



BIDDING REQUIREMENTS AND CONTRACT DOCUMENTS

FOR

CITY OF PASCO 19072 WWTP IMPROVEMENTS PHASE 1

NOVEMBER 2020

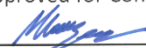
VOLUME 4 OF 5

Funded in part by the Washington State Department of Ecology: 2021-00020 Clean Water Preservation Project Phase 1

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Approved for Construction:


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11/13/2020
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SEALS PAGE

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CBA STAMP



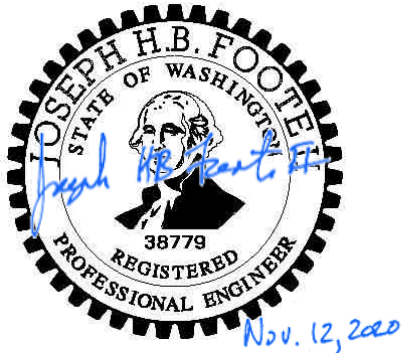
MAC STAMP



DMB STAMP



JHBF II STAMP



JWC STAMP



MEW STAMP



MEV STAMP



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PART 5 DRAWINGS

See Sheets G-002 and G-003 for Drawing Index

END OF SECTION

SECTION 31 05 13 - SOILS FOR EARTHWORK

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes range of soil and subsoil materials intended to be referenced by other sections, generally for fill and grading purposes. Materials are indicated by "Type" to assist in referencing from other sections and on Drawing notes.
- B. Section includes:
 - 1. Subsoil materials.
 - 2. Topsoil materials.

1.2 RELATED SECTIONS

- A. Section 31 05 16 - Aggregates for Earthwork.
- B. Section 31 10 00 – Site Clearing.
- C. Section 31 22 13 - Rough Grading.
- D. Section 31 23 16 – Excavation.
- E. Section 31 23 17 - Trenching.
- F. Section 31 23 23 - Fill.

1.3 REFERENCES

- A. American Association of State Highway and Transportation Officials:
 - 1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.
- B. ASTM International:
 - 1. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
 - 2. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).
 - 3. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.4 SUBMITTALS

- A. Section 01 33 00 – Submittal Procedures: Requirements for submittals.
- B. Materials Source: Submit name of imported materials source.

- C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

- A. Furnish materials of each type from same source throughout the Work.
- B. Soil Testing:
 - 1. Soil sampling and testing to be completed by an independent laboratory approved by the Engineer.
 - 2. Frequency of testing shall be determined by the Engineer.
 - 3. All soil testing shall be paid for by the Contractor.
- C. Compaction Tests:
 - 1. Maximum density at optimum moisture content determined by ASTM D1557 (AASHTO T180).
 - 2. In-place density in accordance with Nuclear Testing Method, ASTM D6938.
- D. Soil Classification: All imported materials shall be classified in accordance with ASTM D2487.

PART 2 PRODUCTS

2.1 SUBSOIL MATERIALS

- A. Subsoil Type S1, Select Native Material:
 - 1. Select earth obtained from on-site excavations approved for use by Engineer.
 - 2. Graded.
 - 3. Free of peat, humus, vegetative matter, organic matter and rocks larger than 6 inches in diameter.
 - 4. Processed as required to be placed in thickness as prescribed and at the optimum moisture content to obtain level of compaction required by these specifications.
- B. Subsoil Type S2, Imported Fill Material:
 - 1. Imported earth approved for use by Engineer.
 - 2. Meeting the requirements of Subsoil Type S1.

2.2 TOPSOIL MATERIALS

A. Topsoil Type TS1, Select Native Topsoil Material:

1. Top 6 - 12 inches of existing soil containing organic matter.
2. Engineer decision shall be final as to determination of what material is topsoil quality.
3. Graded.
4. Free of roots, rocks larger than 1/2 inch subsoil, debris, large weeds and foreign matter.
 - a. Screening: Single screened.

B. Topsoil Type TS2, Imported Topsoil Material:

1. Imported borrow.
2. Friable loam.
3. Reasonably free of roots, rocks larger than 1/2 inch, subsoil, debris, large weeds, and foreign matter.
 - a. Screening: Single screened.
4. Acidity range (pH) of 5.5 to 7.5.
5. Containing minimum of 4 percent and maximum of 25 percent inorganic matter.

2.3 SPOILS

- A. All excess material not suitable or not required for backfill and grading shall be hauled off site and disposed of at a location provided by the Contractor and approved by the Engineer.
- B. Make arrangements for disposal of the material at no additional cost to the Owner.
- C. Landfill permit to be obtained by the Contractor and provided to Engineer prior to commencement of disposal.

2.4 SOURCE QUALITY CONTROL

- A. Testing and Analysis of Subsoil Material: Perform in accordance with ASTM D1557 (AASHTO T180).

- B. When tests indicate materials do not meet specified requirements, change material or vary compaction methods and retest. Additional testing shall be completed and paid for by the Contractor with no reimbursement by the Owner.
- C. Furnish materials of each type from same source throughout the Work.

PART 3 EXECUTION

3.1 EXCAVATION

- A. Excavate material of every nature and description to the lines and grades as indicated on the Drawings and/or as required for construction of facilities.
- B. Site within clearing limits shall be stripped of topsoil as required to obtain additional topsoil necessary to complete Work indicated in the Drawings or as specified.
- C. When practical, do not excavate wet topsoil.
- D. Stockpile excavated material meeting requirements for subsoil materials and topsoil materials.
- E. Remove excess excavated subsoil and topsoil not intended for reuse from Site.
- F. Remove excavated materials not meeting requirements for subsoil materials and topsoil materials from Site.

3.2 STOCKPILING

- A. Stockpile soils at locations shown in the Drawings or at locations as approved by Engineer for redistribution as specified.
 - 1. Site may not have sufficient area to stockpile excavated material that will be required for fill later in the project. If additional stockpile area is required to complete the Project on schedule, arrange off-site stockpile areas.
 - 2. No additional payments will be made for stockpiling excavated materials off-site.
- B. Stockpile in sufficient quantities to meet Project schedule and requirements.
- C. Separate differing materials with dividers or stockpile apart to prevent mixing.
- D. Prevent intermixing of soil types or contamination.
- E. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

1. Grade surface of stockpiles to prevent ponding of water.
 2. Cover stockpiles to minimize the infiltration of water.
- F. Stockpile unsuitable and/or hazardous materials on impervious material and cover to prevent erosion and leaching, until disposed of.

3.3 STOCKPILE CLEANUP

- A. Remove stockpile, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.
- B. When borrow area is indicated, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION

SECTION 31 05 16 - AGGREGATES FOR EARTHWORK

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes range of coarse and fine aggregate materials intended to be referenced by other Sections, generally for fill and grading purposes. Materials are indicated by "Type" to assist in referencing from other Sections and in Drawing notes.
- B. Section Includes:
 - 1. Coarse aggregate materials.
 - 2. Fine aggregate materials.

1.2 RELATED SECTIONS

- A. Section 31 05 13 - Soils for Earthwork.
- B. Section 31 22 13 - Rough Grading.
- C. Section 31 23 17 - Trenching.
- D. Section 31 23 19 - Dewatering.
- E. Section 31 23 23 - Fill.
- F. Section 32 11 23 - Aggregate Base Courses.
- G. Section 33 41 40 - Storm Utility Drainage Piping.

1.3 REFERENCES

- A. American Association of State Highway and Transportation Officials:
 - 1. AASHTO M147 - Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses.
 - 2. AASHTO T27 - Sieve Analysis of Fine and Coarse Aggregates.
 - 3. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.
 - 4. AASHTO TP61 - Standard Method of Test for Determining the Percentage of Fracture in Coarse Aggregate
- B. ASTM International:
 - 1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

2. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
 3. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).
 4. ASTM D4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
 5. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
- C. Washington State Department of Transportation (WSDOT) Standard Specifications for Road, Bridge, and Municipal Construction

1.4 SUBMITTALS

- A. Section 01 33 00 - Contractor Submittals: Requirements for submittals.
- B. Materials Source: Submit name of imported materials suppliers.
- C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.
- D. Results of aggregate sieve analysis and standard proctor tests for all granular material.

1.5 QUALITY ASSURANCE

- A. Furnish each aggregate material from single source throughout the Work.
- B. Aggregate Testing:
 1. Aggregate sampling and testing to be completed by an independent laboratory approved by the Engineer.
 2. The frequency of testing one per aggregate per source with testing performed no greater than one year prior to aggregate use.
 3. All aggregate testing shall be paid for by the Contractor.
- C. Compaction Tests:
 1. Maximum density at optimum moisture content determined by ASTM D1557 (AASHTO T180).
 2. In-place density in accordance with Nuclear Testing Method, ASTM D6938.
- D. Aggregate Classification: All imported materials shall be classified in accordance with ASTM D2487.

PART 2 PRODUCTS

2.1 COARSE AGGREGATE MATERIALS

- A. Coarse Aggregate Type A1, Dense-Graded Aggregate with material, gradation and quality as shown in the Drawings and equal to Crushed Surfacing Base Course per WSDOT Section 9-03.9(3).
- B. Coarse Aggregate Type A2: Crushed or uncrushed rock or gravel as shown in the Drawings and equal to Gravel Backfill for Pipe Zone Bedding per WSDOT Section 9-03.12(3).
- C. Top Course Aggregate Type A3, shall meet the requirements for material, grading and quality as shown in the Drawings and equal to Crushed Surfacing Top Course and Keystone per WSDOT Section 9-03.9(3).

2.2 SAND

- A. Sand: Sand material shall consist of granular material, naturally produced or produced from crushed gravel, or dredge sand that is reasonably free of organic material, mica, clay, fly ash and other deleterious material, as shown in the Drawings and equal to Backfill for Sand Drains per WSDOT Section 9-03.13.

2.3 SOURCE QUALITY CONTROL

- A. Coarse Aggregate Material - Testing and Analysis: Perform in accordance with ASTM C136 and ASTM D1557 (AASHTO T180).
- B. Sand - Testing and Analysis: Perform in accordance with ASTM C136 and ASTM D1557 (AASHTO T180).
- C. When tests indicate materials do not meet specified requirements, change material and retest. Additional testing shall be completed and paid for by the Contractor with no reimbursement by the Owner.

PART 3 EXECUTION

3.1 STOCKPILING

- A. Stockpile materials imported to site as shown in the Drawings or at locations as approved by Engineer for redistribution as specified.
- B. Separate different aggregate materials with dividers or stockpile individually to prevent mixing.

- C. Prevent intermixing of aggregate types or contamination.
- D. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.
 - 1. Grade surface of stockpiles to prevent ponding of water.
 - 2. Cover stockpiles to minimize the infiltration of water.

3.2 STOCKPILE CLEANUP

- A. Remove stockpile, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.
- B. When borrow area is indicated, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION

SECTION 31 10 00 - SITE CLEARING

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes clearing site of incidental paving and curbs, debris, grass, trees, and other plant life in preparation for site or building excavation work.

1.2 RELATED SECTIONS:

- A. Section 02 41 00 - Demolition
- B. Section 31 22 13 - Rough Grading

1.3 DEFINITIONS

- A. Clearing: Removal of interfering or objectionable material lying on or protruding above ground surface.
- B. Grubbing: Removal of vegetation and other organic matter including stumps, buried logs, and roots greater than 2-inch caliper to a depth of 12 inches below subgrade.
- C. Interfering or Objectionable Material: Trash, rubbish, and junk; vegetation and other organic matter, whether alive, dead, or decaying; topsoil.
- D. Limits of Disturbance: Work area boundary as shown on the Plans.
- E. Root Wad: Tree stump and root mass including all roots greater than 1-inch diameter.
- F. Stripping: Removal of topsoil remaining after applicable scalping is completed.

1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Clearing, Grubbing, and Stripping Plan: Drawings clearly showing proposed limits to clearing, grubbing, and stripping activities at Site.
- C. Certification or disposal permit for landfill and/or waste disposal site.
- D. A copy of written permission of private property owners, with copy of fill permit for said private property, as may be required for disposal of materials.

1.5 QUALITY ASSURANCE

- A. Existing Conditions: Determine the extent of Work required and limitations before proceeding with Work.
- B. Obtain Engineer's approval of staked clearing, grubbing, and stripping limits prior to commencing clearing, grubbing, and stripping.
- C. Conform to applicable local, state, and federal codes for environmental requirements and disposal of debris,
 - 1. Burning on project site will not be permitted.
 - 2. Use of herbicides will not be permitted.
- D. Permits: The Contractor is responsible for obtaining all necessary permits required for completion of the Work described in this Section.
- E. Protection of Persons and Property: Meet all federal, state, and local safety requirements for the protection of laborers, other persons, and property in the vicinity of the work and requirements of the General Provisions.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Existing Materials: All materials, equipment, miscellaneous items, and debris involved, occurring or resulting from demolition, clearing, and grubbing work shall become the property of the Contractor at the place of origin, except as otherwise indicated in the Drawings or specifications.
- B. Wound Paint: Emulsified asphalt formulated for use on damaged plant tissues.

PART 3 EXECUTION

3.1 GENERAL

- A. Clear, grub, and strip areas needed for waste disposal, borrow, or Site improvements within limits shown in approved Clearing, Grubbing, and Stripping Plan.
- B. Remain within the property lines at all times.
- C. Do not injure or deface vegetation or structures that are not designated for removal.

3.2 EXAMINATION

- A. Verify existing plant life designated to remain is tagged or identified.
- B. Identify waste and salvage areas for placing removed materials.

3.3 PREPARATION

- A. Carefully coordinate the work of this Section with all other work and construction.
- B. Call Local Utility Line Information service at 1-800-424-5555, not less than three working days before performing Work.
- C. Request underground utilities to be located and marked within and surrounding construction areas.
 - 1. Disconnect or arrange for disconnection of utilities (if any) affected by required work.
 - 2. Keep all active utilities intact and in continuous operations.
- D. Prepare Site only after:
 - 1. Erosion and sediment controls are in place.
 - a. Limit areas exposed uncontrolled to erosion during installation of temporary erosion and sediment controls and in compliance with COP Erosion and Sediment Control Manual and ESC Permits.
 - 2. Tree and vegetation protection is installed.
 - a. Protect existing site improvements, trees, and shrubs to remain to preclude damage during construction.
 - 3. Temporary fencing is installed along the Limits of Disturbance.
 - 4. Notification of utility agencies; disconnect or arrange for disconnection of utilities (if any) affected by required work. Keep all active utilities intact and in continuous operation.

3.4 PROTECTION

- A. Utilities: Locate, identify, and protect utilities located by utilities and indicated in the Drawings to remain from damage.
- B. Survey control: Protect benchmarks, survey control points, and existing structures from damage or displacement.

C. Preservation and Trimming of Trees, Shrubs, and Other Vegetation:

1. Avoid injury to trees, shrubs, vines, plants, grasses, and other vegetation growing outside of the areas to be cleared and grubbed and those trees and shrubs designated to be preserved.
2. Protect existing trees and shrubs against cutting, breaking or skinning of roots, skinning and bruising of bark, smothering of roots by stockpiling construction materials, excavated materials, excess foot or vehicular traffic, and parking of vehicles within drip line.
3. Provide temporary guards, as necessary, to protect trees and vegetation to be left standing.
4. Temporarily cover exposed roots with wet burlap to prevent roots from drying out; cover with earth as soon as possible.
5. Provide protection for roots and limbs over 1-1/2-inch diameter cut during construction operations. Coat cut faces with emulsified asphalt.
6. Repairable damage to trees and shrubs designated to remain shall be made by a professional tree surgeon approved by the Engineer. Cost shall be borne by the Contractor.

D. Landscaped Areas:

1. When any portion of the Work crosses private property or landscaped areas, excavate topsoil separately and pile it on the opposite side of the trench from the subsoil.
2. Conduct Work in a manner that will restore original conditions as nearly as practicable.
3. Remove and replace any trees, shrubs, plants, sod, or other vegetative material as needed to complete Work.
4. All shrubs or plants shall be balled by experienced workers, carefully handled and watered, and replaced in their original positions without damage. Sod shall be handled in a similar manner.
5. Wherever sod cannot be saved and restored, the ground must be reseeded and cared for until a stand of grass is reestablished.
6. Plants or shrubs killed or destroyed shall be replaced and paid for by the Contractor.

7. It is the intent of this paragraph that the Contractor shall leave the surface and plantings in substantially the same conditions as before the Work is undertaken.
- E. Miscellaneous Site Features: Protect all existing miscellaneous site features from damage by excavating equipment and vehicular traffic, including but not limited to existing structures, fences, mailboxes, sidewalks, paving, and curbs.
- F. Repair and Replacement:
 1. Damaged items, including but not restricted to those noted above, shall be repaired or replaced with new materials as required to restore damaged items or surfaces to a condition equal to and matching that existing prior to damage or start of work of this contract.
 2. Any damage to existing facilities or utilities to remain as caused by the Contractor's operations shall be repaired at the Contractor's expense.

3.5 LIMITS

- A. As follows:
 1. Excavation: 5 feet beyond top of cut slopes.
 2. Trench Excavation: 6 feet from trench centerline, regardless of actual trench width.
 3. Fill:
 - a. Clearing and Grubbing: 5 feet beyond toe of permanent fill.
 - b. Stripping: 2 feet beyond toe of permanent fill.
 4. Structures: 15 feet outside of new structures.
 5. Roadways: Clearing, grubbing, scalping, and stripping 5 feet from roadway shoulders.
 6. Other Areas: As shown.
- B. Remove rubbish, trash, and junk from entire area within the Limits of Disturbance as material is generated. Stockpiling shall not be permitted without written approval of Owner.

3.6 CLEARING AND GRUBBING

- A. Clear and grub areas within limits shown in approved Clearing, Grubbing, and Stripping Plan.

- B. Except in areas to be excavated, all holes resulting from the clearing and grubbing operations shall be backfilled and compacted in accordance with the applicable sections of these Specifications.
- C. Clearing:
 - 1. Remove trees, saplings, snags, stumps, shrubs, brush, vines, grasses, weeds, and other vegetative growth within the clearing limits shown in the Drawings, except those trees and shrubs noted to remain in the Drawings or as directed by the Engineer.
 - 2. Clearing shall be performed in such a manner as to remove all evidence of the presence of vegetative growth from the surface of the project site and shall be inclusive of sticks and branches of thickness or diameter greater than 3/8-inch and of grasses, weeds, exceeding 12 inches in height except as otherwise indicated.
 - 3. Clear undergrowth and deadwood, without disturbing subsoil.
- D. Grubbing: Clear areas required for access to site and execution of Work and remove all stumps, root wads, and roots over 1-inch diameter to the following depths:

1. Future Structures and Building Areas	24 Inches
2. Roads and Parking Areas	18 Inches
3. All other Areas	12 Inches

3.7 TREE REMOVAL

- A. Exercise care in cutting, felling, trimming, and handling of those trees shown for removal to prevent damage to neighboring trees and structures to remain.
- B. Tree Salvage: As shown on the Plans.
- C. No trees may be removed unless approved and permitted by the Engineer.
- D. Do not top trees unless otherwise specified or approved by Owner in writing.

3.8 REMOVAL AND DISPOSAL

- A. Native vegetation may be mulched and used on Site.
- B. Asphalt and Gravel Surfaces:
 - 1. Asphalt, concrete, and gravel surfaces designated for removal shall be done to full depth.
 - 2. Asphalt, concrete, and gravel removed at Site may be reused at Site where shown in the Drawings or following approval of the Engineer.

3. Haul removed asphalt, concrete, and gravel which is unsuitable for reuse or that exceeds quantity required.
- C. Remove debris, rock, abandoned piping, and extracted plant life from Site.
 - D. Remove from the Site all debris, materials, equipment, and items found thereon and materials and debris resulting from the Work, except as otherwise indicated.
 1. All existing improvements designated on the Drawings or specified to be removed including but not limited to structures, pipelines, walls, footings, foundations, slabs, pavements, curbs, fencing, and similar structures occurring above, at, or below existing ground surface shall be included in the Work.
 2. Unless otherwise specified, any resulting voids shall be thoroughly cracked out for drainage and backfilled with suitable excavated or imported material compacted to the density of the adjacent soil.
 - E. Continuously clean-up and remove waste materials from site. Do not allow materials to accumulate on site.
 - F. Do not burn or bury materials on site. Leave site in clean condition.
 - G. Removal: All material resulting from demolition, clearing and grubbing, and trimming operations shall be removed from the Site and disposed of in a lawful manner. Materials placed on property of private property owners shall be by written permission only.
 - H. Cleanup: During and upon completion of work, promptly remove all unused tools and equipment, surplus materials, and debris.
 - I. Adjacent areas shall be returned to their existing condition prior to the start of Work.

3.9 CLEANUP

- A. During the time Work is in progress, make every effort to maintain the Site in a neat and orderly condition.
- B. All refuse, broken pipe, excess fill material, cribbing, and debris shall be removed as soon as practicable.
- C. Should the Work not be maintained in a satisfactory condition, the Owner may cause the work to stop until the cleanup of the Work has been done to the satisfaction of the Engineer.

- D. The Work will not be considered complete or the final payment certificate issued until all rubbish, unused material, or equipment shall have been removed and the premises left in a condition satisfactory to the Owner and the Engineer.

END OF SECTION

SECTION 31 22 13 - ROUGH GRADING

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes rough grading and filling associated with contouring of Site in preparation for building excavation and subsequent site work.
- B. Section Includes:
 - 1. Excavating topsoil
 - 2. Excavating subsoil
 - 3. Cutting, grading, filling, and rough contouring of Site

1.2 RELATED SECTIONS:

- A. Section 31 05 13 - Soils for Earthwork
- B. Section 31 05 16 - Aggregates for Earthwork
- C. Section 31 10 00 - Site Clearing
- D. Section 31 23 16 - Excavation
- E. Section 31 23 17 - Trenching
- F. Section 31 23 23 - Fill

1.3 REFERENCES

- A. American Association of State Highway and Transportation Officials:
 - 1. AASHTO T99 - Standard Specification for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop
 - 1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop
- B. ASTM International (ASTM):
 - 1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
 - 2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³))
 - 2. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³))

3. ASTM D2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
4. ASTM D2434 - Standard Test Method for Permeability of Granular Soils (Constant Head)
5. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
6. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Soils for Earthwork: As specified in Section 31 05 13, Soils for Earthwork.
- C. Aggregates for Earthwork: As specified in Section 31 05 16, Aggregates for Earthwork.

1.5 CLOSEOUT SUBMITTALS

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

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with ASTM C136, ASTM D2419, and ASTM D2434.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Structural Fill: Type A1, Dense-Graded Aggregate as specified in Section 31 05 16, Aggregates for Earthwork. Size of aggregate as shown in the Drawings.
- B. Granular Fill: Type A2, Granular Drain Backfill Material as specified in Section 31 05 16, Aggregates for Earthwork. Size of aggregate as shown in the Drawings.
- C. Granular Fill: Type A3, Top Course Aggregate as specified in Section 31 05 16, Aggregates for Earthwork. Size of aggregate as shown in the Drawings.
- D. Subsoil: Type S1, Select Native Material as specified in Section 31 05 13, Soils for Earthwork.
- E. Subsoil: Type S2, Imported Fill Material as specified in Section 31 05 13, Soils for Earthwork.

- F. Topsoil: Type TS1, Select Native Topsoil Material as specified in Section 31 05 13, Soils for Earthwork.
- G. Topsoil: Type TS2 Imported Topsoil Material as specified in Section 31 05 13, Soils for Earthwork.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify survey benchmark and intended elevations for the Work are as indicated on Drawings.

3.2 PREPARATION

- A. Call Local Utility Line Information service at 1-800-424-5555 not less than 3 working days before performing Work.
 - 1. Request underground utilities to be located and marked within and surrounding construction areas.
 - 2. Notify Engineer of any potential conflicts resulting from utility locations and the Drawings.
 - 3. Notify utility company to remove and relocate utilities, as may be necessary.
- B. Identify required lines, levels, contours, and datum.
- C. See Section 31 10 00, Site Clearing for additional requirements in protection of existing utilities, survey control, plant life, and landscaped areas in coordination with the Work of this Section.

3.3 TOPSOIL EXCAVATION

- A. Excavate and stockpile topsoil as specified in Section 31 05 13, Soils for Earthwork.

3.4 SUBSOIL EXCAVATION

- A. Excavate subsoil from areas to be further excavated, re-landscaped, or re-graded as shown in the Drawings.
- B. When practical, do not excavate wet subsoil. When wet subsoil must be excavated and is to be reused on site for the Work, process wet material to obtain optimum moisture content.

- C. Stockpile excavated material in area designated onsite in accordance with Section 31 05 13, Soils for Earthwork.
- D. When excavating through roots, perform Work by hand and cut roots with sharp axe.
- E. Stability: Replace damaged or displaced subsoil as specified for fill.

3.5 FILLING

- A. General:
 - 1. Grading and filling operations shall not take place when weather conditions and moisture content of fill materials prevent the attainment of specified density.
 - 2. Vertical curves or roundings at abrupt changes in slope shall be established as approved by Engineer.
 - 3. Bring all graded areas to a relatively smooth, even grade and slope by blading or dragging. Remove high spots and fill depressions.
- B. Fill areas to contours and elevations shown in the Drawings with unfrozen materials.
- C. Topsoil Fill:
 - 1. Scarify prepared subgrade to depth of 4 inches immediately prior to placing topsoil.
 - 2. Place topsoil in areas to be seeded to depths indicated in the Drawings, minimum depth of 6 inches.
 - 3. Place topsoil material loose; do not compact, do not place in wet or muddy conditions.
- D. Place material in continuous layers as follows:
 - 1. Subsoil Fill: Maximum 8 inches compacted depth.
 - 2. Structural Fill: Maximum 12 inches compacted depth.
 - 3. Granular Fill: Maximum 12 inches compacted depth.
- E. Maintain optimum moisture content of fill materials to attain required compaction density.
- F. Slope grade away from building minimum 2 percent slope for minimum distance of 10 feet, unless noted otherwise.
- G. Make grade changes gradual. Blend slope into level areas.

- H. Repair or replace items indicated in the Drawings to remain which are damaged by excavation or filling. All costs shall be borne by the Contractor.

3.6 TOLERANCES

- A. Top Surface of Subgrade: Plus or minus 1/10 of a foot from required elevation.

3.7 FIELD QUALITY CONTROL

- A. Perform laboratory material tests in accordance with AASHTO T99.
- B. Perform in place compaction tests in accordance with the following:
 - 1. Density Tests: ASTM D2922
 - 2. Moisture Tests: ASTM D3017
- C. Frequency and location of testing is dependent upon type of material placed. See Section 31 23 23 - Fill for testing requirements.
- D. When tests indicate Work does not meet specified requirements, remove Work, replace, and retest at the sole expense of the Contractor.

END OF SECTION

SECTION 31 23 16 - EXCAVATION

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes excavation required for building foundations, site structures, or under slabs-on-grade or paving. Excavating for utilities outside building is included in Section 31 23 17, Trenching.
- B. Section Includes:
 - 1. Excavating for building foundations
 - 2. Excavating for paving, roads, and parking areas
 - 3. Excavating for slabs-on-grade
 - 4. Excavating for site structures
 - 5. Excavating for landscaping

1.2 RELATED SECTIONS

- 1. Section 02 41 00 - Demolition
- 2. Section 31 05 13 - Soils for Earthwork
- 3. Section 31 05 16 - Aggregates for Earthwork
- 4. Section 31 10 00 - Site Clearing
- 5. Section 31 22 13 - Rough Grading
- 6. Section 31 23 17 - Trenching
- 7. Section 31 23 19 - Dewatering
- 8. Section 31 23 23 - Fill
- 9. Section 31 50 00 - Excavation Support and Protection
- 10. Supplemental Information: Geotechnical report; bore hole locations, and findings of subsurface materials.

1.3 DEFINITIONS

- A. Common Excavation: All excavation required for Work, regardless of the type, character, composition, or condition of the material encountered. Common Excavation

shall further include all debris, junk, broken concrete, and all other material. All excavation shall be classified as Common Excavation.

- B. Common Material: All soils, aggregate, debris, junk, broken concrete, and miscellaneous material encountered in Common Excavation.
- C. Concrete Excavation: The removal of pieces of concrete larger than 1 cubic yard in volume that requires drilling, splitting and breaking methods, or a necessitating a trench width increase of 18 inches or more than the width of the preceding 10 feet of trench. Concrete excavation includes materials composed of Portland cement that are not identified other than manholes, structures, sewer pipe, or other appurtenances.
- D. Exploratory Excavation: The removal and replacement of material from locations shown on the Drawings, or as directed for the purpose of investigating underground conditions and identifying potential utility conflict between existing and proposed utilities.
- E. Overbreak: Material beyond and outside of the slope limits established by the Owner's Representative, which becomes displaced or loosened during excavation and is excavated.
- F. Pothole Excavation: Pothole excavation is the removal and replacement of all materials via coring, vacuum extraction, or similar method, not classified as exploratory excavation, for the purposes of locating an underground utility and to investigate underground conditions.
- G. Spoils: Excavated materials from Site unsuitable for use as fill or not required for backfill and grading.
- H. Unsuitable Materials: See Spoils.

1.4 REFERENCES

- A. Local utility standards when working within 24 inches of utility lines.

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Excavation Protection Plan: At a minimum, to include the following:
 - 1. Methods and sequencing of mass excavation.
 - 2. Proposed onsite and off-site spoil disposal locations.
 - 3. Anticipated difficulties and proposed resolutions.

4. Proposed routes for Owner's access to Owner's facilities impacted by excavation Work.
 5. Proposed haul routes.
- B. Excavation support plan and utility protection plan as specified in Section 31 50 00, Excavation Support and Protection.

1.6 QUALITY ASSURANCE

- A. Allowable Tolerances: Final grades shall be plus or minus 0.1-foot.
- B. Provide adequate survey control to avoid unauthorized over-excavation.
- C. Weather Limitations:
1. Material excavated when frozen or when air temperature is less than 32 degrees Fahrenheit (F) shall not be used as fill or backfill until material completely thaws.
 2. Material excavated during inclement weather shall not be used as fill or backfill until after material drains and dries sufficiently for proper compaction.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION

3.1 PREPARATION

- A. Prior to commencing work in this Section, become familiar with site conditions. In the event discrepancies are found, notify the Engineer as to the nature and extent of the differing conditions.
- B. Call Local Utility Line Information service at 1-800-424-5555 not less than 3 working days before performing Work.
1. Request underground utilities to be located and marked within and surrounding construction areas.
 2. Coordinate with and notify utility companies should it be necessary to remove or relocate facilities.
- C. Identify required lines, levels, contours, and datum.

- D. See Section 31 10 00, Site Clearing for additional requirements in protection of existing utilities, survey control, plant life, and landscaped areas in coordination with Work in this Section.

3.2 SITE CONDITIONS

- A. Quantity Survey: The Contractor shall be responsible for calculations for quantities and volume of cut and fill from existing site grades to finish grades established under this contract as indicated in the Drawings or specified and shall include the cost for all earthwork in the total basic bid.
- B. Dust Control: Must meet all federal, state, and local requirements. Protect persons and property from damage and discomfort caused by dust. Water surfaces as necessary and when directed by Engineer to quell dust.
- C. Soil Control: Soil shall not be permitted to accumulate on surrounding streets or sidewalks nor to be washed into sewers.

3.3 EXISTING UNDERGROUND UTILITIES

- A. Protect active utilities encountered, located or otherwise, and notify persons or agencies owning same.
- B. Remove inactive or abandoned utilities from within the project grading limits as shown on Drawings.
- C. For sewer and other miscellaneous drainage facilities, fill and plug pipes as follows:
 - 1. General:
 - a. Remove all structures to a minimum of 3 feet below subgrade, unless otherwise noted.
 - b. Cover top surface of all abandoned structures with two sheets of nonwoven geotextile, extended at least 1-foot beyond the outside walls of the abandoned manhole, sump, or basin.
 - c. Plug all abandoned pipes with permanent plugs as shown on drawings.
 - 2. Sumps:
 - a. Remove existing sediment, soil, and water. Properly dispose of these materials in accordance with the requirements of these specifications.
 - b. Remove top cone and first solid concrete section to a depth of approximately 8 to 10 feet below ground.

- c. Fill sump with CLSM.
 - d. Backfill remaining voids for facilities within existing or proposed roadways with approved materials meeting the requirements of Section 32 11 23, Aggregate Base Courses.
3. Salvaging Manhole Frames, Covers, and Grates:
- a. Remove manhole frames, covers, and grates scheduled for salvage and store in approved location.
 - b. Frames, grates, and covers meeting Specifications may be salvaged from structures to be adjusted and may be reused in the Work if of suitable size and condition.
 - c. Replace, at no additional cost to the Owner, all items damaged or lost by the Contractor with similar items that are comparable in all respects with those they are to replace, and which are adequate for the intended purpose.
 - d. Clean salvaged components to be reused of foreign material by methods that will not harm the components.
4. Existing Manhole Frames and Covers: Manhole frames and covers removed by the Contractor are the property of the Owner. Notify the Engineer a minimum of 48 hours before removal to arrange for pickup of the removed frames and covers, if not reused.

3.4 PRESERVATION OF EXISTING IMPROVEMENTS

- A. Protect adjacent existing structures which may be damaged by excavation work.
- 1. Conduct operations in such a manner that existing street facilities, utilities, railroad tracks, structures, and other improvements, which are to remain in place, will not be damaged. Furnish and install cribbing and shoring or whatever means necessary to support material around existing facilities, or to support the facilities themselves, and maintain such supports until no longer needed.
 - 2. Open slopes shall not be cut within 5 feet of any existing spread footings unless approved by the Engineer.
 - 3. Do not interfere with 45 degree bearing splay of foundations unless approved by the Engineer
 - 4. Excavated material shall not be placed adjacent to existing or proposed structures.

3.5 EXCAVATION

A. General:

1. Method of excavation shall be the Contractor's option, but care shall be exercised as final grade is approached to leave it in undisturbed condition.
2. If the final grade for supporting structures is disturbed, it shall be restored to requirements of these Specifications and satisfaction of the Engineer at no additional cost to Owner.
3. The Contractor is advised that footings should be poured as soon as possible to minimize unfavorable final grade conditions from developing.
4. Provide all measures to ensure public safety.

B. Control of Water:

1. Provide and maintain equipment to remove and dispose of water during the course of the work of this Section and keep excavations dry and free of frost or ice.
2. Bearing surfaces that become softened by water or frost must be re-excavated to solid bearing at Contractor's expense and backfilled with compacted crushed rock at Contractor's expense.
3. Grade top perimeter of excavation to prevent surface water from draining into excavation.
4. See additional requirements in Section 31 23 19, Dewatering.

C. Frozen Ground: Frost protection shall be provided for all structural excavation work. Foundation work shall not be placed on frozen ground.

D. Excavate material of every nature and description to the lines and grades as indicated in the Drawings and/or as required for construction of the facility.

1. Allow for forms, shoring, working space, granular base, topsoil, and similar items, wherever applicable.
2. Trim excavations to neat lines. Remove loose matter and lumped subsoil.

E. Excavated Materials: Soils excavated at Site will be treated and used as one of two general categories of material as provided below.

1. Fill:

- a. Subsoil Type S1, Select Native Fill, as approved for use by Engineer.

2. Spoils:

- a. Ensure there is sufficient suitable material available to complete embankments and other required fillings prior to disposing of any excavated materials.
- b. Make arrangements for disposal of spoils and include as part of contract work in preparing of project bids.
- c. Landfill permit or written permission from private property owner to be obtained by the Contractor and provided to the Engineer.

F. Shoring:

1. As specified in Section 31 50 00, Excavation Support and Protection.
1. The Contractor shall be solely responsible for excavation protection and worker safety and shall provide sheeting and shoring wherever required, all in accordance with current local, state, and federal laws, codes, and ordinances.
2. Where shoring, sheet piling, sheeting, bracing, lagging, or other supports are necessary to prevent cave-ins or damage to existing structures, it shall be the responsibility of the Contractor to design, furnish, place, maintain, and remove such supports in accordance with applicable ordinances and safety requirements.
3. The design, planning, installation, and removal of all sheeting accomplished in such a manner as to maintain the undisturbed state of the soil below and adjacent to the excavation.

G. Slope existing banks with machine to angle of repose or less until shored.

1. Shape, trim, and finish cut slopes to conform to lines, grades, and cross-sections shown, with proper allowance for topsoil or slope protection, where shown.
2. Protection of excavation side slopes:
 - a. Use excavation methods that will not shatter or loosen excavation slopes.
 - b. Where practical, excavate materials without previous loosening and in limited layers or thickness to avoid breaking the material back of the established slope line.
 - c. Avoid overbreaks. Overbreak is incidental to the Work, except in cases where the Owner's Representative determines that such overbreak was unavoidable.
 - d. Excavation in rock or rocky cuts:

- 1) Once completed, thoroughly test the slopes with bars or other approved means to remove all loose, detached, broken, or otherwise unstable material.
 - 2) Remove jutting points. Scale slopes using mine scaling rods or other approved methods to remove loose or overhanging materials and provide a safe, trim, neat, and stable condition.
 - 3) Dispose of the materials removed under this subparagraph in the same manner as other excavated material.
- e. Remove all exposed roots, debris, and all stones more than 3 inches in size which are loose or could become loosened.
3. Construct slopes free of all exposed roots.
 4. Construct slopes free of unstable rock and loose stones exceeding 3 inches in diameter.
 5. Round tops of cut slopes in soil to not less than a 6-foot radius, provided such rounding does not extend off-site, outside of easements, outside of rights-of-way, or adversely impacts existing facilities, adjacent property, or completed Work.
 6. Trim all surfaces neatly and smoothly.
- H. Compact disturbed load bearing soil in direct contact with foundations to original bearing capacity; perform compaction in accordance with Section 31 23 17, Trenching and Section 31 23 23, Fill.
- I. Notify Engineer of unexpected subsurface conditions.
- J. Over-excavation for Unsuitable Foundation Conditions:
1. Cross-sectional dimensions and depths of excavations shown in the Drawings shall be subject to such changes as may be found necessary by the Engineer to secure foundations free from soft, weathered, shattered, and loose material or other objectionable materials.
 2. Unsuitable materials encountered shall be removed and replaced with Coarse Aggregate Type A1 of Section 31 05 16, Aggregates for Earthwork. All material placed shall be compacted to 95 percent of maximum dry density.
 3. Unsuitable materials shall be removed and replaced only as directed in writing by Engineer.
- K. Rock Removal:

1. Remove boulders and rock up to 1/2 cubic yard measured by volume per the requirements of this Section.
 2. Concrete removal, as defined herein, shall be treated as Rock Removal.
- L. Stockpile excavated material in area(s) designated on or off site in accordance with Section 31 05 13, Soils for Earthwork.

