall proceed in a systematic manner so that a minimum of inconvenience will result to the public in the course of construction. It is, therefore, necessary to confine operations to as small a length of work area per crew as is practical. Normally, the trenching equipment shall not be farther than 200 feet ahead of each pipe-laying crew or such distance as is necessary to provide maximum safety. Backfill the trench so no section of properly laid pipe is left uncovered longer than is absolutely necessary. The safety conditions of open excavations shall be the Contractor's responsibility. Completely backfill and clean up after each section of pipe has been inspected and approved.
- B. Grade and/or alignment adjustments shall be made by the Contractor during the construction, subject to the approval of the ENGINEER, to avoid the need to relocate conflicting utilities. Potential conflicts with existing facilities shall be resolved by exposing far enough ahead of the pipe laying so that the grade and/or alignment can be adjusted within the specified limits of deflection. The Contractor shall be responsible for performing this work and for informing the Inspector of the need for a grade and/or alignment adjustment. No additional payment will be made for this work.
- C. Clean up construction debris, excess excavation, excess materials, and completely restore fences, mailboxes, ditches, culverts, signposts, and similar items immediately following the final backfilling.

PART 3 - SITE CONDITIONS

3.1 SITE INVESTIGATION AND REPRESENTATION

- A. The Contractor acknowledges satisfaction as to the nature and location of the work, the general and local conditions, particularly those bearing upon availability of transportation, access to the site, disposal, handling and storage of materials, availability of labor, water, electric power, roads, and uncertainties of weather, river stages, or similar physical conditions at the site, the conformation and conditions of the ground, the character of equipment and facilities needed preliminary to and during the prosecution of the work, and all other matters which can in any way affect the work or the cost thereof under this Contract and has accounted for difficulties arising from these conditions in estimating the cost and his ability to successfully perform the work.
- B. The Contractor further acknowledges satisfaction as to character, quality, and quantity of surface and subsurface materials to be encountered from his inspection of the site and from reviewing any available records of exploratory work furnished by the OWNER or included in these Documents. Failure by the Contractor to become acquainted with the physical conditions of the site and all the available information will not relieve the Contractor from responsibility for properly estimating the difficulty or cost of successfully performing the work.
- C. The Contractor warrants that as a result of examination and investigation of all the aforesaid data, the Contractor can perform the work in a good and workmanlike manner and to the satisfaction of the OWNER. The OWNER assumes no responsibility for any representations made by any of its officers or agents during or prior to the execution of this Contract, unless (1) such representations are expressly stated in the Contract, and (2) the Contract expressly provides that the responsibility therefor is assumed by the OWNER.

PART 4 - INFORMATION ON SITE CONDITIONS**4.1 GENERAL**

- A. Any information obtained by the ENGINEER regarding site conditions, subsurface information, groundwater elevations, existing construction of site facilities, as applicable, and similar data will be available for inspection at the office of the ENGINEER upon request. Such information is offered as supplementary information only. Neither the ENGINEER nor the OWNER assumes any responsibility for the completeness or interpretation of such supplementary information.

4.2 SUBSURFACE INVESTIGATION

- A. A subsurface investigation was not conducted.

4.3 UTILITIES

- A. Known utilities and structures adjacent to or expected to be encountered in the work are shown on the Drawings. The locations shown are taken from existing records; however, it is expected that there may be some discrepancies and omissions in the locations and quantities of utilities and structures shown. Those shown are for the convenience of the Contractor only, and no responsibility is assumed by either the OWNER or the ENGINEER for their accuracy or completeness.
- B. The following is a list of the major utilities serving the work area indicating the name and telephone number of the responsible authority of the various utilities which should be notified if conflicts or emergencies arise during the progress of the work:

<u>Name of Utility</u>	<u>Responsible Authority</u>	<u>Telephone No</u>
One-Call	Utilities Notification Center	800-332-2344
Electrical	Klickitat County PUD	509-493-2255
Water	Klickitat County PUD	503-505-0384
Sewer	Klickitat County PUD	509-637-3875
Gas	NW Natural Gas Co.	800-233-3111
Telephone	CenturyLink	800-786-4421
County	Klickitat County Road Dept.	509-773-4616
OWNER	Dalles Fruit Company	509-493-1133
ENGINEER	Bell Design Company	509-493-3886

4.4 CONTRACTOR'S RESPONSIBILITY FOR UTILITY PROPERTIES AND SERVICE

- A. Where the Contractor's operations could cause damage or inconvenience to railway, telegraph, telephone, television, power, oil, gas, water, sewer, or irrigation systems, the operations shall be suspended until all arrangements necessary for the protection of these utilities and services have been made by the Contractor.
- B. Notify all utility offices which are affected by the construction operation at least 48 hours in advance. Under no circumstances expose any utility without first obtaining permission from the appropriate agency. Once permission has been granted, locate, expose, and provide temporary support for all existing underground utilities.

- C. Power poles less than 5 feet from the trench centerline, or 3 feet from the edge of an excavation required to construct the waterline, such as a pipe ramming pit or receiving pit, shall be protected at no cost to the OWNER. Protect all other poles from damage. If interfering power poles, telephone poles, guy wires, or anchors are encountered, notify the ENGINEER and the appropriate utility company at least 48 hours in advance of construction operations to permit the necessary arrangements for protection or relocation of the interfering structure.
- D. The Contractor shall be solely and directly responsible to the OWNER and operators of such properties for any damage, injury, expense, loss, inconvenience, delay, suits, actions, or claims of any character brought because of any injuries or damage which may result from the construction operations under this Contract.
- E. Neither the OWNER nor its officers or agents shall be responsible to the Contractor for damages as a result of the Contractor's failure to protect utilities encountered in the work.
- F. In the event of interruption to domestic water, sewer, storm drain or other utility services as a result of accidental breakage due to construction operations, promptly notify the proper authority. Cooperate with said authority in restoration of service as promptly as possible and bear all costs of repair. In no case shall interruption of any water or utility service be allowed to exist outside working hours unless prior approval is granted.
- G. In the event the Contractor encounters water service lines that interfere with trenching, he may, by obtaining prior approval of the property owner, Water Department, or Fire Department, as applicable, and the ENGINEER, cut the service, dig through, and replace the entire service with similar and equal materials at the Contractor's expense. The entire service between existing joints must be replaced. No couplers or unions will be allowed.
- H. The Contractor shall replace, at his own expense, all existing utilities or structures removed or damaged during construction, unless otherwise provided for in these Contract Documents or ordered by the ENGINEER.

4.5 INTERFERING STRUCTURES

- A. Take necessary precautions to prevent damage to existing structures whether on the surface, aboveground, or underground. An attempt has been made to show major structures on the Drawings. The completeness and accuracy of information shown cannot be guaranteed, and it is presented simply as a guide to avoid known possible difficulties.
- B. Protect underground and aboveground existing structures from damage, whether or not they lie within the limits of the easements obtained by the OWNER. Where such existing fences, gates, barns, sheds, buildings, or any other structure must be removed in order to properly carry out the construction, or are damaged during construction, restore to their original condition to the satisfaction of the property owner involved at the Contractor's own expense. Notify the ENGINEER of any damaged underground structure, and make repairs or replacements before backfilling.
- C. Without additional compensation, the Contractor may remove and replace in a condition as good as or better than original, such small miscellaneous structures as fences, mailboxes, and signposts that interfere with the Contractor's operations.

4.6 FIELD RELOCATION

- A. During the progress of construction, it is expected that minor relocations of the work will be necessary. Such relocations shall be made only by direction of the ENGINEER. If existing structures are encountered which prevent the construction, and which are not properly shown on the Drawings, notify the ENGINEER before continuing with the construction in order that the ENGINEER may make such field revisions as necessary to avoid conflict with the existing structures. If the Contractor shall fail to so notify the ENGINEER when an existing structure is encountered, and shall proceed with the construction despite this interference, he shall do so at his own risk.

4.7 LAND MONUMENTS

- A. The Contractor shall notify the ENGINEER of any existing federal, state, county, city, and private land monuments encountered. Private monuments that are within 5 feet of the trench centerline shall be preserved, or replaced by a licensed surveyor at the Contractor's expense. When Government monuments are encountered, the Contractor shall notify the ENGINEER at least 2 weeks in advance of the proposed construction in order that the ENGINEER will have ample opportunity to notify the proper authority and reference these monuments for later replacement.

PART 5 - TEMPORARY CONSTRUCTION UTILITIES AND FACILITIES

5.1 TEMPORARY WATER

- A. The Contractor shall make his own arrangements the OWNER to obtain suitable water and shall pay all costs.

5.2 TEMPORARY ELECTRIC POWER

- A. The Contractor shall make arrangements with the OWNER to obtain and pay for electrical power used until final acceptance by the OWNER.

5.3 SANITARY FACILITIES

- A. The Contractor shall provide and maintain sanitary facilities for his employees and his subcontractor's employees that will comply with the regulations of the local and state departments of health and as directed by the ENGINEER.

5.4 STORAGE OF MATERIALS

- A. Materials shall be so stored as to ensure their preservation and fitness for the work. When considered necessary, they shall be on wooden platforms or other hard, clean surfaces, and not on the ground. Stored materials shall be located so as to facilitate prompt inspection. Private property shall not be used for storage purposes without the permission of the owner or lessee.
- B. Delicate instruments and materials subject to vandalism shall be under locked cover and, if necessary, provided with temperature control as recommended by the manufacturer.

PART 6 - SAFETY AND CONVENIENCE

6.1 CONSTRUCTION SAFETY PROGRAM

- A. The Contractor shall develop and maintain for the duration of this Contract a safety program that will effectively incorporate and implement required safety provisions. The Contractor shall appoint a safety supervisor who is qualified and authorized to supervise and enforce compliance with the safety program.
- B. The duty of the ENGINEER to conduct construction review of the Contractor's performance is not intended to include a review or approval of the adequacy of the Contractor's safety supervisor, the safety program, or any safety measures taken in, on, or near the construction site.

6.2 SAFETY EQUIPMENT

- A. The Contractor, as part of his safety program, shall maintain at his office or other well-known place at the job site, safety equipment applicable to the work as prescribed by the governing safety authorities, all

articles necessary for giving first-aid to the injured, and shall establish the procedure for the immediate removal to a hospital or a doctor's care of any person who may be injured on the job site.

- B. The Contractor shall do all work necessary to protect the general public from hazards, including, but not limited to, surface irregularities or unramped grade changes in pedestrian sidewalk or walkway, and trenches or excavations in roadway. Barricades, lanterns, and proper signs shall be furnished in sufficient amount to safeguard the public and the work.
- C. The performance of all work and all completed construction, particularly with respect to ladders, platforms, structure openings, scaffolding, shoring, lagging, machinery guards and the like, shall be in accordance with the applicable governing safety authorities.
- D. During construction, the Contractor shall construct and at all times maintain satisfactory and substantial temporary chain link fencing, solid fencing, railing, barricades or steel plates, as applicable, at all openings, obstructions, or other hazards in streets, sidewalks, floors, roofs, and walkways. All such barriers shall have adequate warning lights as necessary, or required, for safety.

6.3 ACCIDENT REPORTS

- A. If death or serious injuries or serious damages are caused, the accident shall be reported immediately by telephone or messenger to the ENGINEER. In addition, the Contractor must promptly report in writing to the ENGINEER all accidents whatsoever arising out of, or in connection with, the performance of the work whether on, or adjacent to the site, giving full details and statements of witnesses.
- B. If a claim is made by anyone against the Contractor or any subcontractor on account of any accident, the Contractor shall promptly report the facts in writing to the ENGINEER, giving full details of the claim.

6.4 SAFE ACCESS BY FEDERAL STATE, AND LOCAL GOVERNMENT OFFICIALS

- A. Authorized representatives of the Washington State Department of Ecology, Washington State Board of Health, and other government officials shall at all times have safe access to the work, and the Contractor shall provide proper facilities for such access and inspection.

6.5 TRAFFIC MAINTENANCE AND SAFETY

- A. The Contractor shall comply with all rules and regulations of the state, county, and city authorities regarding closing or restricting the use of public streets or highways. No public or private road shall be closed, except by express permission of the OWNER. Conduct the work so as to assure the least possible obstruction to traffic and normal commercial pursuits. Protect all obstructions within traveled roadways by installing approved signs, barricades, and lights where necessary for the safety of the public. The convenience of the general public and residents along the pipeline, and the protection of persons and property are of prime importance and shall be provided for in an adequate and satisfactory manner.
- B. Where traffic will pass over trenches after they are backfilled and before they are paved, the top of the trench shall be maintained in a condition that will allow normal vehicular traffic to pass over. Temporary access driveways must be provided where required. Cleanup operations shall follow immediately behind backfilling and the worksite shall be kept in an orderly condition at all times.
- C. When flagmen and guards are required by regulation or when deemed necessary for safety, they shall be furnished with approved orange wearing apparel and other regulation traffic-control devices.

6.6 TRAFFIC CONTROL

- A. Traffic control on all County and State of [Washington](#) highway rights-of-way shall meet the requirements of the current edition (including all amendments) of the Manual on Uniform Traffic Control Devices for Streets and Highways published by the US Department of Transportation Federal Highway and Administration as adopted by the State of [Washington](#) and all State of [Washington](#) Supplements.

6.7 PROTECTION OF PROPERTY

- A. Protect stored materials, cultivated trees and crops, and other items located adjacent to the proposed work. Notify property owners affected by the construction at least 48 hours in advance of the time construction begins. During construction operations, construct and maintain such facilities as may be required to provide access by all property owners to their property. No person shall be cut off from access to his residence or place of business for a period exceeding 8 hours, unless the Contractor has made special arrangements with the affected persons.
- B. Provide for access at all times for livestock through farm areas, and no portion of farmlands in which livestock are pastured shall be cut off from ready access by the farm animals.

6.8 USE OF EXPLOSIVES

- A. The use of explosives will be allowed provided that the Contractor meets the following requirements.
 - 1. A permit from the White Salmon Fire Department is obtained for blasting operations.
 - 2. In accordance with UFC 7701.4 the minimum bond or public liability insurance policy for all blasting operations shall be \$1,000,000.
 - 3. Two sets of plans and specifications must be provided to the Fire Department showing the blasting operation complies with the Uniform Fire Code (1997 Edition), the NFPA 495- Explosive Materials Code (1996 Edition), and the WAC 296-52 Safety Standards for the Possession and Handling of Explosives (9-15-98)
 - 4. The documentation shall include but not be limited to:
 - a. Current Washington State Blasters License.
 - b. Blasting Plan that shows compliance with Chapter 8 of the NFPA 495 for ground vibration, air blast, and flyrock.
 - c. Bond or insurance policy with a minimum amount of \$1,000,000.
- B. Depending on the size and scope of the blasting operation, "technical assistance" as specified in UFC 103.1.1 may be required.
- C. Prior to a permit being issued, an inspection of the "blast area" (as defined in WAC 296-52-417) by a Fire Department Official and the Fire Department's technical assistant, if technical assistance was required for the project, shall be performed to determine compliance with the approved plans and specifications.
- D. If there are conflicts in requirements between the UFC, the NFPA, or the WAC, the most restrictive requirement shall apply.