3.6 FIELD QUALITY CONTROL

- A. Perform excavation and controlled fill operations in accordance with the requirements of this Section.
- B. Coordinate the visual inspection and approval of all bearing surfaces by Engineer before installing subsequent work.

3.7 PROTECTION

- A. Prevent displacement or loose soil from falling into excavation; maintain soil stability and store excavated materials at a distance from top of excavation.
- B. Protect structures, utilities, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth operations.

END OF SECTION

SECTION 31 23 17 - TRENCHING

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes the requirements for excavation and backfill of all utilities, including installation of pipe bedding, pipe zone backfill, trench backfill, and related Work as shown on the Drawings and as specified.
- B. Section includes:
 - 1. Excavating trenches for pipe, utility vaults, and other utilities.
 - 2. Compacted fill from top of utility bedding to final grades.
 - 3. Trench and utility vault backfilling and compaction.
- C. Related Sections
 - 1. Section 03 30 00 - Cast-In-Place Concrete
 - 2. Section 31 05 13 - Soils for Earthwork
 - 3. Section 31 05 16 - Aggregates for Earthwork
 - 4. Section 31 10 00 - Site Clearing
 - 5. Section 31 22 13 - Rough Grading
 - 6. Section 31 23 16 - Excavation
 - 7. Section 31 23 23 - Fill
 - 8. Section 31 23 24 - Flowable Fill
 - 9. Supplemental Information: Geotechnical report; bore hole locations and findings of subsurface materials.

1.2 REFERENCES

- A. American Association of State Highway and Transportation Officials:
 - 1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop
- B. ASTM International (ASTM):

1. ASTM C403 - Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance
2. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³))
3. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
4. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
5. D4832, Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders

1.3 DEFINITIONS

- A. Controlled Low Strength Material (CLSM): Also referred to as Flowable Fill. Lean cement concrete fill. A self-compacting, cementitious material.
- B. Flexible Pipe: For the purposes of these Specifications, tubing between 1/2-inch and 4-inch diameter constructed of polyvinyl chloride (PVC) and high-density polyethylene (HDPE) are considered flexible pipes. HDPE piping 4 inches in diameter and larger is also considered flexible pipe.
- C. Geosynthetics: Geotextiles, geogrids, geomembranes, and drainage composite materials.
- D. Imported Material: Materials obtained from sources offsite, suitable for specified use.
- E. Lift: Loose (uncompacted) layer of material.
- F. Obstructions: Items which may be encountered during utility and vault trenching which do not require replacement.
- G. Optimum Moisture Content:
 1. Determined in accordance with ASTM Standard specified to determine maximum dry density for relative compaction.
 2. Determine field moisture content on basis of fraction passing 3/4-inch sieve.
- H. Pipe Bedding: Trench backfill zone for full trench width which extends from the bottom outside surface of the pipe to a minimum of 6 inches below the bottom outside surface of pipe, conduit, cable, or duct bank to the trench foundation so as to uniformly support the barrel of the pipe.

- I. Pipe Zone: Trench backfill zone for full trench width which extends from the bottom outside surface of the pipe to a minimum of 12 inches above the top outside surface of pipe, conduit, cable, or duct bank.
- J. Pipe Bedding, Pipe Zone, and Trench Backfill Classifications:
 - 1. Class A: Backfill with suitable native or imported material that is approved to meet the characteristics required for the specific surface loading or other criteria of the backfill zone.
 - 2. Class B: Backfill with imported granular material consisting of gravel or crushed rock meeting the requirements of this Section and Coarse Aggregate Type A1 as specified in Section 31 05 16, Aggregates for Earthwork.
 - 3. Class C: Backfill with Fine Sand, as specified in Section 31 05 16, Aggregates for Earthwork.
 - 4. Class D: Backfill with approved pit run or bar run material, well-graded from coarse to fine; maximum dimension shall be 3 inches.
 - 5. Class E: Backfill with CLSM. See Section 31 23 24, Flowable Fill.
- K. Pothole Excavations: Removal and replacement of all materials via coring, vacuum extraction, or similar method for the purposes of locating an underground utility and to investigate underground conditions.
- L. Prepared Trench Bottom: The bottom of the trench on which the pipe bedding is to lie and which provides support for the pipe.
- M. Relative Compaction: Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM Standards.
- N. Rigid Pipe: For the purposes of these Specifications, pipe constructed of PVC, ductile iron, steel, concrete, and clay pipes are considered rigid pipes.
- O. Sewer, Pipes, and Mains: Conduits of circular or other geometric shapes, used to convey liquids or gases, or other material.
- P. Trench Backfill: Trench backfill zone for full trench width extending from the top of the pipe zone to pavement base rock, ground surface, or other surface material.
- Q. Trench Stabilization: Removal of unsuitable material in the bottom of a trench and replacement with specified material for support of a pipe, main, conduit, structure, or appurtenances.
- R. Utility: Any buried pipe, duct, conduit, or cable.

- S. Well-Graded: A mixture of particle sizes with no specific concentration or lack thereof of one or more sizes that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

1.4 SUBMITTALS

- A. Section 01 33 00, Submittal Procedures: Requirements for submittals.
- B. Excavation Protection Plan: At a minimum, to include the following:
 - 1. Methods and sequencing of mass excavation.
 - 2. Proposed on-site and off-site spoil disposal locations.
 - 3. Anticipated difficulties and proposed resolutions.
 - 4. Proposed routes for Owner's access to Owner's facilities impacted by excavation Work.
 - 5. Proposed haul routes.
- B. Excavation support plan and utility protection plan as specified in Section 31 50 00, Excavation Support and Protection.
- C. Product Data:
 - 1. Geotextile fabric, indicating fabric and construction
 - 2. Marking tapes
 - 3. Tracer wire
 - 4. Connectors for tracer wire and/or marking tapes
 - 5. Tracer wire locate boxes
 - 6. Marker balls
 - 7. Locator stations
 - 8. Ground wires
 - 9. Plastic or copper markers for service laterals.
- D. Imported Materials:
 - 1. Materials Source: Submit name and location of imported fill materials suppliers.
 - 2. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.
 - 3. Submit results of aggregate sieve analysis and standard proctor test for granular material.

- E. CLSM: Mix designs in accordance with Submittal requirements of Section 31 23 24, Flowable Fill.
- F. Concrete: Mix designs in accordance with Submittal requirements of Section 03 30 00, Cast-in-Place Concrete.

1.5 QUALITY ASSURANCE

- A. Subsoil and topsoil fill materials: In accordance with Quality Assurance requirements stated in Section 31 05 13, Soils for Earthwork.
- B. Aggregate fill materials: In accordance with Quality Assurance requirements stated in Section 31 05 16, Aggregates for Earthwork.
- C. CLSM:
 - 1. In-place testing: In accordance with ASTM C403.
 - 2. Compressive testing: In accordance with ASTM D4832.
- D. Allowable Tolerances: Final grades shall be plus or minus 0.1-foot.

1.6 QUALIFICATIONS

- A. NOT USED

1.7 COORDINATION

- A. Verify Work associated with lower elevation utilities is complete before placing higher elevation utilities.
- B. Coordinate trenching and utility installation work with other work at utility construction location occurring near or adjacent to specified herein.

PART 2 PRODUCTS

2.1 FILL MATERIALS

- A. Subsoil Fill: Type S1, Select Native Material as specified in Section 31 05 13, Soils for Earthwork.
- B. Imported Granular Fill: Coarse Aggregate Type A1, Dense-Graded Aggregate with gradation as shown in the Drawings and specified in Section 31 05 16, Aggregates for Earthwork.
- C. Concrete:

1. Lean concrete as specified in Section 31 23 24, Flowable Fill, with compressive strength of 100 pounds per square inch (psi).
 2. Structural concrete as specified in Section 03 30 00, Cast-in-Place Concrete with compressive strength of 3,000 psi.
- D. Drain Rock: Coarse Aggregate Type A2, Granular Drain Backfill Material with gradation as shown in the Drawings and specified in Section 31 05 16, Aggregates for Earthwork.
- E. Sand: As specified in Section 31 05 16, Aggregates for Earthwork.
- F. Trench Stabilization Material: Coarse Aggregate Type A1, Dense-Graded Aggregate, 2-1/2-inch - 0 gradation as specified in Section 31 05 16, Aggregates for Earthwork.

2.2 MARKING TAPE

- A. Detectable:
1. Solid aluminum foil, visible on unprinted side, encased in protective high visibility, inert polyethylene plastic jacket.
 2. Foil Thickness: Minimum 0.35 mils.
 3. Laminate Thickness: Minimum 5 mils.
 4. Width: 6 inches.
 5. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.
 6. Joining Clips: Tin or nickel-coated furnished by tape manufacturer.
 7. Manufacturers and Products:
 - a. Reef Industries; Terra Tape, Sentry Line Detectable
 - b. Mutual Industries; Detectable Tape
 - c. Presco; Detectable Tape
- B. Color: In accordance with APWA Uniform Color Code for Temporary Marking of Underground Facilities and as specified in NEMA Z535.1, Safety Color Code.

Color	Facility
Red	Electric power lines, cables, conduit, and lightning cables
Orange	Communicating alarm or signal lines, cables, or conduit
Yellow	Gas, oil, steam, petroleum, or gaseous materials
Green	Sewers and drain lines

Color	Facility
Blue	Potable water
Purple	Reclaimed water, irrigation, and slurry lines

2.3 ELECTRONIC LOCATING MATERIALS

A. Tracer Wire:

1. Direct burial No. 12 AWG solid, annealed copper-clad steel (CCS) high strength tracer wire.
2. Tensile Breaking Load: 380-pound average.
3. Jacket:
 - a. High molecular weight high-density polyethylene complying with ASTM D1248, 30-volt rating.
 - b. Color: Provide in colors per Article 2.03 B above.
4. Manufacturer and Product: Copperhead Industries; LLC, 12 CCS high strength reinforced tracer wire, or approved equal.

B. Tracer Wire Connectors:

1. Waterproof, corrosion proof and suitable for No. 12 AWG solid core wire.
2. Prefilled with silicone and suitable for use with low-voltage tracer lines of less than 50 volts.
3. Lug Connectors:
 - a. Waterproof plastic housing that encases the silicone prefilled lug terminals.
 - b. Manufacturer and Product: King Innovations; DryConn™ Direct Bury Lug or approved equal.
4. Twist Connectors:
 - a. Waterproof epoxy-filled packaging that encases the silicone prefilled twist connectors.
 - b. Manufacturer and Product: 3M Division; DBY Direct Bury Splice Kit 09053 connectors or approved equal.

C. Ground Wire: No. 12 AWG bare solid copper wire.

D. Locator Station:

1. Test Station:

- a. Lexan® polycarbonate.
- b. Color: Provide in colors per Article 2.2 B above.

2. Terminals suitable for No. 12 AWG leads.

3. Use single (two lead) locator stations with two terminals, one for ground wire and one for tracer wire, when only one tracer wire is terminated in manhole.

4. Use multi-lead locator stations with the appropriate number of terminals when 2 or more tracer wire leads are terminated in manhole.

5. Manufacturer and Product: Cott Manufacturing Company; FlangeFink® Cathodic Protection Test Station.

2.4 VISUAL IDENTIFICATION MATERIALS

A. Tracer Wire Locate Boxes:

1. Material: Polyolefin.

2. Cover:

- a. Color: Provide in colors per 2.2.B above.
- b. Provide box cover identification marking for facility type such as “Sewer Locate Wire”, as approved by Owner.
- c. Locking type with a nominal 6-inch opening.

3. Manufacturer and Product: Carson Industries LLC; L Series Model 708 or approved equal.

B. Service Lateral Plastic or Copper Markers:

1. Service Lateral Plastic or Copper Markers: Use markers of the type that requires installation to be recessed below grade.

- a. Material: Plastic or copper. In new concrete, use “new construction” markers; in existing concrete use “retrofit” markers and use adhesive recommended by the manufacturer.

b. Plastic Pavement Markers:

- 1) UV stabilized and fade resistant.
 - 2) Material: Meet or exceed a tensile strength of 3,500 psi, and meet test requirements as outlined in ASTM G53, Standard Practice for Light and Water Exposure of Nonmetallic Material.
 - 3) Color: Provide in color per Article 2.2 B above with the words, "WARNING, BURIED UTILITY" , Call Before You Dig," molded to the top of marker.
 - a) Provide wording for specific facility as approved by Owner.
 - 4) Manufacturer and Product: Rhino Marking and Protective Systems; A-TAG pavement markers or approved equal.
- c. Copper Pavement Markers:
- 1) Material: Copper material chosen by manufacturer.
 - 2) Diameter: 1-5/32-inch.
 - 3) Wording: Provide facility identification wording stamped on the top such as "Sewer Lateral" as approved by Owner.
 - 4) Manufacturer and Product: Berntsen Concrete Marker; BP2-U or approved equal.

C. Service Lateral 2-inch by 4-inch Markers:

1. S4S Douglas fir, pressure-treated 2-inch by 4-inch lumber, utility grade or better.
2. Grade stamped by an American Lumber Standards certified inspection agency.

PART 3 EXECUTION

3.1 PREPARATION

- A. Call Local Utility Line Information service at 1-800-424-5555 not less than three working days before performing Work.
1. Request underground utilities to be located and marked within and surrounding construction areas.
 2. Coordinate with and notify utility companies should it be necessary to remove or relocate facilities.
 3. Maintain and protect above and below grade utilities indicated to remain.

- B. Identify required lines, levels, contours, and datum locations.
- C. Drawings and/or specifications cover and govern replacement and restoration of foreseeable damage.
- D. The site of an open cut excavation shall be first cleared of all obstructions preparatory to excavation in accordance with Section 31 10 00, Site Clearing.
- E. See Section 31 10 00, Site Clearing for additional requirements in protection of existing utilities, survey control, plant life, and landscaped areas in coordination with Work in this Section.
 - 1. Intent of Drawings and Specifications is that all streets, structures, and utilities be left in condition equal to or better than original condition.
 - 2. Where damage occurs, and cannot be repaired or replaced, the Contractor shall purchase and install new material, which is satisfactory to Owner.
- F. Potholing / Exploratory Test Pits: Dig such exploratory test pits and perform potholing as may be necessary in advance of trenching to determine the exact location and elevation of subsurface structures, pipelines, duct banks, conduits, and other obstructions which are likely to be encountered or need to be connected to and shall make acceptable provision for their protection, support, and maintenance of their continued operation.
- G. Paved or Surfaced Streets:
 - 1. Wherever paved or surfaced streets are cut, saw wheel or approved cutting devices shall be used.
 - 2. Width of pavement cut shall be as shown in the Drawings.
 - 3. Any cut or broken pavement shall be removed from site during excavation.
- H. Traffic:
 - 1. Maintain street traffic at all times as required by the Drawings and as specified herein.
 - 2. Erect and maintain barricades, warning signs, traffic cones, and other safety devices during construction in accordance with the latest edition of Manual of Uniform Traffic Control Devices (MUTCD), Part 6, to protect the traveling public in any area applicable.
 - 3. Provide flaggers as required during active work in roadway areas.

- I. Operations shall be confined to rights-of-way and easements provided. Avoid encroachment on, or damage to, private property or existing utilities unless prior arrangements have been made with copy of said arrangement submitted to Engineer.

3.2 EASEMENTS

- A. Where portions of the Work are located on private property, easements and permits will be obtained by the Owner. Easements shall provide for the use of property for construction purposes to the extent indicated on the easements.
- B. Copies of these easements and permits will be available from the Owner for inspection by the Contractor. It shall be the Contractor's responsibility to determine the adequacy of the easement obtained in every case.
- C. Confine construction operations to within the easement limits or street right-of-way limits or make special arrangements with the property owners for the additional area required and notify the Engineer with a copy of the written approval from property owners of any such conditions.
- D. Any damage to private property, either inside or outside the limits of right-of-way or easements provided by the Owner, resulting from Work shall be the responsibility of the Contractor. Before the Engineer will authorize final payment, the Contractor will be required to furnish the Owner with written releases from property owners where the Contractor has obtained special agreements or easements or where the Contractor's operations, for any reason, have not been kept within the construction right-of-way obtained by the Owner.

3.3 PROTECTION

- A. Existing Facilities:
 1. It is the intent of these specifications that all streets, structure, and utilities be left in a condition equal to or better than original condition at the completion of the Project.
 2. Where damage occurs, and cannot be repaired or replaced, the Contractor shall purchase and install new material to the satisfaction to the Engineer.
 3. Drawings and/or specifications cover and govern replacement and restoration of foreseeable damage.
- B. Removal of Water:
 1. As specified in Section 31 23 19, Dewatering.

2. At all times during construction provide and maintain ample means and devices with which to remove promptly and dispose of properly all water entering the excavations or other parts of the Work.
 3. Keep all excavations dry until the utilities or vaults to be placed therein are completed. In water bearing sand, well points and/or sheeting shall be supplied, together with pumps and other appurtenances of ample capacity to keep the excavation dry as specified.
 4. Dispose of water from the Work in a suitable legal manner without damage to adjacent property or structures.
- C. Trench Protection:
1. Provide the materials, labor, and equipment necessary to protect trenches at all times.
 2. Trench protection shall provide safe working conditions in the trench and protect the Work, existing property, utilities, pavement, etc.
 3. The method of protection shall be according to the Contractor's design.
 4. The Contractor may elect to use a combination of shoring, overbreak, tunneling, boring, sliding trench shields, or other methods of accomplishing the work provided the method meets the approval of all applicable local, state, and federal safety codes.
 5. Damages resulting from improper shoring, improper removal of shoring, or from failure to shore shall be the sole responsibility of the Contractor.

3.4 LINES AND GRADES

- A. Trench excavation for piping, utility vaults, and other utilities shall be performed to the alignment and grade as indicated in the Drawings.
- B. Where grades are not shown in the Drawings, utilities shall be laid to grade between control elevations shown.
- C. Water mains shall be installed with a minimum cover of 42 inches.
- D. The Engineer reserves right to make changes in lines, grades, and depths of utilities when changes are required for Project conditions.
- E. Changes in the grade and horizontal alignment of the pipeline as shown in the Drawings or as provided elsewhere in the Specifications may be necessary due to unanticipated interferences or other reasons.

1. No additional compensation will be allowed the Contractor for changes in horizontal alignment.
 2. No additional compensation will be allowed for changes in grade which require additional depth of trench excavation and backfill up to 2 feet from those shown in the Drawings.
- F. Use laser-beam instrument with qualified operator to establish lines and grades.

3.5 OBSTRUCTIONS

- A. Obstructions to the construction of the trench, such as tree roots, stumps, abandoned pilings, abandoned buildings and concrete structures, logs, rubbish, and debris of all types shall be removed without additional compensation from the Owner.
- B. The Engineer may, if requested by the Contractor or Owner, make changes in the trench alignment to avoid major obstructions if such alignment changes can be made within the perpetual easement and right-of-way and without adversely affecting the intended function of the facility or increasing costs to the Owner.

3.6 INTERFERING ROADWAYS AND STRUCTURES

- A. Remove, replace and/or repair any damage done during trenching activities to fences, buildings, cultivated fields, drainage crossings, and any other properties without additional compensation from the Owner.
 1. Replace or repair these structures to a condition as good as or better than their pre-construction condition prior to commencing work in the area.
- B. Paved Roadways:
 1. Where paved roadways are cut as part of trenching activities, Class D trench backfill will be required to the bottom of pavement base.
 2. New pavement shall be equal to or better than the existing paved surface.
 3. New surface shall not deviate by more than 1/4-inch from the existing finish elevation.
- C. Existing Structures:
 1. If existing structures are encountered as part of trenching activities which will prevent construction and are not adequately shown in the Drawings, the Contractor shall notify the Engineer before continuing with the Work.

2. The Engineer may make such field revisions to the utility alignment as necessary to avoid conflict with the existing conditions.
3. The cost of waiting or “down time” during such field revisions shall be borne by the Contractor without additional cost to the Owner or liability to the Engineer.
4. If the Contractor fails to so notify the Engineer when a conflict of this nature is encountered, but proceeds with construction despite this interference, the Contractor shall do so at the Contractor’s own risk with no additional payment.

3.7 TRENCHING

- A. Excavate subsoil as required for construction of utilities to elevations shown in the Drawings.
- B. Remove boulders and rock up to 1/2 cubic yard measured by volume per the requirements of this Section.
- C. Open Trench Limit:
 1. Do not advance open trench beyond the distance which will be backfilled and compacted the same day.
 2. A maximum length of open trench shall not exceed 100 feet at any one time.
 3. Temporary resurfacing shall be completed within 300 feet of the associated open trench limit for each main pipe laying operation.
 4. Cover or backfill excavations at the end of each day.
 5. If the trench is not backfilled at the end of each working day:
 - a. Provide means to prevent caving of excavation sides, as necessary, during non-working hours.
 - b. Cover the excavation with a system as needed to provide public safety and prevention of entry during non-working hours.
 - c. Provide signed and stamped submittal of caving prevention system and cover system.
 6. New trenching shall not be started when earlier trenches need backfilling or the surfaces of streets or other areas need to be restored to a safe and proper condition.
- D. Utility Crossings: Avoid horizontal and vertical conflicts with existing utilities.

1. Perform excavation within 24 inches of existing utility service in accordance with utility's requirements.
 2. Vertical clearance between the new pipe and existing utilities shall be 12 inches minimum, unless otherwise noted on the Drawings.
 3. Where existing utility lines are damaged or broken during trenching activities, the utility shall be repaired or replaced. For water or sewer bearing lines, care being taken to insure a smooth flow line and absolutely no leakage at the new joints.
 4. All expenses involved in the repair or replacement of leaking or broken utility lines that have occurred due to the Contractor's operations shall be borne by the Contractor, and the amount thereof shall be absorbed in the unit prices of its bid.
- E. Water Lines Crossing Sewer Lines: Whenever water lines cross sewer lines, the Contractor shall comply with local Health Department requirements.
1. Wherever possible, the bottom of the water line shall be 18 inches or more above the top of sewer pipe. One full length of the water line pipe shall be centered at the crossing.
 2. For clearances less than 1-1/2 feet, the Contractor shall replace the existing sewer pipe with ductile iron or PVC of equal size, centered at the utility crossing, or shall encase existing sewer pipe with concrete for a minimum of 10 feet on both sides of crossing, as directed by the Engineer, at no additional cost to the Owner.
- F. Excavate trenches to width and depth as indicated on Drawings. No additional payment will be provided for trenching activities beyond dimensions shown in the Drawings.
1. Excavation for trenches in which pipelines are to be installed shall provide adequate space for workers to place and joint the pipe properly and safely, but in every case the trench shall be kept to a minimum width.
 2. The width of the pipe trench at and below the top of the pipe shall be such that the clear space between the barrel of the pipe and the trench shall not exceed 12 inches on either side of the pipe.
 3. Excavation for utility vaults and other structures shall be wide enough to provide 18 inches between the structure surface and the sides of the excavation.
 4. For pipe or utility vaults to have bedding material, excavate to a depth of 6 inches below the bottom of the pipe or utility vault. Care shall be taken not to excavate below depths required.
 5. If over digging occurs, the trench bottom shall be filled to grade with compacted bedding material.

- G. Remove water or materials that interfere with Work.
 - 1. The trench at all times shall be kept free from water to facilitate fine grading, the proper laying and joining of pipe, and prevention of damage to completed joints.
 - 2. Adequate pumping equipment shall be provided to handle and dispose of the water without damage to adjacent property.
 - 3. Water in the trench shall not be allowed to flow through the pipe while construction work is in progress unless special permission to do so has been given by the Engineer.
 - 4. An adequate screen shall be provided to prevent the entrance of objectionable material into the pipe.
 - 5. Remove and dispose of existing abandoned sewer pipe, structures, and other facilities as necessary to construct the improvements.
 - a. Where the excavation activities require the removal of portions of an abandoned pipeline, masonry plugs shall be installed in the open ends of the pipe, unless otherwise noted in the Drawings or by the Engineer.
 - b. Coordinate with Engineer prior to plugging.
 - c. For plugs less than 36 inches in diameter, 8-inch deep masonry units shall be used. For plugs in larger pipelines, 12-inch deep masonry units shall be used.
 - 6. The costs associated with the removal of water and materials noted above will be considered incidental to trench excavation and backfill.
- H. Do not interfere with 45 degree bearing splay of foundations.
- I. Over-excavation for Unsuitable Trench Foundation Conditions:
 - 1. Cross-sectional dimensions and depths of excavations shown in the Drawings shall be subject to such changes as may be found necessary by the Engineer to secure foundations free from soft, weathered, shattered, and loose material or other objectionable materials.
 - 2. Unsuitable materials shall be removed and replaced only as directed in writing by Engineer.
 - 3. Unsuitable materials encountered shall be removed and replaced with Coarse Aggregate Type A1, 2-1/2-inch – 0 gradation, as specified in Table 31 05 16-A of Section 31 05 16, Aggregates for Earthwork. All material placed shall be compacted to 95 percent of maximum dry density.

4. Install nonwoven geotextile under trench stabilization material, over the soft or yielding excavated surface.
 - a. Install the nonwoven geotextile ahead of placement of the trench stabilization material, continuously along the excavation bottom and centered on the pipe centerline.
 - b. Use nonwoven geotextile width equal to the pipe diameter plus 2 feet.
 - c. Place laps or splices in the geotextile in the direction of the pipe laying.
- J. Trim excavation. Hand trim for bell and spigot pipe joints. Remove loose matter.
- K. Excavated material shall be placed at locations and in such a manner that it does not create a hazard to pedestrian or vehicular traffic or interfere with the function of existing drainage facilities or system operation.
- L. Remove excess subsoil not intended for reuse from site.
- M. Stockpile excavated material in area designated on site in accordance with Section 31 05 13, Soils for Earthwork.

3.8 TUNNELING

- A. In lieu of open cut trenching as specified above, the Contractor may utilize tunnel methods for installation of pipe where ground conditions are favorable and such methods will not disturb foundations under curbs, sidewalks and other structures.
 1. The Engineer must approve tunneling methods prior to utility installation.
 2. Where tunneling is used, payment for the pipe installation will be made for the equivalent trench excavation and backfill as if the open cut method was used. Payment will not be made for surface restoration including pavement, curbs, sidewalks, and other surface improvements whose replacement is avoided by the tunneling method.

3.9 SHEETING AND SHORING

- A. Sheet, shore, and brace excavations to prevent danger to persons, new and existing structures, and adjacent and neighboring properties and to prevent caving, erosion, settlement, and loss of surrounding subsoil.
- B. Support trenches more than 5 feet deep excavated through unstable, loose, or soft material. Provide sheeting, shoring, bracing, or other protection to maintain stability of excavation.

- C. Repair damage caused by failure of the sheeting, shoring, or bracing and for settlement of filled excavations or adjacent soil.
- D. Repair damage to new and existing Work from settlement, water or earth pressure or other causes resulting from inadequate sheeting, shoring, or bracing.
- E. Design sheeting and shoring to be removed at completion of excavation work, unless shown otherwise in the Drawings.
- F. Construction Sheeting Left in Place:
 - 1. Furnish, install, and leave in place construction sheeting and bracing when specified or when indicated or shown on the Drawings.
 - 2. Construction sheeting and bracing originally intended for temporary installation, placed by the Contractor to protect adjacent and neighboring structures, may be left in place if desired by the Contractor and approved by the Engineer. All such sheeting and bracing left in place shall be included in the cost for excavation.
 - 3. Any construction sheeting and bracing which the Contractor has placed to facilitate its work may be ordered in writing by the Engineer to be left in place. The right of the Engineer to order sheeting and bracing left in place shall not be construed as creating an obligation on its part to issue such orders. Failure of the Engineer to order sheeting and bracing left in place shall not relieve the Contractor of its responsibility under the contract.
 - 4. For sheeting and shoring to be left in place as part of the completed Work, cut off minimum 18 inches below finished grade.

3.10 COMPACTION

- A. Testing will be required to show specified densities of compacted backfill are being achieved by the Contractor's compaction methods.
- B. Moisture Control:
 - 1. Moisture condition backfill material to within 2 percent of optimum moisture content required for compaction throughout each lift of the fill.
 - 2. Add moisture to granular backfill by sprinkling during compaction operation.
 - 3. Compaction by ponding or jetting is not permitted.
- C. Compact all materials and areas that are not accessible for in-place density testing, as determined by the Engineer, in place by whatever equipment and method is practicable or specified, and as approved by the Engineer.

1. Perform compaction at such moisture content as is required to produce well-filled, dense, and firm material in place that will show no appreciable deflection or reaction under the compacting equipment.

3.11 BEDDING

- A. All utility vaults, potable water pipe 4-inch nominal diameter and over, all steel pipe, all concrete sewer pipe, all plastic pipe, all pipe under existing or future structures or roadways, and any and all utilities at a depth greater than 6 feet shall be laid in pipe bedding material.
- B. Unless otherwise noted in the Drawings, pipe or conduit of less than 4-inch diameter, outside structure lines and at a depth of less than 6 feet shall be bedded in native material properly shaped as specified below, all as detailed on the Drawings.
- C. Compacted bedding material shall be placed the full width of the excavated trench to a depth as shown on the trench detail included in the Drawings.
 1. In lieu of a detail, the depth shall be 6 inches.
- D. Spread the bedding smoothly over entire width of trench to the proper grade so that the pipe is uniformly supported along the barrel.
- E. Hand grade and compact each lift to provide a firm, unyielding surface along the entire pipe length. For rigid pipe, compact to at least 90 percent relative compaction.
- F. Excavate bell holes at each joint to permit proper assembly and inspection of the joint.
- G. Check grade and correct irregularities in bedding material.
- H. Center pipes horizontally in trench width.

3.12 BACKFILLING

- A. Backfill trenches to contours and elevations with unfrozen fill materials.
- B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.
- C. Maintain optimum moisture content of fill materials to attain required compaction density.
- D. Place fill material, with the exception of CLSM, in continuous layers and compact in 6- to 8-inch lifts.
 1. Prevent pipe from moving either horizontally or vertically during placement and compaction of pipe zone material.

2. Where trenches are under existing or future structures, paved areas, road shoulders, driveways or sidewalks, or where designated on the Drawings or specified elsewhere in these specifications, the trench backfill shall be Class B or Class E and pipe zone backfill shall be Class B or Class E. Class B backfill shall be compacted to 95 percent of maximum density at optimum moisture content.
 3. Where trenches are outside existing or future structures, paved areas, road shoulders, driveways or sidewalks, or where designated on plans or specified elsewhere, the trench backfill shall be Class A and pipe zone backfill in these areas shall be Class B. For these locations, compaction of Class B backfill shall be to not less than 90 percent of maximum density at optimum moisture content. Class B backfill shall be compacted to not less than 95 percent of maximum density at optimum moisture content.
- E. Employ placement method that does not disturb or damage nearby or adjacent foundation perimeter drainage or utilities in trench.
 - F. Do not use power-driven impact compactors to compact pipe zone material.
 - G. Backfill Immediately: All trenches and excavations shall be backfilled immediately after pipe or conduit is in approved condition to receive it and shall be carried to completion as rapidly as possible, unless otherwise directed by the Engineer.
 - H. Under no circumstances shall water be permitted to rise in open trenches after pipe has been placed.
 - I. Do not allow backfill material to free fall into the trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 2 feet of backfill has been provided over the top of pipe.
 - J. Use hand compactors for compaction until at least 2 feet of backfill is placed over top of pipe. Thoroughly tamp each lift, including area under haunches, with handheld tamping bars supplemented by "walking in" and slicing material under haunches with a shovel to ensure that voids are completely filled before placing each succeeding lift.
 - K. Placement of Sand:
 1. Place medium sand in lifts not exceeding 8 inches in uncompacted thickness.
 2. Compact each lift to a minimum of 95 percent relative compaction prior to placing succeeding lifts.
 - L. Placement of CLSM:
 1. Discharge from truck-mounted drum-type mixer into trench.

2. Place in lifts not exceeding 2 feet in thickness.
 3. No compaction of CLSM is allowed.
 4. Use steel plates to protect the CLSM from traffic a minimum of 24 hours. After 24 hours, the CLSM may be paved, or opened to traffic until permanent surface restoration is completed, if it has hardened sufficiently to prevent rutting.
- M. New trenching shall not be started when earlier trenches need backfilling or the surfaces of streets or other areas need to be restored to a safe and proper condition.
- N. Do not leave trench open at end of working day.

3.13 MARKING TAPE INSTALLATION

- A. Continuously install marking tape along centerline of all buried piping, install 24 inches below finished grade. Coordinate with piping installation drawings.

3.14 ELECTRONIC LOCATING FACILITY INSTALLATION

- A. Marker Balls:
1. Install according to manufacturer's recommendations and as shown or directed and according to the following requirements:
 - a. Install marker balls directly above the pipe alignment at a depth no less than 3 feet and no more than 4-1/2 feet below final surface grade.
 - b. Install marker balls during trench backfill operations by placing the marker ball in compacted backfill.
 - c. Cover marker ball with a minimum of 6 inches of backfill and compact backfill before continuing trench backfill operations.
 - d. Install markers balls with trenchless pipe installations by core-drilling hole of a minimal diameter needed to allow clearance for placement of marker ball. Backfill with approved trench backfill, pavement base and pavement, as applicable.
 2. Water Marker Ball Locations: Install at locations as required by Sewer Marker Ball Locations specified herein.
 3. Sewer Marker Ball Locations:
 - a. Install marker balls directly above connection points, termination points and all fitting locations, and at a minimum spacing of 50 linear feet on sewers with a straight horizontal alignment.

- b. Install marker balls at a minimum spacing of 25 lineal feet directly above sewer mains installed on a radius.
- c. Install marker balls on new or reconstructed sewer service laterals, directly above the centerline of the end of the lateral at the curb, property line or other end of lateral location, as directed.
- d. Install marker balls directly above every alignment change along sewer mains and service laterals.
- e. Install marker balls directly above manholes for manholes with buried covers.

B. Tracer Wire and Terminal Appurtenances:

1. Tracer Wire:

- a. Install as shown or directed directly over the pipe centerline and on top of the pipe zone in all sewer trenches, including mainline sewers, service laterals and storm sewer inlet leads.
- b. Connect mainline and service lateral tracer wires using either an approved direct-bury lug connector or direct-bury twist connector.
- c. Extend tracer wire to locator stations in manholes, locator boxes, storm inlets, or other visually identifiable terminal appurtenances, allowing for access with electronic locating equipment, as shown or directed and according to the following requirements:

2. Locator Stations:

- a. Install locator stations as shown within manholes.
- b. Mount locator station to manhole wall within 18 inches of manhole rim with two stainless steel expansion anchors.
- c. Drill a minimum 3/8-inch diameter hole through the manhole wall within 18 inches of the finish grade of the manhole rim.
- d. Extend the tracer wire from the pipe trench in one continuous piece up the outside of the manhole and through the hole and into a locator station and attach to one of the lugs in the locator station.
- e. When multiple tracer wires are terminated in manhole install a multi-lead locator station.

- f. Extend a ground wire from the locator station through a minimum 3/8-inch diameter hole in the manhole wall.
 - g. Install ground wire approximately 3 feet deep and extend from the outside manhole wall a minimum of 3 feet horizontally in any direction.
 - h. Seal all holes drilled in manhole walls with silicone sealant.
- 3. Storm Inlet Tracer Wire Termination: Terminate tracer wire inside inlet and directly over storm outlet pipe by placing tracer wire as follows:
 - a. Drill a minimum 3/8-inch diameter hole through inlet wall to pass tracer wire through to inside inlet wall.
 - b. Seal hole with silicon sealer or material approved by Engineer.
 - c. Leave 6 inches of coiled tracer wire along inside of inlet wall approximately 3 inches below the inlet frame and grate or as directed by Engineer.
- 4. Service Lateral Tracer Wire Termination: Terminate tracer wire at ends of service laterals as shown or directed, as follows:
 - a. Termination in Tracer Wire Locate Boxes: Extend the tracer wire in one continuous piece up vertically from the pipe trench and into the bottom of the locate box. Leave 18 inches of coiled tracer wire inside locate box.
 - b. Termination at 2-inch by 4-inch Markers: Extend tracer wire in one continuous piece directly up service lateral 2-inch by 4-inch markers and leave 18 inches of tracer wire wrapped around the exposed top end of 2-inch by 4-inch marker.

3.15 VISUAL IDENTIFICATION FACILITIES

- A. Tracer Wire Locate Boxes: Install tracer wire locate boxes directly over service laterals at property line, service boundary, or other location as shown or directed by the Engineer.
- B. Service Lateral Plastic or Copper Markers:
 - 1. Install plastic or copper markers in the concrete curb directly over the centerline of the service lateral, as shown or directed by the Engineer.
 - 2. Either plastic or copper markers may be used.
 - 3. If there is not suitable concrete curb for marker placement, then install a lateral cleanout as close to property line as practical at location approved by Engineer.
- C. Service Lateral 2-inch by 4-inch Markers:

1. Place a 2-inch by 4-inch marker at the end of each new service lateral not connected to a building sewer.
2. Omit markers only as approved.
3. Block the capped or plugged service lateral end with a wood block against undisturbed earth and install the marker.
4. Extend the marker from the blocked service lateral invert to at least 12 inches above the existing or proposed finish ground surface.
5. Install marker in one piece. No splicing will be accepted.
6. Paint the exposed portion of the marker after its installation with quality quick drying enamel white paint for a storm only sewer and green paint for a sanitary or combined sewer.
7. After the paint has dried, use black, quick drying enamel, and neatly indicate the distance from the ground surface to the top of the service lateral in feet and inches.
8. Do not disturb the position and location of the marker during the backfilling operation.
9. If the marker is broken, moved out of location, or vertical alignment is changed during the backfilling operation, reopen the trench and replace the marker.

3.16 FIELD QUALITY CONTROL

- A. All testing and reporting shall be conducted and completed by an independent laboratory provided by the CONTRACTOR.
- B. Perform laboratory material tests in accordance with ASTM D1557 (AASHTO T180).
- C. In-place compaction testing of pipeline backfill materials shall be performed at 2-foot elevation increments, one test per **200** lineal feet of pipeline trench as measured along pipe centerline.
 1. The Engineer may reduce the frequency when satisfied with method of compaction.
 2. The Engineer may direct testing at a higher frequency at no additional cost to the Owner upon failure to obtain specified densities or if the Contractor changes compaction equipment or methods of compaction.
 3. The Engineer shall determine all test locations.

- D. Perform in place compaction tests in accordance with the following:
 - 1. Density Tests: ASTM D2922
 - 2. Moisture Tests: ASTM D3017
- E. When tests indicate Work does not meet specified requirements, remove Work, replace and retest at the sole expense of the Contractor.

3.17 SURFACE RESTORATION AND CLEANUP

- A. Open Trenches: At the end of each workday, all open trenches shall be backfilled and all trenches within streets shall be temporarily paved or covered to the satisfaction of the Engineer and the local permitting agency.
 - 1. Temporary paving shall be replaced with permanent street paving at the completion of construction within street rights-of-way, or sooner, if deemed necessary by the ENGINEER.
 - 2. No gravel-filled trenches shall be left open within the street right-of-way at the end of the workday.
- B. Topsoil:
 - 1. Where trenches cross lawns, garden areas, pastures, cultivated fields, or other areas on which reasonable topsoil conditions exist, remove the topsoil to the specified depth and place the material in a stockpile.
 - 2. Topsoil shall not be mixed with other excavated material.
 - 3. After the trench has been backfilled, the topsoil shall be replaced.
- C. Clean up and remove all excess materials, construction materials, debris from construction, etc. Replace or repair any fences, mailboxes, signs, landscaping, or other facilities removed or damaged during construction. Replace all lawns, topsoil, shrubbery, flowers, etc., damaged or removed during construction. The Contractor shall be responsible for seeing that lawns, shrubs, etc. remain alive and leave premises in condition equal to original condition before construction.

END OF SECTION

SECTION 31 23 19 - DEWATERING

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes temporary dewatering and surface water control systems for open excavations and utility trenches.
- B. Section includes:
 - 1. Dewatering systems.
 - 2. Surface water control systems.
 - 3. System operation and maintenance.
 - 4. Water disposal.

1.2 RELATED SECTIONS

- A. Section 31 05 16 - Aggregates for Earthwork
- B. Section 31 23 16 - Excavation
- C. Section 31 23 17 - Trenching

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Dewatering Plan:
 - 1. Descriptions of proposed groundwater and surface water control facilities including, but not limited to, equipment; methods; standby equipment and power supply; pollution control facilities; discharge locations to be utilized; and provisions for immediate temporary water supply as required by this Section.
 - 2. Plan to be reviewed by the Engineer prior to the beginning of construction activities requiring dewatering. Review by the Engineer of the design shall not be construed as a detailed analysis of the adequacy of the dewatering system, nor shall any provisions of the above requirements be construed as relieving the Contractor of its overall responsibility and liability for the work.

1.4 DEFINITIONS

- A. Dewatering includes the following:
 - 1. Lowering of ground water table and intercepting horizontal water seepage to prevent ground water from entering excavations, trenches, tunnels, and /or shafts.

2. Reducing piezometric pressure within strata to prevent failure or heaving of excavations, trenches, tunnels, and /or shafts.
3. Disposing of removed water.

B. Surface Water Control: Removal of surface water within open excavations.

1.5 QUALITY CONTROL

- A. All dewatering operations shall be adequate to assure the integrity of the finished project and shall be the responsibility of the Contractor.
- B. Provide all labor, materials, and equipment necessary to dewater trench and structure excavations, in accordance with the requirements of the Contract Documents.
- C. Secure all necessary permits to complete the requirements of this Section.
- D. Control the rate and effect of the dewatering in such a manner as to avoid all objectionable settlement and subsidence.
- E. Where the critical structures or facilities exist immediately adjacent to areas of proposed dewatering, reference points shall be established and observed at frequent intervals to detect any settlement which may develop.
 1. The responsibility for conducting the dewatering operation in a manner which will protect adjacent structures and facilities rests solely with the Contractor.
 2. The cost of repairing any damage to adjacent structures and restoration of facilities shall be the responsibility of the Contractor.

PART 2 PRODUCTS

2.1 EQUIPMENT

Dewatering, where required, may include the use of well points, sump pumps, temporary pipelines for water disposal, rock or gravel placement, and other means. Standby pumping equipment shall be maintained on the jobsite.

PART 3 EXECUTION

3.1 DEWATERING

- A. Provide all equipment necessary for dewatering.

1. Have on hand, at all times, sufficient pumping equipment and machinery in good working condition.
 2. Have available, at all times, competent workers for the operation of the pumping equipment.
 3. Adequate standby equipment shall be kept available at all times to insure efficient dewatering and maintenance of dewatering operation during power failure.
- B. Dewatering for structures and pipelines shall commence when groundwater is first encountered and shall be continuous until such times as water can be allowed to rise in accordance with the provisions of this Section or other requirements.
- C. Site Grading:
1. At all times, site grading shall promote drainage.
 2. Surface runoff shall be diverted from excavations.
 3. Water entering the excavation from surface runoff shall be collected in shallow ditches around the perimeter of the excavation, drained to sumps, and be pumped or drained by gravity from the excavation to maintain a bottom free from standing water.
- D. Dewatering shall at all times be conducted in such a manner as to preserve the undisturbed bearing capacity of the subgrade soils at proposed bottom of excavation.
- E. If foundation soils are disturbed or loosened by the upward seepage of water or an uncontrolled flow of water, the affected areas shall be excavated and replaced with drain rock.
- F. Maintain the water level below the bottom of excavation in all work areas where groundwater occurs during excavation construction, backfilling, and up to acceptance.
- G. Flotation shall be prevented by maintaining a positive and continuous removal of water. The Contractor shall be fully responsible and liable for all damages which may result from failure to adequately keep excavations dewatered.
- H. If well points or wells are used, they shall be adequately spaced to provide the necessary dewatering and shall be sandpacked and/or other means used to prevent pumping of fine sands or silts from the subsurface. A continual check shall be maintained to ensure that the subsurface soil is not being removed by the dewatering operation.
- I. Dispose of water from the work in a suitable manner without damage to the environment or adjacent property. No water shall be drained into work built or under

construction without prior consent of the Engineer. Water shall be filtered using an approved method to remove sand and fine sized soil particles before disposal into any drainage system.

- J. The release of groundwater to its static level shall be performed in such a manner as to maintain the undisturbed state of the natural foundation soils, prevent disturbance of compacted backfill and prevent flotation or movement of structures, pipelines, and sewers.
- K. Dewatering of trenches and other excavations shall be considered as incidental to the construction of the work and all costs thereof shall be included in the various contract prices in the bid forms.

END OF SECTION

SECTION 31 23 23 - FILL

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes backfilling required at building perimeter and site structures to subgrade elevations, fill under interior and exterior slabs-on-grade or pavement, and fill under landscaped areas. Backfilling for utilities within building proper is included within this section; backfilling for utilities outside building is included in Section 31 23 17, Trenching.
- B. Section includes:
 - 1. Backfilling building perimeter to subgrade elevations.
 - 2. Backfilling site structures to subgrade elevations.
 - 3. Fill under slabs-on-grade.
 - 4. Fill under paving.
 - 5. Fill for over-excavation.

1.2 RELATED SECTIONS

- A. Section 03 30 00 - Cast-In-Place Concrete
- B. Section 31 05 13 - Soils for Earthwork
- C. Section 31 05 16 - Aggregates for Earthwork
- D. Section 31 22 13 - Rough Grading
- E. Section 31 23 16 - Excavation
- F. Section 31 23 17 - Trenching
- G. Section 31 23 24 - Flowable Fill
- H. Supplemental Information: Geotechnical report; bore hole locations and findings of subsurface materials.

1.3 REFERENCES

- A. American Association of State Highway and Transportation Officials:
 - 1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. ASTM International (ASTM):

1. ASTM C403 - Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance
2. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
3. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
4. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
5. ASTM D4832 - Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.

1.4 DEFINITIONS

- A. Controlled Low Strength Material (CLSM): Also referred to as Flowable Fill elsewhere in these Specifications. A self-compacted, cementitious material.
- B. Imported Material: Materials obtained from sources offsite, suitable for specified use.
- C. Lift: Loose (uncompacted) layer of material.
- D. Optimum Moisture Content:
1. Determined in accordance with ASTM Standard specified to determine maximum dry density for relative compaction.
 2. Determine field moisture content on basis of fraction passing 3/4-inch sieve.

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Imported Materials:
1. Materials Source: Submit name and location of imported fill materials suppliers.
 2. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.
 3. Submit results of aggregate sieve analysis and standard proctor test for granular material.

- C. CLSM: Mix designs in accordance with Submittal requirements of Section 31 23 24, Flowable Fill.

1.6 QUALITY ASSURANCE

- A. Subsoil and topsoil fill materials: In accordance with Quality Assurance requirements stated in Section 31 05 13, Soils for Earthwork.
- B. Aggregate fill materials: In accordance with Quality Assurance requirements stated in Section 31 05 16, Aggregates for Earthwork.
- C. CLSM:
 - 1. In-place testing: In accordance with ASTM C403.
 - 2. Compressive testing: In accordance with ASTM D4832.
- D. Allowable Tolerances: Final grades shall be plus or minus 0.1-foot.

PART 2 PRODUCTS

2.1 FILL MATERIALS

- A. Subsoil Fill: Type S2, Imported Fill Material, as specified in Section 31 05 13, Soils for Earthwork.
- B. Imported Granular Fill: Coarse Aggregate Type A1, Dense-Graded Aggregate with gradation as shown in the Drawings and specified in Section 31 05 16, Aggregates for Earthwork.
- C. Concrete:
 - 1. Lean concrete as specified in Section 31 23 24, Flowable Fill, with compressive strength of 100 pounds per square inch (psi).
 - 2. Structural concrete as specified in Section 03 30 00, Cast-in-Place Concrete. Compressive strength as required by the application or as noted in the Drawings.
- D. Drain Rock: Coarse Aggregate Type A2, Granular Drain Backfill Material with gradation as shown in the Drawings and specified in Section 31 05 16, Aggregates for Earthwork.
- E. Foundation Stabilization Material: Coarse Aggregate Type A1, Dense-Graded Aggregate, 2-1/2-inch - 0 gradation as specified in Section 31 05 16, Aggregates for Earthwork.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Prior to Work in this Section, become familiar with Site conditions. In the event discrepancies are found, notify Engineer as to the nature and extent of the differing conditions.
- B. Verify sub-drainage, damp-proofing, or waterproofing installation has been inspected.
- C. Verify underground tanks are anchored to their own foundations to avoid flotation after backfilling.
- D. Verify structural ability of unsupported walls to support loads imposed by fill.

3.2 SITE CONDITIONS

- A. Quantity Survey: The Contractor shall be responsible for calculations for quantities and volume of cut and fill from existing site grades to finish grades established under this contract as indicated in the Drawings or specified and shall include the cost for all earthwork in the total basic bid.
- B. Dust Control: Must meet all federal, state, and local requirements. Protect persons and property from damage and discomfort caused by dust. Water surfaces as necessary and when directed by Engineer to quell dust.
- C. Soil Control: Soil shall not be permitted to accumulate on surrounding streets or sidewalks nor to be washed into sewers.
- D. See provisions for Work in Section 31 25 00, Erosion and Sediment Controls.

3.3 PREPARATION

- A. Identify required lines, levels, contours, and datum locations.
- B. Control of Water:
 - 1. Excavated areas shall be kept free of water and frost.
 - 2. Bearing surfaces which become softened by water or frost shall be re-excavated to solid bearing at Contractor's expense and backfilled with compacted crushed rock at Contractor's expense.
 - 3. See Section 31 23 19, Dewatering for additional details.
- C. Compact subgrade to density requirements for subsequent backfill materials.

- D. Cut out soft areas of subgrade not capable of compaction in place and replace with specified granular fill material. See Article 3.5, Over-excavation for Unsuitable Foundation Conditions in Section 31 23 16, Excavation for additional details.
- E. Proof roll to identify soft spots; fill and compact to density equal to or greater than requirements for subsequent fill material.
- F. Subgrade to be approved by Engineer prior to placement of structures and commencement of backfill activities.
- G. Do not allow or cause any work performed or installed to be covered up or enclosed prior to required tests and approvals. Should any Work be enclosed or covered up, uncover at Contractor's expense.

3.4 BACKFILLING

- A. Backfill areas to contours and elevations shown in the Drawings with unfrozen materials.
- B. Do not place materials when weather conditions and/or moisture content prevent attainment of specified density.
- C. Maintain optimum moisture content of backfill materials to attain required compaction density.
- D. Employ placement method that does not disturb or damage other work.
- E. Mechanical tampers permitted in confined areas.
- F. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.
- G. Foundation Base for Structures:
 - 1. Bring excavation to required subgrade elevation shown in the Drawings.
 - 2. Place foundation base material to required grade shown in the Drawings.
 - 3. Place foundation base material in 6-inch lifts and compact to 95 percent maximum dry density.
 - 4. Foundations established near finished site grades:
 - a. Place a 3-inch thick layer of Coarse Aggregate Type A1, Dense-Graded Aggregate, 3/4-inch-0 gradation in the bottom of footing excavations to minimize disturbance of silty foundation soils during wet weather.

- b. Lightly compact material with a light-weight hand-operated vibratory plate compactor.
- c. To provide uniform support, slabs should be underlain by a minimum 8-inch thick granular base course consisting of 1-1/2- or 3/4-inch - 0 gradation.
- d. The base course material should be installed in a single lift and compacted to at least 95 percent of the maximum dry density. See Drawings for details.

H. Backfill for Structures:

- 1. Prior to placing backfill, remove forms, temporary construction, and debris below grade.
- 2. Backfill shall not be placed against poured concrete until 28 days have passed from completion of original concrete pour, unless otherwise approved by Engineer.
- 3. Heavy compactors and large pieces of construction equipment shall be kept away from any embedded wall a distance of at least 5 feet in order to avoid the build-up of excessive lateral pressures.
 - a. Over-compaction of fill near walls should be avoided.
- 4. Compaction within 5 feet of the walls shall be accomplished using hand-operated vibratory plate compactors or tamping units.
- 5. The maximum particle size of granular material placed against buried structures shall be limited to no greater than 1-1/2-inch diameter.
- 6. Structural fill backfill material shall be brought up on all sides of the walls and footings in such a manner as to avoid adverse differential lateral earth pressures on the vertical surfaces.
- 7. Appropriate lift thickness will depend on the type of compaction equipment used and the type of material being placed. All material shall be compacted to at least 95 percent of the standard maximum dry density.
 - a. For moderate- to heavy-weight compactors, a maximum loose lift thickness of 12 inches shall be used.
 - b. For hand-operated or small compactors, a maximum loose lift thickness of 8 inches shall be used.
- 8. Particular care must be taken to avoid damage to the pipe connections to the structure.

9. Utility trench backfill within 10 feet of all structural perimeters shall meet the requirements for structural fill.
- I. For areas receiving surface structures or existing paved areas to be constructed or replaced, such as driveways, parking lots, and sidewalks:
 1. Place Coarse Aggregate Type A1, Dense-Graded Aggregate, 3/4-inch-0 gradation in 6-inch lifts.
 2. Compact with vibratory equipment to 95 percent maximum density, unless otherwise specified or shown in the Drawings.
- J. Slope grade away from building minimum 2 percent slope for minimum distance of 10 feet, unless noted otherwise in the Drawings.
- K. Make gradual grade changes. Blend slope into level areas.
- L. Remove surplus backfill materials from Site in accordance with Section 31 23 16, Excavation.

3.5 FIELD QUALITY CONTROL

- A. All testing and reporting shall be conducted and completed by an independent laboratory provided by the CONTRACTOR. Initial testing will be paid for by the Owner. Subsequent testing after failure of initial acceptance testing shall be paid by the Contractor.
- B. Perform laboratory material tests in accordance with ASTM D1557 (AASHTO T99).
- C. In-place compaction testing for structural fill material shall be performed at 2-foot elevation increments in the fill material with at a minimum of one test per each 2,500 square feet of material placed. The Engineer shall be provided with the results of each compaction test at the time of testing.
- D. Perform in place compaction tests in accordance with the following:
 1. Density Tests: ASTM D2922.
 2. Moisture Tests: ASTM D3017.
- E. Compaction testing for construction of aggregate subbase and base course for placement under asphalt of concrete paving a specified in Section 32 11 23 – Aggregate Base Course.
- F. When tests indicate Work does not meet specified requirements, remove Work, replace and retest at the sole expense of the Contractor.

- G. When testing of subgrade is not possible or feasible as detailed above, proof roll compacted fill surfaces under slabs-on-grade, pavers, paving, and as may be otherwise required by the Engineer.

3.6 PROTECTION OF FINISHED WORK

- A. Reshape and re-compact fills subjected to vehicular traffic.

END OF SECTION

SECTION 31 23 24 - FLOWABLE FILL

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes flowable lean concrete mix used for structure backfill, utility bedding and backfill and other subgrade Site Work. Applications also include filling abandoned structures and utilities that remain in place.
- B. Section Includes:
 - 1. Structure backfill
 - 2. Utility bedding
 - 3. Utility backfill

1.2 RELATED SECTIONS

- A. Section 02 41 00 - Demolition
- B. Section 31 23 16 - Excavation
- C. Section 31 23 17 - Trenching
- D. Section 31 23 23 - Fill

1.3 DEFINITIONS

- A. Flowable Fill: Also referred to as Controlled Low Strength Material (CLSM) elsewhere in the Specifications. Lean cement concrete fill.
- B. Utility: Any buried pipe, duct, conduit, manhole, tank, or cable.

1.4 REFERENCE STANDARDS

- A. ASTM International (ASTM):
 - 1. ASTM C33 - Standard Specification for Concrete Aggregates
 - 2. ASTM C94 - Standard Specification for Ready-Mixed Concrete
 - 3. ASTM C150 - Standard Specification for Portland Cement
 - 4. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete
 - 5. ASTM C403 - Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance
 - 6. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete

7. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
8. ASTM C1017 - Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
9. ASTM C1040 - Standard Test Methods for Density of Unhardened and Hardened Concrete in Place by Nuclear Methods
10. ASTM D4832 - Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- C. Field Quality-Control Submittals:
 1. Mix Design:
 - a. Furnish flowable fill mix design for each specified strength.
 - b. Furnish separate mix designs when admixtures are required for the following:
 - 1) Flowable fill Work during hot and cold weather.
 - 2) Air entrained flowable fill Work.
 - c. Identify design mix ingredients, proportions, properties, admixtures, and tests.
 2. Furnish test results to certify flowable fill mix design properties meet or exceed specified requirements.
- D. Delivery Tickets:
 1. Furnish duplicate delivery tickets indicating actual materials delivered to Project Site.

1.6 QUALITY ASSURANCE

- A. In-place testing of Flowable Fill: In accordance with ASTM C403.
- B. Compressive testing of Flowable Fill: In accordance with ASTM D4832.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Minimum Conditions: The following minimum conditions shall be met at time of flowable fill placement.
 - 1. Do not install flowable fill during inclement weather.
 - 2. Ambient temperature must be at least 34 degrees Fahrenheit (F) (4 degrees Celsius (C)) and rising.
 - 3. Flowable fill shall be at 40 degrees F (4 degrees C).
 - 4. Subgrade on which flowable fill is to be placed shall be free of disturbed or soft material, debris and water.

1.8 FIELD MEASUREMENTS

- A. Verify field measurements before installing flowable fill to establish quantities required to complete the Work.

PART 2 PRODUCTS

2.1 FLOWABLE FILL

- A. Flowable Fill:
 - 1. Composed of cement, pozzolans, fine aggregate, water, and admixtures.
 - 2. Low cement content.
 - 3. Non-segregating, self-consolidating, free-flowing, and excavatable material which will result in a hardened, dense, non-settling fill.
 - 4. Compressive strength at 28 days of 100 to 200 pounds per square inch (psi), if not otherwise shown in Drawings or specified.

2.2 MATERIALS

- A. Portland Cement: ASTM C150.
- B. Fine Aggregates: ASTM C33.
- C. Water: Clean and not detrimental to concrete.

2.3 ADMIXTURES

- A. Air Entrainment: ASTM C260.

- B. Chemical Admixture: ASTM C494.
- C. Fly Ash: ASTM C618 Class C or F, obtained from residue of electric generating plant using ground or powdered coal.

2.4 MIXES

- A. Mix and deliver flowable fill according to ASTM C94, Option C.
- B. Flowable Fill Design Mix:

ITEM	PROPERTIES
Cement Content	75 to 100 lb/cu yd
Fly Ash Content	[None]
Water Content	As specified
Air Entrainment	5 to 35 percent
28-Day Compressive Strength	Maximum 200 psi.
Unit Mass (Wet)	80 to 110 pcf
Temperature, Minimum at Point of Delivery	50 degrees F (10 degrees C)

- C. Provide water content in design mix to produce self-leveling, flowable fill material at time of placement.
- D. Design mix air entrainment and unit mass are for laboratory design mix and source quality control only.

2.5 SOURCE QUALITY CONTROL

- A. Test and analyze properties of flowable fill design mix and certify results for the following:
 - 1. Design mix proportions by weight of each material.
 - 2. Aggregate: ASTM C33 for material properties and gradation.
 - 3. Properties of plastic flowable fill design mix including:
 - a. Temperature
 - b. Slump
 - c. Air entrainment
 - d. Wet unit mass
 - e. Yield
 - f. Cement factor

4. Properties of hardened flowable fill design mix including:
 - a. Compressive strength at 1-day, 7 days, and 28 days. Report compressive strength of each specimen and average specimen compressive strength.
 - b. Unit mass for each specimen and average specimen unit mass at time of compressive strength testing.
- B. Prepare delivery tickets containing the following information:
 1. Project designation
 2. Date
 3. Time
 4. Class and quantity of flowable fill
 5. Actual batch proportions
 6. Free moisture content of aggregate
 7. Quantity of water withheld

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify excavation specified in Section 31 23 16, Excavation and trenching specified in Section 31 23 17, Trenching is complete.
- B. Verify utility installation as specified in elsewhere in the specifications is complete and tested before placing flowable fill.
- C. Verify excavation is dry and dewatering system is operating, as may be required, prior to placement of flowable fill.

3.2 PREPARATION

- A. Support and restrain utilities to prevent movement and flotation during installation of flowable fill.
- B. Protect structures and utilities from damage caused by hydraulic pressure of flowable fill before fill hardens.
- C. Protect utilities and foundation drains to prevent intrusion of flowable fill.

3.3 INSTALLATION - FILL, BEDDING, AND BACKFILL

- A. Place flowable fill by chute, pumping, or other methods as approved by Engineer.

- B. Place flowable fill in lifts to prevent lateral pressures from exceeding structural capacity of structures and utilities.
- C. Place flowable fill evenly on both sides of utilities to maintain alignment.
- D. Place flowable fill to elevations indicated on Drawings without vibration or other means of compaction.

3.4 INSTALLATION - FILLING ABANDONED UTILITIES

- A. As shown on Drawings and specified in Section 02 41 00, Demolition.

3.5 FIELD QUALITY CONTROL

- A. Perform inspection and testing according to ASTM C94.
 - 1. Take samples for tests for every 100 cubic yards of flowable fill, or fraction thereof, installed each day.
 - 2. Sample, prepare, and test four compressive strength test cylinders according to ASTM D4832. Test one specimen at 3 days, one at 7 days, and two at 28 days.
 - 3. Measure temperature at point of delivery when samples are prepared.
- B. Further construction proceeding upon placed flowable fill will be permitted only after initial set is attained, as measured by ASTM C 403.
 - 1. Perform in place penetration (density) tests using handheld penetrometer to measure penetration resistance of hardened flowable fill.
 - 2. Perform tests at locations as directed by Engineer.
- C. Defective Flowable Fill: The Engineer reserves the right to reject all flowable fill failing to meet the following test requirements or flowable fill delivered without the following documentation.
 - 1. Test Requirements:
 - a. Minimum temperature at point of delivery.
 - b. Compressive strength requirements for each type of fill.
 - 2. Documentation: Duplicate delivery tickets.
- D. No traffic or construction equipment shall be allowed on flowable fill for a least 24 hours after placement.

3.6 CLEANING

- A. Remove spilled and excess flowable fill from Project Site.
- B. Restore facilities and Site areas damaged or contaminated by flowable fill installation to existing condition before installation.

END OF SECTION

SECTION 31 50 00 - EXCAVATION SUPPORT AND PROTECTION

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes shoring and support systems of all types necessary to protect existing utility facilities and new utility facilities.
- B. The Contractor is responsible for the selection and design of excavation support systems and the design of utility support systems in conformance with Federal, State, and City requirements and the minimum design criteria specified herein.
- C. Temporary shoring is to be installed for protection of the structures to remain, buried utilities to remain, adjacent buildings and walkways.
- D. Care must be taken during the planning and construction of earth support systems to minimize settlements and displacements of the shoring system itself and to surrounding properties.

1.2 RELATED SECTIONS

- A. Section 31 23 16, Excavation
- B. Section 31 23 17, Trenching
- C. Section 31 23 19, Dewatering
- D. Section 31 23 23, Fill

1.3 DESIGN CRITERIA

- A. Design excavation support systems and all components to support the earth pressures, unrelieved hydrostatic pressures, utility loads, equipment, traffic, and construction loads including impact, and other surcharge loads in such manner as will allow the safe and expeditious construction of the permanent structures to minimize ground movement or settlement, and to prevent damage to adjacent structures, and utilities.
- B. Design support members to resist the maximum loads expected to occur during the excavation and support removal stages.
- C. Design system so that water seepage is minimized. Provide dewatering and positive means for preventing sloughing and containing material behind lagging.
- D. Design system to prevent sloughing and to contain running sand and silt behind the lagging.

- E. Vertical support capacity shall be provided for wall systems and internal bracing elements for loads due to vertical force components and live loads on any portion of the system.
- F. Design calculations and shop drawings of all excavation support systems.
 - 1. Calculations and shop drawings shall be made and stamped by a registered Professional Civil or Structural Engineer experienced in the design of excavation support systems in the State of Washington.
 - 2. Comply with the applicable requirements of OSHA and the Washington equivalent Structural Specialty Code with respect to excavation and construction.

1.4 SUBMITTALS

- A. Section 01 33 00, Submittals - Submittal Procedures: Requirements for submittals.
- B. Excavation Support Systems
 - 1. Plans and details for trench and excavation support systems.
 - a. Shop drawings and supporting calculations shall meet the specified design criteria requirements and include the following:
 - 1) Arrangement, size, and details for individual excavation support system.
 - 2) Construction methods and sequencing to be used for the installation and removal of each excavation support system.
 - 3) Contingency plan for alternative procedures to be implemented if the excavation support system is found to perform unfavorably or if obstructions are encountered in the installation.
 - 2. Provide for Engineer review prior to the beginning of construction activities requiring such systems.
 - 3. No excavations shall be started until the submittal review is complete.
 - 4. Review by the Engineer of the submitted design shall not be construed as a detailed analysis of the adequacy of the support system, nor shall any provisions of the above requirements be construed as relieving overall responsibility and liability for the work.
- B. Excavation Support Systems
 - 1. Plans and details for trench and excavation support systems.

- a. Calculations and shop drawings shall be made and stamped by a Washington-registered Professional Engineer experienced in the design of excavation support systems and shall comply with the applicable requirements of OSHA and the Washington equivalent Structural Specialty Code with respect to excavation and construction.
 - 1) Arrangement, size, and details for individual excavation support systems.
 - 2) Construction methods and sequencing to be used for the installation and removal of individual excavation support systems.
- b. Provide plans, details, and calculations for Engineer review prior to the beginning of construction activities requiring such systems.
- c. Review by the Engineer of the submitted design shall not be construed as a detailed analysis of the adequacy of the support system, nor shall any provisions of the above requirements be construed as relieving overall responsibility and liability for the work.
- 2. Provide plans, details, and calculations for trench and excavation support systems to the City of Pasco as required to obtain all necessary construction permits.
- 3. No excavations shall be started until the submittal review is complete and proper permits are obtained.
- C. Excavation Plan
 - 1. Designed to prevent damage to existing and surrounding properties, structures and utilities.
- D. Settlement Monitoring Plan, to include the following:
 - 1. General location of settlement monitoring points shown on the Drawings. Settlement monitoring points shall include baseline elevations of structure features, such as foundation elevations at a permanent known point, structure wall block elevations along a known row, and rebar pins. Rebar pins shall be 3-foot length steel rods driven into the ground with the upper end of the rod flush with the grade and protected with a casing that allows the surveying rod to be placed over the settlement point.
 - 2. The Contractor shall provide specific control benchmarks to be used for the settlement monitoring around the site, in sufficient spacing and quantity, to provide adequate coverage to all monitoring points. The benchmarks shall be located at least 100 feet away from the edge of any excavation and away from construction activity, to prevent impact from equipment or settling. These control benchmarks shall be documented with elevation and location information.

3. Survey procedures (including name of survey crew leader and equipment to be used). At a minimum, a licensed surveyor shall record the elevations of the monitoring points at the beginning and end of construction. Monitoring and documentation of settlement points shall occur on a weekly basis during construction. If excavation has not occurred then settlement points in the vicinity of the construction does not need to occur.
4. Approach to recording surveyed readings and means of reporting of results to the Owner.

E. Contingency Plan

1. Provide alternative procedures to be implemented if the excavation support systems are found to perform unfavorably or if obstructions are encountered in the installation of excavation support systems.
2. Contingency plan is to demonstrate a preparedness to mitigate the effects of movement or settlement.
3. The following minimum requirements for a contingency plan are:
 - a. Measures to be taken in order to protect existing facilities and neighboring properties from additional settlement or movement.
 - b. Identification of all material, manpower, equipment, and other items to be available and onsite at all times while excavations and dewatering activities are ongoing and reasonably after the work has been completed.

F. Site Conditions Survey

1. Videotape surveys, photographs, and other data significant in noting the pre-construction conditions of the existing project site, as well as the pre-construction conditions of the neighboring properties and their existing structures. Each settlement monitoring point shall be recorded twice before excavation begins to establish baseline elevations.
2. Provide to the OWNER for record purposes prior to, but not more than 3 weeks before, commencement of any construction activities.
3. A complete set of all photographs and survey data of the post-construction conditions shall be completed and submitted prior to final inspection by the Owner and Engineer.

1.5 QUALITY ASSURANCE

- A. Contractor is solely responsible for quality assurance of temporary shoring.

- B. At each excavation support system location, provide the following:
 - 1. Continual verification system is planned, executed, and maintained in accordance with applicable codes, regulations, and good construction practice.
 - 2. Systematic observation of suitability of shoring materials.
 - 3. Installation, excavation, settlement, and lateral deflection monitoring.
 - 4. Groundwater control.
 - 5. Adjacent construction activities.
 - 6. Other factors, as necessary.
- C. Continually verify installation of the shoring is in conformance with the plans prepared by the Contractor's design engineers.

1.6 CONTRACTOR QUALIFICATIONS

- A. The work of this Section shall be done by a firm specializing in this type of work. The firm shall:
 - 1. Regularly and presently perform shoring installation as one of their principal services.
 - 2. Have technical qualifications, experience, training, and facilities to properly install shoring.
 - 3. Provide the services of a supervising engineer, registered in the State, with at least 5 years of experience in the design and construction of shoring walls.
 - 4. A foreman or superintendent experienced in the installation and removal shoring walls shall be present while this work is performed.

1.7 PERMITTING

- A. Secure all permits necessary to complete the requirements of this Section.

PART 2 PRODUCTS

2.1 GENERAL

- A. Materials and equipment shall be safe and in good condition and shall conform to local, state, and federal codes.

PART 3 EXECUTION

3.1 GENERAL

- A. Provide sheeting, shoring, and other protection and support systems wherever required, in accordance with current local, state, and federal laws, codes, and ordinances.
- B. The Contractor is solely responsible for excavation protection and worker safety.
- C. The Contractor shall be solely responsible for the protection of existing utilities and structures. Under no circumstance shall work threaten the integrity (physical and operational) of these utilities and/or structures.

3.2 EXCAVATION SUPPORT SYSTEMS

- A. The excavation support systems shall not disturb the state of soil adjacent to the trench or excavation and below the excavation bottom.
- B. Water control measures shall be provided at all times in accordance with the requirements specified in Section 31 23 19, Dewatering.
- C. The support system shall extend below the main excavation bottom elevation to a depth adequate to prevent hydrostatic uplift, seepage and piping, and lateral movement and to adequately support applied vertical loads.
- D. Damage to existing utilities or structures during installation of excavation support system shall be avoided. If damage occurs, it shall be repaired at no cost and to the satisfaction of the Owner and the utility owner.
- E. A company representative from the excavation support system shall be onsite during initial setup of the system. Install excavation support system in strict conformance with the representative's recommendations.

3.3 CONTINGENCY PLAN IMPLEMENTATION

- A. Excess movements or settlements: Work shall be stopped immediately and the causes of excess or detrimental movements evaluated if:
 - 1. Damage is noted to existing site features or surrounding properties.
 - 2. Shoring wall movements exceed the limits specified herein or per submitted calculations.
- B. Immediately notify the Engineer and begin the implementation of the approved contingency plan to mitigate the effects of settlement or movement occurred.

3.4 REMOVAL OF SUPPORT SYSTEMS

- A. Removal of excavation support systems shall be performed in a manner that does not disturb or damage adjacent new or existing structures or utilities.
- B. Fill all voids immediately with specified backfill material.
- C. All damage to property resulting from removal shall be promptly repaired at no cost to the OWNER. The Engineer shall be the sole judge as to the extent and determination of the methods and materials for repair.

3.5 SCHEDULE

- A. A excavation support system selected by the CONTRACTOR shall be provided for the excavation of the following structures, unless otherwise approved by the ENGINEER:
 - 1. Primary Clarifier Box
 - 2. Aeration Basins

END OF SECTION

SECTION 32 11 23 - AGGREGATE BASE COURSES

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes construction of an aggregate subbase and base course for placement under asphalt or concrete paving, unit paving, or placed and left exposed.
- B. Section Includes:
 - 1. Aggregate subbase
 - 2. Aggregate base course

1.2 RELATED REQUIREMENTS:

- A. Section 31 22 13 - Rough Grading
- B. Section 31 23 17 - Trenching
- C. Section 31 23 23 - Fill
- D. Section 31 05 16 - Aggregates for Earthwork
- E. Section 32 12 16 - Asphalt Paving

1.3 REFERENCE STANDARDS

- A. American Association of State Highway and Transportation Officials (AASHTO):
 - 1. AASHTO M288 - Standard Specification for Geotextile Specification for Highway Applications
 - 2. T11, Standard Method of Test for Materials Finer Than 75 μ m (No. 200) Sieve in Mineral Aggregates by Washing
 - 3. T27, Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates
 - 4. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop
- B. ASTM International (ASTM):
 - 1. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³))
 - 2. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method

3. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
4. ASTM D2940 - Standard Specification for Graded Aggregate Material for Bases or Subbases for Highways or Airports
5. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

1.4 DEFINITIONS

- A. Completed Course: Compacted, unyielding, free from irregularities and standing water, with smooth, tight, even surface, true to grade, line, and cross-section.
- B. Completed Lift: Compacted with uniform cross-section thickness.
- C. Keystone: Fine aggregate used to aid in binding of loose surface stone.

1.5 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Product Data:
 1. Submit data for geotextile fabric and herbicide.
- C. Materials Source: Submit name of aggregate materials suppliers.
- D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.6 QUALITY ASSURANCE

- A. Furnish each aggregate material from single source throughout the Work.

PART 2 PRODUCTS

2.1 SHOULDER AGGREGATE

- A. Of the size shown on the Plans.
- B. Coarse Aggregate: Type A1, Dense-Graded Aggregate as specified in Section 31 05 16, Aggregates for Earthwork.