6.9 FIRE PREVENTION AND PROTECTION

- A. The Contractor shall perform all work in a fire-safe manner. He shall supply and maintain on the site adequate fire-fighting equipment capable of extinguishing incipient fires. The Contractor shall comply with applicable federal, state, and local fire-prevention regulations. Where these regulations do not apply, applicable parts of the National Fire Prevention Standard for Safeguarding Building Construction Operations (NFPA No. 241) shall be followed.

6.10 ACCESS FOR POLICE, FIRE, AND POSTAL SERVICE

- A. Notify the fire department and police department before closing any street or portion thereof. No closing shall be made without the OWNER's approval. Notify said departments when the streets are again passable for emergency vehicles. Do not block off emergency vehicle access to consecutive arterial crossings or dead-end streets, in excess of 300 linear feet, without special written permission from the fire department. Conduct operations with the least interference to fire equipment access, and at no time prevent such access.

- B. The Contractor shall leave a night emergency telephone number or numbers with the police department, so that contact may be made easily at all times in case of barricade and flare trouble or other emergencies.
- C. Maintain postal service facilities in accordance with the requirements of the US Postal Service. Move mailboxes to temporary locations designated by the US Postal Service and, at the completion of the work in each area, replace them in their original location and in a condition satisfactory to the US Postal Service.

PART 7 - PRESERVATION, RESTORATION, AND CLEANUP

7.1 SITE RESTORATION AND CLEANUP

- A. At all times during the work, keep the premises clean and orderly, and upon completion of the work, repair all damage caused by equipment and leave the project free of rubbish or excess materials of any kind.
- B. Stockpile excavated materials in a manner that will cause the least damage to adjacent lawns, grassed areas, gardens, shrubbery, or fences, regardless of whether these are on private property, or on state, county, or city right-of-way. Remove all excavated materials from grassed and planted areas, and leave these surfaces in a condition equivalent to their original condition. Replace top soiled areas as specified in Section TRENCH EXCAVATION AND BACKFILL, raked and graded to conform to their original contours.
- C. All existing drainage ditches and culverts shall be reopened and graded and natural drainage restored. Restore culverts broken or damaged to their original condition and location.
- D. Upon completion of pipe laying and backfilling operations, hand-rake and drag all former grassed and planted areas, leaving all disturbed areas free from rocks, gravel, clay, or any other foreign material and ready, in all respects, for seeding. The finished surface shall conform to the original surface, and shall be free draining and free from holes, ruts, rough spots, or other surface features detrimental to a seeded area.

7.2 TREE REMOVAL AND REPLACEMENT

- A. The balling and burlapping of trees to be preserved shall conform to the recommended specifications set forth in the American Standards for Nursery Stock. All balls shall be firm and intact and "made" balls will not be accepted. All balled and burlapped trees shall at all times be handled by the ball and not by the top. When approved by the ENGINEER, trees may be temporarily planted in a suitable storage area for preservation.

7.3 TREE REMOVAL

- A. No trees, except those specifically shown on the Drawings to be shall be removed without the express approval of the ENGINEER. Removed trees will be disposed of, off the worksite, by the Contractor. Merchantable timber shall be cut into lengths as indicated by the Engineer and decked at indicated locations. Timber shall remain the property of the landowner.

7.4 RESEEDING AND FERTILIZING

- A. Originally seeded areas shall be fertilized and reseeded with first-quality seed or planted with new sod as approved by the property owner. All ground preparation, reseeded, and sodding shall be done in accordance with the best-accepted practices for lawn planting. The Contractor shall be responsible for obtaining a satisfactory grass turf acceptable to the property owner.
- B. In areas not originally seeded, all disturbed areas along the pipe line corridor shall be hydroseeded. Exceptions are roads and top of trenches with Class D backfill.
- C. All pastureland shall be hydroseeded.

7.5 FINISHING OF SITE, BORROW, AND STORAGE AREAS

- A. Upon completion of the project, all areas used by the Contractor shall be properly cleared of all temporary structures, rubbish, and waste materials and properly graded to drain and blend in with the abutting property. Areas used for the deposit of waste materials shall be finished to properly drain and blend with the surrounding terrain.

7.6 REMOVAL OF ROCK FROM FINISHED SURFACES

- A. Remove and dispose of all loose rock and boulders larger than 2-inch diameter occurring on the finished surfaces as a result of the construction operations.

7.7 STREET CLEANUP DURING CONSTRUCTION

- A. Thoroughly clean all spilled dirt, gravel, or other foreign material caused by the construction operations from all streets and roads at the conclusion of each day's operation.

7.8 DUST PREVENTION

- A. Give all unpaved streets, roads, detours, or haul roads used in the construction area an approved dust-preventive treatment or periodically water to prevent dust. Applicable environmental regulations for dust prevention shall be strictly enforced. Maintain dust control until the area has been satisfactory re-seeded in the Owners opinion.

7.9 PRESERVATION OF DRAINAGE DITCHES

- A. After backfilling of the trenches, restore all storm drain ditches destroyed, damaged, or otherwise modified during construction to a condition equivalent, in the opinion of the ENGINEER, to the condition of the ditch before construction. Ditches so reconstructed shall be built in their original locations.

7.10 LANDSCAPE PRESERVATION AND RESTORATION IN SPECIAL AREAS

- A. Take special precautions on easements where the pipeline crosses lawn and garden areas.
- B. Topsoil removal and replacement shall be as specified in Section TRENCH EXCAVATION AND BACKFILL.

7.11 TEMPORARY ACCESS RESTORATION

- A. Construction access for pipeline construction shall be as those shown on the drawings and labeled as temporary construction access. The contractor will consult with the landowner to establish access route location and width in access area where no roads or driveways exist. If in the opinion of the Engineer or the landowner, the use of the access route is causing undue damage or disturbance, immediate steps shall be taken to correct the damage and prevent further damage from occurring. This may include surfacing the access route with pit run rock or other remedies as presented by the contractor and acceptable to the landowner.

7.12 WATER BARS

- A. In areas where the pipeline is laid on slopes greater than 20 percent, provide water bars spaced apart approximately every 25 feet. Water bars shall be at least 8 inches deep and shall traverse across the entire disturbed area.

PART 8 - PAYMENT

8.1 GENERAL

- A. Payment for the work in this section will be included as part of the applicable unit prices stated in the Proposal.

END OF SECTION 15000

SECTION 15068 – PIPE AND FITTINGS**PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. This section covers the work necessary for furnishing and installing ductile iron pipe, pvc pressure class pipe, steel pipe, hdpe pipe, abs pipe, and steel and ductile iron fittings, complete.

1.2 RELATED SECTIONS

- A. For specification on copper tube used in services or to connect buried corporation stops other appurtenances see “Service Connections” in section 15090.

1.3 QUALITY CONTROL

- A. All pipe material and appurtenances shall comply with NSF 61 for materials used for potable water.
- B. All pipe and fittings shall be new, shipped directly from the manufacturer.

PART 2 - PRODUCTS**2.1 JOINTS**

- A. Pipe joints shall be push-on joints, except where specifically shown or detailed otherwise.
- B. Fitting joints shall be mechanical joint ends, except where specifically shown or detailed otherwise.

2.2 MECHANICAL JOINT FITTINGS

- A. Mechanical joint ductile iron fittings shall conform to AWWA C110 or C153 and shall be of a class at least equal to that of the adjacent pipe. Cement mortar lining for fittings shall be same thickness specified for pipe.

2.3 FLANGED DUCTILE IRON FITTINGS

- A. Flanged fittings shall conform to ANSI B16.1 and shall be faced and drilled 125-pound ANSI template. The fittings shall be 250 psi rated working pressure for water and cement-mortar lined to same thickness specified for pipe. Fittings shall conform to AWWA C153 and or AWWA C110.
- B. Flange Adapter: Flange adapters shall be forged with flanges conforming to ANSI B16.1 with one side having an ANSI class 250 flange and the other side of the adapter having an ANSI class 125 flange. Common centerlines shall be marked to eliminate difficulty in installation.

2.4 MECHANICAL JOINT RETAINER GLANDS

- A. FOR USE WITH DUCTILE IRON PIPE: Retainer glands shall be cast of high strength ductile iron, grade 60-42-10. Set screws shall be cup point, square head, and double heat treated steel. Tee head bolts and gaskets shall conform to ANSI A21.11. The restraint shall be the EBAA Iron Series 1100 Megalug or approved equal.

- B. When retainer glands are to be used on existing fittings and pipes, the retainer gland shall be constructed in a split body style and conform to the specification in 2.4.A. The retainer glands shall be the EBAA Iron Series 1100SD Split Megalug.
- C. FOR USE WITH PVC PIPE: Restraint glands used on PVC pipe shall be cast of high strength ductile iron conforming to ASTM A536-80. The gland shall be such that it replaces the standardized mechanical joint gland and can be used with the standardized mechanical joint bell conforming to ANSI/AWWA A21.11/C111 and ANSI/AWWA C153/A21.53 or latest revision. Twist off nuts, sized same as tee-head bolts, shall be used to insure proper actuating of restraining devices. The restraining glands shall have a pressure rating equal to that of the pipe on which it is used. The restraining glands shall have been tested to UNI-B-13-92. The restraint shall be the EBAA Iron Series 2000PV or approved equal.
- D. BOLT-THROUGH RESTRAINTS: Bolt-through mechanical joint restraints manufactured of ductile iron conforming to ASTM A 80-55-06. The positive restraint device shall connect the valves and/or fittings at a linear distance not to exceed one inch and without attachment to pipe. The bolt-through MJ positive restraining device shall be supplied with asphaltic coatings in accordance with ANSI/AWWA C153/A21.53 and ANSI/AWWA C104/A21.4 and sized to be used with standard mechanical joint fittings (AWWA C110 or C153) and valves. The device shall have a working pressure rating of 350 psi minimum and shall be manufactured by Infact Corporation FOSTER ADAPTER or equal.

2.5 GASKETS

- A. Gasket material for flanged joints in ductile iron pipe shall be cloth-inserted sheet rubber gaskets conforming to AWWA C207 and ANSI B16.21, 1/8-inch thick. The gasket shall be full-cut, with holes to pass bolts. Gasket material shall be free from corrosive alkali or acid ingredients.
- B. MECHANICAL JOINT GASKETS: Gasket material for mechanical joint fittings between CI outside diameter pipe shall gaskets made from virgin SBR per ASTM D 2000 MBA 10, compounded for water service. All gaskets shall meet AWWA C111 standards.
- C. MECHANICAL JOINT TRANSITION GASKETS: Gasket material for mechanical joint fittings between IPS outside diameter pipe shall use transition gaskets made from virgin SBR per ASTM D 2000 MBA 710, compounded for water and sewer service.

2.6 BOLTS

- E. Ductile iron or cor-ten bolts shall be used on all mechanical joints.
- F. Flanged Joints:
 - 1. In areas where flanged joints are to be buried, bolts shall be stainless steel.
 - 2. In areas where flanged joints are to be installed within a building or vault use electro-galvanized ASTM A307 bolts.

2.7 TIE RODS

- A. All Rods shall be the nominal diameter of the bolts normally used for the fittings. All Rods shall be galvanized. When rods are to be bent they shall be bent in the factory. The number of rods used shall be the same number at the number of bolts normally used in the fitting or as specified in the drawings. When tying between mechanical joint fitting use Ductile Lugs as manufactured by ROMAC Industries, INC. or equivalent.

2.9 DRESSER COUPLINGS

- A. The center ring and end rings shall be ductile iron per ASTM A 536, Grade 65-45-12 with shop coat. The gasket shall be virgin SBR per ASTM D 2000 MBA 710, compounded for water service. Bolts and nuts shall be corrosion resistant steel per AWWA C111. The sleeve shall be a 501 straight, transition and long barrel coupling as manufactured by Romac Industries, INC. or equivalent.

2.10 DUCTILE IRON PIPE

- A. Push-On Joint Pipe: Push-on joint ductile iron pipe shall be centrifugally cast of 60-42-10 iron and shall conform to ANSI A21.51 or AWWA C151. Pressure class shall be 350. The pipe shall be cement-mortar lined and seal coated in accordance with ANSI/AWWA C104/A21.4. The rubber-ring gaskets shall be suitable for the specified pipe sizes and pressure and shall conform to applicable parts of the latest Federal Specification WW-P-421, and shall be furnished by the pipe manufacturer. A nontoxic vegetable soap lubricant shall be supplied with the pipe in sufficient quantities for installing the pipe.
- B. Flange End Pipe: Flanged joint pipe shall be fabricated from thickness class 53 ductile iron pipe. The pipe barrel shall meet all requirements of the pipe specified in 2.10 A, "Push-On Joint Pipe". The flanged joint shall meet all requirements of ANSI/AWWA C115/A21.15. The bolt circle and bolt holes of the flanges shall conform to class 125 flanges shown in ANSI B16.1 and shall be capable of being joined with Class 125 B16.1 or Class 150 ANSI B16.5 flanges. Pipe shall be working pressure rated for a minimum of 250 psi. Flanges shall be ductile iron of the screwed type, power tightened on to the barrel of the pipe at the factory. Flanges shall be refaced to ensure a good seat of the gasket over the machined ends of the pipe. Flange End Pipe shall be field measured and ordered to length. Field fabricated flanges shall not be permitted. Where pressures exceed 250 psi, ANSI 250-pound flange templates may be specified on for the pipe. Flanges shall have a minimum working pressure of 300 psi for water service and conform to ANSI B16.1

2.11 PVC PIPE

- A. Pipe with nominal diameters between 4 and 12 inches shall be unplasticized polyvinyl chloride (PVC) and conform to ASTM D-3034 and minimum SDR of 35. AWWA C900 specifications. The pipe must have outside diameters (OD)'s which conform to ductile iron pipe OD's. Pipe shall be bell and spigot push-on type. The bell shall consist of an integral wall section with a factory installed, solid cross section elastometric ring which meets the requirements of ASTM F-477. Pipe shall withstand minimum burst pressures of 755 psi when tested in accordance with ASTM D 1599. All pipes shall withstand drop impacts of 100 ft/lbs without showing visible evidence of shattering or splitting when tested in accordance with ASTM D 2444. All pipe shall be class 150, diameter ratio (DR) of 18, unless otherwise shown on the drawings. Pipe shall be that as manufactured by J-M pipe, or equivalent.

2.12 SOLID WALL HIGH DENSITY POLYETHYLENE (HDPE) PIPE

- A. Furnish pipe resin that has a hydrostatic design basis of 1,600 psi when tested and analyzed according to ASTM D 2837, and has a material designation code of 3408 as listed by the Plastic Pipe Institute. The resin shall meet the requirements of ASTM D 3350 and have a minimum cell classification of PE345444C (Code D or E may also be used for pipe bursting and lining pipe and for slip lining pipe). The polyethylene composition for code C classification shall contain a minimum of 2% and not more than 3% by weight of well-dispersed and finely divided carbon black when tested according to ASTM D 1603 and ASTM D 4218. The pipe shall contain no recycled compound except that generated in the manufacturer's own plant from resin of the same specification from the same raw material pipe. Pipe (excluding black colored pipe) stored outside shall not be recycled. Provide pipe and fittings meeting the requirements of ASTM F 714 and ASTM D 3261 as modified for the specified material. ASTM D 3261 as modified for the specified material.

2.13 ADS PIPE

- A. Pipe with nominal diameters between 3 and 24 inches shall be corrugated ADS and conform to ASTM F 667 - 12.

2.14 STEEL FLANGES

- A. Steel flanges shall conform to ANSI B15.5 and AWWA C207 standards. Gasket material shall conform to the flange class being used. Bolt template patterns shall line up with adjacent pipe. Flange Class F shall be used where working pressures exceed 250 psi.

2.15 MANUFACTURER

- A. All pipe and fittings shall be by a domestic manufacturer.

2.16 OWNER SUPPLIED MATERIALS

- A. The owner may elect to supply material such as pipes and fitting. When these items are to be supplied by the owner the drawings with indicated the items to be supplied by the owner.

2.17 PIPE LOCATION FOIL

- A. Pipe locating foil shall be Terra Tape D, or equivalent, with one mil metallic foil core, stating "Caution: Buried Waterline Below"

2.18 PIPE LOCATION WIRE

- A. Pipe location wire shall be 10 gage insulated cooper wire.

2.19 HANDLING, SHIPPING, AND STORAGE

- A. Handle the pipe so as to prevent server impact blows, abrasion damage, and gouging or cutting by metal surfaces or rocks. Do not stress bell joints or damage bevel.
- B. All ductile iron pipe shall be delivered and stored with end caps supplied and attached by the manufacturer. End caps shall be sufficient to completely eliminate the entrance of foreign matter and the penetration of rodents into the pipe which can cause heterotrophic bacteria growth in the pipes.

2.20 IMPORTED GRANULAR MATERIAL FOR PIPE BASE AND FOR PIPE ZONE

- A. Crushed rock for pipe base and pipe zone shall conform to the ¾"-minus gradation as specified in Section "02575 Surface Restoration" sub-section 2.1 C.

PART 3 - EXECUTION**3.1 PREPARATION OF TRENCH**

- A. Grade: Grade the bottom of the trench by hand to the line and grade to which the pipe is to be laid, with proper allowance for pipe thickness and for pipe base when specified or indicated. Before laying each section of the pipe, check the grade and correct any irregularities found. The trench bottom shall form a continuous and uniform bearing and support for the pipe between bell holes, except that the grade may be disturbed for the removal of lifting tackle.
- B. Imported Granular Material for Pipe Base: Provide imported granular material for pipe base under all pipe. Place granular base for pipe in the trench to a minimum depth of 4 inches for pipe 16 inches in diameter and smaller, and to a depth of 6 inches for pipe 18 inches in diameter and larger. Grade the top of the base to the bottom of the pipe ahead of pipe laying for the full width of the trench. Base shall provide a firm support along entire pipe length.
- C. Bell (Joint) Holes: At the location of each joint, dig bell joint holes of ample dimensions in the bottom of the trench and at the sides where necessary to permit the joint to be made properly and to permit easy visual inspection of the entire joint.
- D. Removal of Water: Provide and maintain ample means and devices at all times to remove and dispose of all water entering the trench excavation during the process of pipe laying.

3.2 LAYING

- A. Distributing Pipe: Distribute material on the job from the cars, trucks, or storage yard no faster than can be used to good advantage. In general, distribute no more than 1 week's supply of material in advance of the laying.
- B. Handling Material: Provide and use proper implements, tools, and facilities for the safe and proper prosecution of the work. Lower all pipe, fittings, and appurtenances into the trench, piece by piece, by means of a crane, slings, or other suitable tools or equipment, in such a manner as to prevent damage to the pipeline materials and protective coatings and linings. Do not drop or dump pipeline materials into the trench.

- C. **Cleaning Pipe and Fittings:** Wipe the ends of mechanical joint pipe and fittings and of rubber gasket joint pipe and fittings clean of all dirt, grease, and foreign matter.
- D. **Placing of Pipe in the Trench:** Do not allow foreign material to enter the pipe while it is being placed in the trench.
1. **Push-On Joint Pipe:** After the first length of push-on joint pipe is installed in the trench, secure pipe in place with approved backfill material tamped under and along sides to prevent movement. Keep ends clear of backfill. After each section is jointed, place backfill as specified to prevent movement.
- E. **Number of Pipes Laid Before Jointing:**
1. **Push-On Joint Pipe:** Connect mechanical joint pipe and push-on joint pipe as hereinafter specified as soon as they are placed in the trench.
- F. **Preventing Trench Water From Entering Pipe:** Conform to requirements for dewatering in Section TRENCH EXCAVATION AND BACKFILL.
- G. **Cutting Pipe:**
1. **General:** Cut pipe for inserting valves, fittings, or closure pieces in a neat and workmanlike manner without damaging the pipe or lining and so as to leave a smooth end at tight angles to the axis of the pipe.
 2. **Ductile Iron Pipe:** Cut pipe with milling type cutter or saw. Do not flame cut.
 3. **Dressing Cut Ends:** Dress cut ends of push-on joint pipe by beveling, as recommended by the manufacturer.
- H. **Bell End to Face Direction of Laying:** Unless otherwise directed, lay pipe with bell end facing in the direction of the laying. For lines on an appreciable slope, face bells upgrade at the discretion of the Engineer.
- I. **Permissible Deflection at Joints:** Wherever it is necessary to deflect pipe from a straight line, either in the vertical or horizontal plane, to avoid obstructions, or where long-radius curves are permitted, the amount of deflection allowed shall not exceed the values in the following table:

Maximum Deflection Permitted*				
18' Length Pipe				
Pipe Dia. (In.)	Mechanical Joint**		Push-On Joint (DI pipe only)	
	Max. Defl. Angle Deg. & Min.	Defl (In.)	Max. Defl. Angle Deg.	Defl (In.)
4	8-18	31	5	18
6	7-07	27	5	18
8	5-21	20	5	18
10	5-21	20	5	18
12	5-21	20	5	18
14	3-35	13.5	3	11
18	3-00	11	3	11
20	3-00	11	3	11
* The maximum deflection shall be whichever is less, the table or that recommended by pipe manufacturer.				
** Safe deflection for 150 pounds pressure. For higher pressure, reduce tabulated deflection 10 percent for each 150 pounds added				

- J. **Alignment:** Pipelines intended to be straight shall not deviate from the straight line at any joint in excess of 1 inch.

- K. Unsuitable Conditions for Laying Pipe: Do not lay pipe in water or when, in the opinion of the Engineer, trench conditions are unsuitable.
- L. Deflection of PVC pipe: Deflection of PVC push on joints shall not be allowed. Horizontal bending of PVC pipe shall not be allowed. Small horizontal deflections of PVC pipe may be accomplished by using MJ x MJ connectors between pipes at the allowable deflections listed in "Permissible Deflection at Mechanical Joints" in this section
- M. Install solid wall HDPE and corrugated polyethylene pipe and fittings according to the manufacturer's recommendations.

Assemble and join solid wall HDPE pipe at the site using the thermal butt-fusion method to provide a leak proof joint. Threaded or solvent-cement joints are not allowed. All equipment and procedures used shall be in strict compliance with the manufacturer's recommendations. Use personnel certified as fusion technicians by the manufacturer of the pipe or fusing equipment to accomplish the fusing.

3.3 OWNER SUPPLIED MATERIALS

- A. When materials are supplied by the owner, coordinate with the owner to inspect the materials being supplied. Provide all labor or work necessary to modify or adapt materials as needed so that they may be readily installed. Supply all ancillary materials such as glands, bolts, and gaskets.
- B. Make all arrangements and bear all costs to transport owner supplied materials to the project site.

3.4 JOINING PUSH-ON JOINT PIPE AND MECHANICAL JOINT FITTINGS

- A. Lay and join pipe with push-on type joints in strict accordance with the manufacturer's recommendations. Provide all special tools and devices, such as special jacks, chokers, and similar items required for the installation. Lubricant for the pipe gaskets shall be furnished by the pipe manufacturer, and no substitutes will be permitted under any circumstances.
- B. Mechanical joint fittings vary slightly with different manufacturers. Install the particular fittings furnished in accordance with the manufacturer's recommendations. In general, the procedure shall be as hereinafter specified. Clean the ends of the fittings of all dirt, mud, and foreign matter by washing with water and scrubbing with a wire brush, after which slip the gland and gasket on the plain end of the pipe. If necessary, lubricate the end of the pipe to facilitate sliding the gasket in place. Then guide the fitting onto the spigot of the pipe previously laid.

3.5 ANCHORAGE

- A. Limiting Pipe Diameter and Degree of Bend: On all pipelines 4 inches in diameter or larger, securely anchor by suitable thrust blocking, all tees, plugs, caps, and bends equal to and exceeding 11-1/4 degrees, as shown, and at other locations where unbalanced forces exist, as directed by the Engineer.
- B. Thrust Blocking: Provide reaction or thrust blocking, as shown, or as directed by the Engineer. The concrete mix shall have 28-day compressive strength of not less than 2,500 pounds per square inch. Place blocking between the undisturbed ground and the fitting to be anchored. The bearing surface shall be as shown or as directed by the Engineer. Place the blocking so that the pipe and fitting joints will be accessible to repairs, unless otherwise shown.
- C. Thrust Collars: Provide thrust collars as shown. The concrete mix shall have 28-day compressive strength of not less than 2,500 pounds per square inch. Place collars against undisturbed ground. The bearing surface against undisturbed ground shall be as shown.
- D. Retainer Glands: Provide retainer glands on 6-inch pipe only in locations where there is insufficient undisturbed earth against which to place a concrete thrust block. Place retainer glands on larger diameter pipe in combination with concrete thrusts. Locations for retainer glands shall be as shown on the Drawings or as approved by the Engineer. Tighten all set screws to 75-foot-pounds torque by alternately tightening set screws on opposite sides of the pipe or as specified by manufacturer.

- E. Tie Rods: Tie rods shall be spaced symmetrically around fittings. Tighten rods alternatively so as to provide even pressure around the fittings. Provide and tighten nuts on retainer gland side of tie rods.
- F. Pipe Stands: Where steel or ductile iron pipe is to be installed within vaults or structures, the pipe must be adequately supported to reduce unnecessary stress on the pipe, joints, fittings, and valves. Support pipe with pipe stands at all locations shown on the drawings and wherever else is necessary to adequately support pipes or where is deemed necessary by the engineer. Where downward support is necessary bolt stands to the floor and strap pipe to the pipe stand cradles.

3.6 DEFINITION OF PIPE ZONE

- A. The pipe zone shall include the full width of the trench from the bottom of the pipe to a point 12 inches above the top of the pipe barrel.

3.7 IMPORTED GRANULAR MATERIAL

- A. Import and place imported granular material as hereinbefore specified.
- B. Imported granular material shall be used for the full depth of the pipe zone. This material shall be placed, in a manner approved by the Engineer, simultaneously on both sides of pipe in lifts not to exceed 6 inches. Each lift shall be compacted with mechanical vibrating or impact tampers as required to prevent subsequent settlement.

3.8 PIPE LOCATING FOIL

- A. Place pipe locating foil in trench 12 inches above pipe. Place tape so that words face upward.

3.9 PIPE LOCATING WIRE

- A. Place pipe location wire directly above pipe. Allow ample wire length at valve locations to insert wire into valve boxes.

3.10 HYDROSTATIC TESTS

- A. Make pressure and leakage tests on all newly laid pipe. Furnish all necessary equipment and material, make all taps in the pipe as required and conduct the tests. The tests shall be conducted between valved sections of the pipeline, or as approved by the Engineer. The Engineer will monitor the tests.
- B. Furnish the following equipment and materials for the tests:

Amount	Description
2	Graduated containers
2	Pressure gauges
1	Hydraulic force pump
1	Suitable hose and suction pipe as required

- C. Conduct the tests after the trench has been backfilled or partially backfilled with the joints left exposed for inspection, or when completely backfilled as permitted by the Engineer. Where any section of pipe is provided with concrete reaction blocking, do not make the pressure test until at least 5 days have elapsed after the concrete thrust blocking is installed. If high-early cement is used for the concrete thrust blocking, the time may be cut to 2 days.
- D. Conduct the pressure test in the following manner, unless otherwise approved by the Engineer: After the trench has been backfilled or partially backfilled as hereinbefore specified, fill the pipe with water, expelling all air during the filling. The test pressure shall be 1.5 times maximum static pressure in the portion of line being tested or 150 psi whichever is greater. At a minimum tests shall be in accordance with AWWA C600-10 (5.2) or AWWA C605-05 (7.3) as appropriate.
 - 1. Duration: The duration of each pressure test shall be 2 hours, unless otherwise directed by the Engineer.
 - 2. Procedure: Slowly fill the pipe with water and allow to stand for 24 hours. Expel all air from the pipe. Apply and maintain the specified test pressure by continuous pumping if necessary for the

entire test period. The test pressure shall be calculated for the point of lowest elevation, or as specified by the Engineer. The pump suction shall be in a barrel or similar device, or metered so that the amount of water required to maintain the test pressure may be measured accurately.