2.2 DENSE-GRADED BASE AGGREGATES

- A. Of the size shown on the Plans.

- B. Coarse Aggregate: Type A1, Dense-Graded Aggregate as specified in Section 31 05 16, Aggregates for Earthwork.

2.3 OPEN-GRADED BASE AGGREGATES

- A. Of the size shown on the Plans.
- B. Coarse Aggregate: Type A2, Granular Drain Backfill Material as specified in Section 31 05 16, Aggregates for Earthwork.

2.4 SOURCE QUALITY CONTROL

- A. Perform tests necessary to locate acceptable source of materials meeting specified requirements.
- B. Final approval of aggregate material will be based on test results of installed materials.
- C. Should separation of coarse from fine materials occur during processing or stockpiling, immediately change methods of handling materials to correct uniformity in grading.

2.5 EQUIPMENT

- A. Compaction Equipment: Adequate in design and number to provide compaction and to obtain specified density for each layer.

2.6 ACCESSORIES

- A. Geotextile Fabric: AASHTO M288; non-woven, polypropylene.

PART 3 EXECUTION

3.1 SUBGRADE PREPARATION

- A. Obtain Engineer's acceptance of subgrade before placing base course or surfacing material.
- B. Verify compacted substrate is dry and ready to support paving and imposed loads.
 - 1. Proof roll substrate with equipment approved by the Engineer in minimum two perpendicular passes to identify soft spots.
 - 2. Remove soft substrate and replace with compacted fill as specified in Section 31 23 23.

3.2 PREPARATION

- A. Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and re-compacting.
- B. Do not place base course or surfacing materials in snow or on soft, muddy, or frozen subgrade.

3.3 HAULING AND SPREADING

- A. Hauling Materials:
 - 1. Do not haul over surfacing in process of construction.
 - 2. Loads: Of uniform capacity.
 - 3. Maintain consistent gradation of material delivered; loads of widely varying gradations will be cause for rejection.
- B. Spreading Materials:
 - 1. Distribute material to provide required density, depth, grade, and dimensions with allowance for subsequent lifts.
 - 2. Produce even distribution of material on prepared surface without segregation.
 - 3. Should segregation of coarse from fine materials occur during placing, immediately change methods of handling materials to correct uniformity in grading.
 - 4. Maintain consistent gradation of material. Widely varying gradation will be cause for rejection.

3.4 CONSTRUCTION OF COURSES

- A. Untreated Aggregate Base Course:
 - 1. If the required compacted depth of the base course exceeds 6 inches, construct it in two or more layers of nearly equal thickness. The maximum compacted thickness of any one layer shall not exceed 6 inches.
 - 2. Completed Course Total Thickness: As shown on the Plans, 8-inch minimum.
 - 3. Spread lift on preceding course to required cross-section. Place each layer in spreads as wide as practical and to the full width of the course before a succeeding layer is placed.
 - 4. Lightly blade and roll surface until thoroughly compacted.

5. Add keystone to achieve compaction and as required when aggregate does not compact readily due to lack of fines or natural cementing properties, as follows:
 - a. Use 3/4-inch leveling course or surfacing material as keystone.
 - b. Spread evenly on top of base course, using spreader boxes or chip spreaders.
 - c. Roll surface until keystone is worked into interstices of base course without excessive displacement.
 - d. Continue operation until course has become thoroughly keyed, compacted, and will not creep or move under roller.
 6. Blade or broom surface to maintain true line, grade, and cross-section.
- B. Gravel Surfacing and Leveling Course:
1. Place shoulder aggregates in a single layer, or two or more layers of nearly equal thickness. The maximum compacted thickness of any one layer shall not exceed 9 inches.
 2. Spread on preceding course in accordance with cross-section shown.
 3. Blade lightly and roll surface until material is thoroughly compacted.
 4. Complete Total Thickness: As shown on the Plans, 8-inch minimum.

3.5 ROLLING AND COMPACTION

- A. Commence compaction of each layer of base immediately after spreading operations and continue until density of 95 percent of maximum density has been achieved as determined by AASHTO T99.
- B. Roll each layer of material until there is no appreciable reaction or yielding under the compactor before succeeding layer is applied.
- C. Shape and maintain the surface of each layer during compaction operations. Commence rolling at outer edges and continue toward center; do not roll center of road first.
- D. Apply water as needed to obtain specified densities.
- E. Place and compact each lift to the required density before succeeding lift is placed.
- F. Surface Defects: Remedy by loosening and rerolling. Reroll entire area, including surrounding surface, until thoroughly compacted.

- G. Finished surface shall be true to grade and crown before proceeding with surfacing.

3.6 SURFACE TOLERANCES

- A. Blade or otherwise work surfacing as necessary to maintain grade and cross-section at all times, and to keep surface smooth and thoroughly compacted.
- B. Finished Surface of Untreated Aggregate: Within plus or minus 0.04-foot of grade shown at any individual point.
- C. Overall Average: Within plus or minus 0.04-foot from crown and grade specified.

3.7 FIELD QUALITY CONTROL

- A. Quality control testing shall be performed by an independent testing laboratory provided by the CONTRACTOR.
- B. Refer to table below for minimum sampling and testing requirements for aggregate base course and surfacing. The OWNER reserves the right to complete additional testing.

Property	Test Method	Frequency	Sampling Point
Gradation	AASHTO T11 and AASHTO T27	One sample every 500 tons but at least every 4 hours of production	Roadbed after processing
Moisture Density (Maximum Density)	AASHTO T99	One test for every aggregate grading produced	Production output or stockpile
In-Place Density and Moisture Content	AASHTO T310	One for each 500 ton but at least every 10,000 square feet of area	In-place completed, compacted area

3.8 CLEANING

- A. Remove excess material from the Work area. Clean stockpile and staging areas of all excess aggregate. Restore per Specifications as applicable.

END OF SECTION

SECTION 32 12 16 - ASPHALT CONCRETE PAVEMENT

PART 1 GENERAL

1.1 SCOPE

This section includes the construction of asphalt concrete pavement.

1.2 REFERENCE STANDARDS

- A. References herein to "AASHTO" shall mean Association of American State Highway Transportation Officials.
- B. Standard Specifications: Where the term "Standard Specifications" is used, such reference shall mean the current edition of the City of Pasco Design and Construction Standards and Specifications for Public Works Improvements. Where reference is made to a specific part of the Standard Specifications, such applicable part shall be considered as part of this section of the Specifications. In case of a conflict in the requirements of the Standard Specifications and the requirements stated herein, the requirements herein shall prevail.

1.3 DEFINITIONS

- A. Maximum Density Test (MDT): Theoretical maximum density of the bituminous mixture determined by multiplying the theoretical maximum specific gravity, determined by ASTM D2041 (Rice), by 62.4 pounds per cubic foot.

1.4 SUBMITTALS

- A. Aggregate Source Approval: In accordance with Standard Specifications for aggregate used in aggregate base.
- B. Aggregate Source Approval: In accordance with Standard Specifications for aggregate used in asphalt concrete.
- C. Job mix formula shall be an approved job mix formula. Submit formula, supplier, and product identification to the Engineer 30 days prior to start.
 - 1. Definite percentage for:
 - a. Each sieve fraction.
 - b. New asphalt cement.
 - c. Recycled asphalt pavement.
 - 2. Temperature of completed mix when discharged from mixer.

3. Character and quantity of anti-strip and recycling agents.

1.5 QUALITY ASSURANCE

- A. All testing to determine compliance with the specifications shall be performed by an independent testing laboratory contracted by the Contractor and approved by the Engineer. All testing costs shall be borne by the Contractor.
- B. A minimum of five (5) nuclear densometer readings shall be taken in random locations within every test area. Each test area shall not exceed 200 tons of asphalt; however, smaller areas may be designated by the Engineer.
- C. The surface smoothness of the new asphalt concrete pavement shall be such that when a 10-foot straightedge is laid longitudinally across the paved area in any direction, the new pavement shall not deviate from the straightedge more than 1/8 inch. Surface drainage shall be maintained. Additionally, paving must conform to the design grade and crown and contain no abrupt edges, low or high areas or any other imperfections as determined by the Engineer. Pavement construction not meeting these requirements will be repaired by grinding the existing pavement to a 1 1/2-inch depth and replacing with 1/2 -inch dense graded Asphaltic Concrete the full width at no cost to Owner.

1.6 PRE-PAVING CONFERENCE

- A. Any supervisory personnel of the Contractor and any subcontractors who are to be involved in the paving work shall meet with the Engineer, at a time mutually agreed upon, to discuss methods of accomplishing all phases of the paving work.
- B. The Contractor shall be prepared to review the size and type of equipment to be used and the anticipated rate of placement to determine equipment needs.

PART 2 PRODUCTS

2.1 AGGREGATE MATERIAL

- A. Aggregate Base for Dense Graded Asphalt Concrete: The aggregate material shall be a clean, well-graded crushed base aggregate conforming to the Standard Specifications.

2.2 ASPHALT CONCRETE PAVEMENT

- A. Dense Graded Hot Mix Asphalt Concrete
 1. Use 1/2 inch-dense graded, PG 64S-28 HMA. Conform to the requirements as specified in the Standard Specifications.

2. Asphaltic concrete pavement delivered to the site shall be accompanied by a ticket with the approved "job mix formula" number shown. Loads without tickets identifying the job mix formula will not be accepted.
3. Percent of recycled asphalt pavement used in new asphalt pavement shall not exceed 20 percent. Recycled asphalt pavement may not be used in top wearing course unless otherwise approved by the Engineer.

B. Tack Coat

In accordance with Standard Specifications. Use CSS-1, CSS-1h or emulsified asphalt may be diluted once with water at a rate not to exceed one part water to one part emulsified asphalt.

C. Seal and Cover Coat

Asphalt material shall be CRS-2 cationic emulsified asphalt. Cover stone shall conform to size ¾ -inch -#10 aggregate in the Standard Specifications.

D. Subgrade Geotextile

1. As specified in the Standard Specifications.

E. Subgrade Stabilization

In the event that unstable materials are encountered during excavation, the additional excavation and installation of geotextile fabric and twelve (12) inches of rock substructure will be required, as directed. Conform to the requirements as specified in the Standard Specifications. For subgrade separation, use subgrade geotextile as specified in the Standard Specifications.

PART 3 EXECUTION

3.1 AGGREGATE PAVEMENT BASE

- A. Place pavement base to the depth shown on the plans or as specified in all cases, pavement base shall be compacted to a minimum depth of 6 inches. Bring the top of the pavement base to a smooth, even grade at a distance below finished grade equivalent to the required pavement depth.
- B. Compact the pavement base with mechanical vibratory or impact tampers to a density of not less than 95 percent of the maximum density, as determined by AASHTO T-99.
- C. Obtain the Engineer's acceptance of the subgrade before beginning construction of the aggregate base course.

- D. When, in the judgment of the Engineer, the weather is such that satisfactory results cannot be secured, suspend operations. Place no aggregate base course in snow or in soft, muddy, or frozen subgrade.
- E. If the required compacted depth of aggregate base course exceeds six (6) inches, construct in two or more lifts of approximately equal thickness. Maximum compacted thickness of any one lift shall not exceed six (6) inches. Compact each layer to the specified density before a succeeding lift is placed.

3.2 ASPHALT CONCRETE PAVEMENT

- A. Construct asphalt concrete pavement in accordance with Section 5 of the Standard Specifications.
- B. Conform to the requirements for prime coat and tack coat in the Standard Specifications. Tack coat all edges of existing pavement, manhole and clean out frames, inlet boxes and like items. When rate is not specified, asphalt will be applied at the rate of 0.1 gallon per square yard.
- C. Obtain the Engineer's acceptance of the aggregate base course before beginning construction of the asphalt concrete wearing course.
- D. Hot mix asphalt shall be placed on dry, prepared surfaces, when air temperature in the shade of 40° F or warmer, unless otherwise authorized by the Engineer.
- E. Placing asphalt pavement during rain or other adverse weather conditions will not be permitted unless otherwise authorized by the Engineer, except that asphalt mix in transit at the time these adverse conditions occur may be placed provided it is of proper temperature, the mix has been covered during transit, and it is placed on a foundation free from mud or free-standing water.
- F. Correct any defects in material and workmanship, as directed, when determined detrimental by the Engineer. These include segregation of materials, non-uniform texture, and fouled surfaces preventing full bond between successive spreads of mixture. The corrections or replacement of defective material or workmanship shall be at the Contractor's expense.
- G. Compact the bituminous mixture to at least 92 percent of the Theoretical Maximum Density.
- H. The finished surface of each course of layer of mixture shall be of uniform texture, smooth, and free of defects and shall closely parallel that specified for the top surface finished grade. Remove and replace boils and slicks immediately with suitable materials.

- I. The surface of each layer when tested with a Contractor-furnished 10-foot straightedge shall not vary from the testing edge by more than 0.02-foot for underlying courses of pavements and 0.015-foot for finished top courses or wearing courses of pavements. At no point shall the finished top of the wearing course vary more than 0.03-foot from the specified finished grade.
- J. Lift thickness shall be as shown on the drawings or specified, but not to exceed 3 inches.
- K. Do not place asphalt concrete pavement on emulsified asphalt (tack coat) until the asphalt separates from the water (breaks) but before it loses its tackiness.
- L. Asphalt and sand seal edges where new asphalt concrete meets existing pavement.

3.3 FIELD QUALITY CONTROL

- A. Job mix will be sampled immediately behind the paving machine.
- B. Temperature of the mix will be measured immediately behind the paver.
- C. The theoretical maximum specific gravity of the bituminous mixture will be determined in accordance with ASTM D2041.
- D. Properties of the job mix will be measured using ASTM D2041.
- E. Density of the compacted job mix will be measured in accordance with ASTM D2922 at a rate described in the Standard Specifications, Section 5.

3.4 ADJUSTMENT OF EXISTING MANHOLE COVERS AND VALVE BOXES

Prior to placing asphalt concrete pavement, the CONTRACTOR shall make all necessary adjustments to existing manhole frames and covers and valve box covers to ensure that the tops of the manhole covers or valve box lids are flush with the finished grade of the adjoining pavement or ground surface, and that valve boxes and PVC pipes are centered and plumb over operating nut valve.

END OF SECTION

SECTION 32 31 13 - CHAIN LINK FENCING AND GATES

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes chain link steel fencing and gates as shown on the Drawings or specified elsewhere. All fences and gates shall be furnished with top rails and knuckled periphery edges.
- B. Section includes:
 - 1. Chain link fabric
 - 2. Posts
 - 3. Rails
 - 4. Tension wires
 - 5. Braces
 - 6. Fittings
 - 7. Gates
 - 8. Lock assemblies and gate stops

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Chain Link Fence Manufacturer's Institute:
 - 1. Galvanized Steel Chain Link Fence Fabric
 - 2. Industrial Steel Specifications for Fence-Posts, Gates and Accessories
- B. ASTM International (ASTM):
 - 1. A121, Standard Specification for Metallic-Coated Carbon Steel Barbed Wire
 - 2. A313, Standard Specification for Stainless Steel Spring Wire
 - 3. A392, Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric
 - 4. A491, Standard Specification for Aluminum-Coated Steel Chain-Link Fence Fabric
 - 5. A497, Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete
 - 6. A615, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
 - 7. A780, Standard Specification for Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings

8. A824, Standard Specification for Metallic-Coated Steel Marcellled Tension Wire for Use with Chain Link Fence
9. A1011, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability
10. C94, Standard Specification for Ready-Mixed Concrete
11. C150, Standard Specification for Portland Cement
12. C387, Standard Specifications for Packaged, Dry, Combined Materials for Mortar and Concrete
13. F552, Standard Terminology Relating to Chain Link Fencing
14. F567, Standard Practice for Installation of Chain-Link Fence
15. F626, Standard Specification for Fence Fittings
16. F900, Standard Specification for Industrial and Commercial Swing Gates
17. F1043, Standard Specification for Strength and Protective Coatings on Metal Industrial Chain Link Fence Framework
18. F1083, Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures
19. F1183, Standard Specifications for Aluminum Alloy Chain Link Fence Fabric
20. F1184, Standard Specifications for Industrial and Commercial Horizontal Slide Gates
21. F1916, Standard Specification for Selecting Chain Link Barrier Systems with Coated Chain Link Fence Fabric and Round Posts for Detention Applications

C. Conflicts in requirements shall use this Section to take precedence.

1.3 SUBMITTALS

- A. Section 01 33 00, Submittal Procedures: Requirements for submittals.
- B. Shop Drawings:
 1. Product Data: Include construction details, material descriptions, dimensions of individual components, and finishes for chain link fences and gates.

2. Fence, gate posts, rails, and fittings.
 3. Chain link fabric.
 4. Gates and hardware.
- C. Manufacturer's recommended installation instructions.
 - D. Evidence of Supplier and installer qualifications.

1.4 QUALITY ASSURANCE

- A. Use skilled workers thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.
- B. Provide each type of steel fence and gate as a complete unit produced by a single manufacturer, including necessary erection accessories, fittings, and fastenings.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Site in undamaged condition.
- B. Store materials off the ground to provide protection against oxidation caused by ground contact.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Fabric
 1. Continuous chain link fence.
 2. Height: As shown on the Drawings.
 3. Mesh: 2-inch. All mesh shall have knuckled periphery to eliminate sharp appendages.
 4. #9-gauge steel core wire.
 5. Top and bottom selvage: Knuckled finish.
 6. Galvanized after weaving.
 7. Zinc coating shall not be less than 0.9 ounces per square foot.

B. Line Posts

Line posts shall be hot dipped galvanized 2.375-inch outside diameter hot dipped galvanized pipe, weighing 3.12 pounds per lineal foot.

C. Terminal Posts

End, corner, and pull posts shall be hot dipped galvanized pipe 2.875 inches outside diameter and weighing not less than 4.64 pounds per lineal foot.

D. Top Rail

1. Top rail shall be hot dipped galvanized 1.660-inch outside diameter pipe, weighing 1.83 pounds per lineal foot.
2. Furnish in random lengths of approximately 20 feet.
3. Jointed using a pressed steel or malleable sleeve, not only allowing for expansion and contraction, but also providing a continuous brace from end to end of each stretch of fence.

E. Tension Wire

Bottom tension wire shall be #6-gauge heavy galvanized high carbon steel coil spring wire, securely fixed to the fabric, line posts, and terminal posts.

F. Braces

1. All terminal posts shall be braced with 1.660-inch outside diameter. horizontal pipe bracing of the same material as the top rail, securely attached to the terminal and first line post with malleable iron fittings.
2. Braces shall be truss-braced from the first line post to the bottom of the terminal post, with a 3/8-inch galvanized truss rod assembly.
3. Corner posts shall be braced in both directions.

G. Fittings

1. Malleable, cast iron, or pressed steel.
2. Hot dip galvanized.

H. Fabric Ties

1. #11-gauge galvanized wire ties shall be used to tie the fabric to the line posts and rails.

I. Chain Link Gates

1. Frames:

- a. Made of heavy galvanized 1.90-inch outside diameter pipe, weighing 2.28 pounds per lineal foot.
 - b. Welded or assembled with corner fittings.
2. Corner fittings, ball and socket hinges, catch stops, and center rest to be heavy galvanized malleable iron.
 3. Hinges as required.
 4. Provide diagonal cross-bracing.

J. Gate Posts

Posts shall be hot dipped galvanized pipe 2.875-inch outside diameter weighing 4.64 pounds per lineal foot.

K. Framework Material

All posts, rails, and braces to be heavy galvanized.

L. Lock Assembly and Gate Stop

1. Provide for each gate one double-hasp drive gate drop rod lock assembly set in concrete and one gate stop set in concrete.
2. All lock assemblies and gate stops shall be fabricated from heavy galvanized malleable iron.
3. Provide one vandal-proof keyed lock and three keys for each gate assembly.

PART 3 EXECUTION

3.1 INSTALLATION

- A. All materials and workmanship shall be first class in all respects and shall be done in a neat and workmanlike manner.
- B. Installation shall be conducted in accordance with the requirements of the Chain Link Fence Manufacturers Institute and these Drawings & Specifications.

- C. All line, terminal, gate stops, gate drop, and gate posts shall be fixed with a minimum of 3-foot embedment in concrete poured into a 1-foot diameter hole and plumb upon curing of the concrete.
- D. Line posts shall be spaced not further than 10-foot on-center.
- E. Gates shall have 3-inch clearance above ground surface and sized for the application shown.
- F. Space ties at 14 inches on center.

END OF SECTION

SECTION 32 91 21 - FINISH GRADING AND SEEDING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Soil Preparation
2. Weed control
3. Fertilizing
4. Seeding
5. Mulching
6. Hydroseeding
7. Hydromulching
8. Erosion Control Blanket
9. Maintenance and Establishment Period

B. Related Sections:

1. Section 31 22 13 - Rough Grading
2. Section 31 23 17 - Trenching
3. Section 32 05 13 - Soils for Exterior Improvements
4. Section 32 84 00 - Irrigation

1.2 REFERENCES

A. ASTM International (ASTM):

1. ASTM C602 - Standard Specification for Agricultural Liming Materials.
2. 7 USC 1551-1611 - Federal Seed Act.

1.3 DEFINITIONS

- A. Certified Seed: A grass or legume seed named variety that has been reviewed and accepted into the State Certified Seed program. Currently certified seed is individually sold in bags with a Certification Tag.
- B. Pure Live Seed (PLS): Is a measure used to describe the percentage of a quantity of seed that will germinate. PLS is obtained by multiplying the purity percentage by the percentage of total viable seed, then dividing by 100.
- C. Establishment Period: A period when planting work has been performed and initially accepted, and there is a contract requirement to care for the planted areas in some way until the period ends.

- D. Sensitive Areas: Defined areas such as wetlands, natural water and riparian resources, special environmental zones, or where certain activities are restricted such as the use of chemicals.
- E. Weeds: Vegetative species other than specified species to be established in given area.
- F. Invasive Plants: Any species that appears on the City of Pasco's Standard's current noxious weed list, plus known problem species including phalaris arundinacea, mentha pulegium, holcus lanatus, anthoxanthum odoratum odoratum. The last crop plants (if listed as non-native on United States Department of Agriculture (USDA) Plants Database) are considered invasive if it comprises more than 15 percent in any newly established vegetation.

1.4 SUBMITTALS

- A. Product Data: Submit data for seed mix, mulch, tackifier, erosion control blanket, soil amendment materials, pesticides, herbicides, and other accessories. The product should meet or exceeds all product requirements specified herein.
- B. Grass Seeds Manufacturer's Certificate: Certify products meet or exceed specified requirements.
 - 1. Certification of seed analysis, germination rate, and inoculation. Include the year of production and date of packaging. Certify that each lot of seed has been tested by a testing laboratory certified in seed testing within 12 months of delivery date. Also include:
 - a. Name and address of laboratory
 - b. Date of test
 - c. Lot number for each seed certified
 - d. Test Results: Name, percentages of purity and of germination, and weed content for each seed mix.
- C. Operation and Maintenance Data: Include maintenance instructions and weed control.
- D. Load Tickets: Contractor shall provide all delivery load tickets for seed, fertilizer, and mulch. Submit to Owner prior to commencement of work under this section.

1.5 QUALITY ASSURANCE

- A. Provide seed mixture in containers showing percentage of seed mix, germination percentage, inert matter percentage, weed percentage, year of production, net weight, date of packaging, and location of packaging.

- B. Planting and seeding shall be done with the approval of the Owner when the ground is not frozen, snow covered, or in an otherwise unsuitable condition for planting.

1.6 QUALIFICATIONS

- A. Seed Supplier: Company specializing in manufacturing Products specified in this section with minimum 3 years documented experience.
- B. Installer: Company specializing in performing work of this section with minimum 2 years documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver grass seed mixture in sealed containers. Seed in damaged packaging is not acceptable.
- B. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.
- C. Deliver tackifier sealed containers showing weight, chemical analysis, and name of manufacturer.

PART 2 PRODUCTS

2.1 GROWING MEDIA

- A. Fertilizer: Biosol Mix 7-2-3 Natural-All Purpose Fertilizer, or equivalent.
- B. Guaranteed Analysis:
 - 1. Total Nitrogen (N): 7%
 - a. 0.5 % Water Soluble Nitrogen
 - b. 6.5% Water Insoluble Nitrogen (Slowly Available Nitrogen from fermented cottonseed and fermented soybean meal).
 - 2. Available Phosphate (P2O5): 2%
 - 3. Soluble Potash (K2O): 3%
- C. Plant Nutrients Derived From: Fermented Soybean Meal, Fermented Cottonseed Meal, Sulfate of Potash Magnesia.
- D. Sterilized and Free of Weed Seeds All-Natural Organic Nitrogen.

- E. Application Rate: 35 lbs. per 1,000 square feet.

2.2 SEED MIXTURE

- A. Seed Mixture and Application Rate: Native Seed Mix. Computations for quantity of seed required are based on the percent of purity and percent of germination: pounds of seed X purity X germination = pounds of pure live seed (PLS).

Botanical Name	PLS Lbs. per Acre
Bluebunch wheatgrass "Secar"	6
Sandberg's bluegrass	2
Thickspike wheatgrass "Critana"	2
Indian ricegrass "Nezpar"	2
Bottlebrush squirreltail	2
TOTAL:	12

2.3 SOD

- A. Sod shall be field grown one calendar year or older, have a well-developed root structure, and be free of all weeds, disease, and insect damage.

2.4 ACCESSORIES

- A. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; non-toxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15% and a pH range of 4.5 to 6.5. Mulch Application Rate: 2,000 lbs. per acre.
- B. Mulch Binder: Non-asphaltic Tackifier. Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; non-toxic and free of plant-growth or germination inhibitors. Application Rate: 50 lbs. per acre.
- C. Fertilizer: Commercial grade; recommended for grass to eliminate deficiencies of

2.5 SOURCE QUALITY CONTROL

- A. Analyze soil to ascertain percentage of nitrogen, phosphorus, potash, soluble salt content, organic matter content, and pH value.
- B. Provide recommendation for fertilizer and lime application rates for specified seed mix as result of soil testing.
- C. Testing is not required when recent tests and certificates are available for imported topsoil. Submit these test results to testing laboratory. Indicate, by test results, information necessary to determine suitability.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Planting Season: Plant seeds when growing conditions are conducive to seed germination and quick but thorough establishment of seedlings.
 - 1. Depending on latitude and elevation in the Pacific Northwest, these conditions occur either in September through October or April through May.
 - 2. Avoid planting seed during the heat of summer or in late fall to avoid freezes that kill sprouting grass seeds.

3.2 SOIL PREPARATION

- A. Prepare area for seeding while generally considering the following:
 - 1. Remove any matter detrimental or toxic to the growth of plants, including weeds, clods, rocks, or debris.
 - 2. Application rates of fertilizer or lime shall be based on soil testing results.
 - 3. Prepare a tilled, fine, but firm seedbed.
 - 4. The soil shall have a pH range of 5.5 to 8.0.

3.3 FERTILIZING

- A. Apply fertilizer hydraulically, at the same time as mulch is applied (described below). Fertilizer composition and application rates are provided above.

3.4 SEEDING

- A. Broadcast Seeding: Use a whirly-bird type spreader to broadcast seed over all bare areas, at a rate of 14 PLS pounds per acre. Apply seed in two equal applications, in perpendicular directions, to assure uniformity.
- B. Lightly rake seeded areas after seed is broadcast.
- C. Seeding will not be permitted when wind velocity is such as to prevent uniform seed distribution. No application shall be undertaken during inclement or the forecast of inclement weather. No application shall take place in the presence of free surface water or when the ground is frozen or otherwise not tillable.

3.5 MULCHING

- A. Mulch Application: Mulching of seed areas shall be accomplished using an approved hydromulcher to apply the specified fiber mulch at a rate of 2,000 pounds per acre.
- B. Fertilizer and mulch binder shall be applied at the same time and by the same machine as the fiber mulch, at application rates specified above. Prior to application, mulch, mulch binder, and fertilizer shall be well mixed to ensure a homogenous mixture is applied.
- C. Mulching shall not be done in the presence of free surface water resulting from rains, melting snow, or other causes.
- D. Areas not properly mulched, or damaged due to the Contractor's negligence, shall be repaired and remulched in an acceptable manner at the Contractor's expense. Mulch removed by wind prior to acceptance shall be re-established by the Contractor at his own expense.
- E. The seeded area shall be mulched within 24 hours after seeding. Areas not mulched within 24 hours after seeding must be re-seeded with the specified seed mix at the Contractor's expense.
- F. Contractor shall remove all hydromulch from plant materials, fences, paved areas (including paved path), and buildings as directed by Owner.

3.6 TEMPORARY MULCH FOR EROSION CONTROL

- A. As required by the SWPPP for this project, no soils shall remain exposed and unworked for more than 30 days during the dry season (July 1 to September 30) and 15 days during the wet season (October 1 to June 30). Regardless of the time of year, all soils shall be stabilized at the end of the shift before a holiday or weekend if needed based on weather forecast.
- B. Soil stabilization shall be provided by applying mulch and tackifier at the application rates specified above.

3.7 SOD

- A. Prior to cutting, the sod shall be green, in an active and vigorous state of growth, and mowed to a height not exceeding 1 inch. Sod strips shall be placed within 48 hours of being cut. Placement shall be without voids and have the end joints staggered. Following placement, the sod shall be rolled with a smooth roller to establish contact with the soil.

3.8 WORK QUALITY

- A. After application, apply water with fine spray immediately after each area has been hydroseeded. Apply water with fine spray immediately after each area has been mulched.
- B. Drift - Prevent drift and displacement of seed and fertilizer regardless of equipment and methods used.
- C. Displacement - Prevent seed, fertilizer, and mulch from falling or drifting onto other areas where grass is detrimental. Remove material that falls on plants, roadways, gravel shoulders, structures, and other surfaces where material is not specified.
- D. Damage - Prevent damage to prepared areas and to completed fertilizer, seed, and mulch work. Replace all material that becomes displaced before acceptance of the work.

3.9 CLEAN UP AND PROTECTION

- A. During landscape work, keep pavements clean and work area in an orderly condition. Any damage to other work done by landscape crew is to be reported and repaired immediately.
- B. Protect landscape work and materials from damage due to landscape operations, operations by other Contractors and trades and trespassers. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged landscape work as directed.

END OF SECTION

SECTION 33 01 30.13 - SEWER AND MANHOLE TESTING

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes methods for testing of gravity sewer piping, pressure sewer piping, and manholes.
- B. Section includes:
 - 1. Testing of Gravity Sewer Piping:
 - a. Low pressure air testing
 - 2. Testing of pressure piping
 - 3. Deflection testing of plastic sewer piping
 - 4. Testing of Manholes:
 - a. Vacuum testing
 - b. Exfiltration testing

1.2 RELATED SECTIONS

- A. Section 33 05 13 - Manholes
- B. Section 33 41 10 - Storm Utility Drainage Piping

1.3 REFERENCE STANDARDS

- A. ASTM International (ASTM):
 - 1. ASTM C1244 - Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill
 - 2. ASTM D2122 - Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings
- B. American Water Works Association (AWWA):
 - 1. AWWA C600 - Installation of Ductile Iron Mains and Their Appurtenances
 - 2. AWWA C605 - Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings.

1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Submit following items prior to start of testing:
 - 1. Testing procedures
 - 2. List of test equipment
 - 3. Testing sequence schedule
 - 4. Provisions for disposal of flushing and test water
 - 5. Certification of test gage calibration
 - 6. Deflection mandrel drawings and calculations
- C. Test and Evaluation Reports: Indicate results of manhole and piping tests.

PART 2 PRODUCTS

2.1 VACUUM TESTING

- A. Equipment:
 - 1. Vacuum pump
 - 2. Vacuum line
 - 3. Vacuum Tester Base:
 - a. Compression band seal
 - b. Outlet port
 - 4. Shutoff valve
 - 5. Stopwatch
 - 6. Plugs
 - 7. Vacuum Gage: Calibrated to 0.1-inch hectogram (Hg) (0.34 kilopascal (kPa)).

2.2 EXFILTRATION TESTING

- A. Equipment:
 - 1. Plugs
 - 2. Pump
 - 3. Measuring device

2.3 AIR TESTING

A. Equipment:

1. Air compressor
2. Air supply line
3. Shutoff valves
4. Pressure regulator
5. Pressure relief valve
6. Stopwatch
7. Plugs
8. Pressure Gage: Calibrated to 0.1 pounds per square inch (psi)

2.4 HYDROSTATIC TESTING

A. Equipment:

1. Hydro pump
2. Pressure hose
3. Water meter
4. Test connections
5. Pressure relief valve
6. Pressure Gage: Calibrated to 0.1 psi

2.5 DEFLECTION TESTING

A. Equipment:

1. "Go, no go" mandrels
2. Pull/retrieval ropes

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify manholes and piping are ready for testing.
- B. Verify trenches are backfilled.
- C. Verify pressure piping thrust restraint system is installed, as may be required.

3.2 PREPARATION

A. Obstructions:

1. After backfilling and restoration of surfaces, gravity pipelines shall be inspected for obstructions and shall be cleaned.

2. Pipes less than 24 inches in diameter shall be cleaned using the sewer ball method.
3. Lines larger than 36 inches in diameter may be cleaned by flushing as long as they are first visually inspected to assure that no physical obstructions exist.
 - a. Flushing shall be such that velocities are at least 2-1/2 feet per second.

B. Lamping:

1. Lamp gravity piping after flushing and cleaning of lines, checking manholes for unfinished work.
2. Perform lamping operation by shining light at one end of each pipe section between manholes.
3. Observe light at the other end.
4. Pipe not installed with uniform line and grade will be rejected.
5. Remove and reinstall rejected pipe sections.
6. Reclean and lamp until pipe section is installed to uniform line and grade.

C. Plugs:

1. Plug outlets, wye branches, and laterals.
2. Brace plugs to resist test pressures.

3.3 FIELD QUALITY CONTROL

A. Testing of Gravity Sewer Piping:

1. Low Pressure Air Testing:
 - a. Test each reach of gravity sewer piping between manholes.
 - b. Introduce air pressure slowly to approximately 4 pound-force per square inch gauge (psig).
 - 1) Determine ground water elevation above spring line of piping.
 - 2) For every foot of ground water above spring line of piping, increase starting air test pressure by approximately 0.4 psi.
 - 3) Do not increase pressure above 10 psig.
 - c. Allow pressure to stabilize for at least 5 minutes.

- d. Adjust pressure to 3-1/2 psig or to increased test pressure as determined above when ground water is present.
- e. Testing:
 - 1) Determine test duration for reach of sewer with single pipe size from following table; do not make allowance for laterals.

Table 33 01 30.13 -1
Air Testing Duration for Gravity Sewer Piping

NOMINAL PIPE SIZE, INCHES	MINIMUM TESTING TIME, MIN/100 FEET
6	0.7
8	1.2
10	1.5
12	1.8
15	2.1
18	2.4
21	3.0
24	3.6
27	4.2
30	4.8
33	5.4
36	6.0

- 2) Record drop in pressure during testing period.
- 3) If air pressure drops more than 1.0 psi during testing period, piping has failed.
- 4) If 1.0 psi air pressure drop has not occurred during testing period, piping is acceptable; discontinue testing.
- 5) If piping fails, test reach of piping in incremental stages until leaks are isolated, repair leaks, and retest entire reach between manholes.

B. Testing of Pressure Piping:

1. Test system according to AWWA C600.

C. Deflection Testing of Plastic Sewer Piping:

1. Perform vertical ring deflection testing on PVC and acrylonitrile butadiene styrene (ABS) sewer piping after backfilling has been in place for at least 30 days but not longer than 12 months.
 2. Allowable maximum deflection for installed plastic sewer pipe is no greater than 5 percent of original vertical internal diameter.
 3. Perform deflection testing using properly sized rigid ball or "go, no go" mandrel.
 4. Furnish rigid ball or mandrel with diameter not less than 95 percent of base or average inside diameter of pipe, as determined by ASTM standard to which pipe is manufactured; measure pipe diameter in compliance with ASTM D2122.
 5. Perform testing without mechanical pulling devices.
 6. Locate, excavate, replace, and retest piping that exceeds allowable deflection.
- D. Testing of Manholes:
1. Description:
 - a. Option of air testing or exfiltration testing.
 - b. If air testing, test whenever possible prior to backfilling in order to more easily locate leaks.
 - c. Repair both outside and inside of joint to ensure permanent seal.
 - d. Test manholes with manhole frame set in place.
 2. Vacuum test according to ASTM C1244 and following:
 - a. Plug pipe openings; securely brace plugs and pipe.
 - b. Inflate compression band to create seal between vacuum base and structure.
 - c. Connect vacuum pump to outlet port with valve open, then draw vacuum to 10-inch Hg.
 - d. Close valve.
 - e. Testing:

- 1) Determine manhole testing duration using following table:

MANHOLE DIAMETER (feet)	TEST PERIOD
4	60 seconds
5	75 seconds
6	90 seconds

- 2) Record vacuum drop during test period.
 - 3) If vacuum drop is greater than 1-inch Hg during testing period, repair and retest manhole.
 - 4) If vacuum drop of 1-inch Hg does not occur during test period, manhole is acceptable; discontinue testing.
 - 5) If vacuum test fails to meet 1-inch Hg drop-in specified time after repair, repair and retest manhole.
3. Exfiltration Testing:
 - a. Plug pipes in manhole.
 - b. Remove water from manhole.
 - c. Observe plugs over period of not less than two hours to ensure that there is no leakage into manhole.
 - d. Determine ground water level outside manhole.
 - e. Fill manhole with water to its rim at the start of the test.
 - f. Prior to testing, allow manhole to soak from minimum of 4 hours to maximum of 72 hours.
 - g. After soak period, adjust water level to rim of manhole.
 - h. Leakage in the manhole shall not exceed 0.2 gallons per foot of head above the highest invert after a one-hour test period.
 4. If unsatisfactory testing results are achieved, repair manhole and retest until result meets criteria.
 5. Repair visible leaks regardless of quantity of leakage.