3. Leakage: Leakage shall be defined as the quantity of water necessary to hold the specified test pressure for the duration of the test period. No pipe installation will be accepted if the leakage is greater than the number of gallons per hour as determined by the following formula:

$$L = \frac{SD\sqrt{P}}{148,000}$$

In the above formula:

L = Allowable leakage, in gallons per hour

S = Length of pipe tested.

D = Nominal diameter of pipe, in inches

P = Test pressure during the leakage test, in pounds per square inch

4. Correction of Excessive Leakage: Should any test of pipe laid disclose leakage greater than that allowed, locate and repair the defective joints or pipe until the leakage of a subsequent test is within the specified allowance.

PART 4 - PAYMENT

4.1 GENERAL

- A. No payment for pipe or fittings, in place, will be made until the pipe has successfully been disinfected and passed the leakage test.
- B. The Engineer will withhold full payment on any section of pipe deemed unsatisfactory due to excessive leakage or any other causes until such defects have been corrected in accordance with these Contract Documents and are acceptable to the Engineer.

4.2 PIPE

- A. Payment for the ductile iron pipe, PVC pipe, and steel pipe will be made at the unit price per linear foot stated in the Proposal.
- B. The measurement for payment will be the field-measured centerline length of the pipe, in place, within the limits shown. Laying lengths of valves and fittings will not be included.
- C. The unit price per linear foot shall constitute full payment for the pipe, in place, including imported pipe base, imported pipe zone, polyethylene encasement of the pipe, if any, anchorage, joint fabrication, hydrostatic tests, disinfection, dechlorination, and verification.
- D. Payment for any required foundation stabilization shall be made under the foundation stabilization bid item and will include the required over excavation.

4.3 FITTINGS

- A. Payment for furnishing and installing ductile iron fittings will be made at the unit price stated in the Proposal. This payment shall constitute full compensation for all materials (i.e. gaskets, bolts, glands, retainer glands, anchorage and tie rods) and work required for furnishing and installing the fittings, complete. Fitting may be bid on a per unit item basis or on a per pound basis. If the unit bid price is on a per weight basis, the weights of ductile iron fittings used to determine the engineers estimate and which will be used to calculate the final payment for the fittings are as follows:

Description	Weight (Pounds)	Body Style
6" FE x 10" MJ Reducer	105	Full
6" MJ Connector	70	Full
6" FE x MJ Adapter	36	Compact

6" MJ 22-1/2 deg. Bend	37	Compact
6" MJ 11-1/4 deg. Bend	33	Compact
6" FE x MJ 45 deg. Bend	57	Compact
6" MJ 45 deg. Bend	38	Compact
6" MJ 90 deg. Bend	48	Compact
6" MJ x FE Tee	64	Compact
6" FE Tee	75	Compact
6" FE Wye	115	Full
6" MJ Plug w/2" Tap	18	Full
6" Blind Flange w/2" Tap	25	Full
6" MJ Plug	18	Compact
8" FE x MJ Adapter	52	Compact
8" MJ 11-1/4 deg. Bend	48	Compact
8" MJ 90 deg. Bend	68	Compact
8" x 6" MJ Tee	80	Compact
8" x 6" FE Tee	90	Compact
10" MJ Connector	130	Full
10" FE x MJ Adapter	67	Compact
10" FE x MJ 11-1/4 deg. Bend	75	Compact
10" MJ 11-1/4 deg. Bend	61	Compact
10" MJ 22-1/2 deg. Bend	67	Compact
10" MJ x FE 22-1/2 deg. Bend	122	Compact
10" MJ x FE 45 deg. Bend	122	Compact
10" FE x MJ 90 deg. Bend	121	Compact
10" MJ 90 deg. Bend	107	Compact
10" FE Tee	170	Compact
10" x 6" FE Tee	145	Compact
10" x 8" FE Eccentric Reducer	110	Full
12" x 4" MJ Tee	104	Compact

- B. Payment for furnishing and installing dresser-coupling fittings will be made at the unit price stated in the Proposal. This payment shall constitute full compensation for all materials (i.e. gaskets, bolts) and work required for furnishing and installing the coupling, complete.
- C. Payment for furnishing retainer glands. All fitting shall be furnished with Megalug or equivalent retainer glands, as approved by the engineer. The purchase, shipment, and installation of these retainer glands shall be considered incidental to the project and the cost should be include with the price of the fittings. All retainer glands installed by the Contractor shall be installed at the Contractors own expense and considered incidental to the contract.
- D. Payment for furnishing bolt-through restraints (Foster Adapters) as called for and shown on the plans shall be made at the unit price stated in the Proposal. This payment shall constitute full compensation for all material and work required for furnishing and installing the bolt-through restraint.

4.4 CONCRETE THRUST COLLARS

- A. Payment for furnishing and installing concrete thrust collars will be made at the unit price per collar stated in the Proposal.

END OF SECTION 15068

SECTION 15085 – GRAVITY SEWER PIPE**PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. This section covers all work necessary for furnishing and installing gravity sewer pipe and fittings of the sizes and classes indicated.

PART 2 - PRODUCTS**2.1 PIPE**

- A. Polyvinyl Chloride (PVC) Pipe and Fittings: PVC pipe and fittings 15-inch diameter and under for general service shall conform to ASTM D3034, standard dimension ratio not to exceed 35, except that the cell classification shall be 12454-B or 12454-C as defined in ASTM D1784.

When specifically shown on the drawings as AWWA C900, pipe shall be unplasticized polyvinyl chloride (PVC) and conform to AWWA C900 specifications. The pipe must have outside diameters (OD)'s which conform to ductile iron pipe OD's. Pipe shall be bell and spigot push-on type. The bell shall consist of an integral wall section with a factory installed, solid cross section elastometric ring which meets the requirements of ASTM F-477. Pipe shall withstand minimum burst pressures of 755 psi when tested in accordance with ASTM D 1599. All pipes shall withstand drop impacts of 100 ft/lbs without showing visible evidence of shattering or splitting when tested in accordance with ASTM D 2444. All pipe shall be class 150, diameter ratio (DR) of 18, unless otherwise shown on the drawings. Pipe shall be that as manufactured by J-M pipe, or equivalent.

- B. Ductile Iron Pipe and Fittings: Ductile iron pipe shall be centrifugally cast of 60-42-10 iron and shall conform to ANSI A21.51 or AWWA C151. Thickness Class 50 shall be used. Fittings shall conform to AWWA C110.
- C. Solid Wall High Density Polyethylene (HDPE) Pipe: furnish pipe resin that has a hydrostatic design basis of 1,600 psi when tested and analyzed according to ASTM D 2837, and has a material designation code of 3408 as listed by the Plastic Pipe Institute. The resin shall meet the requirements of ASTM D 3350 and have a minimum cell classification of PE345444C (Code D or E may also be used for pipe bursting and lining pipe and for slip lining pipe). The polyethylene composition for code C classification shall contain a minimum of 2% and not more than 3% by weight of well-dispersed and finely divided carbon black when tested according to ASTM D 1603 and ASTM D 4218. The pipe shall contain no recycled compound except that generated in the manufacturer's own plant from resin of the same specification from the same raw material pipe. Pipe (excluding black colored pipe) stored outside shall not be recycled. Provide pipe and fittings meeting the requirements of ASTM F 714 and ASTM D 3261 as modified for the specified material. ASTM D 3261 as modified for the specified material.
- D. ADS PIPE: Pipe with nominal diameters between 3 and 24 inches shall be corrugated ADS and conform to AASHTO M 252, AASHTO M 294, ASTM F 405 and ASTM F 606. Filter wrap will be GEOTEX 801HUV or comply with the following table:

PROPERTY	TEST METHOD	VALUES
MATERIALS		
Color		Desert Tan
MECHANICAL		
Tensile Strength (Grab)	ASTM D-4632	205 lbs
Elongation	ASTM D-4632	50%
CBR Puncture	ASTM D-6241	525 lbs
Trapezoidal Tear	ASTM D-4533	80 lbs
ENDURANCE		
UV Resistance % Retained at 500 hrs	ASTM D-4355	90%
UV Resistance % Retained at 1000 hrs	ASTM D-4355	70%
HYDRAULIC		
Apparent Opening Size (AOS) ³	ASTM D-4751	80 US Std. Sieve
Permittivity	ASTM D-4491	1.5 sec ⁻¹
Water Flow Rate	ASTM D-4491	110 gpm/ft ²

2.2 PIPE JOINTS

- A. Ductile Iron Pipe Joints:
1. Furnish ductile iron pipe with the types of ends for the shown. Where the pipe joint type is not specified, it is optional.
 2. Center Rings: Ductile iron per ASTM A 536, Grade 65-45-12.
 3. End Rings: Ductile iron per ASTM A 536, Grade 65-45-12.
 4. Gaskets: SBR per ASTM D 2000 MBA 710, compounded for water and sewer service.
 5. Bolts and Nuts: Trackhead bolts, heavy hex nuts, UNC 5/8" rolled thread, high strength, low alloy, corrosion resistant steel per AWWA C111.
- B. Polyvinyl Chloride (PVC) Pipe Joints: Fittings shall meet ASTM D-3034 and SDR 35 Specifications. Joints shall be rubber gasketed type conforming in all respects to the requirements of ASTM D3212 for gravity sewers. Gaskets shall conform to ASTM F477. Furnish complete information on the basic gasket polymer and results of tests of physical properties. Lubricant for jointing shall be as approved by the pipe manufacturer.
- C. Mechanical Joint Transition Gaskets: Gasket material for mechanical joint fittings between IPS outside diameter pipe shall use transition gaskets made from virgin SBR per ASTM D 2000 MBA 10, compounded for sewer service.
- D. HDPE Joints: Assemble and join solid wall HDPE pipe at the site using the thermal butt-fusion method to provide a leak proof joint. Threaded or solvent-cement joints are not allowed. All equipment and procedures used shall be in strict compliance with the manufacturer's recommendations. Use personnel certified as fusion technicians by the manufacturer of the pipe or fusing equipment to accomplish the fusing.

2.3 TEE FITTINGS for Sanitary sewers

- A. Joints on all tee fittings shall be the same as the joints used on the sewer pipe. Caps or plugs shall be furnished with each tee outlet or stub with the same type gasket and joint as furnished with the service connection pipe specified. The plug or cap shall be banded or otherwise secured to withstand all test pressures involved without leakage.
- B. Furnish all tee outlets with gasketed type joint or approved adapter to join service connection pipe used.
- C. Tee fittings shall be fabricated by the pipe manufacturer. Tee stubs shall not protrude inside the sewer pipe. Fabrication details for tees shall be submitted to the Engineer for review prior to delivery of tees to the jobsite.

2.4 HYDROSTATIC TESTING

- A. Make all arrangements for furnishing water from the nearest hydrant or other suitable source for testing purposes. Perform the tests and provide all hoses, tank trucks, plugs, and other necessary equipment to conduct the tests.

2.5 POLYETHYLENE FILM ENVELOPE

- A. Where specified on the plans for ductile iron pipe and fittings, polyethylene encasement shall conform to AWWA C105 or ANSI A21.5. Film shall be Class "C"-Black, with a minimum nominal thickness of 0.008 inch (8 mils). The polyethylene film envelope shall be free as is commercially possible of gels, streaks, pinholes, particles of foreign matter, and undispersed raw materials. There shall be no visible defects such as holes, tears, blisters, or thinning-out at folds.
- B. Tape for securing the film shall be thermoplastic material with a pressure-sensitive adhesive face capable of bonding to metal, bituminous coating, and polyethylene. Tape shall have a minimum thickness of 8 mils and a width of 1 inch.

2.6 MANUFACTURER

- A. All pipe and fittings shall be by a domestic manufacturer.

2.7 PIPE LOCATION FOIL

- A. Pipe locating foil shall be Terra Tape D, or equivalent, with one mil metallic foil core, stating "Caution: Buried Waterline Below"

2.8 PIPE LOCATION WIRE

- A. Pipe location wire shall be 10 gage insulated cooper wire.

2.9 HANDLING, SHIPPING, AND STORAGE

- A. Handle the pipe so as to prevent server impact blows, abrasion damage, and gouging or cutting by metal surfaces or rocks. Do not stress bell joints or damage bevel.

2.10 IMPORTED GRANULAR MATERIAL FOR PIPE BASE AND FOR PIPE ZONE

- A. Crushed rock for pipe base and pipe zone shall conform to the $\frac{3}{4}$ "-minus gradation as specified in Section "02575 Surface Restoration" sub-section 2.1 C.

PART 3 - EXECUTION

3.1 PREPARATION OF TRENCH

- A. Grade: Grade the bottom of the trench by hand to the line and grade to which the pipe is to be laid, with proper allowance for pipe thickness and for pipe base when specified or indicated. Before laying each section of the pipe, check the grade and correct any irregularities found. The trench bottom shall form a continuous and uniform bearing and support for the pipe between bell holes, except that the grade may be disturbed for the removal of lifting tackle.
- B. Imported Granular Material for Pipe Base: Provide imported granular material for pipe base under all pipe. Place granular base for pipe in the trench to a minimum depth of 4 inches for pipe 16 inches in diameter and smaller, and to a depth of 6 inches for pipe 18 inches in diameter and larger. Grade the top of the base to the bottom of the pipe ahead of pipe laying for the full width of the trench. Base shall provide a firm support along entire pipe length.
- C. Bell (Joint) Holes: At the location of each joint, dig bell joint holes of ample dimensions in the bottom of the trench and at the sides where necessary to permit the joint to be made properly and to permit easy visual inspection of the entire joint.
- D. Removal of Water: Provide and maintain ample means and devices at all times to remove and dispose of all water entering the trench excavation during the process of pipe laying.

3.2 LAYING

- A. Distributing Pipe: Distribute material on the job from the cars, trucks, or storage yard no faster than can be used to good advantage. In general, distribute no more than 1 week's supply of material in advance of the laying.
- B. Handling Material: Provide and use proper implements, tools, and facilities for the safe and proper prosecution of the work. Lower all pipe, fittings, and appurtenances into the trench, piece by piece, by means of a crane, slings, or other suitable tools or equipment, in such a manner as to prevent damage to the pipeline materials and protective coatings and linings. Do not drop or dump pipeline materials into the trench.
- C. Cleaning Pipe and Fittings: Inspect all pipe and fittings prior to lowering into trench to ensure no cracked, broken, or otherwise defective materials are being used. Wipe the ends of mechanical joint pipe and fittings and of rubber gasket joint pipe and fittings clean of all dirt, grease, and foreign matter.
- D. Placing of Pipe in the Trench: Do not allow foreign material to enter the pipe while it is being placed in the trench.