END OF SECTION

SECTION 33 05 13 - MANHOLES

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes cast-in-place and precast concrete manholes and covers for access to subsurface drainage piping or utilities.
- B. Section Includes:
 - 1. Cast-in-place concrete manholes with transition to cover frame, covers, anchorage, and accessories.
 - 2. Modular precast concrete manhole with tongue-and-groove joints with precast transition to cover frame, covers, anchorage, and accessories.
 - 3. Bedding and cover materials.

1.2 RELATED SECTIONS

- A. Section 03 11 00 - Concrete Work
- B. Section 03 21 00 - Reinforcing Steel
- C. Section 31 05 13 - Soils for Earthwork
- D. Section 31 05 16 - Aggregates for Earthwork
- E. Section 31 23 16 - Excavation
- F. Section 31 23 23 - Fill
- G. Section 33 01 30.13 - Sewer and Manhole Testing
- H. Section 33 41 10 - Storm Utility Drainage Piping

1.3 REFERENCE STANDARDS

- A. American Association of State Highway and Transportation Officials (AASHTO):
 - 1. AASHTO M-198B – Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
- B. American Concrete Institute (ACI):
 - 1. ACI 301 – Building Code Requirements for Structural Concrete
 - 2. ACI 315 – Details and Detailing of Concrete Reinforcement
 - 3. ACI 318 – Building Code Requirements for Structural Concrete
- C. ASTM International (ASTM):
 - 1. ASTM A48 - Standard Specification for Gray Iron Castings

2. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
 3. ASTM A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
 4. ASTM C55 - Standard Specification for Concrete Building Brick
 5. ASTM C62 - Standard Specification for Building Brick (Solid Masonry Units Made from Clay or Shale)
 6. ASTM C150 - Specifications for Portland Cement
 7. ASTM C387 - Standard Specification for Packaged, Dry, Combined Materials for Concrete and High Strength Mortar
 8. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
 9. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections
 10. ASTM C497 - Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile
 11. ASTM C827 – Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures
 12. ASTM C913 - Standard Specification for Precast Concrete Stormwater and Wastewater Structures
 13. ASTM C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals
 14. ASTM C990 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
- D. Federal Specifications:
1. SS-S-00210 (210-A) – Specification for Sealing Compound, Preformed Plastic, for Expansion Joints and Pipe Joints
- E. US Army Corp of Engineers:
1. CRD-C 621 – Specifications for Non-Shrink Grout

1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Product Data:
 - 1. Pre-cast concrete manholes:
 - a. Design criteria and calculations.
 - b. Details of reinforcement.
 - 2. Steps.
 - 3. Cover and frame construction, features, configuration, dimensions and material specifications.
 - 4. Rubber gaskets.
 - 5. Grout and mortar.
- C. Shop Drawings:
 - 1. Indicate manhole by location.
 - 2. Provide dimensions, elevations, joints, location, and type of lifting inserts.
 - 3. Indicate connecting piping material, piping size, piping connection angles and offsets, and sizes of penetrations.
- D. Manufacturer's Certificate: Certification that products meet or exceed specified requirements.
- E. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.
- F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- B. Comply with precast concrete manufacturer's instructions and ASTM C913 for unloading, storing, and moving precast manholes and drainage structures.

C. Storage:

1. Store precast concrete manholes as to prevent damage to Owner's property or other public or private property.
2. Repair property damaged from materials storage.

PART 2 PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA FOR MANHOLES

- A. Equivalent strength: Based on structural design of reinforced concrete as outlined in ACI 318.
- B. Design of Lifting Devices for Precast Components: According to ASTM C913.
- C. Design of Joints for Precast Components:
1. According to ASTM C913.
 2. Lipped male/female joints.
 3. Maximum Leakage: 0.025 gallons per hour per foot of joint at 3 feet of head.
- D. Shaft Construction:
1. Reinforced concrete.
 2. Concentric with eccentric cone top section
 3. Sleeved to receive pipe connections.
- E. Wall Thickness:
1. Minimum wall thickness shall be 5 inches.
 2. Cones shall have the same wall thickness and reinforcement as riser sections.
- F. Shape: Cylindrical.
- G. Clear Inside Dimensions:
1. As indicated on Drawings.
 2. Sections shall consist of circular sections in standard nominal inside diameters of 42, 48, 54, 60, 72, 84, 96, 108, 120, 132, or 144 inches.
- H. Design Depth:
1. As indicated on Drawings.

- I. Clear Cover Opening: As indicated on Drawings, minimum of 30 inches.
- J. Pipe Entry: Furnish openings as required and as indicated on the Drawings.
- K. Steps:
 - 1. Rungs:
 - a. Material: Formed polypropylene with 1/2-inch diameter, Grade 60 reinforcing bar.
 - b. Comply with ASTM C478.
 - c. Reinforcing bar to comply with ASTM A615.
 - 2. Formed integral with manhole sections.
 - 3. Width: Minimum 12 inches.
 - 4. Spacing: 12 inches on center vertically.

2.2 MANHOLES

A. Precast Concrete Manholes:

- 1. Sections:
 - a. Description: Reinforced precast concrete according to ASTM C478.
 - b. Gaskets: According to ASTM C923.
 - c. Heights: Multiples of 6 inches.
- 2. Bases:
 - a. Base slab integral with sidewalls.
 - b. Monolithic construction, conforming to ASTM C478.

B. Cast-in-Place Concrete Manholes:

- 1. Sections: Reinforced cast-in-place concrete as specified in Section 03 30 00 - Cast-in-Place Concrete.
- 2. Concrete forming in accordance with Section 03 10 00, Concrete Forming and Accessories.

C. Joint Materials:

- 1. Mortar:

- a. Conform to ASTM C387.
 - b. Admixtures
 - 1) Allowable, not exceeding the following percentages of weight of cement:
 - a) Hydrated lime, 10 percent
 - b) Diatomaceous earth or other inert materials, 5 percent
 - c. Consistency: Shall be such that it will readily adhere to the precast concrete if using the standard tongue and groove type joint.
 - d. Mortar not used within 30 minutes of initial mixing shall be discarded and not be used.
2. Non-Shrink Grout:
- a. Description: Non-metallic, cementitious, commercial grout exhibiting zero shrinkage per ASTM C827 and CRD-C-621.
 - b. Manufacturers:
 - 1) Preco-Patch
 - 2) Sika 212
 - 3) Euco N-S
 - 4) Five-Star
 - 5) Approved equal
3. Grout shall not be amended with water after initial mixing.
4. Grout not used within 20 minutes of initial mixing shall be discarded and not be used.
5. Commercial Concrete Bonding Agent:
- a. Non-shrink grout shall be placed or packed only with the use of an approved commercial concrete bonding agent applied to all cured concrete surfaces being grouted.
 - b. Bonding agent shall be compatible with the brand of grout used.
 - c. Water shall not be used as a substitute for the commercial bonding agent.
- D. Preformed mastic gaskets for manhole joints shall meet Federal Specifications SS-S-00210 (210-A), AASHTO M-198B and ASTM C990.

E. Reinforcement:

1. Formed steel wire.

2.3 FRAMES AND COVERS

A. Description:

1. Construction: ASTM A48, Class 30B cast iron.
2. Lid:
 - a. Machined flat bearing surface.
 - b. Removable.
3. Cover Design: Closed.
4. Live Load Rating: AASHTO H20 loading.
5. Cover: Molded with "CITY OF PASCO - SEWER" cast in.
6. Coefficient of Friction on Outside Face: Minimum of 0.60.

2.4 RISER RINGS

A. Description:

1. Four inches to 6 inches Thick:
 - a. Material: Precast concrete.
 - b. Comply with ASTM C478.
2. Less than 4 inches Thick:
 - a. Material: Cast iron.
 - b. Comply with AASHTO M306.
3. Rubber Seal Wraps:
 - a. Wraps and Band Widths: Conform to ASTM C877, Type III.
 - b. Cone/Riser Ring Joint: Minimum 3 inches overlap.
 - c. Frame/Riser Ring Joint: 2 inches overlap.
 - d. Additional Bands: Overlap upper band by 2 inches.

2.5 MATERIALS

A. Bedding and Cover:

1. Bedding: Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.
2. Backfill Around Structure: Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.
3. Soil Backfill from Above Pipe to Finish Grade:
 - a. In existing or future roadways, right-of-way:
 - 1) Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.
 - b. In non-paved areas outside of footprint of existing or future structures, outside of right-of-way:
 - 1) Soil Type S1, as specified in Section 31 05 13, Soils for Earthwork.
 - 2) Subsoil: No rocks over 6 inches in diameter, frozen earth, or foreign matter.

2.6 FINISHES

A. Steel:

1. Galvanizing:
 - a. ASTM A123.
 - b. Hot dip galvanize after fabrication.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify items provided by other Sections of Work are properly sized and located.
- B. Verify built-in items are in proper location and ready for roughing into Work.
- C. Verify correct size of manhole excavation.

3.2 PREPARATION

- A. Design the method of placement for all precast items and add all reinforcing steel, embeds, bracing, and other items necessary for placement. All portions of embeds which remain embedded in the concrete shall be made of stainless steel.
- B. Mark each precast structure by indentation or waterproof paint showing date of manufacture, manufacturer, and identifying symbols and numbers as indicated on Drawings to indicate its intended use.

- C. Coordinate placement of inlet and outlet pipe or duct sleeves required by other Sections.
- D. Do not install manholes where site conditions induce loads exceeding structural capacity of manhole components.
- E. Inspect precast concrete structures immediately prior to placement in excavation to verify structures are internally clean and free from damage; remove and replace damaged units.
- F. Subgrade
 - 1. Subgrade shall be compacted to 95 percent of maximum density.
 - 2. Compacted subgrade shall be covered with a minimum of 6 inches of aggregate base compacted to 95 percent of maximum density, extending a minimum of 6 inches beyond the outside limits of the manhole, unless otherwise indicated on Drawings.
 - 3. Grade the aggregate base to a uniform, level surface which will fully support the structure and to an elevation that will ensure proper positioning of the top slab or lid.

3.3 INSTALLATION

- A. Excavation and Backfill:
 - 1. Excavate manholes as specified in Section 31 23 16, Excavation in location and to indicated depth.
 - 2. Provide 12 inches of clearance around sidewalls of structure for construction operations.
 - 3. When groundwater is encountered, prevent accumulation of water in excavations and place manholes in dry trench.
- B. Where possibility exists of watertight structure becoming buoyant in flooded excavation, anchor structure to avoid flotation as approved by Engineer.
- C. Base Pad:
 - 1. Place base pad.
 - 2. Trowel top surface level.
- D. Backfill excavations for manholes as specified in Section 31 23 23, Fill.

- E. Form and place manhole cylinder plumb and level and to correct dimensions and elevations.
- F. Grout base of shaft sections to achieve slope to exit piping, trowel smooth, and contour to form continuous drainage channel.
- G. Set cover frames and covers level without tipping and to correct elevations.
- H. Coordinate with other Sections of Work to provide correct size, shape, and location.
- I. Precast Concrete Manholes:
 - 1. Assembly:
 - a. Install precast structures in accordance with the manufacturer's recommendations unless otherwise required by the Contract Documents.
 - b. Verify installed manholes meet required alignment and grade.
 - c. Lift precast components at lifting points designated by manufacturer.
 - d. When lowering manholes into excavations and joining pipe to units, take precautions to ensure that interior of pipeline and structure remains clean.
 - e. Set precast structures bearing firmly and fully on crushed stone bedding, compacted as specified in Section 31 23 23, Fill or on other support system as indicated on Drawings.
 - f. Assemble multi-section structures by lowering each section into excavation; set level and firmly position base section before placing additional sections.
 - g. Place manhole sections plumb and level, trim to correct elevations, and anchor to base pad.
 - h. Remove foreign materials from joint surfaces and verify sealing materials are placed properly.
 - i. Maintain alignment between sections by using guide devices affixed to lower section.
 - 2. Joints:
 - a. Sealing materials may be installed onsite or at manufacturers plant.
 - b. All joints shall be sealed watertight by the use of rubber gaskets or other approved preformed sealant.

- c. All joints shall then be filled with non-shrink grout on both the inside and outside surfaces to produce smooth interior and exterior surfaces.

3. Concrete Base Installation:

- a. Bases shall be set at the proper grade to allow pipe openings to match the grades for connecting pipes.
- b. Invert shall be constructed to a section identical with that of the sewer pipe.
- c. Where the size of sewer pipe is changed at the manhole, the invert shall be constructed to form a smooth transition without abrupt breaks or unevenness of the invert surfaces.
- d. Prevent sewage or water from contacting the new concrete or mortar surfaces to prevent damage to the fresh concrete or mortar until the initial set has been achieved.
- e. Manhole bases shall be set level so base gravel fully and uniformly supports them in true alignment with uniform bearing throughout full circumference.
- f. Do not level the base sections by wedging gravel, or other material, under the edges.
- g. Flexible connectors shall be installed in the base section to form a permanently watertight seal.

4. Manhole Riser Sections:

- a. Precast manhole components may be used to construct standard, drop and carry-through manholes. Manholes less than 4 feet in depth measured from the spring line of the pipe to the bottom of the lower riser ring shall be flat-top manholes.
- b. Install manhole riser sections at the location shown on the plans. All sanitary sewer and pollution control manholes joints shall be watertight and shall use rubber gaskets or a preformed sealant. All joints shall then be filled with non-shrink grout inside and out so as to produce smooth interior and exterior surfaces. All manhole penetrations shall be watertight. Complete manholes shall be rigid. Compact backfill in accordance with the provisions stated elsewhere in this document.
- c. All lift holes shall be thoroughly wetted, completely filled with mortar, and smoothed and pointed both inside and out to ensure watertightness.

- d. The shortest length of riser section to be incorporated into the manhole shall be installed immediately below the flat slab top or cone.
 - e. Properly locate and plumb each manhole riser section.
 - f. Install manhole extensions and top slabs in accordance with manufacturer's specifications and as shown on the plans. Lay section risers with the sides plumb and the tops level. Make joints and penetrations watertight.
 - g. Remove knockouts or cut structure to receive piping without creating openings larger than required to receive pipe; fill annular spaces with mortar.
5. Entrances/Exits:
- a. Cut pipe flush with interior of structure.
 - b. Shape inverts through manhole as indicated on Drawings.
 - c. All rigid non-reinforced pipe entering or leaving the manhole (new or existing manhole) shall be provided with flexible joints within 1-foot of the structure and shall be placed on compacted bedding.
 - d. Ribbed HDPE pipe connections shall be grouted watertight with non-shrink grout.
 - e. PVC pipe shall be connected to manholes using an approved adapter specifically manufactured for the intended service.
 - 1) Adapters shall be Fernco, Kor-N-Seal, or approved equal.
6. Grates, Frames, and Covers:
- a. Manhole frames, grates, and covers shall be installed in such a manner as to prevent infiltration of surface or groundwater between the frame and the concrete of the manhole section. Use preformed rubber ring to form a watertight seal.
 - b. Manhole frames and covers shall be installed to grades shown on the drawings or as directed.
 - c. Adjustment of manhole castings shall be made using specified precast grade rings and approved rubber ring joints.
 - d. The maximum depth of adjustment below any manhole casting shall be 16 inches, and a minimum depth of adjustment shall be 4 inches.

J. Cast-in-Place Concrete Manholes:

1. Prepare crushed stone bedding or other support system as indicated on Drawings to receive base slab as specified for precast structures.
2. Erect and brace forms against movement as specified in Section 03 11 00, Concrete Work.
3. Install reinforcing steel as indicated on Drawings and as specified in Section 03 11 00, Concrete Work.
4. Place and cure concrete as specified in Section 03 11 00, Concrete Work.
5. Frames and Covers:
 - a. Set frames using mortar and masonry.
 - b. Install radially laid concrete brick with 1/4-inch thick vertical joints at inside perimeter.
 - c. Lay concrete brick in full bed of mortar and completely fill joints.
 - d. If more than one course of concrete brick is required, stagger vertical joints.
 - e. Set frame and cover as indicated on Drawings.

3.4 FIELD QUALITY CONTROL

- A. Test concrete manhole and structure sections according to ASTM C497.
- B. Perform manhole testing according to Section 33 01 30.13, Sewer and Manhole Testing.
- C. Test cast-in-place concrete as specified in Section 03 11 00, Concrete Work.
- D. Vertical Adjustment of Existing Manholes:
 1. If required, adjust top elevation of existing manholes to finished grades as indicated on Drawings.
 2. Reset existing frames, grates, and covers that were carefully removed and cleaned of mortar fragments to required elevation according to requirements specified for installation of castings.
 3. When removal of existing concrete wall is required, remove concrete without damaging existing vertical reinforcing bars, clean concrete from vertical bars, and

bend into new concrete top slab or splice to required vertical reinforcement as indicated on Drawings.

4. Clean and apply sand-cement bonding compound on existing concrete surfaces to receive cast-in-place concrete as specified in Section 03 11 00, Concrete Work.

END OF SECTION

SECTION 33 05 13.13 – PRECAST CONCRETE FRP-PVC MANHOLE SYSTEM

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes installation of a precast concrete Fiberglass Reinforced Plastic (FRP)-PVC manhole system.
- B. Section Includes:
 - 1. FRP concrete protective liners for manhole base and top sections, including all appurtenances.
 - 2. Concrete manhole base and top sections cast around the FRP concrete protective liners.
 - 3. PVC pressure pipe section.
 - 4. Elastomeric sealant and external joint wrap for the purpose of joining the lined concrete base, PVC pressure pipe riser, and lined concrete top manhole sections.
 - 5. Grading rings, manhole ring and cover.

1.2 RELATED SECTIONS

- A. Section 03 11 00 - Concrete Work
- B. Section 03 21 00 – Reinforcing Steel
- C. Section 31 05 13 - Soils for Earthwork
- D. Section 31 05 16 - Aggregates for Earthwork
- E. Section 31 23 16 - Excavation
- F. Section 31 23 23 - Fill
- G. Section 33 01 30.13 - Sewer and Manhole Testing
- H. Section 40 05 10.02 – Stainless Steel Pipe and Fittings
- I. Section 40 05 10.07 – HDPE Pipe

1.3 REFERENCE STANDARDS

- A. American Association of State Highway and Transportation Officials (AASHTO):
 - 1. AASHTO M-198B – Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
- B. American Concrete Institute (ACI):

1. ACI 301 – Building Code Requirements for Structural Concrete
 2. ACI 315 – Details and Detailing of Concrete Reinforcement
 3. ACI 318 – Building Code Requirements for Structural Concrete
- C. ASTM International (ASTM):
1. ASTM A493 – Standard Specification for Stainless Steel Wire and Wire Rods for Cold Heading and Cold Forging
 2. ASTM A666 – Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
 3. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections
 4. ASTM C877 – Standard Specification for External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections
 5. ASTM C913 - Standard Specification for Precast Concrete Stormwater and Wastewater Structures
 6. ASTM C990 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
 7. ASTM D395 - Standard Test Methods for Rubber Property – Compression Set
 8. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension
 9. ASTM D471 - Standard Test Method for Rubber Property – Effect of Liquids
 10. ASTM D543 - Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents
 11. ASTM D573 - Standard Test Method for Rubber – Deterioration in an Air Oven
 12. ASTM D624 - Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
 13. ASTM D638 - Standard Test Method for Tensile Properties of Plastics
 14. ASTM D695 - Test Methods for Compressive Properties of Rigid Plastics
 15. ASTM D790 - Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and electrical Insulating Materials

16. ASTM D792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
 17. ASTM D1149 - Standard Test Methods for Rubber Deterioration – Cracking in an Ozone Controlled Environment
 18. ASTM D2137 - Standard Test Methods for Rubber Property - Brittleness Point of Flexible Polymers and Coated Fabrics
 19. ASTM D2240 - Standard Test Method for Rubber Property – Durometer Hardness
 20. ASTM D2584 - Test Method for Ignition Loss of Cured Reinforced Resins
 21. ASTM D4060 - Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser
- D. American Water Works Association (AWWA)
1. AWWA C900-16 – PVC Pressure Pipe and Fabricated Fittings, 4 In. Through 60 In.
- E. Greenbook 2009 (or later):
1. Standard Specifications for Public Works Construction, Chemical Resistance Test (Pickle Jar Test)

1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Product Data:
1. Pre-cast concrete manholes:
 - a. Design criteria and calculations.
 - b. Details of reinforcement.
 2. PVC riser:
 - a. Design criteria and calculations.
 3. FRP liners:
 - a. Design criteria and calculations.
 4. Ring, cover and frame construction, features, configuration, dimensions and material specifications.

- 5. Grout and mortar.
- C. Shop Drawings:
 - 1. Provide dimensions, elevations, joints, location, and type of lifting inserts.
 - 2. Indicate connecting piping material, piping size, piping connection angles and offsets, and sizes of penetrations.
- D. Manufacturer's Certificate: Certification that products meet or exceed specified requirements.
- E. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.
- F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- B. Comply with precast concrete FRP-PVC manhole system manufacturer's instructions and ASTM C913 for unloading, storing, and moving structure.
- C. Storage:
 - 1. Store precast concrete FRP-PVC manhole system so as to prevent damage to Owner's property or other public or private property.
 - 2. Repair property damaged from materials storage.

PART 2 PRODUCTS

2.1 CONFIGURATION FOR PRECAST CONCRETE FRP-PVC MANHOLE SYSTEM

- A. General Overview: The manhole base and top section shall be ASTM C478 compliant precast concrete manhole sections with an integral cast-in FRP Baseline and Top Liner respectively, providing corrosion, abrasion, inflow and infiltration resistance to the precast concrete manhole sections. The FRP Top Liner shall incorporate an integral Access Collar and Gasket to accept and an FRP Telescoping access Tube providing corrosion, inflow and infiltration resistance from the grade ring down. Each cast-in FRP liner component shall be constructed from one-piece homogenous composite and/or thermoplastic with minimum thickness of 1/8". FRP concrete protective liners are non-

structural elements and structural integrity must be provided by the precast concrete manhole sections. The manhole riser section shall be a one-piece AWWA C900 compliant, DR-51 pressure class PVC pipe. PVC pipe to FRP liner joints shall be a spigot joints with rubber butyl sealant and optional external joint wrap.

B. Cast-in FRP Baseliners: Each FRP manhole Baseline shall include:

1. Full flow channels with side walls to the crown of the pipe(s) or above;
2. A non-skid pattern on inner bench surfaces;
3. Gasketed, flexible and watertight, bell type pipe connections for specific pipe types to receive the collection pipes at the exact angles and slopes as specified on the Drawings.

The bells shall be monolithically attached to the manhole base liner channels, be integral to the Baseline and have a water stop on the outside and a pipe stop on the inside that matches the diameter and wall thickness of the collection pipe and ensure that the flow line from the pipe stop to the inside channels are smooth and without obstruction. The Bells shall conform to the outside and inside curve of the manhole walls. The Baseline shall have a spigot joint facing the PVC riser tube and connecting to the inside of the PVC pressure pipe riser. An ASTM C990 compliant butyl rubber sealant shall be used in the joint interface. An ASTM C877 compliant external joint wrap shall be used to seal the joint from the outside. The FRP Baseline shall be monolithically precast in an ASTM C478 compliant steel reinforced manhole base section. Poured in place concrete bases are not acceptable.

C. Cast-in FRP Top Liner with Integral Access Collar and Gasket: The FRP Top Liner component shall provide concrete protection from corrosion, abrasion, inflow and infiltration for the manhole cone section and shall feature an integral FRP Access Collar and Gasket at the manway opening, to receive an FRP Telescoping Access Tube. The FRP Top Liner shall either have cone or flat top configuration depending on the requirements of Contract Documents. The Top Liner shall have a spigot joint facing the PVC riser tube and connecting to the inside of the PVC pressure pipe riser. An ASTM C990 compliant butyl rubber sealant shall be used in the joint interface. An ASTM C877 compliant external joint wrap shall be used to seal the joint from the outside. The FRP Top liner shall be monolithically precast in an ASTM C478 compliant steel reinforced manhole lid section. Poured in place concrete lid sections are not acceptable.

D. Telescoping Access Tube: The FRP Telescoping Access Tube shall provide concrete protection from corrosion, abrasion, inflow and infiltration for the manway entry section, between the casting at the finished grade and top of the manhole top section. The Telescoping Access Tube shall accommodate grading adjustments up to 12" of height.

- E. Precast Concrete Manhole Sections: Precast manhole sections cast around the FRP liners result in a lined manhole sections with no bare concrete exposed to the wastewater environment. Precast manhole sections shall be manufactured in accordance with and meet the requirements of specification ASTM C-478. All precast manhole sections shall be monolithically manufactured by the wet cast method.
- F. PVC Riser Tube: The one-piece AWWA C900 compliant, DR-51 pressure class PVC pipe shall function as a corrosion resistant manhole riser. The PVC riser tube shall accommodate penetrations as specified in Drawings, including gasketed pipe connections using flexible connectors.

2.2 DIMENSIONS:

- A. As indicated on Drawings.
- B. FRP Baseliners and Top Liners shall have outside diameters of 51", 58" and 61.75", corresponding substantially to the outside diameters of 48", 54" and 60" C900 DR-51 PVC pressure pipes. Tolerance on the outside diameter shall be +/- 1%.
- C. FRP Baseliners and Top Liners shall have spigot joint diameters of 48.80", 55.30" and 59.19", corresponding to the inside diameters of 48", 54" and 60" C900 DR-51 PVC pressure pipes. Tolerance on the spigot joint diameter shall be +/- 0.125".
- D. Allowable tolerance for Baseline invert elevations shall be 0.125" and 2% for pipe slope.
- E. Access Collars and Telescopic Access Tube shall accommodate manway openings of 24", 27", 32" or 36" as indicated on the Drawings. Telescopic Access Tube shall have a nominal height of 15". Access Collars can be either eccentric or concentric.

2.3 MATERIALS

- A. FRP Liners: The resins used shall be unsaturated, supplier certified, commercial grade polyester resins. Mixing lots of resin from different manufacturers, or "odd-lotting" of resins shall not be permitted. Quality assurance records on the resin shall be maintained. The reinforcing materials shall be commercial grade "E-CR" type glass, specially formulated for corrosive environments, in the form of mat, chopped roving, continuous roving, roving fabric or a combination of the above, having a coupling agent that will provide a suitable bond between the glass reinforcement and resin. Fiberglass and/or polypropylene ribs and/or structural members may be utilized to meet the design criteria. No inert fillers shall be used. Additives, such as thixotropic agents, catalysts, promoters, etc., may be added as required by the specific manufacturing process to be used to meet the requirements of this standard. The laminate shall consist of multiple layers of glass matting and resin. The surface exposed to the sewer/chemical environment shall be resin rich and shall have no exposed fibers.

1. FRP Liner Physical Properties: All FRP Liner test methods shall be performed per corresponding ASTM standard and per "Greenbook" 2009 edition (or later), Standard Specifications for Public Works Construction, Chemical Resistance Test (Pickle Jar Test). Tensile specimens shall be prepared and tested in accordance with ASTM D412 using Die B. Weight change specimens shall be 1 IN by 3 IN samples. All FRP liner material shall have the following physical properties when tested at 77 °F ± 5 degrees:

Property	Standard	Units	Initial	(Par. VI.F.)
Density	ASTM D792	g/cm ³	1.02	
Thickness	--	Mm	3 min.	--
Tensile Strength	ASTM D638	psi	7,000 min.	6,500 min.
Hardness (Shore "A")	ASTM D2240		95-97	89-97
Weight change	- -	--	--	0.05% max.
Flexural Strength	ASTM D790	lbf	124 avg.	--
Compressive Strength	ASTM D695	psi	13,000	--
Ignition Loss	ASTM D2584	%	52 avg.	--
Taber abrasion test (weight loss)	ASTM D4060	%	0.075	--

2. FRP Liner Exterior Surface: The exterior surface shall be finished with embedded aggregates and FRP bonding bridges to allow for adequate bonding with the surrounding concrete once cast. The exterior surface shall be free of blisters larger than 0.5" in diameter, delamination and fiber show, except in the vicinity of FRP bonding bridges where fiber show is acceptable. Gel-coat or paint or other coatings are not allowed.
3. FRP Liner Interior Surface: The interior surfaces shall be resin rich with no exposed fibers. Interior flow surfaces shall be smooth for improved corrosion resistance and reduced sludge build-up. The surface shall be free of crazing, delamination, blisters larger than 0.25" in diameter, and wrinkles of 0.125" or greater in depth. Gel-coat shall be permitted on interior surfaces, no paint or other coatings are allowed.
4. FRP Liner Chemical Resistance: FRP manhole liners must demonstrate having sufficient corrosion resistance by passing the "Greenbook" 2009 edition (or later), Standard Specifications for Public Works Construction, Chemical Resistance Test (Pickle Jar Test), per third-party accredited laboratory test results.
5. Bells: Bell shall be manufactured from the same unsaturated, supplier certified, commercial grade polyester resins as the main FRP Baseline body. If available, polypropylene injection molded Bells are also allowed.
6. Gaskets: Resilient materials for connectors and filler rings shall be manufactured from natural rubber, polyisoprene, neoprene, nitrile, or ethylene propylene diene

monomer (EPDM) synthetic rubber and shall conform to the material requirements prescribed in this specification. If a splice is used in the manufacture of the seal, its strength shall be such that the seal shall with-stand a 180° bend with no visible separation. All gaskets shall have the following physical properties:

Property	Standard	Units	Requirement
Chemical resistance: 1N sulfuric acid 1N hydrochloric acid	ASTM D543 (at 24°C for 48 hr.)	% %	No weight loss No weight loss
Tensile Strength	ASTM D412	psi	1,200 min.
Elongation at Break	ASTM D412	%	350 min.
Hardness (Shore A)	ASTM D2240	--	±5 from the connector manufacturer's specified hardness
Accelerated oven aging	ASTM D573 (at 70°C for 7 days)	%	Max 15% decrease in tensile strength; Max 20% decrease in elongation
Compression set	ASTM D 395, Method B (at 70°C for 22 hr.)	%	Max 25% decrease of original deflection
Water absorption	ASTM D471 (at 70°C for 48hr.)	%	Increase of max 10% of original weight (19 by 25mm specimen)
Ozone Resistance	ASTM D1149	--	Rating 0
Low temperature brittle point	ASTM D2137	--	No fracture at -40°C
Tear resistance	ASTM D624, Die B	kN/m	34

7. Mechanical Devices: Expansion rings, tension bands, and take-up devices used for mechanically compressing the resilient portion of the connector against the pipe or manhole shall be made from a material or materials in combination that will ensure durability, strength, resistance to corrosion, and have properties that will ensure continued resistance to leakage.

- B. Precast Concrete Manhole Sections: The manhole base and top sections shall be constructed of precast reinforced concrete, for the purpose of providing structural integrity to the FRP manhole liners. The sections shall conform to the requirements of ASTM C-478 and shall be manufactured using the wet cast method.

1. Precast Concrete Requirements: Concrete tests shall be in accordance with ASTM C-497. All precast concrete manhole sections shall be manufactured by the wet cast method. The minimum compressive strength of the concrete for all precast concrete sections shall be 4000 psi. The maximum allowable absorption of the concrete shall not exceed 9 percent of the dry weight. Steel reinforcement for all manhole diameters shall be in accordance with ASTM C-478 and per Contract Documents.

- C. Manhole PVC Riser: The PVC riser pipe shall strictly comply with AWWA C900 and shall have DR-51 pressure rating.
- D. Grading Rings: Grade rings shall be constructed of reinforced precast concrete.
- E. Ring and Cover: Casting shall be tough gray iron, free from cracks, holes, swells, and cold shuts. All manhole casting shall be made accurately to the pattern and to the dimensions shown on Contract Documents.
- F. Mortar: Mortar to be used in setting manhole frames shall be prepared by thoroughly mixing: one (1) volume of Type II Portland Cement with three (3) volumes of sand and sufficient clean water to produce a rich mass of approved consistency. Mixing mortar on the ground or any paved surface shall not be permitted. Sand to be used in making mortar shall be clean, well-graded, and shall pass a standard No. 4 sieve.
- G. Connecting Pipe Gaskets: A-Lok Premium gasket, or equal.
- H. Backfill Material: The initial backfill material, in direct contact with the precast PVC manhole system, shall be composed of well graded, crushed stone or gravel conforming to the following requirements, unless modified by the Contract Documents:

Crushed Stone or Gravel	Percent
Passing 1-1/2 inch sieve	100
Passing 1 inch sieve	95 to 100
Passing 3/8 inch sieve	25 to 60
Passing No. 4 sieve	0 to 10
Passing No. 8 sieve	0 to 5

2.4 MANUFACTURER

- A. FRP Liner manufacturer shall have 25 years of FRP concrete protective liner manufacturing experience and shall have fabricated and delivered at least 20,000 FRP concrete protective liners for wastewater applications.
- B. Precast concrete plant shall be NPCA certified.
- C. FRP liner and concrete manhole base and top sections shall be manufactured by Predl Systems, LF Manufacturing, or equal.
- D. PVC pressure pipe shall be manufactured by Diamond Plastics Corp, or equal.

PART 3 EXECUTION

3.1 EXAMINATION

- A. FRP manhole liners shall be examined for dimensional requirements and workmanship prior to precasting.
- B. Verify items provided by other Sections of Work are properly sized and located.
- C. Verify built-in items are in proper location and ready for roughing into Work.
- D. Verify correct size of manhole excavation.

3.2 PRECASTING

- A. FRP manhole liners must not be dropped or impacted. When stored for extended periods (more than a few days) Baseliners shall be stored on a flat surface, upside down to minimize deformation.
- B. Baseliners shall not be exposed to direct sunlight for extended periods, either before or after precasting.
- C. Liners must be monolithically cast within a concrete manhole section using the wet cast method. Custom pouring supports shall be provided with FRP liners to fully support the liners during the concrete pouring process against the vertical and horizontal forces created by the concrete during casting.
- D. The poured manhole base must not be moved until adequate hydration has occurred.
- E. Lifting devices, no more than 3 per section, must not penetrate any surface of the liner. No liner may have holes or openings which will permit the intrusion of liquids or gases through the liner wall and into the concrete.

3.3 INSTALLATION

- A. Precast concrete FRP-PVC manhole system installation should strictly follow the manufacturer's recommended installation procedures to ensure long-term corrosion resistant service. In addition, local codes may apply and should be consulted as applicable in manhole installation.
- B. Excavation at manhole location shall be wide enough to provide working room around manhole. Ensure the depth of manhole is sufficient to accommodate for at least two concrete rings for adjustment of ring and cover at top of final grade and for a minimum of 6 inches of crushed stone directly below the manhole base for the purpose of adequate leveling.
- C. Set and level manhole base section and connect sewer lines to manhole.

- D. Install rubber butyl sealant on manhole base spigot joint following manufacturer's installation instructions.
- E. Lift PVC riser in place using recommended lifting apparatus and set plumb and level. Ensure that a positive seal is established between the manhole base and the PVC riser.
- F. Install rubber butyl sealant on manhole top lid spigot joint following manufacturer's installation instructions.
- G. Lift manhole top section in place and set level. Ensure that a positive seal is established between the manhole top section and the PVC riser.
- H. If specified, install apply external joint wrap on joint sections, following manufacturer's installation instructions.
- I. Initial backfill material shall be used for backfilling around the manhole for a minimum distance of one foot from the outside surface and extending from the bottom of the excavation to the top of the reducer section. Secondary backfill material may be used for the remainder of the backfill. This material will be subject to approval by Engineer.
- J. Backfill shall be placed in layers of not more than 12 loose measure inches and mechanically tamped to 95% Standard Proctor Density, unless otherwise approved by Engineer. Flooding will not be permitted. Backfill shall be placed in such a manner as to prevent any wedging action against the PVC manhole structure.
- K. Bring to Grade: Construct reinforced concrete ring encasement as identified on details. The top the PVC manhole may be brought to proper grade for receiving manhole frames by using not more than four courses precast concrete grade rings.

3.4 FIELD QUALITY CONTROL

- A. Test concrete manhole and structure sections according to ASTM C497.
- B. Perform manhole testing according to Section 33 01 30.13, Sewer and Manhole Testing.
- C. Test cast-in-place concrete as specified in Section 03 11 00, Concrete Work.
- D. Any manhole liner repair is required to meet all requirements of this specification. All repair must all be preapproved by the manufacturer.

END OF SECTION

SECTION 33 05 17 - PRECAST CONCRETE VALVE VAULTS AND METER BOXES

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Precast concrete valve vaults.
 - 2. Precast concrete meter boxes.

1.2 RELATED SECTIONS

- A. Section 05 50 00, Metal Fabrications
- B. Section 31 05 16, Aggregates for Earthwork
- C. Section 31 23 16, Excavation
- D. Section 31 23 23, Fill.