3.3 LINE AND GRADE

A. Gravity Pipe:

1. Do not deviate from line or grade, as established by the Engineer, more than 1/2-inch for line and 1/4-inch for grade, provided that such variation does not result in a level or reverse sloping invert.
2. Measure for grade at the pipe invert, not at the top of the pipe.
3. Establish line and grade for pipe by the use of lasers.

3.4 LAYING AND JOINTING PIPE AND FITTINGS

A. General:

1. Pipe laying shall generally proceed upgrade with spigot ends pointing in direction of flow. All pipe shall be laid uniformly to line and grade so that the finished sewer will present a uniform bore. When field cutting or machining the pipe is necessary, use only tools and methods recommended by the pipe manufacturer and approved by the Engineer.
2. The pipe bedding shall form a continuous and uniform bearing and support for the pipe barrel between joints. Care shall be taken to ensure that the pipe does not rest directly on the bell or pipe joint. Place sufficient pipe bedding material to secure the pipe from movement before the next joint is installed to assure proper pipe alignment and joint makeup.
3. Excavate bell holes at each joint to permit proper assembly and inspection of entire joint. After a section of pipe has been placed in its approximate position for jointing, clean the end of the pipe to be joined, the inside of the joint, and, if applicable, the rubber ring immediately before joining the pipe. Make assembly of the joint in accordance with the recommendations of the manufacturer of the type of joint used. Provide all special tools and appliances required for the jointing assembly. Apply sufficient pressure in making the joint to assure that the joint is "home" as defined in the standard installation instructions provided by the pipe manufacturer. Check pipe for alignment and grade after the joint has been made.
4. Pipe shall be laid so the inside joint space does not exceed 50 percent of the pipe manufacturer's recommended maximum allowable joint space.
5. Prevent excavated or other foreign material from getting into the pipe during the laying operation. Close and block the open end of the last laid section of pipe to prevent entry of foreign material or creep of the gasketed joints when laying operations are not in progress, and at the close of the day's work. Take all necessary precautions to prevent the "uplift" or floating of the line prior to the completion of the backfilling operation.
6. Plug or close off pipes which are stubbed off for manhole or structure construction with temporary watertight plugs.
7. When pipe is laid within a movable trench shield, take all necessary precautions to prevent pipe joints from pulling apart when moving the shield ahead.
8. Plug or close off pipes which are stubbed off for manhole construction or for connection by others, with temporary plugs as specified in the manhole specifications.
9. Where pipe is connected to manholes or concrete structures a standard pipe joint shall be located within 1.5 feet of the outside face of the structure.

B. Ductile Iron Pipe:

1. Mechanical joint ductile iron pipe varies slightly with different manufacturers. Install the particular pipe furnished in accordance with the particular manufacturer's recommendations, as approved by the Engineer.
2. Lay and join ductile iron pipe with rubber gasket type joints, in accordance with the manufacturer's recommendations, as approved by the Engineer. Provide all special tools and devices such as special jacks, chokers, and similar items required for the installation.
3. Pipe shall be cut at right angles to the centerline of the pipe in a neat workmanlike manner without damage to the pipe and so as to leave a smooth end. All pipes shall be cut with an approved mechanical cutter. The cut end of pipe to be used with rubber gasket joints shall be tapered by grinding or filing about 1/8 inch back at an angle of approximately 30 degrees with the centerline of the pipe, and any sharp or rough edges shall be removed.

4. Corrosion protection shall be provided for all ductile iron pipe by use of polyethylene wrap. Before installing the polyethylene wrap, the exterior of the pipe shall be free of foreign material. The polyethylene wrap shall be cut approximately 2 feet longer than that of the pipe section. After assembling the pipe joint, the polyethylene shall be overlapped approximately 1 foot and sealed at all joints with approved adhesive tape. Additional taping shall be used at 3-foot intervals along the pipe. Any rips, punctures, or other damage to the polyethylene shall be repaired immediately with adhesive tape.
5. When fittings cannot be practically wrapped in a tube, a flat sheet or split tube shall be used. All seams shall be securely taped.

- C. Ductile Iron Pipe Connected to PVC Pipe: Connect ductile iron to standard sewer pipe by means of a flexible coupling.

3.5 INSTALLATION OF SERVICE CONNECTION TEES for Sanitary sewers

- A. Install tee fittings in accordance with the Sewer Service Connection Details shown on the Drawings. Provide all tees with caps or plugs, as specified.

3.6 BACKFILL AT THE PIPE ZONE

- A. The pipe zone shall be considered to include the full width of the excavated trench from the bottom of the pipe to a point 12 inches above the top outside surface of the barrel of the pipe.
- B. Particular attention must be given to the area of the pipe zone from the invert to 75 percent of the outside diameter of pipe to ensure that firm support is obtained to prevent any lateral movement of the pipe during the final backfilling of the pipe zone.
- C. Pipe zone material shall be used for the full depth of the pipe zone. This material shall be placed simultaneously on both sides of pipe in lifts not to exceed 6 inches loose. Each lift shall be thoroughly tamped with tamping bars supplemented by walking in and slicing with a shovel to ensure that the material is in firm and intimate contact with the entire bottom surface of the pipe. Take particular attention and care to prevent damage to the pipe.
- D. Until the pipe zone backfill reaches 75 percent of the outside diameter, each two lifts of pipe zone material placed under and around flexible pipe materials shall be compacted by at least three passes with a vibratory compactor over the area between the sides of the pipe and the trench walls.
- E. After the full depth of pipe zone material has been placed in lifts as specified, compact the material by a minimum of three passes with a vibratory compactor, over the area between the sides of the pipe and the trench walls.
- F. Impact compactors shall not be used for compaction of backfill at the pipe zone. Further, as specified in Section TRENCH EXCAVATION AND BACKFILL, impact compactors shall not be used until a minimum of 3 feet of cover has been placed over the top of the pipe.
- G. Deflection of flexible pipe shall be kept to a minimum and in no case shall it exceed 7.5 percent of the nominal inside pipe diameter. All flexible pipe shall be tested for deflection between 30 to 40 days after completion of the backfill. The test for pipe 15 inches and smaller shall be conducted by hand pulling a mandrel having a minimum of nine runner through the completed pipeline. Any section of pipe not meeting these requirements shall be repaired and retested. The use of a vibratory rerounding device will not be allowed as an acceptable repair method.

3.7 Pipe Locating Foil

- A. Place pipe locating foil in trench 12 inches above pipe. Place tape so that words face upward.

3.8 Pipe Locating wire

- A. Place pipe location wire directly above pipe. Allow ample wire length at valve locations to insert wire into valve boxes.

3.9 MATERIALS, TESTS, AND INSPECTIONS

- A. PVC and Ductile Iron Pipe:
 - 1. The manufacturer or fabricator shall furnish appropriate certification, based on manufacturer's routine quality control tests, that the materials in the pipe meet the specifications.
 - 2. Pipe and accessories that are chipped, cracked, or contain other imperfections, or do not satisfactorily meet the manufacturer's standard test requirements, shall be rejected.

3.10 HYDROSTATIC AND AIR TESTS FOR GRAVITY SEWERS

- A. All gravity sewers and appurtenances shall successfully pass a hydrostatic or air test prior to acceptance and shall be free of visible leakage. Use either method of testing. Information regarding air testing may be obtained from the Engineer. Manholes shall be tested as specified in Section MANHOLE CONSTRUCTION.
 - 1. General:
 - a. Plugging of Tees, Stubs, and Service Connections: Plug all wyes, tees, stubs, and service connections with gasketed caps or plugs securely fastened or blocked to withstand the internal test pressure. Such plugs or caps shall be removable, and their removal shall provide a socket suitable for making a flexible jointed lateral connection or extension.
 - b. Testing Equipment and Procedure: Furnish all necessary testing equipment and perform the tests in a manner satisfactory to the Engineer. Any arrangement of testing equipment which will provide observable and accurate measurements of either air or water leakage under the specified conditions will be permitted. Gauges for air testing shall be calibrated with a standardized test gauge provided by the Engineer at the start of each testing day. The calibration shall be witnessed by the Engineer.
 - c. Time of Testing: Testing of sections of the constructed sanitary sewer for acceptance will not be performed until all service connections, manholes, and backfilling are completed between the stations to be tested. Attention is directed to time of payment for pipe under PART 4, PAYMENT.
 - d. Repairs: Repair or replace, in a manner approved by the Engineer, any section of pipe not meeting the air or hydrostatic test requirements, at no cost to the Owner. The Engineer will make the decision as to whether repair or replacement will be required based on the severity of the deficiencies found during testing.
 - e. Subsequent Failure:
 - 1) Infiltration of groundwater in an amount greater than herein specified, following a successful hydrostatic or air test as specified, shall be considered as evidence that the original test was in error or that subsequent failure of the has occurred. The Contractor shall correct such failure in a manner approved by the Engineer and at no cost to the Owner should they occur within the warranty period.
 - 2) The Contractor, in contracting to do this work, agrees that the leakage allowances as indicated herein are fair and practical.
 - 2. Hydrostatic Testing:

- a. Maximum amount allowable leakage in pipes and joints shall be 0.16 gallon per hour per inch-diameter per 100 feet when field tested by exfiltration methods. The hydrostatic head for test purposes shall exceed the maximum estimated groundwater level in the section being tested by at least 6 feet and in no case shall be less than 6 feet above the inside top of the highest section of Pipe in the test section, including service connections. In every case, the height of the water table at the time of the test shall be determined by the Contractor by exploratory holes or such other methods approved by the Engineer. The Engineer will make the final decisions regarding test height for the water in the pipe section being tested. The length of pipe tested by exfiltration shall be limited so that the pressure on the invert of the lower end of the section shall not exceed 30 feet of water column.
 - b. The pipe test section may be filled 24 hours prior to time of exfiltration testing, if desired, to permit normal absorption into the pipe walls to take place.
 - c. All service connection footage, included in the test section and subjected to the minimum head specified, shall be taken into account in computing allowable leakage.
3. Air Testing:
- a. Procedure:
 - 1) After all plugs are in place and securely blocked, introduce air slowly into the pipe section to be tested until the internal air pressure reaches 4 pounds per square inch greater than the average back pressure of any groundwater that may submerge the pipe. Allow a minimum of 2 minutes for the air temperature to stabilize. Determine the height of the groundwater table, at the time of the test, as specified for hydrostatic testing.
 - 2) The pipe and joints will be considered as satisfactory when the time required in seconds for the pressure to decrease from 3.5 to 2.5 pounds per square inch greater than the average back pressure of any groundwater that may submerge the pipe is not less than that computed utilizing the following table:

TABLE 1*

A Pipe Diameter (Inches)	B Time per Foot up to Length in Col C (Seconds)	C Test Length (Feet)	D Test Time for any Length Between Col C & E (Min:Sec)	E Length at Which Time in Col F Applies (Feet)	F Time per Foot for Total Length (Seconds)
4	0.18	636	1:54	1114	0.10
8	0.71	318	3:47	557	0.41
12	1.60	212	5:40	371	0.91
15	2.50	170	7:05	297	1.42
EXAMPLE: 15-inch diameter with of 150, 250, and 500 feet.					
For 150 feet T = 2.50 sec (Col B) x 150 ft = 375 Sec = 6: 15					
For 250 feet T = 7:05 (Col D)					
For 500 feet T = 1.42 Sec (Col F) x 500 ft = 710 Sec = 11:50					
Based on 0.003 cfm per square foot with a minimum significant loss of 2 cfm and a maximum loss of 3.5 cfm.					

3.11 FINAL SEWER CLEANING

- A. Prior to final acceptance and final manhole-to-manhole inspection of the sewer system by the Engineer, flush and clean all parts of the system. Remove all accumulated construction debris, rocks, gravel, sand, silt, and other foreign material from the sewer system at or near the closest downstream manhole. Use only high pressure water for cleaning.
- B. Upon the Engineer's final manhole-to-manhole inspection of the sewer system, if any foreign matter is still present in the system, reflush and clean the sections and portions of the lines as required.

3.12 TELEVISION INSPECTION OF SANITARY SEWERS

- A. During the wet weather season immediately following the completion of all sewer construction, testing and repairs, the contractor shall conduct a color or black and white TV acceptance inspection of all installed lines 6 inches to 72 inches. The inspections shall take place after ground water conditions have risen to their normal winter levels and within 48 hour of a significant rain event. Coordinate inspection with the Engineer.
- B. The contractor shall ensure that recording equipment is functioning properly and that a clear and usable record is made of all possible defects. The equipment used for recording shall be equipped with a footage meter which records a visual record on the tape. A voice accounting of suspected deficiencies shall be made on the sound track.
- C. A written report shall be made at the time of each television inspection. The video record and the written report of the acceptance inspection and the warranty inspection shall be submitted to the engineer and will become the property of the owner.
- D. The audio and visual reports of the acceptance inspection and the warranty inspection shall include identification of individual groundwater infiltration sources such as sewer laterals, building sewer connections and construction defects.

PART 4 - PAYMENT

4.1 PIPE

- A. Payment for pipe will be based upon the unit price per linear foot as stated in the Proposal for the various classes, types, and sizes of pipe installed as shown or as directed by the Engineer. Payment for pipe will be based on the actual number of feet installed, as measured by the Engineer. The pipe will be measured horizontally from center-to-center of manholes or to the end of the pipe, whichever is applicable.
- B. The unit price per linear foot shall constitute full payment for the pipe in place, pipe base, backfill in the pipe zone, leakage testing, and all other work specified.
- C. No payment will be made on any section of pipe deemed unsatisfactory due to excessive leakage, unsatisfactory line and grade, or any other cause until such defects have been corrected in accordance with the intent of these Contract Documents.
- D. If, within warranty period, any section of the sewer system, although originally accepted, is actually not acceptable due to subsequent excessive leakage, or any other defects, the Contractor shall repair or replace the affected portion at no cost to the Owner. It is understood that if the Contractor fails to do such work as required, the Surety shall be liable for said costs of repair or replacement.

4.2 SANITARY SEWER TEE FITTINGS

- A. Service connection tees installed in the sewerlines will be paid for at the unit price stated in the Proposal for the various sizes. Payment for service connection pipe plugs, stoppers, or caps will also be included under this item.
- B. Since no deduction will be made under payment for pipe for the length of the tee, unit price for tee fittings should include only the additional cost of furnishing and installing the tee fitting, over the cost of furnishing and installing an equivalent straight run of pipe.

END OF SECTION 15085

SECTION 15114 - VALVES AND VALVE BOXES**PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. Work necessary to furnish and install, complete, the ballcentric plug and v-port plug valves and valve boxes.