1.3 REFERENCE STANDARDS

- A. ASTM International (ASTM):
 - 1. ASTM A48 - Standard Specification for Gray Iron Castings.
 - 2. ASTM A185 - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
 - 3. ASTM A536 - Standard Specification for Ductile Iron Castings.
 - 4. ASTM A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - 5. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - 6. ASTM C33 - Standard Specification for Concrete Aggregates.
 - 7. ASTM C150 - Standard Specification for Portland Cement.
 - 8. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
 - 9. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections.
 - 10. ASTM C497 - Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.

11. ASTM C890 - Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures.
12. ASTM C913 - Standard Specification for Precast Concrete Water and Wastewater Structures.
13. ASTM C990 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
14. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft³ (600 kN-m/m³)).
15. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
16. ASTM D4104 - Standard Test Method (Analytical Procedure) for Determining Transmissivity of Nonleaky Confined Aquifers by Overdamped Well Response to Instantaneous Change in Head (Slug Tests).
17. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.4 COORDINATION

- A. Coordinate Work with utilities within construction area.
- B. The drawings identify precast vaults and meter boxes by manufacturer and model number. This information is provided for dimensional information only. Provide precast items in accordance with the requirements of this Section.

1.5 PREINSTALLATION MEETINGS

- A. Convene a minimum of 1-week prior to commencing Work of this Section.

1.6 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Product Data: Submit data on valve vaults and meter boxes.
- C. Shop Drawings for Precast Concrete Valve Vaults:
 1. Indicate plan, location, and inverts of connecting piping.
 2. All interior and exterior dimensions.
 3. Location and type of lifting inserts, connection embeds, and joints.
 4. Details of reinforcement.
 5. Covers or hatches.

6. Ladders and grating.

- D. Manufacturer's Certificate: Certify that precast concrete valve vaults and meter boxes meet or exceed ASTM standards and specified requirements.
- E. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.7 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations and inverts of buried pipe, components, and connections.

1.8 QUALITY ASSURANCE

- A. Perform Work according to standards identified in Article 1.2 herein.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- B. Transport and handle precast concrete units with equipment designed to protect units from damage.
- C. Storage:
 - 1. Store precast concrete valve vaults and meter boxes according to manufacturer instructions.
 - 2. Do not place concrete units in position to cause overstress, warping, or twisting.

PART 2 PRODUCTS

2.1 DESIGN REQUIREMENTS

- A. Performance and Design Criteria:
 - 1. Watertight, Precast, Reinforced, Air-Entrained Concrete Structures:
 - a. Manufactured to conform to ASTM C913.
 - 2. Loading:
 - a. Design to ASTM C890-A16 / AASHTO HS20 live loading and installation conditions.

- b. Where vaults are below grade, a dead load of 125 pounds per cubic foot shall be added for the soil.
- c. Lateral loads:
 - 1) Static: 105 x Depth of fill per square foot (psf) triangular equivalent fluid pressure plus a surcharge of an additional 3 feet of soil depth in areas subject to vehicular traffic (assume traffic load in all areas, unless indicated otherwise by the Contract Documents).
 - 2) Seismic acceleration: UBC Zone 3 requirements ($I = 1.25$) where I = importance factor, $I = 1.25$, but not less than 0.20 grams (g) acting on structure mass. Seismic loading need not be considered simultaneously with traffic surcharge.
- 3. Minimum 28-Day Compressive Strength: 3,000 pounds per square inch (psi).
- 4. Honeycombed or re-tempered concrete is not permitted.
- 5. No knockouts shall be cast into vault walls. All pipe penetrations shall be pre-formed or core-drilled at the required locations.
- 6. Accessories: Accessories such as ladders, floor grates at sumps, and other features shall be provided as shown on the Drawings.
- 7. Size: Vault dimensions shall be as required by the Drawings.

2.2 PRECAST CONCRETE VALVES AND METER BOXES

A. Manufacturers:

- 1. Furnish materials according to **Owner** standards **as shown in the details of the Drawings**

B. Valve Vault and Meter Box Frames and Covers:

1. Cast Iron Castings:

- a. ASTM A48, Class 30 or better.
- b. Free of bubbles, sand, air holes, and other imperfections.

C. Access Steps:

1. Steel reinforced formed polypropylene:

- a. ASTM C478
- b. Reinforced rod: ASTM A615, Grade 60, 1/2-inch diameter

2. Aluminum: ASTM B221, Alloy 6061-T6
3. Width: Minimum 12 inches
4. Spacing: 12 inches on center vertically.

2.3 ACCESS HATCHES AND LIDS

- A. Unless noted otherwise elsewhere in the Contract Documents, vaults shall have concrete top slabs with access openings as shown on the Drawings.
- B. Vault manufacturer shall provide the access hatches per the requirements of Section 05 50 00, Metal Fabrications.
- C. Lids shall have lifting holes.
- D. When leveling bolts are used to set the vault top sections, ensure the load from the top slab is transferred through grout to the vault walls so that the load is not carried by the leveling bolts.

2.4 MATERIALS

- A. Portland Cement:
 1. ASTM C150, Type II
- B. Coarse Aggregates:
 1. ASTM C33
 2. Graded 1 inch to No. 4 sieve
- C. Sand:
 1. ASTM C33
 2. Fineness Modulus: 2.35
- D. Water:
 1. Potable.
 2. Clean and free of injurious amounts of acids, alkalis, salts, organic materials, and substances incompatible with concrete or steel.
- E. Air-Entraining Admixtures: ASTM C260
- F. Reinforcing Steel:

1. Deformed Bars: ASTM A615, Grade 40 minimum
 2. Welded Wire Fabric: ASTM A185
- G. Gaskets:
1. Rubber gaskets: ASTM C443
- H. Joint Sealant:
1. ASTM C990
- I. Bedding:
1. Aggregate Bedding Material: Fill Type A1 as specified in Section 31 05 16, Aggregates for Earthwork. Size as shown in the Drawings.

2.5 FABRICATION

- A. Fabricate precast reinforced concrete structures according to ASTM C913, to dimensions indicated on Drawings, and to specified design criteria.
- B. Vaults may be formed with separate top and bottom slabs.
- C. Walls shall be cast so that all sides are continuous at corners and their full length with no block-outs or knockouts.
- D. Horizontal joints may be provided so that walls can be placed in horizontal segments.
- E. All horizontal joints shall be keyed to prevent offsets and shall be provided with a watertight gasket.
- F. Finish:
1. Formed surfaces shall be smooth and uniform with no fins, bulges, or other irregularities.
 2. Any void greater in width than 1/2-inch or deeper than 3/8-inch shall be repaired.
 3. Unformed interior slab surfaces shall have a smooth steel trowel finish.
 4. Unformed exterior slab surfaces shall have a light broom finish applied to a steel trowel finish.

2.6 MIXES

- A. Design concrete mix to produce required concrete strength, air-entrainment, watertight properties, and loading requirements.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that piping connections, sizes, locations, and inverts are as indicated on Drawings.

3.2 PREPARATION

- A. Ream pipe ends and remove burrs.
- B. Remove scale and dirt from components before assembly.
- C. Establish invert elevations for each component in system.
- D. Hand trim excavation to suit valve vaults and meter boxes; remove stones, roots, and other obstructions.

3.3 INSTALLATION

- A. Vaults/Meter and Bedding:
 - 1. Excavate as specified in Section 31 23 16, Excavation for Work of this Section.
 - 2. Hand trim excavation for accurate placement of vaults and meter boxes to elevations indicated.
 - 3. Place bedding material level in one continuous layer to a minimum compacted depth of 6 inches.
 - 4. Compact bedding material to 95 percent maximum density.
 - 5. Bases for precast concrete structures shall be set level so that bedding material fully and uniformly supports them in true alignment with uniform bearing throughout full perimeter. Do not level bases by wedging gravel under the edges.
 - 6. Backfill around sides of vaults and meter boxes as required by the Drawings.
- B. Connect piping.

3.4 FIELD QUALITY CONTROL

- A. Request examination of subgrade by Engineer prior to placing aggregate base under precast materials.
- B. Compaction Testing: In accordance with Field Quality Control requirements of Section 31 23 23, Fill.

- C. When tests indicate Work does not meet specified requirements, remove Work, replace, and retest.
- D. Frequency of Compaction Tests: In accordance with Section 31 23 23 - Fill.

END OF SECTION

SECTION 33 41 10 - STORM UTILITY DRAINAGE PIPING

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes pipe materials and accessories normally used with gravity storm drainage sewers.
- B. Section includes:
 - 1. Storm drainage piping
 - 2. Piping accessories
 - 3. Connection to existing manholes
 - 4. Catch basins and area drains
 - 5. Cleanouts
 - 6. Bedding and cover materials

1.2 RELATED SECTIONS

- A. Section 03 11 00 – Concrete Work
- B. Section 03 60 00 - Grouting
- C. Section 31 05 13 - Soils for Earthwork
- D. Section 31 05 16 - Aggregates for Earthwork
- E. Section 31 23 16 - Excavation
- F. Section 31 23 17 - Trenching
- G. Section 31 23 23 - Fill
- H. Section 33 01 30.13 - Sewer and Manhole Testing
- I. Section 33 05 13 - Manholes

1.3 REFERENCE STANDARDS

- A. American Association of State Highway and Transportation Officials (AASHTO):
 - 1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.
- B. ASTM International (ASTM):
 - 1. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.
 - 2. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

3. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
4. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
5. ASTM C913 - Standard Specification for Precast Concrete Water and Wastewater Structures.
6. ASTM C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
7. ASTM C1479 - Standard Practice for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations.
8. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
9. ASTM D1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
10. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
11. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
12. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
13. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
14. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
15. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
16. ASTM D3212 - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
17. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

18. ASTM F679 - Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.

C. American Water Works Association (AWWA):

1. AWWA C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
2. AWWA C105 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
3. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
4. AWWA C150 - Thickness Design of Ductile-Iron Pipe.
5. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast.
6. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Transmission and Distribution.

1.4 COORDINATION

- A. Notify affected utility companies at least 72 hours prior to construction.

1.5 SUBMITTALS

- A. In accordance with Section 01 33 00, Submittal Procedures.
- B. Product Data: Submit manufacturer catalog cuts and other information indicating proposed materials, accessories, details, and construction information.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements. The certificate shall be signed by an authorized agent of the manufacturer.
- D. Test and Evaluation Reports: Submit reports indicating field tests made and results obtained.
- E. Manufacturer Instructions:
1. Indicate special procedures required to install specified products.
 2. Submit detailed description of procedures for connecting new storm sewer to existing storm sewer line.
- F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.6 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record invert elevations and actual locations of pipe runs, connections, manholes, and cleanouts.
- B. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- B. Storage:
 - 1. Store materials according to manufacturer instructions.
- C. Protection:
 - 1. Protect materials from moisture, dust, and direct sunlight by storing in clean, dry location remote from construction operations areas.
 - 2. Block individual and stockpiled pipe lengths to prevent moving.
 - 3. Provide additional protection according to manufacturer instructions.

1.8 EXISTING CONDITIONS

- A. Field Measurements:
 - 1. Verify field measurements prior to fabrication.
 - 2. Indicate field measurements on Shop Drawings.

PART 2 PRODUCTS

2.1 STORM DRAINAGE PIPING

- A. Polyvinyl Chloride (PVC) Pipe:
 - 1. Material:
 - a. Manufactured from rigid polyvinyl chloride compounds conforming to ASTM D1784, Class 12454-B.
 - b. At locations indicated in the Drawings, pipe shall conform to AWWA C900.
 - 2. Pipe and fittings 4 inches to 15 inches in diameter, non-pressurized:

- a. Comply with ASTM D3034, SDR 35.
- 3. Pipe and fittings 18 inches and larger in diameter, non-pressurized:
 - a. Comply with ASTM F679, PS46.
 - b. Pipe shall have a minimum stiffness of 46 pounds per square inch (psi).
- 4. AWWA C900 Pipe:
 - a. At locations shown in the Drawings.
 - b. Four inches to 12 inches in diameter.
 - c. DR 25.
 - d. Pipe shall have minimum stiffness of 149 psi.
- 5. End Connections: Bell and spigot style, with rubber-ring-sealed gasket joint.
- 6. Joints:
 - a. Integral bell push-on type: Comply with ASTM D3212.
 - b. For use with AWWA C900 pipe: Integral bell push-on type comply with ASTM D3139.
- 7. Gaskets:
 - a. Factory installed.
 - b. Elastomeric gaskets: Comply with ASTM F477.
- B. Ductile Iron Pipe:
 - a. Not Used
- C. High Density Polyethylene (HDPE) Pipe:
 - 1. Double wall, ribbed pipe with smooth interior.
 - 2. Solid pipe, perforated pipe, and fittings shall meet the requirements of ASTM F-405 and F-667
 - 3. Pipe 3 inches to 10 inches in diameter: Comply with AASHTO M-252.
 - 4. Pipe 12 inches to 36 inches in diameter: Comply with AASHTO M-294.
 - 5. Joints: Integral bell push-on type.
 - 6. Manufacturers:

- a. ADS, N-12 with Pro Link joints, or approved equal.
- D. Acrylonitrile-Butadiene-Styrene (ABS) Pipe:
 - a. Not Used
- E. Reinforced Concrete Pipe:
 - 1. Comply with ASTM C76, Class V, with Wall Type C.
 - 2. Reinforcement: Mesh.
 - 3. End Connections: Bell and spigot.
 - 4. Fittings: Reinforced concrete.
 - 5. Joints:
 - a. Rubber compression gasket.
 - b. Comply with ASTM C443.

2.2 FLEXIBLE COUPLINGS

- A. Description:
 - 1. Resilient chemical-resistant elastomeric polyvinyl chloride (PVC) coupling.
 - 2. Attachment: Two Series 300 stainless-steel clamps, screws, and housings.

2.3 FLEXIBLE PIPE BOOT FOR MANHOLE PIPE ENTRANCES

- A. Description:
 - 1. Material: Ethylene propylene rubber (EPDM).
 - 2. Comply with ASTM C923.
 - 3. Attachment: Stainless-steel clamp and hardware.

2.4 CONCRETE ENCASEMENT AND CRADLES

- A. Concrete:
 - 1. As specified in Section 03 11 00, Concrete Work.
 - 2. Strength: Minimum 3,000 psi at 28 days.
 - 3. Air entrained.
 - 4. Finish: Rough troweled.
- B. Concrete Reinforcement: As specified in Section 03 11 00, Concrete Work.

2.5 MANHOLES

A. Description:

1. As specified in Section 33 05 13 - Manholes and Structures.
2. Material: Reinforced precast or cast-in-place concrete.
3. Diameter: As shown in the Drawings.
4. Top: As shown in the Drawings
5. Frames and Covers: Watertight cast iron.
6. Cover Inscription: "S".

2.6 CATCH BASINS AND AREA DRAINS

A. Construction:

1. Material: Reinforced precast concrete pipe sections.
 - a. Minimum compressive strength of 3,000 psi at 28 days.
 - b. Precast concrete inlets shall conform to ASTM C913.
2. Joints: Lipped male/female.
3. Nominal Interior Dimensions: As shown in the Drawings.

B. Lids and Frames:

1. Materials: Cast iron.
2. Lid:
 - a. Removable.
 - b. Design: Linear grill.
3. Nominal Lid and Frame Size: As shown in the Drawings.

2.7 CLEANOUTS

A. Construction:

1. Per details provided in the Drawings.

B. Lids and Frames:

1. Materials: Cast iron. Meet H20 load requirement.

2.8 MATERIALS

A. Bedding and Cover:

1. Pipe Bedding: Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.
2. Pipe Zone Backfill: Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.
3. Trench Backfill from Pipe Zone to Finish Grade:
 - a. Material type varies by location, as shown in the Drawings.
 - b. Coarse Aggregate Material Type A1, as specified in Section 31 05 16, Aggregates for Earthwork. Aggregate size as shown in the Drawings.

2.9 MIXES

- ### A. Grout: As specified in Section 03 60 00, Grouting.

2.10 ACCESSORIES

- ### A. Underground Pipe Markers: As specified in Section 31 23 17, Trenching.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that trench cut, or excavation base is ready to receive Work.
- B. Verify that excavations, dimensions, and elevations are as indicated on Drawings.

3.2 PREPARATION

- A. Correct over-excavation in accordance with Section 31 23 17, Trenching.
- B. Remove large stones or other hard materials that could damage pipe or impede consistent backfilling or compaction.
- C. Protect and support existing sewer lines, utilities, and appurtenances.
- D. Utilities:
 1. Maintain profiles of utilities.
 2. Coordinate with other utilities to eliminate interference.
 3. Notify Engineer if crossing conflicts occur.

3.3 INSTALLATION

A. Bedding:

1. Excavate pipe trench as specified in Section 31 23 17, Trenching.
2. Excavate to lines and grades as indicated on Drawings, or as required to accommodate installation of utility.
3. Pipe base shall be observed by Engineer prior to placement of the pipe.
4. Dewater excavations to maintain dry conditions and to preserve final grades at bottom of excavation.
5. Provide sheeting and shoring as specified in Section 31 50 00.
6. Placement:
 - a. Place bedding material at trench bottom.
 - b. Level materials in continuous layer not exceeding 6 inches compacted depth.
 - c. Compact to 95 percent of maximum density.

B. Piping:

1. Install pipe, fittings, and accessories according to standards listed below, and seal joints watertight.
 - a. PVC, HDPE, ABS: Comply with ASTM D2321.
 - b. Ductile Iron: Comply with AWWA C600.
 - c. Reinforced Concrete: Comply with ASTM C1479.
2. Lift or roll pipe into position. Do not drop or drag pipe over prepared bedding.
3. Lay pipe to slope gradients and line as indicated on Drawings.
4. Variations:
 - a. Maximum Variation from Indicated Line: 1/32-inch per inch of pipe diameter, but no more than 1/2-inch, providing that such variation does not result in a level or reverse-sloping invert.
 - b. Maximum Variation from Indicated Grade: 1/32-inch per inch of pipe diameter, but no more than 1/4-inch.
 - c. Variation in the invert elevation between adjoining ends of pipe, include fittings, shall not exceed 1/64-inch per inch of pipe diameter, or 1/2-inch maximum.

5. Begin at downstream end and progress upstream.
6. Assemble and handle pipe according to manufacturer's instructions, except as may be modified on Drawings or by Engineer.
7. Make straight field cuts without chipping or cracking pipe.
8. Keep pipe and fittings clean until Work has been completed and accepted by Engineer.
9. Assemble pipe joints in accordance with manufacturer's recommendations/specifications.
10. Cap open ends during periods of Work stoppage.
11. Lay bell and spigot pipe with bells upstream.
12. Backfill and compact as specified in Section 31 23 17, Trenching.
13. Do not displace or damage pipe when compacting.
14. Pipe Markers: As specified in Section 31 23 17, Trenching.

C. Joints:

1. Just prior to joining the pipes, the surfaces of the joint rings shall be wiped clean and the joint rings and rubber gaskets shall be liberally lubricated with an approved type of vegetable oil soap.
2. The spigot end, with the gasket placed in the groove, shall be entered into the bell of the pipe already laid, making sure that both pipes are properly aligned.
3. Before the joint is fully "home," the position of the gasket in the joint shall be determined by means of a suitable feeler gauge supplied by the pipe manufacturer.
4. If the gasket is found not to be in proper position, the pipes shall be separated, and the damaged gasket replaced.
5. The pipe is then forced "home" firmly and fully.
6. In its final position, the joint between the pipes shall not be deflected more than 1/2-inch at any point.

D. Connection to Existing Manholes:

1. Drilling:

- a. Core drill existing manhole to clean opening.
 - b. Use of pneumatic hammers, chipping guns, and sledgehammers are not permitted.
 2. Install watertight neoprene gasket and seal with non-shrink concrete grout.
 3. Encasement:
 - a. Concrete encase new sewer pipe minimum of 24 inches to nearest pipe joint.
 - b. Use epoxy binder between new and existing concrete.
 4. Prevent construction debris from entering existing sewer line when making connection.
- E. Manholes:
1. Install manholes as specified in Section 33 05 13, Manholes.
- F. Wye Branches and Tees:
1. Concurrent with pipe-laying operations, install wye branches and pipe tees at locations indicated on Drawings.
 2. Use standard fittings of same material and joint type as sewer main.
 3. Maintain minimum 5-foot separation distance between wye connection and manhole.
 4. Use saddle wye or tee with stainless-steel clamps for taps into existing piping.
 5. Mount saddles with solvent cement or gasket and secure with metal bands.
 6. Lay out holes with template and cut holes with mechanical cutter.
- G. Catch Basins
1. Form bottom of excavation clean and smooth, and to indicated elevation.
 2. Cast-in-place Concrete Construction:
 - a. Form and place cast-in-place concrete base pad, with provision for storm sewer pipe end sections.
 - b. Level top surface of base pad.
 - c. Sleeve concrete shaft sections to receive storm sewer pipe sections.

- d. Establish elevations and pipe inverts for inlets and outlets as indicated on Drawings.
- 3. Mount lid and frame level in grout, secured to top cone section to indicated elevation.
- H. Backfilling:
 - 1. Backfill around sides and to top of pipe as specified in Section 31 23 23, Fill.
 - 2. Maintain optimum moisture content of bedding material as required to attain specified compaction density.

3.4 FIELD QUALITY CONTROL

- A. Request inspection by Engineer prior to and immediately after placing bedding.
- B. Testing:
 - 1. If tests indicate that Work does not meet specified requirements, remove Work, replace, and retest.
 - 2. Pipe Testing: As specified in Section 33 01 30.13, Sewer and Manhole Testing.
 - 3. Compaction Testing: See Section 31 23 17, Trenching for Compaction Testing requirements for piping trenches.

3.5 PROTECTION

- A. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

END OF SECTION

SECTION 40 05 07 – HANGERS AND SUPPORTS FOR PROCESS PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. System of pipe supports and anchors with necessary inserts, bolts, nuts, restraining and hanger rods, washers, miscellaneous steel, and other accessories.

1.2 REFERENCES

A. American Society of Mechanical Engineers (ASME): B31.1, Power Piping

B. ASTM International (ASTM):

1. ASTM A36 Standard Specification for Carbon Structural Steel
2. A307 Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

C. Manufacturers' Standardization Society (MSS):

1. SP 58, Pipe Hangers and Supports—Materials, Design and Manufacture.
2. SP 127, Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, and Application.

1.3 DEFINITIONS

- A. Wetted or Submerged: Submerged, less than 1-foot above peak (maximum) water surface elevations in water holding structure, under cover or slab of channel or tank.

1.4 SYSTEM DESCRIPTION

A. Design Requirements:

1. Design, detail, and installation of pipe support system shall be responsibility of Contractor.
2. Pipe support system components shall withstand dead loads imposed by weight of pipes filled with water plus insulation, plus live loads due to thermal expansion, vibration, internal test pressures, and have minimum safety factor of 5.

3. Contractor is responsible for providing them throughout plant, where a specific hanger detail does not apply. This specification applies to pipe hangers, supports, and anchors shown and not shown on the drawings. Hangers, supports and anchors shown on drawings are minimum required for operation and maintenance only, final number and type to be determined by contractor as specified.
4. Supply design loading criteria to precast concrete manufacturer for piping supported from precast members.

1.5 SUBMITTALS

A. Shop Drawings:

1. Submit all support system submittals according to Specification 01 33 00 – Submittal Procedures.
2. Catalog information and piping support drawing of the pipe supporting system, including manufacturer's product data, dimensions, sizes, types, catalog number, location, maximum loadings, thrust anchorage, and installation instructions.
3. Calculations for each type of pipe support, attachment, and anchor.
4. Submit seismic design calculations as described in Specification 01 41 20 – Seismic Requirements for Non-Structural Components and Systems.

PART 2 PRODUCTS

2.1 GENERAL

- A. Manufacturer's products shall be in accordance with MSS standards. MSS types indicated are typical of types and quality of standard pipe supports and hangers to be employed.
- B. Provide factory fabricated piping hangers and supports, clamps, hanger rod attachments, building attachments, saddles, and other miscellaneous products to comply with MSS SP-58, ASME B31.1 and manufacturer's published product information.
- C. Special support and hanger details may be required for cases where standard catalog supports are not available.

2.2 MATERIALS

- A. Hangers, rods, clamps, metal framing, support components, and hanger accessories shall be galvanized unless otherwise noted.

- B. Hangers, rods, clamps, protective shields, metal framing, support components, and hanger accessories for the wetted and submerged piping in wet wells, tanks, and channels shall be Type 304 stainless steel.

2.3 HORIZONTAL PIPE HANGERS AND SUPPORTS

- A. Adjustable Swivel Split Ring Hanger: MSS Type 6.
- B. Adjustable Clevis Hanger: MSS Type 1, fabricated from steel.
- C. Adjustable Band Hanger: MSS Type 7, fabricated from steel.
- D. Adjustable Swivel-Band Hanger: MSS Type 10.
- E. Clamp: MSS Type 4.
- F. Steel Brackets: Welded structural steel shapes complying with following:
 - 1. Light Duty: MSS Type 31.
 - 2. Medium Duty: MSS Type 32.
 - 3. Heavy Duty: MSS Type 33.
- G. Adjustable Saddle Support:
 - 1. MSS Type 38, including saddle, pipe, and reducer.
 - 2. Fabricate base support from steel pipe and include cast iron flange or welded steel plate.
- H. Stanchion Saddle Support:
 - 1. MSS Type 37, including saddle and U-bolt.
 - 2. Fabricate base support from steel pipe and include cast iron flange or welded steel plate.
- I. Strap or wire hangers not acceptable.

2.4 VERTICAL PIPING CLAMPS

- A. Two-Bolt Riser Clamp: MSS Type 8, galvanized or plastic coated.

2.5 HANGERS RODS AND ATTACHMENTS

- A. Hanger Rods:
 - 1. ASTM A36, threaded both ends or continuous thread.

2. Rods shall conform to following sizes.

Pipe Size	Minimum Rod Diameter (in.)
2 1/2 in. and 3 in.	3/8
4 in.	1/2
6 in.	5/8
8 in. to 12 in.	3/4
Trapeze Hangers	As Required

- B. Turnbuckles: MSS Type 13.
- C. Weldless Eye Nut: MSS Type 17.
- D. Eye Socket: MSS Type 16.
- E. Clevis: MSS Type 14.

2.6 BUILDING ATTACHMENTS

- A. Individual Concrete Inserts:
 - 1. MSS Type 18, malleable iron.
 - 2. MSS Type 19, steel.
 - 3. Minimum Safe Load: 1,100 pounds
- B. Continuous Concrete Inserts:
 - 1. Unistrut, P-3200 Series.
 - 2. Grinnel.
 - 3. Superstrut.
 - 4. Or approved equal.
- C. Top Beam C-Clamp: MSS Type 19.
- D. C-Clamps: MSS Type 23, steel.
- E. Single-Side Clamp: MSS Type 25.
- F. Top I-Beam Clamp: MSS Type 25.
- G. Side Beam Clamp: MSS Type 20.
- H. Concrete Anchors:
 - 1. Comply with Section 05 50 00.

2.7 MISCELLANEOUS MATERIALS

- A. Metal Framing Systems:
 - 1. Unistrut, galvanized.
 - 2. B-Line, galvanized.
 - 3. Grinnell, galvanized.
 - 4. Or approved equal.
- B. Shop-Fabricated Anchors and Supports:
 - 1. Steel Plates, Shapes, and Bars: ASTM A36.
 - 2. Restraining Rods: ASTM A307.

PART 3 EXECUTION

3.1 GENERAL

- A. Proceed with installation of hangers, supports, and anchors after required building structural work is complete and concrete support structure has reached 28-day compressive strength as of 3,000 pounds per square inch (psi).
- B. Install hangers, supports, clamps, and attachments from building structure. Comply with MSS SP 58. Group parallel runs of horizontal piping to be supported together on trapeze type hangers where possible.
- C. Install supports to provide indicated pipe slopes and to ensure maximum pipe deflections allowed by ANSI B31.1 are not exceeded.
- D. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.
- E. Do not support piping from other piping.
- F. Prevent contact between dissimilar metals. Where concrete or metal pipe support is used, place 1/8-inch-thick Teflon, neoprene rubber, or plastic strip under piping at point of bearing. Cut to fit entire area of contact between pipe and support.
- G. Prevent electrolysis in support of copper tubing by use of hangers and supports where are copper plated, plastic coated or by other recognized industry methods. Electrician's tape not acceptable isolation method.
- H. Apply anti-seize compound to stainless steel nuts and bolts.

3.2 INSTALLATION OF BUILDING ATTACHMENTS

- A. Support piping from structural framing, unless otherwise noted.
- B. Concrete Inserts:
 - 1. Locate inserts so total load on insert does not exceed manufacturer's recommended maximum load.
 - 2. Where necessary to anchor supports to hardened concrete or completed masonry, use concrete anchors.
- C. Attach to structural steel with beam clamps.

3.3 PIPE SUPPORT

- A. Spacing: Shall be as follows unless specified on design drawings.

Type of Pipe	Maximum Pipe Support Spacing (ft)
<i>Steel</i>	
10 in. and over	20
8 in.	19
6 in.	17
5 in.	16
4 in.	14
3 1/2 in.	13
3 in.	12
2 1/2 in.	11
2 in.	10
1 1/2 in.	9
1 in.	7
3/4 in.	6
1/2 in.	5
<i>Copper</i>	
2 in.	8
1 1/2 in.	8
1 1/4 in.	7
1 in.	5
3/4 in.	5
1/2 in.	5
<i>Plastic (Schedule 80 at 100°F)</i>	
2 in.	6
1 1/2 in.	5-1/2
1 in.	5
3/4 in.	4-1/2
1/2 in.	4-1/2
<i>Cast Iron and Ductile Iron</i>	
3 in. and 4 in.	10
6 in.	12
8 in.	12

- B. Where piping of various sizes is to be supported together, space supports for smallest pipe size or install intermediate supports for smaller diameter pipe.
- C. Where piping connects to equipment, support by pipe support and not by equipment.
- D. Unless otherwise shown, place piping running parallel to walls approximately 1-1/2-inch out from face of wall and at least 3 inches below ceiling.
- E. Pedestal pipe supports shall be adjustable with stanchion, saddle, and anchoring flange.
- F. Piping supports for vertical piping passing through floor sleeves shall be galvanized steel riser clamps. Modular mechanical seals shall be provided between the pump and head works at all locations.
- G. Piping passing through sleeves or openings in interior wall sleeves shall be carried by supports or hangers. Do not rest on wall.
- H. Support piping in manner preventing undue strain on valve, fitting, or equipment. Provide pipe supports at changes in direction or elevation, adjacent to flexible couplings, adjacent to non-rigid joints, and where otherwise shown. Do not install pipe supports and hangers in equipment access areas.
- I. Install supports to allow controlled movement of piping systems, permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- J. Stacked horizontal runs of piping along walls may be supported by metal framing system attached to concrete insert channels.

3.4 INSULATING PIPING

- A. Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed allowable pipe stresses.
- B. Where low compressive strength insulation or vapor barriers are indicated on cold or chilled water piping, install coated protective shields.

END OF SECTION

SECTION 40 05 10 – PROCESS PIPING AND FITTING GENERAL REQUIREMENT

PART 1 GENERAL

1.1 SUMMARY

- A. The Contractor shall furnish and install all piping systems shown and specified, in accordance with the requirements of the Contract Documents. Each system shall be complete with all necessary fittings, hangers, supports, anchors, expansion joints, flexible connectors, valves, accessories, heat tracing, insulation, lining and coating, testing, disinfection, excavation, backfill and encasement, to provide a functional installation.
- B. The piping shown is intended to define the general layout, configuration, routing, method of support, pipe size, and pipe type. The mechanical drawings are not pipe construction or fabrication drawings. It is the Contractor's responsibility to develop the details necessary to construct all mechanical piping systems, to accommodate the specific equipment provided, and to provide and install all spools, spacers, adapters, connectors, etc., for a complete and functional system.

1.2 REFERENCE STANDARDS

A. Commercial Standards:

ANSI/ASME B1.20.1	Pipe Threads, General Purpose (inch)
ANSI B16.5	Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and other Special Alloys
ANSI/AWWA C207	Steel Pipe Flanges for Water Works Service, Sizes 4 in through 144 in.
ANSI/AWWA C606	Grooved and Shouldered Joints
ANSI/AWS D1.1	Structural Welding Code
ASTM A 307	Specification for Carbon Steel Bolts and Studs, 6,000 psi Tensile
ASTM A 325	Specification for High-Strength Bolts for Structural Steel Joints
ASTM A53	Standard Specification for Ductile Iron Castings.
ASTM D 792	Test Methods for Specific Gravity and Density of Plastics by Displacement

ASTM D 2000

Classification System for Rubber Products in Automotive Applications

ANSI/NSF 61

Drinking Water System Components

1.3 SUBMITTALS

- A. The Contractor shall submit complete shop drawings and certificates, test reports, affidavits of compliance, of all piping systems, in accordance with the requirements in Section 01 33 00- Submittal Procedures, and as specified in the individual piping sections.

The shop drawings shall include all necessary dimensions and details on pipe joints, fittings, fitting specials, valves, appurtenances, design calculations, and material lists. The submittals shall include detailed layout, spool, or fabrication drawings which show all pipe spools, spacers, adapters, connectors, fittings, and pipe supports necessary to accommodate the equipment and valves provided in a complete and functional system.

- B. All expenses incurred in making samples for certification of tests shall be borne by the Contractor.
- C. The Contractor shall submit as part of the shop drawings a statement from the pipe fabricator certifying that all pipes will be fabricated subject to a recognized Quality Control Program. An outline of the program shall be submitted to the Engineer for review prior to the fabrication of any pipe.
- D. ANSI/NSF61 certification is required for all potable water piping.

1.4 QUALITY ASSURANCE

- A. Inspection: All pipe shall be subject to inspection at the place of manufacture. During the manufacture of the pipe, the Engineer shall be given access to all areas where manufacturing is in progress and shall be permitted to make all inspections necessary to confirm compliance with the Specifications.
- B. Tests: Except where otherwise specified, all materials used in the manufacture of the pipe shall be tested in accordance with the applicable Specifications and Standards. Welds shall be tested as specified. The Contractor shall perform all tests at no additional cost to the Owner.
- C. Welding Requirements: All welding procedures used to fabricate pipe shall be prequalified under the provisions of ANSI/AWS D1.1. Welding procedures shall be required for, but not necessarily limited to, longitudinal and girth or spiral welds for pipe cylinders, spigot and bell ring attachments, reinforcing plates and ring flange welds, and plates for lug connections.

- D. Welder Qualifications: All welding shall be done by skilled welders, welding operators, and tackers who have had adequate experience in the methods and materials to be used. Welders shall be qualified under the provisions of ANSI/AWS D1.1 by an independent local, approved testing agency not more than 6 months prior to commencing work on the pipeline. Machines and electrodes similar to those used in the work shall be used in qualification tests. The Contractor shall furnish all material and bear the expense of qualifying welders.

PART 2 PRODUCTS

2.1 GENERAL

- A. Pipe Supports: All pipes shall be adequately supported in accordance with the requirements of Section 40 05 07 – Hangers and Supports for Process Piping.
- B. Lining: All requirements pertaining to thickness, application, and curing of pipe lining, are in accordance with the requirements of the applicable industrial standards.
- C. Coating: All requirements pertaining to thickness, application, and curing of pipe coating, are in accordance with the requirements of the applicable industrial standards, unless otherwise specified. Pipes above ground or in structures shall be field painted in accordance with Section 09 97 00.
- D. Pressure Rating: All piping systems shall be designed for the maximum expected pressure as shown on the piping schedule.
- E. Grooved Piping Systems: Piping systems with grooved joints and fittings may be provided in lieu of screwed, flanged, welded, or mechanical joint systems for steel and ductile iron yard piping. (All piping above and below ground within the property limits of treatment plants, pump stations, and similar installations). All grooved couplings on buried piping must be bonded. To assure uniform and compatible piping components, all grooved fittings, couplings, and valves shall be from the same manufacturer. The Contractor shall make the coupling manufacturer responsible for the selection of the correct style of coupling and gasket for each individual location.
- F. All piping material in direct contact with potable water must be ANSI/NSF61 certified.

2.2 PIPE FLANGES

- A. Flanges: Where the design pressure is 150 pounds per square inch (psi) or less, flanges shall conform to either ANSI/AWWA C207 Class D or ANSI B16.5 150-pound class. Where the design pressure is greater than 150 psi, up to a maximum of 275 psi, flanges shall conform to either ANSI/AWWA C207 Class E, Class F, or ANSI B16.5 150-pound class. Where the design pressure is greater than 275 psi up to a maximum of 700 psi, flanges shall conform to ANSI B16.5 300-pound class. Flanges shall have flat faces and

shall be attached with bolt holes straddling the vertical axis of the pipe unless otherwise shown. Attachment of the flanges to the pipe shall conform to the applicable requirements of ANSI/AWWA C207. Flanges for miscellaneous small pipes shall be in accordance with the standards specified for these pipes.