1.2 SUBMITTALS

- A. Quality Control Submittals: Furnish the following documents for gate and butterfly valves:
 - 1. Manufacturer's affidavits showing specification compliance.
 - 2. Performance test data as requested by Engineer.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. In addition to requirements of Division 1, GENERAL REQUIREMENTS, prepare and protect valves for shipment and ship in accordance with AWWA C509 and AWWA C504.
- B. Valves shall not be exposed to the weather or to conditions that will cause rusting or damage to the valve seating.

1.4 QUALITY CONTROL

- A. All valves shall be new, shipped directly from the manufacturer.

PART 2 - PRODUCTS**2.1 BALLCENTRIC PLUG VALVES**

- A. Manufacturers:
 - 1. Pratt
 - 3. Or equal.
- B. Characteristics:
 - 1. Iron body: cast iron ASTM A126 Class B with welded-in overlay of 90% nickel alloy content on all surfaces contacting the face of the plug. Sprayed, plated, nickel welded rings or seats screwed into the body are not acceptable.
 - a. All valves buried or in vaults shall be non rising stem type
 - b. All valves installed in above ground structures shall be rising stem type.
 - 2. Valve Plug: The valve plug shall be ductile iron ASTM A-536, Grade 65-45-12, in valve sizes up to 20", and ASTM A126 Class B cast iron in sizes 24" and larger, with Buna N resilient seating surface to mate with the body seat.
 - 3. Valve Flanges: Valve flanges shall be in strict accordance with ANSI B16.1, Class 125.
 - 4. Valve Bearings: Plug valve shall be furnished with permanently lubricated sleeve type bearings conforming to AWWA C517. Bearings shall be of sintered, oil impregnated type 316 stainless steel ASTM A-743 Grade CF-8M or bronze ASTM B-127.

5. Valve Shaft Seals: Valves shaft seals shall be of the “U” cup type, in accordance with AWWA C517. Seals shall be self adjusting and repackable without moving the bonnet from the valve.
6. Valve Actuators: 6” and smaller exposed valves shall be provided with wrench actuators. 8” and larger exposed valves shall be provided with worm gear type manual actuators. All buried valves shall be provided with worm and gear actuators suited for the intended service. Valve actuators shall be fully grease packed and have stops in the open/close position. The actuator shall have a mechanical stop which will withstand an input torque of 450 lbs. against the stop. The actuator shall be able to provide 1.25 times the required operating torque under full rated line pressure combined with a flow velocity of 8 feet per second.

2.2 V-PORT PLUG VALVES

A. Mechanical Joint or Flange

1. Manufacturers:
 - a. Fluoroseal 8 R152FF/EG-WCB/316-1-G-CCV
 - d. Or equal.
2. Characteristics:
 - a. Valve shall be:
 - Class: 150 lbs
 - Body: ASTM A216 Grade WCB
 - Plug: ASTM A351 Grade CF8M
 - Sleeved: GF2P
 - Cover: ASTM A216 Grade WCB
 - Cover Bolts: ASTM A193 Grade B7
 - b. Valve will be reduced port v-port cage controlled.
 - c. Flange ends connections shall be flanged flat face.
 - d. Valve will be manually operated with enclosed gears.

2.3 VALVE BOXES

A. Manufacturers:

1. Western Water Works Supply Co. Model 910 Valve
2. Or equal.

B. Characteristics:

1. Cast Iron Per ASTM A48 Class 30B
2. Shaft: 6-1/2 inch outside diameter, with 12 or 18 inch length.
3. Cast the word SEWER in the top of the cover.

2.4 BALLCENTRIC PLUG VALVE OPERATOR STEM EXTENSIONS

- A. Steel stem extensions are required to bring operating nut to 1’ 6” below the ground surface. The extension stem shall be constructed of 1-inch barstock steel with centering disc. Extension bottoms shall be equipped with set screws capable of securing the extension to the operating nut of the valve.

2.5 V-PORT PLUG VALVE OPERATOR STEM EXTENSIONS AND FLOOR STAND

- A. Steel stem extensions are required to bring operating nut to the floor stand. The extension stem shall be constructed of 1-inch barstock steel with centering disc. Extension bottoms shall be equipped with set screws capable of securing the extension to the operating nut of the valve.

- B. Manufacturers:
 - 1. Troy Valve Model A25655
 - 2. Or equal.
 - C. Floorstands shall be of the non-rising stem, indicating type, and designed for counterclockwise operation. The distance from the base flange to the handwheel shall be 34 1/4".
 - D. The floorstand shall be of ductile iron grade 65-45-12 and meet ASTM-A536. The floorstand shall be coated in a two part epoxy for corrosion resistance.
 - E. The word open shall be cast in the pedestal at the top, and a "CLOSED" tag shall be field mounted to indicate the closed position of the valve.
- 2.6 VALVE ACTUATORS
- A. All valves shall be equipped with gear actuators that will provide slow speed of disk movement as it approached its seat to minimize the possibility of water hammer.
 - B. Gear actuators used shall be equipped with valve position indicators.
 - C. Gear actuators used on buried valves shall be epoxy coated and suitable for buried use. Use 2-inch wrench nuts with valve boxes for all buried valves.
- 2.7 BACKFILL
- A. Furnish the same material as specified for adjacent pipe trench.
- 2.8 CONCRETE
- A. Concrete for miscellaneous construction shall conform to ASTM C94, Alternate 3; and shall have a design mix proportioned for 3,000 pounds square inch compressive strength at 28 days. Concrete mix shall contain less than 5-1/2 sacks of cement per cubic yard.
- 2.9 HAND WHEELS
- A. All valves used within above ground structures shall be operated with hand wheels. In areas where wheel operators would conflict with grating or other equipment, appropriate extensions shall be provided to allow the hand wheel to clear any conflicts.
 - B. Where extensions are supplied through grating, provisions will be made for quick disconnect of the handle or extension to facilitate easy removal of grates.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions:
 - 1. Determine the suitability of the site and construction for satisfactory performance of work to be accomplished under this section.
 - 2. Verify the absence of defects or errors which would cause defective installation/application of products, or cause latent defects in workmanship and function.

3.2 INSTALLATION

- A. Valves:
 - 1. General:

- a. Clean of all foreign material.
 - b. Inspect for proper operation, both opening and closing, and verify that valves seat properly.
 - c. Install stems vertically.
 - d. Jointing: Conform to AWWA C600 or AWWA C603, whichever is applicable.
2. Flanged Valves:
 - a. Insert gasket.
 - b. Use torque-limiting wrench to tighten bolts uniformly around flange to correct torque limits.

B. Valve Boxes:

1. Top and Extensions: Center and set plumb over wrench nuts so shock or stress is not transmitted to valve.
2. Valve Box Covers: Set top flush with surface of finished pavement, or as shown.
3. Provide concrete pad as shown, when valve box not located in pavement.
4. Extension Length: Sufficient to keep the valve box from riding on extension when set at grade.
5. Place backfill in a manner that will not damage or displace the valve box from proper alignment or grade.
6. Compact backfill to a density equal to that specified for the adjacent trench.
7. Place concrete pad around valve box in all areas where valve box is not located in pavement, as shown on Drawings.
8. Misaligned Valve Boxes: Excavate, reset plumb, and backfill.

C. Valve operator stem extensions

1. Place extension in valve boxes when operation nut is more than 3-feet below finished surface.
2. Lock bottom of valve extension onto valve nut with set screw.

3.3 FIELD TESTS

A. Valves, Joints, and Flanges:

1. Test concurrently with adjacent pipeline.
2. Disconnect and reconnect valves and retest if joints leak under test.
3. Loosen nuts, reset or replace gasket, retighten nuts, and retest if flanges leak under test.

PART 4 - PAYMENT

4.1 GENERAL

- A. Payment will be made for each gate and butterfly valve furnished and installed at the unit prices stated in the Contractor's Proposal. Payment for the valves shall constitute full compensation for the work as specified under this section, including furnishing and installing valve boxes.

END OF SECTION 15114

SECTION 16050 - BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Raceways.
 - 2. Building wire and connectors.
 - 3. Supporting devices for electrical components.
 - 4. Electrical identification.
 - 5. Electricity-metering components.
 - 6. Concrete equipment bases.
 - 7. Electrical demolition.
 - 8. Cutting and patching for electrical construction.
 - 9. Touchup painting.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. FMC: Flexible metal conduit.
- C. IMC: Intermediate metal conduit.
- D. LFMC: Liquidtight flexible metal conduit.
- E. RNC: Rigid nonmetallic conduit.
- F. RMC: Rigid metal conduit.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

1.5 COORDINATION

- A. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.
 - 1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.
- B. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.
- C. Coordinate electrical service connections to components furnished by utility companies.
 - 1. Coordinate installation and connection of exterior underground and overhead utilities and services, including provision for electricity-metering components.
 - 2. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.
- D. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces. Access doors and panels are specified in Division 8 Section "Access Doors."
- E. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.
- F. Where electrical identification markings and devices will be concealed by acoustical ceilings and similar finishes, coordinate installation of these items before ceiling installation.

PART 2 - PRODUCTS

2.1 RACEWAYS

- A. EMT: ANSI C80.3, zinc-coated steel, with set-screw or compression fittings.
- B. FMC: Zinc-coated steel.
- C. IMC: ANSI C80.6, zinc-coated steel, with threaded fittings.
- D. LFMC: Zinc-coated steel with sunlight-resistant and mineral-oil-resistant plastic jacket.
- E. RNC: NEMA TC 2, Schedule 40 PVC, with NEMA TC3 fittings.
- F. RMC: Hot dipped galvanized or electricogalvanized schedule 40 steel.
- G. Raceway Fittings: Specifically designed for the raceway type with which used.

2.2 CONDUCTORS

- A. Conductors, No. 10 AWG and Smaller: Solid or stranded copper.
- B. Conductors, Larger Than No. 10 AWG: Stranded copper, unless AL. alternate specified, AL. alternates to be copper coated.
- C. Insulation: Thermoplastic, rated at 90 deg C minimum, unless specified otherwise.

- D. Wire Connectors and Splices: Units of size, ampacity rating, material, type, and class suitable for service indicated.

2.3 SUPPORTING DEVICES

- A. Material: Cold-formed steel, with corrosion-resistant coating acceptable to authorities having jurisdiction.
- B. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel.
- C. Slotted-Steel Channel Supports: Flange edges turned toward web, and 9/16-inch- (14-mm-) diameter slotted holes at a maximum of 2 inches (50 mm) o.c., in webs.
- D. Slotted-Steel Channel Supports: Comply with Division 5 Section "Metal Fabrications" for slotted channel framing.
 - 1. Channel Thickness: Selected to suit structural loading.
 - 2. Fittings and Accessories: Products of the same manufacturer as channel supports.
- E. Nonmetallic Channel and Angle Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- (14-mm-) diameter holes at a maximum of 8 inches (203 mm) o.c., in at least one surface.
 - 1. Fittings and Accessories: Products of the same manufacturer as channels and angles.
 - 2. Fittings and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.
- F. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.
- G. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.
- H. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Plugs have number and size of conductor gripping holes as required to suit individual risers. Body constructed of malleable-iron casting with hot-dip galvanized finish.
- I. Expansion Anchors: Carbon-steel wedge or sleeve type.
- J. Toggle Bolts: All-steel springhead type.
- K. Powder-Driven Threaded Studs: Heat-treated steel.

2.4 ELECTRICAL IDENTIFICATION

- A. Identification Devices: A single type of identification product for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, and these Specifications.
- B. Raceway and Cable Labels: Comply with ANSI A13.1, Table 3, for minimum size of letters for legend and minimum length of color field for each raceway and cable size.
 - 1. Type: Pretensioned, wraparound plastic sleeves. Flexible, preprinted, color-coded, acrylic band sized to suit the diameter of the item it identifies.

2. Type: Preprinted, flexible, self-adhesive, vinyl. Legend is overlaminated with a clear, weather- and chemical-resistant coating.
 3. Color: Black letters on orange background.
 4. Legend: Indicates voltage.
- C. Colored Adhesive Marking Tape for Raceways, Wires, and Cables: Self-adhesive vinyl tape, not less than 1 inch wide by 3 mils thick (25 mm wide by 0.08 mm thick).
- D. Underground Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape with the following features:
1. Not less than 6 inches wide by 4 mils thick (150 mm wide by 0.102 mm thick).
 2. Compounded for permanent direct-burial service.
 3. Embedded continuous metallic strip or core.
 4. Printed legend that indicates type of underground line.
- E. Tape Markers for Wire: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.
- F. Color-Coding Cable Ties: Type 6/6 nylon, self-locking type. Colors to suit coding scheme.
- G. Engraved-Plastic Labels, Signs, and Instruction Plates: Engraving stock, melamine plastic laminate punched or drilled for mechanical fasteners 1/16-inch (1.6-mm) minimum thickness for signs up to 20 sq. in. (129 sq. cm) and 1/8-inch (3.2-mm) minimum thickness for larger sizes. Engraved legend in black letters on white background.
- H. Interior Warning and Caution Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145. Preprinted, aluminum, baked-enamel-finish signs, punched or drilled for mechanical fasteners, with colors, legend, and size appropriate to the application.
- I. Exterior Warning and Caution Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm), galvanized-steel backing, with colors, legend, and size appropriate to the application. 1/4-inch (6-mm) grommets in corners for mounting.
- J. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers.

2.5 CONCRETE BASES

- A. Concrete Forms and Reinforcement Materials: As specified in Division 3 Section "Cast-in-Place Concrete."
- B. Concrete: 3000-psi (20.7-MPa), 28-day compressive strength as specified in Division 3 Section "Cast-in-Place Concrete."

2.6 TOUCHUP PAINT

- A. For Equipment: Equipment manufacturer's paint selected to match installed equipment finish.
- B. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

PART 3 - EXECUTION

3.1 ELECTRICAL EQUIPMENT INSTALLATION

- A. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide the maximum possible headroom.
- B. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.
- C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.
- D. Right of Way: Give to raceways and piping systems installed at a required slope.

3.2 RACEWAY APPLICATION

- A. Use the following raceways for outdoor installations:
 - 1. Exposed: IMC.
 - 2. Concealed: IMC.
 - 3. Underground, Single Run: RMC.
 - 4. Underground, Grouped: RMC.
 - 5. Boxes and Enclosures: NEMA 250, Type 3R or Type 4.
- B. Use the following raceways for indoor installations:
 - 1. Exposed: EMT.
 - 2. Concealed: EMT.
 - 3. Connection to Vibrating Equipment: FMC; except in wet or damp locations, use LFMC.
 - 4. Damp or Wet Locations: IMC.
 - 5. Boxes and Enclosures: NEMA 250, Type 1, unless otherwise indicated.