- B. Blind Flanges: Blind flanges shall be in accordance with ANSI/AWWA C207, or with the standards for miscellaneous small pipes. All blind flanges for pipe sizes 12 inches and over shall be provided with lifting eyes in form of welded or screwed eye bolts.
- C. Flange Coating: All machined faces of metal blind flanges and pipe flanges shall be coated with a temporary rust-inhibitive coating to protect the metal until the installation is completed.
- D. Flange Bolts: All bolts and nuts shall conform to Section 05 50 00 –Metal Fabrications. Studs and bolts shall extend through the nuts a minimum of 1/4-inch. All- thread studs shall be used on all valve flange connections, where space restrictions preclude the use of regular bolts.
- E. Insulating Flanges: Insulated flanges shall have bolt holes 1/4-inch diameter greater than the bolt diameter.
- F. Insulating Flange Sets: Insulating flange sets shall be provided where shown. Each insulating flange set shall consist of an insulating gasket, insulating sleeves and washers and a steel washer. Insulating sleeves and washers shall be one piece when flange bolt diameter is 1-1/2-inch or smaller and shall be made of acetal resin. For bolt diameters larger than 1-1/2-inch, insulating sleeves and washers shall be two-piece and shall be made of polyethylene or phenolic. Steel washers shall be in accordance with ASTM A 325. insulating gaskets shall be full-face.
- G. Insulating Flange Manufacturers, or Equal:
 - 1. JM Red Devil, Type E
 - 2. Maloney Pipeline Products Co., Houston
 - 3. PSI Products, Inc., Burbank, California
- H. Flange Gaskets: Gaskets for flanged joints shall be full-faced, 1/16-inch thick compressed sheets of aramid fiber base, with nitrite binder and non-stick coating, suitable for temperatures to 700 degrees Fahrenheit (F), a pH of one to eleven, and pressures to 1000 pounds per square inch gauge (psig). Blind flanges shall have gaskets covering the entire inside face of the blind flange and shall be cemented to the blind flange. Ring gaskets shall not be permitted.
- I. Flange Gasket Manufacturers, or Equal:
 - 1. John Crane, style 2160
 - 2. Garlock, style 3000

2.3 THREADED INSULATING CONNECTIONS

- A. General: Threaded insulating bushings, unions, or couplings, as appropriate, shall be used for joining threaded pipes of dissimilar metals and for piping systems where corrosion control and cathodic protection are involved.
- B. Materials: Threaded insulating connections shall be of nylon, Teflon, polycarbonate, polyethylene, or other non-conductive materials, and shall have ratings and properties to suit the service and loading conditions.

2.4 MECHANICAL-TYPE COUPLINGS (GROOVED OR BANDED PIPE)

- A. General: Cast mechanical-type couplings shall be provided where shown. The couplings shall conform to the requirements of ANSI/AWWA C606. Bolts and nuts shall conform to the requirements of Section 05 50 00 - Metal Fabrications. All gaskets for mechanical-type couplings shall be compatible with the piping service and fluid utilized, in accordance with the coupling manufacturer's recommendations. The wall thickness of all grooved piping shall conform with the coupling manufacturer's recommendations to suit the highest expected pressure. To avoid stress on equipment, all equipment connections shall have rigid-grooved couplings, or harness sets in sizes where rigid couplings are not available, unless thrust restraint is provided by other means. The Contractor shall have the coupling Manufacturer's service representative verify the correct choice and application of all couplings and gaskets, and the workmanship, to assure a correct installation.
- B. Couplings for Steel Pipe, Manufacturers, or Equal:
 - 1. Gustin-Bacon (banded or grooved)
 - 2. Victaulic Style 41 or 44 (banded, flexible)
 - 3. Victaulic Style 77 (grooved, flexible)
 - 4. Victaulic Style 07 or HP-70 (grooved, rigid)
- C. Ductile Iron Pipe Couplings, Manufacturers, or Equal:
 - 1. Gustin-Bacon
 - 2. Victaulic Style 31 (flexible or rigid grooving)
- D. Couplings for polyvinyl chloride (PVC) Pipe, Manufacturers, or Equal:
 - 1. Gustin-Bacon
 - 2. Victaulic Style 775

Note: Ductile iron pipe couplings shall be furnished with flush seal gaskets.

Note: Couplings for PVC pipe shall be furnished with radius cut or standard roll grooved pipe ends.

E. Flanged Mechanical Joint Coupling with Cam-Lock Joint Restraint:

1. Smith-Blair Product No. 911. Shall have a pressure rating of 150 psi and a safety factor of 1.5:1 with a fusion bonded epoxy coating per AWWA C213

2.5 SLEEVE-TYPE COUPLINGS

- A. Construction: Sleeve-type couplings shall be provided where shown, in accordance with ANSI/AWWA C219 unless otherwise specified, and shall be of steel with steel bolts, without pipe stop, and shall be of sizes to fit the pipe and fittings shown. The middle ring shall be not less than 1/4-inch in thickness and shall be either 5 or 7 inches long for sizes up to and including 30 inches and 10 inches long for sizes greater than 30 inches, for standard steel couplings, and 16 inches long for long-sleeve couplings. The followers shall be single-piece contoured mill section welded and cold-expanded as required for the middle rings. They shall be of sufficient strength to accommodate the number of bolts necessary to obtain adequate gasket pressure without excessive "oiling". The shape of the follower shall be of such design as to provide positive confinement of the gasket. Bolts and nuts shall conform to the requirements of Section 05 50 00 –Metal Fabrications. Buried sleeve-type couplings shall be epoxy-coated at the factory as specified.
- B. Pipe Preparation: The ends of the pipe, where specified or shown, shall be prepared for flexible steel couplings. Plain ends for use with couplings shall be smooth and round for a distance of 12 inches from the ends of the pipe, with outside diameter not more than 1/64-inch smaller than the nominal outside diameter of the pipe. The middle ring shall be tested by cold-expanding a minimum of one percent beyond the yield point, to proof-test the weld to the strength of the parent metal. The weld of the middle ring shall be subjected to air test for porosity.
- C. Gaskets: Gaskets for sleeve-type couplings shall be rubber-compound material that will not deteriorate from age or exposure to air under normal storage or use conditions. Gaskets for wastewater and sewerage applications shall be Buna "N," grade 60, or equivalent suitable elastomer. The rubber in the gasket shall meet the following specifications:
1. Color - Jet Black
 2. Surface - Non-blooming
 3. Durometer Hardness - 74 ± 5
 4. Tensile Strength -1000 psi Minimum
 5. Elongation -175 percent Minimum

The gaskets shall be immune to attack by impurities normally found in water or wastewater. All gaskets shall meet the requirements of ASTM D 2000, AA709Z, meeting Suffix B13 Grade 3, except as noted above. All gaskets shall be compatible with the piping service and fluid utilized.

- D. Insulating Couplings: Where insulating couplings are required, both ends of the coupling shall have a wedge-shaped gasket which assembles over a rubber sleeve of an insulating compound in order to obtain insulation of all coupling metal parts from the pipe.
- E. Restrained Joints: All sleeve-type couplings on pressure lines shall be harnessed unless thrust restraint is provided by other means. Harnesses shall be in accordance with the requirements of the appropriate reference standard, or as shown.
- F. Manufacturers, or Equal:
 - 1. Romac, Style 400
 - 2. Ford Meter Box Co., Inc., Style FC1 or FC3
 - 3. Smith-Blair, Style 411

2.6 FLEXIBLE CONNECTORS

- A. Flexible connectors shall be installed in all piping connections to engines, blowers, compressors, and other vibrating equipment, and where shown. Flexible connectors for service temperatures up to 180 degrees F shall be flanged, reinforced Neoprene or Butyl spools, rated for a working pressure of 40 to 150 psi, or reinforced, flanged duck and rubber, as best suited for the application. Flexible connectors for service temperatures above 180 degrees F shall be flanged, braided stainless steel spools with inner, annular, corrugated stainless steel hose, rated for minimum 150 psi working pressure, unless otherwise shown. The connectors shall be 9 inches long, face-to-face flanges, unless otherwise shown. The final material selection shall be approved by the manufacturer. The Contractor shall submit manufacturer's shop drawings and calculations.

2.7 EXPANSION JOINTS

- A. All piping subject to expansion and contraction shall be provided with sufficient means to compensate for such movement, without exertion of undue forces to equipment or structures. This may be accomplished with expansion loops, bellow-type expansion joints, or sliding-type expansion joints. Expansion joints shall be of stainless steel, monel, rubber, or other materials, best suited for each individual service. The Contractor shall submit detailed calculations and manufacturer's shop drawings, guaranteeing satisfactory performance of all proposed expansion joints, piping layouts showing all anchors and guides, and information on materials, temperature and pressure ratings. -

2.8 PIPE THREADS

- A. All pipe threads shall be in accordance with ANSI/ASME B1.20.

2.9 PIPE INSULATION

- A. Pipe insulation shall be in accordance with the requirements of Section 40 42 13 – Process Piping Insulation.

2.10 AIR AND GAS TRAPS

- A. Air and gas pipes shall be sloping to low points, provided with drip legs, shut-off valves, strainers and traps. The traps shall be piped to the nearest drain. Air and gas traps shall be not less than 150-pound iron body float type with copper or stainless steel float. Bracket, lever, and pins shall be of stainless steel. Drain traps shall have threaded connections.
- B. Manufacturers, or Equal:
 - 1. Spirax Sarco, Inc.

2.11 DISMANTLING JOINT

- A. General: Adjustable telescoping restraint with double flanged fittings and tie-rods to lock at the required length.
- B. Pressure Rating: Joint shall be rated at the maximum working pressure of the Pipe Flanges Paragraph 2.2.
- C. Adjustment: Flange shall accommodate a minimum of 3-inch longitudinal adjustment to allow access to the appurtenance.
- D. Material:
 - 1. Flange spools shall be AWWA Class D Steel Ring Flange compatible with Pipe Flanges Paragraph 2.2.
 - 2. Pipe:
 - a. 3-12 inch pipe is STD Weight Class per ASTM A53
 - b. 14-72 inch pipe is ASTM plate 1% cold expanded to size.
 - 3. End Ring and Body:
 - a. 3-12 inch end ring and body from ASTM A536 65-45-12 Ductile Iron.
 - b. 14- 72 inch end ring and body from ASTM A36 Steel.
 - 4. Gaskets: Per Pipe Flanges Paragraph 2.2.
 - 5. Bolts and Nuts: Per Pipe Flanges Paragraph 2.2.

- 6. Tie-Rods: Stainless Steel type 304.
- 7. Coating: Fusion bonded epoxy.
- E. Manufacturers, or Equal:
 - 1. Romac Industries.

PART 3 EXECUTION

3.1 DELIVERY, STORAGE, AND PROTECTION

- A. All piping materials, fittings, valves, and accessories shall be delivered in a clean and undamaged condition and stored off the ground, to provide protection against oxidation. All defective or damaged materials shall be replaced with new materials. All pipe and fittings with mortar lining shall be protected from drying out either in shipping or storage. The Contractor shall periodically check all stored mortar lined pipe and fittings for adequate moisture and add water as necessary
- B. Flanges: Securely attach metal, hardboard, or wood protectors over entire gasket surface.
- C. Threaded or Socket Welding Ends: Fit with metal, wood, or plastic plugs or caps.
- D. Linings and Coatings: Prevent excessive drying.
- E. Cold Weather Storage: Locate products to prevent coating from freezing to ground.
- F. Handling: Use heavy canvas or nylon slings to lift pipe and fittings.

3.2 CLEANUP

- A. After completion of the work, all remaining pipe cuttings, joining and wrapping materials, and other scattered debris, shall be removed from the site. The entire piping system shall be handed over in a clean and functional condition.

3.3 INSTALLATION

- A. Where core drilling is required for pipes passing through existing concrete, core drilling locations shall be determined by radiograph of concrete construction to avoid damage to embedded raceways and rebars.
- B. Join pipe and fittings in accordance with manufacturer's instructions, unless otherwise shown or specified.
- C. Remove foreign objects prior to assembly and installation.

D. Flanged Joints:

1. Install perpendicular to pipe centerline.
2. Bolt Holes: Straddle vertical centerlines, aligned with connecting equipment flanges or as shown.
3. Use torque-limiting wrenches to ensure uniform bearing and proper bolt tightness.
4. Plastic Flanges: Install annular ring filler gasket at joints of raised-face flange.
5. Grooved Joint Flange Adapters: Include stainless steel washer plates as required for mating to serrated faces and lined valves and equipment.
6. Raised-Face Flanges: Use flat-face flange when joining with flat-faced ductile or cast-iron flange.
7. Verify compatibility of mating flange to adapter flange gasket prior to selecting grooved adapter flanging.
8. Flange fillers are to be avoided, but if necessary, may be used to make up for small angles up to 6 degrees and for filling gaps up to 2 inches between flanges. Stacked flange fillers shall not be used.
9. Threaded flanged joints shall be shop fabricated and delivered to Site with flanges in-place and properly faced.

E. Threaded and Coupled Joints:

1. Conform to ASME B1.20.1.
2. Produce sufficient thread length to ensure full engagement when screwed home in fittings.
3. Countersink pipe ends, ream and clean chips, and burrs after threading.
4. Make connections with not more than three threads exposed.
5. Lubricate male threads only with thread lubricant or tape as specified on Piping Data Sheets.

F. Grooved-End Joints:

1. Piping shall be grooved in accordance with manufacturer's latest published instructions and shall be accurately cut with tools conforming to coupling manufacturer's standards and to AWWA C606.

2. Install grooved joint couplings and gaskets in accordance with manufacturer's latest published installation instructions.
- G. Soldered Joints:
1. Use only solder specified for particular service.
 2. Cut pipe ends square and remove fins and burrs.
 3. After thoroughly cleaning pipe and fitting of oil and grease using solvent and emery cloth, apply noncorrosive flux to the male end only.
 4. Wipe excess solder from exterior of joint before hardened.
 5. Before soldering, remove stems and washers from solder joint valves.
- H. PVC and chlorinated polyvinyl chloride (CPVC) Piping:
1. Provide Schedule 80 threaded nipple where necessary to connect to threaded valve or fitting.
 2. Use strap wrench for tightening threaded plastic joints. Do not overtighten fittings.
 3. Do not thread Schedule 40 pipe.
- I. Ductile Iron Piping:
1. Cutting Pipe: Cut pipe with milling type cutter, rolling pipe cutter, or abrasive blade cutter. Do not flame cut.
 2. Dressing Cut Ends:
 - a. General: As required for the type of joint to be made.
 - b. Rubber Gasketed Joints: Remove sharp edges or projections.
 - c. Push-On Joints: Bevel, as recommended by pipe manufacturer.
 - d. Flexible Couplings, Flanged Coupling Adapters, and Grooved End Pipe Couplings: As recommended by the coupling or adapter manufacturer.
- J. Polyvinylidene fluoride (PVDF)-Lined Steel Pipe Installation:
1. Cut, make up, and install pipe in accordance with pipe manufacturer's written instructions.
 2. Weld vent extension half-couplings in-place prior to lining pipe.

3. Do not weld on pipe after lining is installed.
 4. Prevent plugging of vent extensions with insulation or paint.
- K. High-Density Polyethylene Piping:
1. Join pipes, fittings, and flange connections by means of thermal butt-fusion.
 2. Perform butt-fusion in accordance with pipe manufacturer's recommendations as to equipment and technique.
 3. Special Precautions at Flanges: Polyethylene pipe connected to heavy fittings, manholes, and rigid structures shall be supported in such a manner that no subsequent relative movement between polyethylene pipe at flanged joint and rigid structures is possible.
- L. Fiberglass Reinforced Piping (FRP):
1. Cut, fabricate, and install in accordance with manufacturer's written instructions.
 2. Provide manufacturer's representative for instructing workers on proper installation and jointing methods.
 3. Installation shall be made by workers experienced in FRP pipe lay-up techniques.

3.4 PIPELINE TESTING

- A. All pipes shall be tested in accordance with Section 40 80 01 –Process Piping Testing.

3.5 MANUFACTURER'S SERVICES

- A. Where the assistance of a manufacturer's service representative is advisable, in order to obtain perfect pipe joints, supports, or special connections, the Contractor shall furnish such assistance at no additional cost to the Owner.

END OF SECTION

SECTION 40 05 10.01 – DUCTILE IRON PIPE AND FITTINGS

PART 1 GENERAL

1.1 SUMMARY

- A. The Contractor shall furnish and install ductile iron pipe and all appurtenant work, complete in place, all in accordance with the requirements of the Contract Documents.
- B. Pipe Types:
 - 1. CLDI, Cement-mortar Lined Ductile Iron
 - 2. GLDI, Glass Lined Ductile Iron

1.2 REFERENCE STANDARDS

- A. ANSI/AWWA C104/A21.4 Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
- B. ANSI/AWWA C105/A21.5 Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids
- C. ANSI/AWWA C110/A21.10 Ductile-Iron and Gray-Iron Fittings, 3 in Through 48 in for Water and Other Liquids
- D. ANSI/AWWA C111/A21.11 Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings
- E. ANSI/AWWA C115/A21.15 Flanged Ductile-Iron and Gray-Iron Pipe with Threaded Flanges
- F. ANSI/AWWA C150/A21.50 Thickness Design of Ductile-Iron Pipe
- G. ANSI/AWWA C151/A21.51 Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids
- H. ANSI/AWWA C153/A21.53 Ductile-Iron Compact Fittings, 3 in. Through 12 in. for Water and Other Liquids
- I. AWWA C600 Installation of Ductile Iron Water Mains and Their Appurtenances
- J. ASTM C 150 Specification for Portland Cement
- K. ASTM B 1000 Standard Practices for Casting Preparation and Test Procedure of Porcelain Enamel-lined Pipe, Fittings, and Valves for Use in the Municipal Wastewater, Sewage, and Water Treatment Industry

1.3 SUBMITTALS

- A. Shop Drawings: The Contractor shall submit shop drawings of pipe and fittings in accordance with the requirements in Section 01 33 00 – Submittal Procedures and the requirements of the referenced standards.
- B. Certifications: The Contractor shall furnish a certified affidavit of compliance for all pipe and other products or materials furnished under this Section of the Specification, as specified in the referenced standards and the following supplemental requirements:
 - 1. Physical and chemical properties.
 - 2. Hydrostatic test reports.
 - 3. AWWA- ANSI/NSF61 certification.
- C. All expenses incurred in making samples for certification of tests shall be borne by the Contractor.

1.4 QUALITY ASSURANCE

- A. Inspection: All pipe shall be subject to inspection at the place of manufacture in accordance with the provisions of the referenced standards, as supplemented by the requirements herein.
- B. Tests: Except as modified herein, all materials used in the manufacture of the pipe shall be tested in accordance with the requirements of the Section 40 80 01 – Process Piping Testing, and the referenced standards as applicable.
- C. The Contractor shall perform said material tests at no additional cost to the Owner. The Engineer shall have the right to witness all testing conducted by the Contractor; provided, that the Contractor's schedule is not delayed for the convenience of the Engineer.
- D. In addition to those tests specifically required, the Engineer may request additional samples of any material including lining and coating samples for testing by the Owner. The additional samples shall be furnished at no additional cost to the Owner.

PART 2 PRODUCTS

2.1 GENERAL

- A. The pipe shall be of the diameter shown, shall be furnished complete with rubber gaskets as indicated in the Contract Documents, and all specials and fittings shall be provided as required under the Contract Documents.

- B. Pipe manufacturer shall submit certification that source manufacturing facility has been producing ductile iron pipe of specified diameters, dimensions, and standards for a period of not less than 10 years. Testing of pipe required by AWWA C151/A21.51 shall be conducted in testing and laboratory facilities located in the USA and operating under USA laws and regulations. Pipe shall be handled during manufacture and shipped without nesting (without insertion of one pipe inside another).

2.2 MATERIALS

- A. Ductile Iron Pipe: Pipe materials shall conform to the requirements of ANSI/AWWA C151.
- B. Cement: Cement for mortar lining shall conform to the requirements of ANSI/AWWA C104; provided, that cement for mortar lining shall be Type II or V. A fly ash or pozzolan shall not be used as a cement replacement.
- C. Glass: ASTM B1000
- D. Polyethylene Sleeve: Material for the polyethylene sleeve shall conform to the requirements of ANSI/AWWA C105.

2.3 DESIGN OF PIPE

- A. General: The pipe furnished shall be ductile iron pipe, mortar-lined and polyethylene-wrapped, with rubber-gasketed joints as shown.
- B. The pipe shall be designed, manufactured, tested, inspected, and marked according to applicable requirements previously stated and except as hereinafter modified, shall conform to ANSI/AWWA C151.
- C. Pipe Dimensions: The pipe shall be of the diameter shown. The minimum wall thickness for each pipe size shall be as specified or shown.
- D. Fitting Dimensions: The fittings shall be of the diameter shown.
- E. Joint Design: Ductile iron pipe and fittings shall be furnished with mechanical joints, push-on joints, flanged joints, and restrained joints as required.
 - 1. Mechanical and push-on joints shall conform to ANSI/AWWA C111/A21.11. 250 pounds per square inch (psi) minimum working pressure
 - 2. Flanged joints: dimensions per AWWA C110/A21.10 flat face, ductile iron, threaded conforming to ANSI/AWWA C115/A21.15.
 - 3. Grooved End: Rigid type radius cut conforming to AWWA C606, 250 psi minimum working pressure; Victaulic.

4. Restrained joints shall be "Flex-Ring" or "Lok-Ring" Restrained Joint by American Ductile Iron Pipe, "TR FLEX" Restrained Joint by U.S. Pipe, or equal.
- F. For bell-and-spigot ends with rubber gaskets, the clearance between the bells and spigots shall be such that when combined with the gasket groove configuration and the gasket itself, will provide watertight joints under all operating conditions when properly installed. The Contractor shall require the pipe manufacturer to submit details complete with significant dimensions and tolerances and also to submit performance data indicating that the proposed joint has performed satisfactorily under similar conditions. In the absence of a history of field performance, the results of a test program shall be submitted.
- G. Shop-applied interior linings and exterior coatings shall be held back from the ends of the pipe as shown or as otherwise acceptable to the Engineer.

2.4 SPECIALS AND FITTINGS

- A. Fittings for ductile iron pipe shall conform to the requirements of ANSI/AWWA C153/A21.53 or ANSI/AWWA C110/A21.10 for diameters 3-inch through 48-inch and shall have a minimum pressure rating of 250 psi.

2.5 CEMENT-MORTAR LINING (PIPE TYPE CLDI)

- A. Cement-Mortar Lining for Shop Application: Except as otherwise provided herein, interior surfaces of all ductile iron pipe, fittings, and specials shall be cleaned and lined in the shop with cement-mortar lining applied centrifugally in conformity with ANSI/AWWA C104. During the lining operation and thereafter, the pipe shall be maintained in a round condition by suitable bracing or strutting. The lining machines shall be of a type that has been used successfully for similar work. Every precaution shall be taken to prevent damage to the lining. If lining is damaged or found faulty at delivery site, the damaged or unsatisfactory portions shall be replaced with lining conforming to these Specifications.
- B. The minimum lining thickness shall be double thickness as defined by AWWA C 602.
- C. Protection of Pipe Lining/Interior: All shop-applied cement mortar lining shall be given a seal coat of asphaltic material in conformance with ANSI/AWWA C104.

2.6 GLASS LINING (PIPE TYPE GLDI)

- A. General: Ductile iron and fittings shall be glass-lined where indicated. The glass lining shall be suitable for handling sewage, primary sludge, digested sludge, and scum. It shall be smooth, continuous, and suitable for prevention of grease and foam build-up. The glass lining shall be capable of withstanding thermal shock of 350 degrees Fahrenheit (F) (430 degrees to 80 degrees) without crazing, blistering, or spalling.

- B. Criteria: The glass lining shall consist of a vitreous material to meet or exceed the following criteria:
1. Unaffected by scraping with a sharp knife, simulating the effects of rodding.
 2. Unaffected by the continuous application of live steam from a steam generator, immediately followed by a cold-water quench.
 3. Unaffected by an 8 percent sulfuric acid solution at 148 degrees F for a 10-minute period.
 4. Minimum thickness: 10 mils by micro test.
 5. Spark tested: Surface must be free of pinholes.
 6. Hardness: 5-6 Mohs.
 7. Density: 2.5-3.0 grams per cubic centimeter (g/cu cm), measured by ASTM D 792 - Test Method for Specific Gravity (Relative Density) and Density of Plastics by Displacement.
- C. Application: Cast or ductile iron pipes and fittings shall be bored or machined smooth to remove voids or protrusions. All interior surfaces shall be grit blasted to white metal and lining shall be fused on to chemically clean metal at above 1400 degrees F. All welded flanges shall be factory-installed before lining. Screwed flanges or cast and ductile iron pipes shall be installed after lining. All pieces shall be sealed and tested prior to shipment. Finish shall be subject to the Engineer's approval.
- D. Manufacturers:
1. A.O. Smith Corp., Florence, Kentucky;
 2. Waterworks, Mfg. Co., Marysville, California.
 3. Or equal

2.7 EXTERIOR COATING OF PIPE

- A. Exterior Coating of Exposed Piping: The exterior surfaces of pipe which will be exposed to the atmosphere inside structures or above ground shall be thoroughly cleaned and then given a shop coat of rust-inhibitive primer. Field coating shall be in accordance with the requirements of Section 09 90 00 – Mechanical Coating.
- B. Exterior Coating of Buried Piping: The exterior coating shall be an asphaltic coating approximately 1-mil thick. In addition, a polyethylene sleeve shall be installed.

PART 3 EXECUTION

3.1 INSTALLATION OF PIPE

- A. Handling and Storage: All pipe, fittings, etc., shall be carefully handled and protected against damage, impact shocks, and free fall. All pipe handling equipment shall be acceptable to the Engineer. Pipe shall not be placed directly on rough ground but shall be supported in a manner which will protect the pipe against injury whenever stored at the trench site or elsewhere. No pipe shall be installed where the lining or coating show defects that may be harmful as determined by the Engineer. Such damaged lining or coating shall be repaired, or a new undamaged pipe shall be furnished and installed.
- B. All pipe damaged prior to Substantial Completion shall be repaired or replaced by the Contractor.
- C. The Contractor shall inspect each pipe and fitting prior to installation to ensure that there are no damaged portions of the pipe.
- D. Before placement of pipe in the trench, each pipe or fitting shall be thoroughly cleaned of any foreign substance, which may have collected thereon and shall be kept clean at all times thereafter. For this purpose, the openings of all pipes and fittings in the trench shall be closed during any interruption to the work.
- E. Pipe Laying: The pipe shall be installed in accordance with ANSI/AWWA C600.
- F. Pipe shall be laid directly on the bedding material. No blocking will be permitted, and the bedding shall be such that it forms a continuous, solid bearing for the full length of the pipe. Excavations shall be made as needed to facilitate removal of handling devices after the pipe is laid. Bell holes shall be formed at the ends of the pipe to prevent point loading at the bells or couplings. Excavation shall be made as needed outside the normal trench section at field joints to permit adequate access to the joints for field connection operations and for application of coating on field joints.
- G. Where necessary to raise or lower the pipe due to unforeseen obstructions or other causes, the Engineer may change the alignment and/or the grades. Such change shall be made by the deflection of joints, by the use of bevel adapters, or by the use of additional fittings. However, in no case shall the deflection in the joint exceed the maximum deflection recommended by the pipe manufacturer. No joint shall be misfit any amount which will be detrimental to the strength and water tightness of the finished joint.
- H. Except for short runs which may be permitted by the Engineer, pipes shall be laid uphill on grades exceeding 10 percent. Pipe which is laid on a downhill grade shall be blocked and held in place until sufficient support is furnished by the following pipe to prevent movement. All bends shall be properly installed as shown.

- I. Cold Weather Protection: No pipe shall be installed upon a foundation into which frost has penetrated or at any time that there is a danger of the formation of ice or penetration of frost at the bottom of the excavation. No pipe shall be laid unless it can be established that the trench will be backfilled before the formation of ice and frost occurs.
- J. Pipe and Specials Protection: The openings of all pipe and specials shall be protected with suitable bulkheads to prevent unauthorized access by persons, animals, water or any undesirable substance. At all times, means shall be provided to prevent the pipe from floating.
- K. Pipe Cleanup: As pipe laying progresses, the Contractor shall keep the pipe interior free of all debris. The Contractor shall completely clean the interior of the pipe of all sand, dirt, mortar splatter, and any other debris following completion of pipe laying, pointing of joints and any necessary interior repairs prior to testing the completed pipeline.
- L. Finish: The pipe shall have smooth dense interior surfaces and shall be free from fractures, excessive interior surface crazing, and roughness.

3.2 RUBBER GASKETED JOINTS

- A. Rubber Gasketed Joints: Immediately before jointing pipe, the bell end of the pipe shall be thoroughly cleaned, and a clean rubber gasket lubricated with an approved vegetable-based lubricant shall be placed in the bell groove. The spigot end of the pipe shall be carefully cleaned and lubricated with a vegetable-based lubricant. The spigot end of the pipe section shall then be inserted into the bell of the previously laid joint and telescoped into its proper position. Tilting of the pipe to insert the spigot into the bell will not be permitted.

3.3 POLYETHYLENE SLEEVE COATING

- A. All buried ductile iron pipe shall be polyethylene encased in accordance with the requirements of ANSI/AWWA C105/A21.5.

3.4 INSTALLATION OF PIPE APPURTENANCES

- A. Protection of Appurtenances: Where pipe is encased in polyethylene sleeves, buried appurtenances shall also be encased in polyethylene.
- B. Installation of Valves: All valves shall be handled in a manner to prevent any injury or damage to any part of the valve. All joints shall be thoroughly cleaned and prepared prior to installation. The Contractor shall adjust all stem packing and operate each valve prior to installation to insure proper operation.
- C. All valves shall be installed so that the valve stems are plumb and, in the location, shown.

3.5 PIPELINE TESTING

- A. All pipes shall be tested in accordance with Section 40 80 01 –Process Piping Testing.

END OF SECTION

SECTION 40 05 10.02 – STAINLESS STEEL PIPE AND FITTINGS

PART 1 GENERAL

1.1 SUMMARY

- A. Scope: This section specifies stainless steel pipe and fittings.
- B. Types of Service: Stainless steel piping for aeration service is included in this section.

1.2 REFERENCE STANDARDS

- A. ANSI B16.9, Factory-Made Wrought Steel Butt Welding Fitting
- B. ANSI B16.28, Wrought Steel Butt Welding Short Radius Elbows and Returns
- C. ASTM A240, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
- D. ASTM A778, Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products

1.3 SUBMITTALS

- A. Shop Drawings: The Contractor shall submit shop drawings of pipe and fittings in accordance with the requirements in Section 01 33 00 – Submittal Procedures and the requirements of the referenced standards.
- B. Certifications: The Contractor shall furnish a certified affidavit of compliance for all pipe and other products or materials furnished under this Section of the Specifications, as specified in the referenced standards and the following supplemental requirements:
 - 1. Physical and chemical properties.
 - 2. Hydrostatic test reports.
- C. All expenses incurred in making samples for certification of tests shall be borne by the Contractor.

1.4 QUALITY ASSURANCE

- A. Inspection: All pipe shall be subject to inspection at the place of manufacture in accordance with the provisions of the referenced standards, as supplemented by the requirements herein.
- B. Tests: Except as modified herein, all materials used in the manufacture of the pipe shall be tested in accordance with the requirements of the referenced standards as applicable.

- C. The Contractor shall perform said material tests at no additional cost to the Owner. The Engineer shall have the right to witness all testing conducted by the Contractor; provided, that the Contractor's schedule is not delayed for the convenience of the Engineer.
- D. In addition to those tests specifically required, the Engineer may request additional samples of any material including lining and coating samples for testing by the Owner. The additional samples shall be furnished at no additional cost to the Owner.

PART 2 PRODUCTS

2.1 GENERAL

- A. Pipe materials, connections, and installation shall meet all of the requirements described within the pipe schedule located in the drawings.

2.2 MATERIALS

- A. ASTM A312/A312M, type 304 seamless, pickled and passivated, schedule as shown on drawings.

2.3 FITTINGS AND JOINTS

- A. 1-1/2" and smaller: Threaded. Forged 1,000 CWP minimum, ASTM A182/A182M, grade F304 or cast Class 150, ASTM A351/A351m, Grade CF8/304
- B. 2" and larger: Butt-welded or flanged.
 - 1. Butt-welded: ASTM A403/A403M, Grade WP304L conforming to ASME B16.9 and MSS SP 43, annealed, pickled and passivated; fitting wall thickness to match adjoining pipe; long radius elbows, unless shown otherwise.
 - 2. Flanged joints:
 - a. Forged Stainless Steel: ASTM A182/A182M, Grade F304L, ASME B16.5 Class 150 or Class 300, slip-on weld neck or raised face. Weld slip-on flanges inside and outside.
 - b. Cast Carbon Steel: ASTM A216/A216M Grade WCA, drilled, ASME B16.5 Class 150 or Class 300 Van Stone Type with stainless steel stub ends, ASTM A240/A240M Type 304L "as-welded grade", conforming to MSS SP 43, wall thickness same as pipe.

3. Blind Flanges, exposed to the atmosphere and not buried nor immersed in liquid, may be either stainless steel or Class 125 ductile iron or Class 150 carbon steel with gaskets as specified herein.

2.4 PIPE SUPPORT SYSTEMS.

- A. Unless otherwise specified, all hangers, rods, structural attachments, and other components of support systems for stainless steel pipe shall be of the same materials as the pipe and conform to Section 40 05 07 – Hangers and Supports for Process Piping.

PART 3 EXECUTION

3.1 PIPE CUTTING, THREADING, AND JOINTING

- A. Pipe cutting, threading, and jointing shall conform to the requirements of ANSI B31.1. All pipe threads shall be lubricated with Teflon tape.

3.2 WELDING

- A. General: Piping with wall thickness up to 11-gauge (0.120-inch) shall be welded with the tungsten inert gas (TIG) (gas tungsten arc welding (GTAW)) process. Unless otherwise specified, heavier walls shall be properly beveled and have a root pass with the TIG (GTAW) process followed by subsequent passes with the TIG (GTAW), metal inert gas (MIG) (gas metal arc welding (GMAW)), or Metalic Arc (shielded metal arc welding (SMAW)) processes. Filler wire of extra low carbon (ELC) grades only shall be added to all welds to provide a cross section at the weld equal to or greater than the parent metal. Weld deposit shall be smooth and evenly distributed and have a crown of no more than 1/16-inch on the internal dimension (ID) and 3/32-inch on the outside dimension (OD) of the piping. Concavity, undercut, cracks or crevices shall not be allowed. Butt welds shall have full penetration to the interior surface, and inert gas shielding shall be provided to the interior and exterior of the joint. Excessive weld deposits, slag, spatter, and projections shall be removed by grinding. Welds on gasket surfaces shall be ground smooth.
- B. Field Welding:
 1. Field welding shall be minimized to the greatest extent possible by the use of couplings and prefabrication of pipe systems at the factory. Pipe butt welds may be performed at the job site, providing the butt welds are performed only with an inert gas shielded process and that other applicable specified welding requirements are rigidly adhered to.
 2. All residue, oxide, and heat stain is to be removed from any type of field weld and the affected areas adjacent by the use of stainless steel wire brushes, followed by

cleaning with an agent such as Eutectic Company's "Eucleen" or equal, followed by complete removal of the agent.

- C. Preparation of Surfaces to be Welded. Surfaces of joints to be welded shall be free from mill scale, slag, grease, oil, paint, rust, and other foreign material. Joints to be welded shall be wire-brushed with stainless steel wire brushes and precisely fitted before welding.
- D. Weather Conditions. Welding shall be done only when the surfaces are completely free of any moisture. Welding of the pipe shall not be done during periods of high winds or rain unless the areas being welded are properly shielded.
- E. Tack Welds, Clips, and Other Attachments. Nicks, gouges, notches, and depressions in the base metal in the area of the joint shall be repaired before the joint weld is made. Tack welds, clips, and other attachments shall be removed, and defects repaired, except where the tack welds occur within the weld area and these tack welds do not exceed the size of the completed weld. Cracked tack welds shall be removed. Areas to be repaired shall be ground to clean metal and then repaired by building up with weld metal. The repaired areas shall be ground smooth to form a plane surface with the base metal.
- F. Defects and Repairs. Welds with cracks, slag inclusions, porosity, undercutting, incomplete penetration, or which are otherwise deficient in quality or made contrary to any provisions of these specifications shall be removed by chipping or grinding throughout their depth to clean base metal. Caulking or peening of welds to correct defects shall not be done. Welds found deficient in dimension but not in quality shall be enlarged by additional welding after thoroughly cleaning the surface of the previously deposited metal and the adjoining plate. Weld deposits, slag, weld spatter, and projections into the interior of the pipe shall be removed by grinding.

3.3 MARKING, SHIPPING, AND STORAGE

- A. All pipe fittings and fabrications shall be properly marked with type, gauge, and heat number. All fabricated piping shall have openings plugged and flanges secured for storage and/or transport after fabrication. All fabricated piping shall be piece-marked with identifying numbers or codes which correspond to the Contractor's layout and installation drawings. The marks will be located on the spools at opposite ends and 180 degrees apart. Pipe spools shall be loaded and blocked and lagged as necessary to ensure protection from damage during shipping. Stainless steel pipe and fittings shall be stored per manufacturer's recommendation. Dents, gouges, and scratches in stainless steel pipe and fittings are not acceptable and are reason for rejecting pipe and fittings.

3.4 FABRICATION/INSTALLATION REQUIREMENTS

- A. The piping supplier during manufacturing, fabricating and handling stages, and the Contractor during handling and installation stages, shall use extreme care to avoid the contact of any ferrous materials with the stainless steel piping. All saws, drills, files, wire brushes, etc. shall be used for stainless steel piping only. Pipe storage and fabrication racks shall be nonferrous or stainless steel or rubber lined. Nylon slings or straps shall be used for handling stainless steel piping. Contact with ferrous items may cause rusting of iron particles embedded in the piping walls. After installation, the Contractor shall wash and rinse all foreign matter from the piping surface. All welded joints shall be treated with a pickling solution, brushed with stainless steel wire brushes and rinsed clean. If rusting of embedded iron occurs, the Contractor shall pickle the affected surface with Oakite Deoxidizer SS or equal, scrub with stainless steel brushes and rinse clean.