3.3 RACEWAY AND CABLE INSTALLATION

- A. Conceal raceways and cables, unless otherwise indicated, within finished walls, ceilings, and floors.
- B. Install raceways and cables at least 6 inches (150 mm) away from parallel runs of flues. Locate horizontal raceway runs above water piping.
- C. Use temporary raceway caps to prevent foreign matter from entering.
- D. Make conduit bends and offsets so ID is not reduced. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.
- E. Use raceway and cable fittings compatible with raceways and cables and suitable for use and location.
- F. Install raceways embedded in slabs in middle third of slab thickness where practical, and leave at least 1-inch (25-mm) concrete cover.
 - 1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
 - 2. Space raceways laterally to prevent voids in concrete.

3. Install conduit larger than 1-inch trade size (DN27) parallel to or at right angles to main reinforcement. Where conduit is at right angles to reinforcement, place conduit close to slab support.
 4. Transition from nonmetallic tubing to Schedule 80 nonmetallic conduit, rigid steel conduit, or IMC before rising above floor.
 5. Make bends in exposed parallel or banked runs from same centerline to make bends parallel. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for exposed parallel raceways.
- G. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of the pull wire.
- H. Install telephone and signal system raceways, 2-inch trade size (DN53) and smaller, in maximum lengths of 150 feet (45 m) and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements, in addition to requirements above.
- I. Connect motors and equipment subject to vibration, noise transmission, or movement with a maximum of 72-inch (1830-mm) flexible conduit. Install LFMC in wet or damp locations. Install separate ground conductor across flexible connections.
- J. Set floor boxes level and trim after installation to fit flush to finished floor surface.

3.4 WIRING METHODS FOR POWER, LIGHTING, AND CONTROL CIRCUITS

- A. Feeders: Type XHHW-2 insulated conductors in raceway.
- B. Underground Feeders and Branch Circuits: Type XHHW-2 or single-wire, Type UF insulated conductors in raceway.
- C. Branch Circuits: Type XHHW-2 insulated conductors in raceway.
- D. Branch Circuits: Type XHHW-2 insulated conductors in raceway where exposed.
- E. Branch Circuits: Type XHHW-2 insulated conductors in raceway where exposed.
- F. Remote-Control Signaling and Power-Limited Circuits: Type XHHW-2 insulated conductors in raceway for Classes 1, 2, and 3, unless otherwise indicated.

3.5 WIRING INSTALLATION

- A. Install splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- B. Install wiring at outlets with at least 12 inches (300 mm) of slack conductor at each outlet.
- C. Connect outlet and component connections to wiring systems and to ground. Tighten electrical connectors and terminals, according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

3.6 ELECTRICAL SUPPORTING DEVICE APPLICATION

- A. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, U-channel system components.
- B. Dry Locations: Steel materials.
- C. Selection of Supports: Comply with manufacturer's written instructions.
- D. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four; minimum of 200-lb (90-kg) design load.

3.7 SUPPORT INSTALLATION

- A. Install support devices to securely and permanently fasten and support electrical components.
- B. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.
- C. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.
- D. Size supports for multiple raceway installations so capacity can be increased by a 25 percent minimum in the future.
- E. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.
- F. Install 1/4-inch- (6-mm-) diameter or larger threaded steel hanger rods, unless otherwise indicated.
- G. Spring-steel fasteners specifically designed for supporting single conduits or tubing may be used instead of malleable-iron hangers for 1-1/2-inch (38-mm) and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to slotted channel and angle supports.
- H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.
- I. Simultaneously install vertical conductor supports with conductors.
- J. Separately support cast boxes that are threaded to raceways and used for fixture support. Support sheet-metal boxes directly from the building structure or by bar hangers. If bar hangers are used, attach bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches (610 mm) from the box.
- K. Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.
- L. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.
- M. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Perform fastening according to the following unless other fastening methods are indicated:

1. Wood: Fasten with wood screws or screw-type nails.
2. Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.
3. New Concrete: Concrete inserts with machine screws and bolts.
4. Existing Concrete: Expansion bolts.
5. Instead of expansion bolts, threaded studs driven by a powder charge and provided with lock washers may be used in existing concrete.
6. Steel: Welded threaded studs or spring-tension clamps on steel.
 - a. Field Welding: Comply with AWS D1.1.
7. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.
8. Light Steel: Sheet-metal screws.
9. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load.

3.8 IDENTIFICATION MATERIALS AND DEVICES

- A. Install at locations for most convenient viewing without interference with operation and maintenance of equipment.
- B. Coordinate names, abbreviations, colors, and other designations used for electrical identification with corresponding designations indicated in the Contract Documents or required by codes and standards. Use consistent designations throughout Project.
- C. Self-Adhesive Identification Products: Clean surfaces before applying.
- D. Identify raceways and cables with color banding as follows:
 1. Bands: Pretensioned, snap-around, colored plastic sleeves or colored adhesive marking tape. Make each color band 2 inches (51 mm) wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side.
 2. Band Locations: At changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (8-m) maximum intervals in congested areas.
 3. Colors: As follows:
 - a. Fire Alarm System: Red.
 - b. Security System: Blue and yellow.
 - c. Telecommunication System: Green and yellow.
- E. Tag and label circuits designated to be extended in the future. Identify source and circuit numbers in each cabinet, pull and junction box, and outlet box. Color-coding may be used for voltage and phase identification.
- F. Install continuous underground plastic markers during trench backfilling, for exterior underground power, control, signal, and communication lines located directly above power and communication lines. Locate 12 to 14 inches (300 to 350 mm) below finished grade. If width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches (400 mm), overall, use a single line marker.
- G. Color-code 208/120-V system secondary service, feeder, and branch-circuit conductors throughout the secondary electrical system as follows:
 1. Phase A: Black.
 2. Phase B: Red.

3. Phase C: Blue.
4. Neutral: White.
5. Ground: Green.

H. Color-code 480/277-V system secondary service, feeder, and branch-circuit conductors throughout the secondary electrical system as follows:

1. Phase A: Yellow.
2. Phase B: Brown.
3. Phase C: Orange.
4. Neutral: White with a colored stripe or gray.
5. Ground: Green.

I. Install warning, caution, and instruction signs where required to comply with 29 CFR, Chapter XVII, Part 1910.145, and where needed to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.

J. Install engraved-laminated emergency-operating signs with white letters on red background with minimum 3/8-inch- (9-mm-) high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.

3.9 UTILITY COMPANY ELECTRICITY-METERING EQUIPMENT

A. Install equipment according to utility company's written requirements. Provide grounding and empty conduits as required by utility company.

3.10 FIRESTOPPING

A. Apply firestopping to cable and raceway penetrations of fire-rated floor and wall assemblies to achieve fire-resistance rating of the assembly. Firestopping materials and installation requirements are specified in Division 7 Section "Firestopping."

3.11 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 0 inches (0 mm) larger, in both directions, than supported unit. Follow supported equipment manufacturer's anchorage recommendations and setting templates for anchor-bolt and tie locations, unless otherwise indicated. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete."

3.12 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.

B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.13 FIELD QUALITY CONTROL

A. Inspect installed components for damage and faulty work, including the following:

1. Raceways.
2. Building wire and connectors.
3. Supporting devices for electrical components.
4. Electrical identification.
5. Electricity-metering components.
6. Concrete bases.
7. Cutting and patching for electrical construction.
8. Touchup painting.

3.14 REFINISHING AND TOUCHUP PAINTING

A. Refinish and touch up paint. Paint materials and application requirements are specified in Division 9 Section "Painting."

1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.15 CLEANING AND PROTECTION

- #### A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.
- #### B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

3.16 PREVAILING STANDARD

- #### A. When this specification conflicts with detailed construction specifications or the 1999 NEC Code (NFPA-70), the construction specifications and/or the 1999 NEC code shall prevail.

PART 4 – PAYMENT

4.1 GENERAL

- #### A. Payment for conductors and conduit will be made at the unit prices stated in the proposal, which will include all materials and labor for installation. Computation of quantities will be as indicated for each item and will be based upon measurements made by the Engineer. Wastage will not be included.

END OF SECTION 16050

SECTION 16060 - GROUNDING AND BONDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.
- B. Related Sections include the following:
 - 1. Division 2 Section "Underground Ducts and Utility Structures" for ground test wells.

1.3 SUBMITTALS

- A. Product Data: For the following:
 - 1. Ground rods.
 - 2. Chemical rods.
- B. Qualification Data: For firms and persons specified in "Quality Assurance" Article.
- C. Field Test Reports: Submit written test reports to include the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
 - 1. Comply with UL 467.
- B. Comply with NFPA 70; for overhead-line construction and medium-voltage underground construction, comply with IEEE C2.
- C. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Grounding Conductors, Cables, Connectors, and Rods:
 - a. Apache Grounding/Erico Inc.
 - b. Boggs, Inc.
 - c. Chance/Hubbell.
 - d. Copperweld Corp.
 - e. Dossert Corp.
 - f. Erico Inc.; Electrical Products Group.
 - g. Framatome Connectors/Burndy Electrical.
 - h. Galvan Industries, Inc.
 - i. Harger Lightning Protection, Inc.
 - j. Hastings Fiber Glass Products, Inc.
 - k. Heary Brothers Lightning Protection Co.
 - l. Ideal Industries, Inc.
 - m. ILSCO.
 - n. Kearney/Cooper Power Systems.
 - o. Korns: C. C. Korns Co.; Division of Robroy Industries.
 - p. Lightning Master Corp.
 - q. Lyncole XIT Grounding.
 - r. O-Z/Gedney Co.; a business of the EGS Electrical Group.
 - s. Racor, Inc.; Division of Hubbell.
 - t. Robbins Lightning, Inc.
 - u. Salisbury: W. H. Salisbury & Co.
 - v. Superior Grounding Systems, Inc.
 - w. Thomas & Betts, Electrical.

2.2 GROUNDING CONDUCTORS

- A. For insulated conductors, comply with Section 16120, "Conductors and Cables."
- B. Material: Copper-clad aluminum, and copper.
- C. Equipment Grounding Conductors: Insulated with green-colored insulation.
- D. Isolated Ground Conductors: Insulated with green-colored insulation with yellow stripe. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.
- E. Grounding Electrode Conductors: Stranded cable.
- F. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.
- G. Bare Copper Conductors: Comply with the following:
1. Solid Conductors: ASTM B 3.
 2. Assembly of Stranded Conductors: ASTM B 8.
 3. Tinned Conductors: ASTM B 33.
- H. Copper Bonding Conductors: As follows:

1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch (6.4 mm) in diameter.
2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches (42 mm) wide and 1/16 inch (1.5 mm) thick.
4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches (42 mm) wide and 1/16 inch (1.5 mm) thick.

I. Ground Conductor and Conductor Protector for Wood Poles: As follows:

1. No. 4 AWG minimum, soft-drawn copper conductor.
2. Conductor Protector: Half-round PVC or wood molding. If wood, use pressure-treated fir, or cypress or cedar.

J. Conduit il. Underground RMC can be used as grounding electrode where permitted by NFPA 70.

2.3 CONNECTOR PRODUCTS

- A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.
- B. Bolted Connectors: Bolted-pressure-type connectors, or compression type.
- C. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

2.4 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel.
 1. Size: 3/4 by 120 inches (19 by 3000 mm) in diameter.
- B. Chemical Electrodes: Copper tube, straight or L-shaped, filled with nonhazardous chemical salts, terminated with a 4/0 bare conductor. Provide backfill material recommended by manufacturer.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.
- B. In raceways, use insulated equipment grounding conductors.
- C. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells.
- D. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.

- E. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Use insulated spacer; space 1 inch (25.4 mm) from wall and support from wall 6 inches (150 mm) above finished floor, unless otherwise indicated.
 - 2. At doors, route the bus up to the top of the door frame, across the top of the doorway, and down to the specified height above the floor.

3.2 EQUIPMENT GROUNDING CONDUCTORS

- A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.
- B. Install equipment grounding conductors in all feeders and circuits.
- C. Install insulated equipment grounding conductor with circuit conductors for the following items, in addition to those required by NEC:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.
 - 6. Flexible raceway runs.
 - 7. Armored and metal-clad cable runs.
- D. Busway Supply Circuits: Install insulated equipment grounding conductor from the grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
- E. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 - 1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch (6.4-by-50-by-300-mm) grounding bus.
 - 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- F. Common Ground Bonding with Lightning Protection System: Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

3.3 INSTALLATION

- A. Ground Rods: Install at least three rods spaced at least six feet from each other and located at least the same distance from other grounding electrodes.
 - 1. Drive ground rods until tops are 2 inches (50 mm) below finished floor or final grade, unless otherwise indicated.
 - 2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except as otherwise indicated. Make connections without exposing steel or damaging copper coating.

- B. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- C. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

3.4 CONNECTIONS

- A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
 - 1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
 - 2. Make connections with clean, bare metal at points of contact.
 - 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 - 4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
 - 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
- C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
- D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.
- E. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.
- F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
- G. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.5 FIELD QUALITY CONTROL

- A. Testing: Engage a qualified testing agency to perform the following field quality-control testing:

1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests, by the fall-of-potential method according to IEEE 81.
3. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
 - a. Equipment Rated 500 kVA and Less: 10 ohms.
 - b. Equipment Rated 500 to 1000 kVA: 5 ohms.
 - c. Equipment Rated More Than 1000 kVA: 3 ohms.
 - d. Substations and Pad-Mounted Switching Equipment: 5 ohms.
 - e. Manhole Grounds: 10 ohms.
4. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

3.6 GRADING AND PLANTING

- A. Restore surface features, including vegetation, at areas disturbed by Work of this Section. Reestablish original grades, unless otherwise indicated. If sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include application of topsoil, fertilizer, lime, seed, sod, sprig, and mulch. Comply with Division 2 Section "Landscaping." Maintain restored surfaces. Restore disturbed paving as indicated.

PART 4 - PAYMENT

4.1 GENERAL

- A. Payment for the work and materials in this section will be included as part of the applicable unit prices stated in the proposal.

END OF SECTION 16060

SECTION 16120 - CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

1.3 SUBMITTALS

- A. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.4 QUALITY ASSURANCE

- A. Listing and Labeling: Provide wires and cables specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.
- B. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver wires and cables according to NEMA WC 26.

1.6 COORDINATION

- A. Coordinate layout and installation of cables with other installations.
- B. Revise locations and elevations from those indicated, as required to suit field conditions and as approved by Engineer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Wires and Cables:
 - a. Alcan Aluminum Corporation; Alcan Cable Div.
 - b. American Insulated Wire Corp.; Leviton Manufacturing Co.
 - c. BICC Brand-Rex Company.
 - d. Carol Cable Co., Inc.
 - e. Senator Wire & Cable Company.
 - f. Southwire Company.
2. Connectors for Wires and Cables:
 - a. AMP Incorporated.
 - b. General Signal; O-Z/Gedney Unit.
 - c. Monogram Co.; AFC.
 - d. Square D Co.; Anderson.
 - e. 3M Company; Electrical Products Division.

2.2 BUILDING WIRES AND CABLES

- A. UL-listed building wires and cables with conductor material, insulation type, cable construction, and rating as specified in Part 3 "Wire and Insulation Applications" Article.
- B. Rubber Insulation Material: Comply with NEMA WC 3.
- C. Thermoplastic Insulation Material: Comply with NEMA WC 5.
- D. Cross-Linked Polyethylene Insulation Material: Comply with NEMA WC 7.
- E. Ethylene Propylene Rubber Insulation Material: Comply with NEMA WC 8.
- F. Conductor Material: Copper.
- G. Conductor Material: Copper, except feeders and services larger than No. 6 AWG may be copper coated aluminum.
- H. Conductor Material: Copper-clad aluminum, except feeders smaller than No. 6 AWG and branch circuits are copper.
- I. Stranding: Solid conductor for No. 10 AWG and smaller; stranded conductor for larger than No. 10 AWG.

2.3 CONNECTORS AND SPLICES

- A. UL-listed, factory-fabricated wiring connectors of size, ampacity rating, material, type, and class for application and service indicated. Comply with Project's installation requirements and as specified in Part 3 "Wire and Insulation Applications" Article.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine raceways and building finishes to receive wires and cables for compliance with requirements for installation tolerances and other conditions affecting performance of wires and cables. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 WIRE AND INSULATION APPLICATIONS

- A. Service Entrance: Type XHHW-2, in raceway.
- B. Feeders: Type XHHW-2 or RHW-2, in raceway.
- C. Branch Circuits: Type XHHW-2 or RHW-2, in raceway.
- D. Fire Alarm Circuits: Power-limited, fire-protective, signaling circuit cable.
- E. Class 2 Control Circuits: Power-limited tray cable, in cable tray.
- F. Class 2 Control Circuits: Type THHN/THWN, in raceway.

3.3 INSTALLATION

- A. Install wires and cables as indicated, according to manufacturer's written instructions and NECA's "Standard of Installation."
- B. Pull Conductors: Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- D. Support cables according to Division 16 Section "Basic Electrical Materials and Methods."
- E. Identify wires and cables according to Division 16 Section "Basic Electrical Materials and Methods."
- F. Identify wires and cables according to Division 16 Section "Electrical Identification."

3.4 CONNECTIONS

- A. Conductor Splices: Keep to minimum.
- B. Install splices and tapes that possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.
- C. Use splice and tap connectors compatible with conductor material.
- D. Use oxide inhibitor in each splice and tap connector for aluminum conductors.
- E. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches (300 mm) of slack.
- F. Connect outlets and components to wiring and to ground as indicated and instructed by manufacturer.

- G. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

- A. Testing: On installation of wires and cables and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
 - 1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.3.1. Certify compliance with test parameters.
- B. Correct malfunctioning conductors and cables at Project site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

PART 4 - PAYMENT

4.1 GENERAL

- A. Payment for the work and materials in this section will be included as part of the applicable unit prices stated in the proposal.
- B. There are situations such as those in Section 16442 and Section 15468 where this section is used to define acceptable materials but the cost is included in the parent section. Materials referenced in this manner will be included in the parent's lump sum and not in the lump sum referred to in 4.1 A above.

END OF SECTION 16120

SECTION 16130 - RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

- 1. Raceways include the following:

- a. RMC.
- b. IMC.
- c. PVC externally coated, rigid steel conduits.
- d. PVC externally coated, IMC.
- e. EMT.
- f. FMC.
- g. LFMC.
- h. LFNC.
- i. RNC.
- j. ENT.
- k. Wireways.
- l. Surface raceways.

- 2. Boxes, enclosures, and cabinets include the following:

- a. Device boxes.
- b. Floor boxes.
- c. Outlet boxes.
- d. Pull and junction boxes.
- e. Cabinets and hinged-cover enclosures.

- B. Related Sections include the following:

- 1. Division 7 Section "Firestopping."
- 2. Division 16 Section "Basic Electrical Materials and Methods" for raceways and box supports.
- 3. Division 16 Section "Wiring Devices" for devices installed in boxes and for floor-box service fittings.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. ENT: Electrical nonmetallic tubing.
- C. FMC: Flexible metal conduit.

- D. IMC: Intermediate metal conduit.
- E. LFMC: Liquidtight flexible metal conduit.
- F. LFNC: Liquidtight flexible nonmetallic conduit.
- G. RMC: Rigid metal conduit.
- H. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: Include layout drawings showing components and wiring for nonstandard boxes, enclosures, and cabinets.

1.5 QUALITY ASSURANCE

- A. Listing and Labeling: Provide raceways and boxes specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.
- B. Comply with NECA's "Standard of Installation."
- C. Comply with NFPA 70.

1.6 COORDINATION

- A. Coordinate layout and installation of raceways and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Metal Conduit and Tubing:
 - a. Alflec Corp.
 - b. Anamet, Inc.; Anaconda Metal Hose.
 - c. Anixter Brothers, Inc.
 - d. Carol Cable Co., Inc.
 - e. Cole-Flex Corp.
 - f. Electri-Flex Co.

- g. Flexcon, Inc.; Coleman Cable Systems, Inc.
 - h. Grinnell Co.; Allied Tube and Conduit Div.
 - i. Monogram Co.; AFC.
 - j. Spiraduct, Inc.
 - k. Triangle PWC, Inc.
 - l. Wheatland Tube Co.
2. Nonmetallic Conduit and Tubing:
- a. Anamet, Inc.; Anaconda Metal Hose.
 - b. Arnco Corp.
 - c. Breeze-Illinois, Inc.
 - d. Cantex Industries; Harsco Corp.
 - e. Certainteed Corp.; Pipe & Plastics Group.
 - f. Cole-Flex Corp.
 - g. Condux International; Electrical Products.
 - h. Electri-Flex Co.
 - i. George-Ingraham Corp.
 - j. Hubbell, Inc.; Raco, Inc.
 - k. Lamson & Sessions; Carlon Electrical Products.
 - l. R&G Sloan Manufacturing Co., Inc.
 - m. Spiraduct, Inc.
 - n. Thomas & Betts Corp.
3. Conduit Bodies and Fittings:
- a. American Electric; Construction Materials Group.
 - b. Crouse-Hinds; Div. of Cooper Industries.
 - c. Emerson Electric Co.; Appleton Electric Co.
 - d. Hubbell, Inc.; Killark Electric Manufacturing Co.
 - e. Lamson & Sessions; Carlon Electrical Products.
 - f. O-Z/Gedney; Unit of General Signal.
 - g. Scott Fetzer Co.; Adalet-PLM.
 - h. Spring City Electrical Manufacturing Co.
4. Metal Wireways:
- a. Hoffman Engineering Co.
 - b. Keystone/Rees, Inc.
 - c. Square D Co.
5. Nonmetallic Wireways:
- a. Hoffman Engineering Co.
 - b. Lamson & Sessions; Carlon Electrical Products.
6. Surface Metal Raceways:
- a. Airey-Thompson Co., Inc.; A-T Power Systems.
 - b. American Electric; Construction Materials Group.
 - c. Butler Manufacturing Co.; Walker Division.
 - d. Wiremold Co. (The); Electrical Sales Division.
7. Surface Nonmetallic Raceways:

- a. Anixter Brothers, Inc.
 - b. Butler Manufacturing Co.; Walker Division.
 - c. Hubbell, Inc.; Wiring Device Division.
 - d. JBC Enterprises, Inc.; Enduro Fiberglass Systems.
 - e. Lamson & Sessions; Carlon Electrical Products.
 - f. Panduit Corp.
 - g. Thermotools Co.
 - h. United Telecom; Premier Telecom Products, Inc.
 - i. Wiremold Co. (The); Electrical Sales Division.
8. Boxes, Enclosures, and Cabinets:
- a. American Electric; FL Industries.
 - b. Butler Manufacturing Co.; Walker Division.
 - c. Crouse-Hinds; Div. of Cooper Industries.
 - d. Electric Panelboard Co., Inc.
 - e. Erickson Electrical Equipment Co.
 - f. Hoffman Engineering Co.; Federal-Hoffman, Inc.
 - g. Hubbell Inc.; Killark Electric Manufacturing Co.
 - h. Hubbell Inc.; Raco, Inc.
 - i. Lamson & Sessions; Carlon Electrical Products.
 - j. O-Z/Gedney; Unit of General Signal.
 - k. Parker Electrical Manufacturing Co.
 - l. Robroy Industries, Inc.; Electrical Division.
 - m. Scott Fetzer Co.; Adalet-PLM.
 - n. Spring City Electrical Manufacturing Co.
 - o. Thomas & Betts Corp.
 - p. Woodhead Industries, Inc.; Daniel Woodhead Co.

2.2 METAL CONDUIT AND TUBING

- A. Rigid Steel Conduit: ANSI C80.1. Hot dipped galvanized or electro-galvanized schedule 40 steel.
- B. Rigid Aluminum Conduit: ANSI C80.5.
- C. IMC: ANSI C80.6.
- D. Plastic-Coated Steel Conduit and Fittings: NEMA RN 1.
- E. Plastic-Coated IMC and Fittings: NEMA RN 1.
- F. EMT and Fittings: ANSI C80.3.
 - 1. Fittings: Set-screw or compression type.
 - 2. Fittings: Set-screw type.
 - 3. Fittings: Compression type.
- G. FMC: Aluminum.
- H. FMC: Zinc-coated steel.
- I. LFMC: Flexible steel conduit with PVC jacket.
- J. Fittings: NEMA FB 1; compatible with conduit/tubing materials.

2.3 OUTLET AND DEVICE BOXES

- A. Sheet Metal Boxes: NEMA OS 1.
- B. Cast-Metal Boxes: NEMA FB 1, Type FD, cast box with gasketed cover.
- C. Nonmetallic Boxes: NEMA OS 2.

2.4 PULL AND JUNCTION BOXES

- A. Small Sheet Metal Boxes: NEMA OS 1.
- B. Cast-Metal Boxes: NEMA FB 1, cast aluminum with gasketed cover.

2.5 ENCLOSURES AND CABINETS

- A. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Nonmetallic Enclosures: Plastic, finished inside with radio-frequency-resistant paint.
- B. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage, and include accessory feet where required for freestanding equipment.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces to receive raceways, boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of raceway installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 WIRING METHODS

- A. Outdoors: Use the following wiring methods:
 - 1. Exposed: Rigid steel or IMC.
 - 2. Concealed: Rigid steel or IMC.
 - 3. Underground, Single Run: RMC.
 - 4. Underground, Grouped: RMC.
 - 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 - 6. Boxes and Enclosures: NEMA 250, Type 3R or Type 4.
- B. Indoors: Use the following wiring methods:
 - 1. Exposed: IMC.
 - 2. Concealed: IMC.

3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
4. Damp or Wet Locations: Rigid steel conduit.
5. Boxes and Enclosures: NEMA 250, Type 1.

C. Bends: Bend radius shall not be less than that permitted by Article 346 of NFPA-70.

3.3 INSTALLATION

- A. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's written instructions.
- B. Minimum Raceway Size: 3/4-inch trade size (DN21).
- C. Install raceways level and square and at proper elevations. Provide adequate headroom.
- D. Complete raceway installation before starting conductor installation.
- E. Support raceways as specified in Division 16 Section "Basic Electrical Materials and Methods."
- F. Use temporary closures to prevent foreign matter from entering raceways.
- G. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab.
- H. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.
- I. Use raceway fittings compatible with raceways and suitable for use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings, unless otherwise indicated.
- J. Run concealed raceways, with a minimum of bends, in the shortest practical distance considering the type of building construction and obstructions, unless otherwise indicated.
- K. Install exposed raceways parallel to or at right angles to nearby surfaces or structural members, and follow the surface contours as much as practical.
 1. Run parallel or banked raceways together, on common supports where practical.
 2. Make bends in parallel or banked runs from same centerline to make bends parallel. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
- L. Join raceways with fittings designed and approved for the purpose and make joints tight.
 1. Make raceway terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
 2. Use insulating bushings to protect conductors.
- M. Tighten set screws of threadless fittings with suitable tools.
- N. Terminations: Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against the box. Where terminations are not secure with 1 locknut, use 2 locknuts: 1 inside and 1 outside the box.

- O. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align raceways so the coupling is square to the box and tighten the chase nipple so no threads are exposed.
- P. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of the pull wire.
- Q. Telephone and Signal System Raceways, 2-Inch Trade Size (DN53) and Smaller: In addition to the above requirements, install raceways in maximum lengths of 150 feet (45 m) and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.
- R. Install raceway sealing fittings according to manufacturer's written instructions. Locate fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
 - 1. Where required by NFPA 70.
- S. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches (150 mm) above the floor. Install screwdriver-operated, threaded flush plugs flush with floor for future equipment connections.
- T. Flexible Connections: Use maximum of 6 feet (1830 mm) of flexible conduit for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquidtight flexible conduit in wet or damp locations. Install separate ground conductor across flexible connections.
- U. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in a nonmetallic sleeve. Do not install aluminum conduits embedded in or in contact with concrete.
- V. PVC Externally Coated, Rigid Steel Conduits: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits.
- W. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

3.4 PROTECTION

- A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure coatings, finishes, and cabinets are without damage or deterioration at the time of Substantial Completion.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.5 CLEANING

- A. On completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

PART 4 - PAYMENT

4.1 GENERAL

- A. Payment for conductors and conduit will be made at the unit prices stated in the proposal, which will include all materials and labor for installation. Computation of quantities will be as indicated for each item and will be based upon measurements made by the Engineer. Wastage will not be included.
- B. There are situations such as those in Section 16442 and Section 15468 where this section is used to define acceptable materials but the cost is included in the parent section. Materials referenced in this manner will be included in the parent's lump sum and not in the lump sum referred to in 4.1 A above.

END OF SECTION 16130