3.5 COATINGS

- A. Painting of the stainless steel pipe is not required. However, the Contractor shall be responsible for supplying and installing the stainless steel piping with a consistently clean surface. Identifying spool piece marks shall be removed with paint thinner or solvents and the entire stainless steel surface shall be washed with detergent and hot water and rinsed clean.

3.6 PIPELINE TESTING

- A. All pipe testing shall be completed in accordance with Section 40 80 01 Process Piping Testing, Hydrostatic Test for Gravity Piping method.

END OF SECTION

SECTION 40 05 10.03 – PVC PIPE AND FITTINGS

PART 1 GENERAL

1.1 SUMMARY

- A. The Contractor shall furnish and install corrosion resistant polyvinyl chloride (PVC) pressure pipe fittings and special items in accordance with the requirements of the Contract Documents.
- B. Pipe schedule as shown on the Drawings.

1.2 REFERENCE STANDARDS

- A. ANSI/AWWA C605 Underground Installation of PVC and PVCO Pressure Pipe and Fittings
- B. ASTM D1784 Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
- C. ASTM D1785 Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe
- D. ASTM D1598 Standard Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure
- E. ASTM D2672 Standard Specification for Joints for IPS PVC Pipe Using Solvent Cement
- F. ASTM D2241 Standard Specification of Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
- G. ASTM F477 Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
- H. ANSI/AWWA C219 Bolted, Sleeve-Type Couplings for Plain-End Pipe
- I. AWWA M23 Manual of Supply Practices - PVC Pipe—Design and Installation, Latest Edition

1.3 SUBMITTALS

- A. Shop Drawings: The Contractor shall submit shop drawings of pipe and fittings in accordance with the requirements in Section 01 33 00 – Submittal Procedures and the requirements of the referenced standards.

- B. Certifications: The Contractor shall furnish a certified affidavit of compliance for all pipe and other products or materials furnished under this Section of the Specifications, as specified in the referenced standards and the following supplemental requirements:
 - 1. Physical and chemical properties.
 - 2. Hydrostatic test reports.
 - 3. AWWA- ANSI certification.
- C. All expenses incurred in making samples for certification of tests shall be borne by the Contractor.

1.4 QUALITY ASSURANCE

- A. Inspection: All pipe shall be subject to inspection at the place of manufacture in accordance with the provisions of the referenced standards, as supplemented by the requirements herein.
- B. Tests: Except as modified herein, all materials used in the manufacture of the pipe shall be tested in accordance with the requirements of the referenced standards as applicable.
- C. The Contractor shall perform said material tests at no additional cost to the Owner. The Engineer shall have the right to witness all testing conducted by the Contractor; provided, that the Contractor's schedule is not delayed for the convenience of the Engineer.
- D. In addition to those tests specifically required, the Engineer may request additional samples of any material including lining and coating samples for testing by the Owner. The additional samples shall be furnished at no additional cost to the Owner.
- E. All references to standards shall be the latest versions of those standards.

PART 2 PRODUCTS

2.1 GENERAL

- A. PVC piping materials shall meet the specifications of this Section and of the appropriate Standards. In the case of conflict, the more stringent specifications shall apply.
- B. Unless otherwise specified herein or shown on the plans, the minimum pressure rating of all pipes specified herein shall be 1.5 times the operating pressure or 150 pounds per square inch (psi) minimum at 73 deg Fahrenheit.
- C. Laying Lengths: Maximum pipe laying lengths shall be 20 feet with shorter lengths provided as required by the Drawings.

2.2 PIPE DESIGN CRITERIA

- A. General: SCH 40 and SCH 80 PVC pipe shall be designed in accordance with the requirements of ASTM Standard D1784 as applicable and as modified in this Section.
- B. Pipe Wall Thickness for Internal Pressure: The pipe shall be designed with a net thickness to withstand the design pressure in accordance with the hoop stress formula.
- C. Pipe shall be manufactured in strict compliance with ASTM D1785 for physical dimensions and tolerances.

2.3 MATERIALS

- A. SCH 40 or SCH 80 PVC Pipe as described on Pipe Schedule: Pipe materials shall conform to the requirements of ASTM D1784, Cell Classification 12454 = PVC Type I Grade I = PVC1120.
- B. Pipe manufactured in compliance with this Section, shall also meet or exceed the test requirements for materials, workmanship, burst pressure, flattening, and extrusion quality defined in ASTM D1785.
- C. All belled-end pipe shall have tapered sockets to create an interference-type fit, which meet or exceed the dimensional requirements and the minimum socket length for pressure-type sockets as defined in ASTM D2672.
- D. Solvent Cement: Socket type joints shall be made employing solvent cement that meets or exceeds the requirements of ASTM D2564 and primer that meets or exceeds requirements of ASTM F656, chemically resistant to the fluid service, and as recommended by pipe and fitting manufacturer. Except solvent weld cement for PVC pipe joints in sodium hypochlorite service shall be free of silica filler and shall be certified by the manufacturer to be suitable for that service, IPS Weld-On 724 or approved equal. Certification shall be submitted

2.4 FITTINGS

Schedule to Match Pipe: ASTM D2466 and ASTM D2467 for socket weld type and ASTM D2464 for threaded type. Fittings shall be manufactured with titanium dioxide for ultraviolet protection.

2.5 JOINTS

- A. Solvent socket weld except where connection to threaded valves and equipment may require future disassembly.
- B. Flanges: One-piece, molded hub type PVC flat face flange in accordance with Fittings above, ASME B16.1, Class 125 drilling

C. Bolting:

1. Flat Face Mating Flange and In Corrosive Areas: ASTM A193/A193M, Type 316 stainless steel Grade B8M hex head bolts, ASTM A194/A194M Grade 8M hex head nuts and ASTM F436 Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.
2. Raised Face Mating Flange: Carbon steel ASTM A307 Grade B square head bolts, ASTM A563 Grade A heavy hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.

D. Gaskets:

1. Flat Face Mating Flange: Full faced 1/8-inch-thick ethylene propylene (EPR) rubber.
2. Raised Face Mating Flange: Flat ring 1/8-inch ethylene propylene (EPR) rubber with filler gasket between optical density (OD) of raised face and flange OD to protect the flange from bolting moment.

PART 3 EXECUTION

3.1 INSTALLATION OF PIPE

- A. Handling and Storage: All pipe, fittings, etc., shall be carefully handled and protected against damage, impact shocks, and free fall. All pipe handling equipment shall be acceptable to the Engineer. Pipe shall not be placed directly on rough ground but shall be supported in a manner which will protect the pipe against injury whenever stored at the trench site or elsewhere. No pipe shall be installed where the lining or coating show defects that may be harmful as determined by the Engineer. Such damaged lining or coating shall be repaired, or a new undamaged pipe shall be furnished and installed.
- B. All pipe damaged prior to Substantial Completion shall be repaired or replaced by the Contractor.
- C. The Contractor shall inspect each pipe and fitting prior to installation to ensure that there are no damaged portions of the pipe.
- D. PVC pressure pipe may be deflected both horizontally and vertically at the joints after assembly. Deflection by bending of the pipe rather than at the joints is not allowed. The maximum pipe deflection shall not exceed one half of the manufacturer's stated joint deflection allowance.

3.2 INSTALLATION OF PIPE APPURTENANCES

- A. Installation of Valves: All valves shall be handled in a manner to prevent any injury or damage to any part of the valve. All joints shall be thoroughly cleaned and prepared prior to installation. The Contractor shall adjust all stem packing and operate each valve prior to installation to insure proper operation.
- B. All valves shall be installed so that the valve stems are plumb and, in the location, shown.

3.3 PIPELINE TESTING

- A. All pipes shall be tested in accordance with Section 40 80 01 – Process Piping Testing.
- B. Do not pneumatically test PVC piping at any pressure.

END OF SECTION

SECTION 40 05 10.07 – HIGH DENSITY POLYETHYLENE PIPE

PART 1 GENERAL

1.1 PIPE TYPES

- A. PE-3608 High Density Polyethylene (HDPE) SDR-17

1.2 THE REQUIREMENT

- A. The Contractor shall furnish and install high density polyethylene pipe and all appurtenant work, complete in place, all in accordance with the requirements of the Contract Documents.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Commercial Standards:

ANSI/AWWA C906	AWWA Standard for Polyethylene (PE) Pressure Pipe and Fittings, 4-inch through 63-inch
ASTM D3350	Standard Specification for Polyethylene Plastics Pipe and Fittings Materials
ASTM D2837	Standard Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials
ASTM D2774	Standard Practice for Underground Installation of Thermoplastic Pressure Piping
ASTM D3035	Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Controlled Outside Diameter
ASTM D3261	Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
PPI TR-33	Plastic Pipe Institute Butt Fusion Process
ASTM F714	Standard Specification for Polyethylene Plastic Pipe (SDR-PR). Based on outside diameter
ASTM D1248	Standard Specification for Polyethylene Plastics Molding and Extrusion Materials
ASTM F2206	Sheet Stock, Plate Stock, or Block Stock

1.4 CONTRACTOR SUBMITTALS

- A. Shop Drawings: The Contractor shall submit shop drawings of pipe and fittings in accordance with the requirements in Section 01 33 00 – Submittal Procedures and the requirements of the referenced standards.
- B. Certifications: The Contractor shall furnish a certified affidavit of compliance for all pipe and other products or materials furnished under this Section of the Specifications, as specified in the referenced standards and the following supplemental requirements:
 - 1. Physical and chemical properties.
 - 2. Hydrostatic test reports.
 - 3. AWWA certification.
- C. All expenses incurred in making samples for certification of tests shall be borne by the Contractor.

1.5 QUALITY ASSURANCE

- A. Inspection: All pipe shall be subject to inspection at the place of manufacture in accordance with the provisions of the referenced standards, as supplemented by the requirements herein.
- B. Tests: Except as modified herein, all materials used in the manufacture of the pipe shall be tested in accordance with the requirements of the referenced standards as applicable.
- C. The Contractor shall perform said material tests at no additional cost to the Owner. The Engineer shall have the right to witness all testing conducted by the Contractor.
- D. In addition to those tests specifically required, the Engineer may request additional samples of any material including lining and coating samples for testing by the Owner. The additional samples shall be furnished at no additional cost to the Owner.

PART 2 PRODUCTS

2.1 GENERAL

- A. The nominal diameters of the pipes are shown on the Drawings.
- B. Finish: The pipe shall have smooth dense interior surfaces and shall be free from fractures and excessive interior surface roughness.

2.2 PIPE DESIGN

- A. General: HDPE pipe shall be designed in accordance with the requirements of ASTM D3350 and PPI-TR4 3408 with hydrostatic design basis (HDB) of 1,600 pounds per square inch (psi) at 73 degrees Fahrenheit (F) as applicable and as modified in this Section.
- B. Pipe Wall Thickness for Internal Pressure: The pipe shall be designed with a net thickness to withstand the design pressure in accordance with the ASTM D2837 Obtaining Hydrostatic Design Basis for thermoplastic pipe materials.
- C. Pipe Wall Thickness for External Load: The pipe shall also be designed with a net thickness to withstand external loads using pipe manufacturer Safe External Pressure by 50-year load duration, standard dimension ratio (SDR) rating, and anticipated water service temperature of 60-80 degrees F. Short term Safe External Pressures shall also be monitored and shall not be exceeded during construction.
- D. For depths of cover of less than 10 feet, HS-20 live load shall be included. For depths of cover of 3 feet or less, HS-20 live load plus impact shall be included. The determination of live load and impact factors shall be as recommended by American Association of State Highway and Transportation Officials (AASHTO) in "Standard Specifications for Highway Bridges."
- E. Ultraviolet (UV) stabilizer and color shall be black with minimum 2 percent carbon black.

2.3 MATERIALS

- A. Pipe: ANSI/AWWA C906, Standard PE Code Designation - PE 3608, minimum cell classification - PE 345464C (ASTM D3350), iron pipe size (IPS) outside diameter (OD). All HDPE pipe and fittings shall be of the dimension ratio (DR) 17, minimum 125 psi rating, unless otherwise shown on the plans.
- B. Joints: Pipe shall be joined using thermal butt fusion method only per ASTM D3261.
- C. Fittings and Fusion Couplings: HDPE fittings and fusion couplings shall be of the same class as or higher-pressure rating than the HDPE piping.
- D. Connections with other pipe types: Connections with other pipe types shall be with PE flange adapter.

2.4 SPECIALS AND FITTINGS

- A. Fittings for HDPE pipe shall conform to the requirements of ASTM D-3350 and shall have a minimum pressure rating of 80 psi.

- B. Fusion couplings for HDPE pipe shall conform to the requirements of ASTM F412, manufactured from a PE 4710 resin. The fusion couplings shall have a minimum pressure rating of 125 psi.

2.5 DESIGN OF PIPE

- A. General: The pipe furnished shall be HDPE pipe, with butt fusion jointing.
- B. The pipe shall be designed, manufactured, tested, inspected, and marked according to applicable requirements previously stated.
- C. Pipe Dimensions: The pipe shall be of the diameter shown. The minimum wall thickness for each pipe size shall be as specified or shown.
- D. Fitting Dimensions: The fittings shall be of the diameter shown.
- E. Fusion Coupling Dimensions: The fusion couplings shall be of the diameter shown.
- F. Joint Design: HDPE pipe and fittings shall be furnished with butt fusion joints as required. Butt fusion joints shall conform to ASTM D3261.

2.6 MANUFACTURERS,

- A. Pipe and Fittings:
 - 1. JM Eagle, Los Angeles, CA
 - 2. Or approved equal
- B. Fusion Couplings:
 - 1. Integrity Fusion Products, Inc., Peachtree City, GA
 - 2. Or approved equal

PART 3 EXECUTION

3.1 INSTALLATION OF PIPE

- A. Handling and Storage: All pipe, fittings, etc., shall be carefully handled and protected against damage, impact shocks, and free fall. All pipe handling equipment shall be acceptable to the Engineer. Pipe shall not be placed directly on rough ground but shall be supported in a manner which will protect the pipe against injury whenever stored at the trench site or elsewhere. No pipe shall be installed where defects are present that may be harmful as determined by the Engineer. Such damaged pipe shall be repaired, or a new undamaged pipe shall be furnished and installed.

- B. All pipe damaged prior to Substantial Completion shall be repaired or replaced by the Contractor.
- C. The Contractor shall inspect each pipe and fitting prior to installation to ensure that there are no damaged portions of the pipe.
- D. Before placement of pipe in the trench, each pipe or fitting shall be thoroughly cleaned of any foreign substance, which may have collected thereon and shall be kept clean at all times thereafter. For this purpose, the openings of all pipes and fittings in the trench shall be closed during any interruption to the Work.
- E. Pipe Laying: The pipe shall be installed in accordance with ANSI/AWWA C600.
- F. Pipe shall be laid directly on the bedding material. No blocking will be permitted, and the bedding shall be such that it forms a continuous, solid bearing for the full length of the pipe. Excavations shall be made as needed to facilitate removal of handling devices after the pipe is laid. Excavation shall be made as needed outside the normal trench section at field joints to permit adequate access to the joints for field connection operations and for application of coating on field joints.
- G. Where necessary to raise or lower the pipe due to unforeseen obstructions or other causes, the Engineer may change the alignment and/or the grades. Such change shall be made by the deflection of joints, by the use of bevel adapters, or by the use of additional fittings. However, in no case shall the deflection of the pipe exceed the maximum deflection recommended by the pipe manufacturer. No joint shall be misfit any amount which will be detrimental to the strength and water tightness of the finished joint.
- H. Except for short runs which may be permitted by the Engineer, pipes shall not be laid uphill on grades exceeding 10 percent. Pipe which is laid on a downhill grade shall be blocked and held in place until sufficient support is furnished by the following pipe to prevent movement. All bends shall be properly installed as shown.
- I. Cold Weather Protection: No pipe shall be installed upon a foundation into which frost has penetrated or at any time that there is a danger of the formation of ice or penetration of frost at the bottom of the excavation. No pipe shall be laid unless it can be established that the trench will be backfilled before the formation of ice and frost occurs.
- J. Pipe and Specials Protection: The openings of all pipe and specials shall be protected with suitable bulkheads to prevent unauthorized access by persons, animals, water, or any undesirable substance. At all times, means shall be provided to prevent the pipe from floating.

- K. Pipe Cleanup: As pipe laying progresses, the Contractor shall keep the pipe interior free of all debris. The Contractor shall completely clean the interior of the pipe of all sand, dirt, mortar splatter and any other debris following completion of pipe laying, pointing of joints and any necessary interior repairs prior to testing the completed pipeline.

3.2 JOINING

- A. Sections of PE pipe shall be joined into continuous lengths on the job site above ground per ASTM D3261. The joining method shall be the thermal butt fusion method and shall be performed in strict accordance with the pipe manufacturer's recommendations. The butt fusion equipment used in the joining procedures should be capable of meeting all conditions recommended by the pipe manufacturer, including, but not limited to, temperature requirements for 400 degrees F, alignment, and 75 psi interfacial fusion pressure.
- B. Butt fusion joining shall be 100 percent efficient providing joint weld strength equal to or greater than the tensile strength of the pipe. Socket fusion will not be allowed. Extrusion welding or hot gas welding of HDPE shall not be used for pressure pipe applications or in fabrications where shear or structural strength is important.
- C. Remove and extract internal fusion bead from pipe.
 - 1. Verify complete internal fusion bead removal was performed by examination of extracted internal fusion bead.
 - 2. Appearance of the extracted internal fusion bead shall have same double roll back semblance as external fusion bead.
 - 3. Possess smooth root cut or pipe smoothness and shall be verified by means of closed-circuit television (CCTV) examination.
 - 4. Removal of internal bead may include pipe wall mass. However, wall mass that is removed shall not exceed 1/10th of pipe wall thickness

3.3 INSTALLATION OF PIPE APPURTENANCES

- A. Installation of Valves: All valves shall be handled in a manner to prevent any injury or damage to any part of the valve. All joints shall be thoroughly cleaned and prepared prior to installation. The Contractor shall adjust all stem packing and operate each valve prior to installation to insure proper operation.
- B. Connections with other pipe type or equipment shall be with flanged connections:
 - 1. PE flange adapter, thermally butt-fused to end of the pipe. Flange "stub ends" are not allowed.

2. Bolt and nut of sufficient length to show a minimum of three complete threads when joint is made and tightened to manufacturer's standard.
3. Follow requirements of PPI Technical Note 38 including mandatory 4-hour bolt re-torquing.

3.4 PIPELINE TESTING

- A. All pipes shall be tested in accordance with Section 40 80 01 –Process Piping Testing, Hydrostatic Test for Gravity Piping method.

END OF SECTION

SECTION 40 05 10.08

HIGH DENSITY POLYETHYLENE (HDPE) FLANGE ADAPTERS

PART 1 GENERAL

1.1 DESCRIPTION

- A. Scope: This section specifies high density polyethylene flange adaptors for connection to ductile iron flange connections.
- B. Types of Adaptors: HDPE IPS flange adapters that connect to ductile iron DIPS pipe shall be provided with an extra thick stub end to allow for a custom bevel for pipe sizes 6" and larger and still provide a minimum pressure rating of the pipe SDR pressure rating. For HDPE flange adapters 4" and smaller, typical flange adapters without bevels (except where needed for valve clearance) may be installed.

1.2 REFERENCES

- A. This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ASTM D3350	Standard Specification for Polyethylene Plastics Pipe and Fittings Materials
ASTM F714	Standard Specification for Polyethylene Plastic Pipe Based on Outside Diameter
ASTM D790	Flexural modulus
ASTM F1473	Standard Test Method for Notch Tensile Test to Measure the Resistance to Slow Crack Growth of Polyethylene Pipes and Resins
ASTM D1505	Standard Test Method for Obtaining Design Basis for Thermoplastic Pipe Materials of Pressure Design Basis for Thermoplastic Pipe Products
ASTM D1238	Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer
ASTM D638	Standard Test Method for Tensile Properties of Plastics
ASTM D2837	Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products
ASTM D746	Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact

Reference	Title
ASTM D3261	Specification for Butt Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
AWWA C906	Standard for Polyethylene (PE) Pressure Pipe and Fittings, 4 In. Through 65 In., for Waterworks

1.3 CONTRACTOR SUBMITTALS

- A. Shop Drawings: The CONTRACTOR shall submit shop drawings of fittings in accordance with the requirements in Section 01 33 00 – Submittals and the requirements of the referenced standards.
- B. Certifications: The CONTRACTOR shall furnish a certified affidavit of compliance for all fittings and other products or materials furnished under this Section of the Specifications, as specified in the referenced standards and the following supplemental requirements:
 - 1. Physical and chemical properties.
 - 2. Hydrostatic test reports.
- C. All expenses incurred in making samples for certification of tests shall be borne by the CONTRACTOR.

1.4 QUALITY ASSURANCE

- A. Inspection: All fittings shall be subject to inspection at the place of manufacture in accordance with the provisions of the referenced standards, as supplemented by the requirements herein.
- B. Tests: Except as modified herein, all materials used in the manufacture of the fittings shall be tested in accordance with the requirements of the referenced standards as applicable.
- C. The CONTRACTOR shall perform said material tests at no additional cost to the OWNER. The ENGINEER shall have the right to witness all testing conducted by the CONTRACTOR; provided, that the CONTRACTOR'S schedule is not delayed for the convenience of the ENGINEER.
- D. In addition to those tests specifically required, the ENGINEER may request additional samples of any material including lining and coating samples for testing by the OWNER. The additional samples shall be furnished at no additional cost to the OWNER.

PART 2 PRODUCTS

2.1 MATERIALS FOR PIPE SIZES 4-INCH DIAMETER AND LARGER

- A. Materials used for the manufacture of polyethylene flange adapters shall be made from a PE 4710 high density polyethylene resin compound meeting a minimum cell classification 445474C per ASTM D3350
- B. High Density Polyethylene (HDPE) fittings shall comply with AWWA Specifications C906.
- C. If rework compounds are required, only those generated in the Manufacturer's own plant from resin compounds of the same class and type from the same raw material supplier shall be used.
- D. Dimensions and workmanship shall be as specified by ASTM F714. HDPE fittings and transitions shall meet ASTM D3261. HDPE fittings shall have a minimum density of 0.960 grams per cubic centimeter. All HDPE fittings shall have a Hydrostatic Design Basis (HDB) of 1,600 psi.
- E. HDPE fittings and accessories 4-inch diameter and larger, shall meet the requirements of the host pipe as shown in the pipe schedule as a MINIMUM STRENGTH.
- F. The fitting Manufacturer must certify compliance with the above requirements.

2.2 ADAPTER REQUIREMENTS

- A. Adapters shall be fully pressure rated to match the pipe SDR pressure rating to which they are made. All fittings shall be molded or fabricated by the manufacturer. No Contractor fabricated fittings shall be used unless approved by the Engineer.
- B. All fittings shall be installed using butt-fused fittings between pipe ends and have the same outside diameter and are not different in wall thickness by more than one Standard DR, for example, SDR 13.5 to SDR 17. Transitions between unlike wall thickness greater than one SDR shall be made with a transition nipple.
- C. All transition from HDPE pipe to ductile iron or PVC shall be made per the approval of Engineer and per the HDPE pipe manufacturer's recommendations and specifications. A molded flange connector adapter within custom bevel and a stainless steel (316) back-up ring assembly shall be used for pipe type transitions. Back-up rings shall mate with steel and stainless steel per ANSI/ASME B16.5 standard and ductile iron per ANSI B16.42.
 - 1. Transition from HDPE to ductile iron fittings and valves shall be approved by ENGINEER or as specified in contract documents before installation.

2. No solid sleeves shall be allowed between such material transitions.
3. Fittings and transitions shall be as manufactured by;
 - a. Improved Piping Products, Inc.
 - b. Performance Pipe
 - c. Or approved equal.
4. The HDPE fitting supplier must certify compliance with the above requirements.

2.3 FITTING IDENTIFICATION

- A. The following shall be continuously indent printed on the fitting or spaced at intervals not exceeding 5-feet:
 1. Unique part number.
 2. Nominal pipe size.
 3. Dimension ratio.
 4. The letters PE followed by the polyethylene grade in accordance with ASTM D1248 followed by the hydrostatic design basis psi.
 5. Manufacturing standard reference, e.g., ASTM F714 or D-3035, as required.
 6. A production code from which the date and place of manufacture can be determined.
- B. Tracing Wire: Tracing Wire shall be per contract specification.
- C. Marking Tape: Marking tape shall be installed per Engineer approval or as specified in contract documents.

PART 3 EXECUTION

3.1 JOINTING METHOD

- A. The fitting shall be joined with butt, heat fusion joints as outlined in ASTM D2657 and conform to the Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe, Technical Report TR-33/2005, published by the Plastic Pipe Institute (PPI). All joints shall be made in strict compliance with the manufacturer's recommendations. A factory qualified joining technician as designated by pipe manufacturer or experienced, trained technician shall perform all heat fusion joints in the presence of the Engineer or Engineer/City's inspector.

- B. On days butt fusions are to be made, the first fusion shall be a trial fusion in the presence of an Engineer/City's inspector. The following shall apply:
1. Heating plates shall be inspected for cuts and scrapes. The plate temperature shall be measured at various locations to ensure proper heating/melting per manufacturer's recommendations and approval by Engineer/City's inspector.
 2. The fusion or test section shall be cut out after cooling completely for inspection.
 3. The test section shall be 12" or 30 times (minimum) the wall thickness in length and 1" or 1.5 times the wall thickness in width (minimum).
 4. The joint shall be visually inspected as to continuity of "beads" from the melted material, and for assurance of "cold joint" prevention (i.e. – joint shall have visible molded material between walls of pipe). Joint spacing between the walls of the two ends shall be a minimum of 1/16" to a maximum 3/16".
- C. The polyethylene flange adapters at pipe material transitions shall be backed up by convoluted stainless steel backing flanges conforming to ANSI B16.5 and shaped as necessary to suit the outside dimensions of the pipe. The flange adapter assemblies shall be connected with corrosion resisting bolts and nuts of Type 316 Stainless Steel as specified in ASTM A726 and ASTM A307. All bolts shall be tightened to the manufacturer's specified torques. Bolts shall be tightened alternately and evenly. After installation apply a bitumastic coating to bolts and nuts.

3.2 INSTALLATION

- A. High Density Polyethylene (HDPE) flange adapters shall be installed in accordance with the instruction of the manufacturer, as shown on the Drawings and as specified herein. A factory qualified joining technician as designated by the pipe manufacturer shall perform all heat fusion joints.
- B. Care shall be taken in loading, transporting and unloading to prevent injury to the fittings. Fittings shall be examined before installation, and no piece shall be installed which is found to be defective. Any damage to the fitting shall be repaired as directed by the Engineer. If any defective fitting is discovered after it has been installed, it shall be removed and replaced with a sound fitting in a satisfactory manner by the contractor, at his own expense.
- C. Under no circumstances shall the fitting or accessories be dropped into the trench or forced through a directional bore upon "pull-back".
- D. Care shall be taken during transportation of the fitting such that it will not be cut, kinked or otherwise damaged.

- E. Ropes, fabric or rubber protected slings and straps shall be used when handling fittings. Chains, cables or hooks inserted into the fitting ends shall not be used. Two slings spread apart shall be used for lifting each fitting.
- F. Fittings shall be stored on level ground, preferably turf or sand, free of sharp objects, which could damage the fitting.
- G. Fittings shall be stored on clean level ground to prevent undue scratching or gouging. The handling of the fitting shall be in such a manner that the fitting is not damaged by dragging it over sharp and cutting objects. The maximum allowable depth of cuts, scratches or gouges on the exterior of the pipe is 5 percent of wall thickness. The interior fitting surface shall be free of cuts, gouges or scratches.
- H. Pipe and fittings shall be laid to lines and grade shown on the Drawings with bedding and backfill as shown on the Drawings.
- I. When laying is not in progress, including lunchtime, the open ends of the fitting shall be closed by fabricated plugs, or by other approved means.
- J. The fittings shall be joined by the method of thermal butt fusion, as outlined in PART 3 – Execution, Paragraph 3.01 Joining Method. All joints shall be made in strict compliance with the manufacturer's recommendations.
- K. Mechanical connections of the polyethylene pipe to auxiliary equipment such as valves, pumps and tanks shall be through flanged connections which shall consists of the following:
 - 1. A polyethylene flange shall be thermally butt-fused to the stub end of the pipe.
 - 2. A 316 stainless steel back up ring shall mate with a 316 stainless steel flange.
 - 3. 316 stainless steel bolts and nuts shall be used.
- L. Flange connections shall be provided with a full-face neoprene gasket.
- M. All HDPE fittings must be at the temperature of the surrounding soil at the time of backfilling and compaction.
- N. If a defective fitting is discovered after it has been installed, it shall be removed and replaced with a sound fitting in a satisfactory manner at no additional cost to the Owner. All pipe and fittings shall be thoroughly cleaned before installation, shall be kept clean until they are used in the work and when laid, shall conform to the lines and grades required.

3.3 CLEANING

- A. Clean flange adapters prior to fusing to pipe per manufactures and HDPE pipe specification requirements.

3.4 TESTING

- A. Test flanges once all HDPE pipe is connected and ready for testing. Test flange adapters along with pipe per pipe specification section 40 05 10.07 – High Density Polyethylene (HDPE) Pipe.

END OF SECTION

SECTION 40 05 52 – PROCESS VALVES

PART 1 GENERAL

1.1 SUMMARY

- A. The Contractor shall provide all valves, actuators, and appurtenances, complete and operable, in accordance with the Contract Documents.
- B. The provisions of this Section shall apply to all valves and valve actuators except where otherwise indicated. Valves and actuators in particular locations may require a combination of units, sensors, limit switches, and controls indicated in other Sections of the Specifications.
- C. Unit Responsibility: A single manufacturer shall be made responsible for coordination of design, assembly, testing, and furnishing of each valve; however, the Contractor shall be responsible to the Owner for compliance with the requirements of each valve section. Unless indicated otherwise, the responsible manufacturer shall be the Manufacturer of the valve.
- D. Single Manufacturer: Where two or more valves of the same type or size are required, the valves shall be furnished by the same Manufacturer.

1.2 REFERENCE STANDARDS

- A. American National Standards Institute (ANSI): Z21.15, Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves.
- B. American Society of Mechanical Engineers (ASME):
 - 1. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
 - 2. B16.44, Manually Operated Metallic Gas Valves for Use in Above Ground Piping Systems up to 5 psi.
- C. American Society of Sanitary Engineers (ASSE): 1011, Performance Requirements for Hose Connection Vacuum Breakers.
- D. American Water Works Association (AWWA):
 - 1. C500, Metal-Seated Gate Valves for Water Supply Service.
 - 2. C504, Rubber-Seated Butterfly Valves, 3 In. (75 mm) Through 72 In. (1,800 mm).
 - 3. C508, Swing-Check Valves for Waterworks Service, 2-In. Through 24-In. (50-mm Through 600-mm) NPS.

4. C509, Resilient-Seated Gate Valves for Water Supply Service.
5. C510, Double Check Valve Backflow Prevention Assembly.
6. C511, Reduced-Pressure Principle Backflow Prevention Assembly.
7. C512, Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service.
8. C515, Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service.
9. C550, Protective Interior Coatings for Valves and Hydrants.
10. C800, Underground Service Line Valves and Fittings.

1.3 SUBMITTAL

- A. General: Submittals shall be furnished in accordance with Section 01 33 00 –Submittal Procedures.
- B. Shop Drawings: Shop drawings shall contain the following information:
 1. Valve name, size, flow coefficient of the valve (Cv) factor, pressure rating, identification number (if any), and specification section number.
 2. Complete information on valve actuator, including size, Manufacturer, model number, limit switches, and mounting.
 3. Cavitation limits for all control valves.
 4. Assembly drawings showing part nomenclature, materials, dimensions, weights, and relationships of valve handles, handwheels, position indicators, limit switches, integral control systems, needle valves, and control systems.
 5. Complete wiring diagrams and control system schematics.
 6. Valve Labeling: A schedule of valves to be labeled, indicating in each case the valve location and the proposed wording for the label.
- C. Owner's Manual: The Owner's Manual shall contain the required information for each valve.
- D. Spare Parts List: A Spare Parts List shall contain the required information for each valve assembly, where indicated.
- E. Factory Test Data: Where indicated, signed, dated, and certified factory test data for each valve requiring certification shall be submitted before shipment of the valve. The

data shall also include certification of quality and test results for factory-applied coatings.

PART 2 PRODUCTS

2.1 PRODUCTS - GENERAL

- A. General: All valves and gates shall be new and of current manufacture. All shut-off valves 6 inches and larger shall have actuators with position indicators. Buried valves shall be provided with valve boxes and covers containing position indicators and valve extensions. Manual shut-off valves mounted higher than 6 feet above working level shall be provided with chain actuators.
- B. Valve Actuators: Unless otherwise indicated, valve actuators shall be in accordance with Section 40 05 57 – Actuators for Process Valves and Gates.
- C. Protective Coating: The exterior surfaces of all valves and the wet interior surfaces of all ferrous valves of sizes 4 inches and larger shall be coated in accordance with Section 09 97 00 – Special Coating. Finish color for valves shall be same as coating system and finish color of connected piping. The valve Manufacturer shall certify in writing that the required coating has been applied and tested in the manufacturing plant prior to shipment, in accordance with these Specifications. Flange faces of valves shall not be epoxy coated.
- D. Valve Labeling: Except when such requirement is waived by the Engineer in writing, a label shall be provided on all shut-off valves and control valves except for hose bibbs and chlorine cylinder valves. The label shall be of 1/16-inch plastic or stainless steel, minimum 2 inches by 4 inches in size, and shall be permanently attached to the valve or on the wall adjacent to the valve as directed by the Engineer.
- E. Valve Testing: As a minimum, unless otherwise indicated, each valve body 4 inches and larger shall be tested hydrostatically to 1.5 times its rated 100 degrees Fahrenheit (F) design water-working pressure, for a period of 5 minutes, without showing any leaks or loss of pressure. In addition, each valve 4 inches and larger shall undergo a functional test to demonstrate satisfactory operation throughout its operating cycle, and a closure test at rated 100 degrees F water-working pressure for a period of 5 minutes to demonstrate tight shut-off. Stem seal leakage shall not be a cause for rejection. All valves 3 inches and smaller shall undergo the Manufacturer's standard test.
- F. Certification: Prior to shipment, the Contractor shall submit for all valves over 12 inches in size, certified, notarized copies of the hydrostatic factory tests, showing compliance with the applicable standards of AWWA, ANSI, and ASTM International (ASTM).

- G. Valve Marking: All valve bodies shall be permanently marked in accordance with Manufacturers Standardization Society (MSS) SP25 - Standard Marking Systems for Valves, Fittings, Flanges, and Unions.
- H. Nuts and Bolts: All nuts and bolts on valve flanges and supports shall be in accordance with Manufacturer's standards.

2.2 VALVE ACCESSORIES

- A. All valves shall be furnished complete with the accessories required to provide a functional system.
- B. Buried and Submerged Valves:
 - 1. Provide seals on shafts and gaskets on valve and actuator covers to prevent water entry.
 - 2. Provide totally enclosed actuator mounting brackets with gasket seals.
- C. Valve Boxes
 - 1. Provide for buried valves.
 - 2. Three-piece screw type cast iron box and cover.
 - 3. Valve box diameter 5-1/4-inch, length as required for installation.
 - 4. Provide extension stems, complete with operating nuts, as required for installation.
- D. Floor Boxes:
 - 1. Provide for valves as shown on Drawings.
 - 2. Cast iron box and cover.
 - 3. Provide valves with extension stems, complete with operating nuts, as required to locate top of operating nuts 2 inches below top of floor box cover.
- E. Extension Stems for Submerged Valves:
 - 1. Provide for valves as shown on Drawings.
 - 2. Provide with intermediate stem guides with maximum spacing not exceeding 10 feet or L/R not exceeding 200.
 - 3. Type 304 stainless steel.

2.3 SPARE PARTS

- A. Where indicated, the Contractor shall furnish the required spare parts suitably packaged and labeled with the valve name, location, and identification number. The Contractor shall also furnish the name, address, and telephone number of the nearest distributor for the spare parts of each valve. All spare parts are intended for use by the Owner, only, after expiration of the guarantee period.

2.4 VALVES

- A. Butterfly Valves (V-100+ Series)

- 1. General:

- a. In full compliance with AWWA C504 and following requirements:

- 1) Suitable for throttling operations and infrequent operation after periods of inactivity.
 - 2) Elastomer seats which are bonded or vulcanized to the body shall have adhesive integrity of bond between seat and body assured by testing, with minimum 75-pound pull in accordance with ASTM D429, Method B.
 - 3) Bubble-tight with rated pressure applied from either side. Test valves with pressure applied in both directions.
 - 4) No travel stops for disc on interior of body.
 - 5) Self-adjusting V-type or O-ring shaft seals.
 - 6) Isolate metal-to-metal thrust bearing surfaces from flow stream.
 - 7) Provide traveling nut or worm gear actuator with handwheel. Valve actuators to meet the requirements of AWWA C504.
 - 8) Buried service operators shall withstand 450 foot-pounds of input torque at fully open and fully closed positions.
 - 9) Provide linings and coatings per AWWA, unless otherwise indicated on Drawings or specified herein.
 - 10) Valves to be in full compliance with NSF/ANSI 61.

- b. Non-AWWA butterfly valves to meet the following actuator requirements:

- 1) For above ground installations, provide handle and notch plate for valves 6 inches and smaller and heavy-duty, totally enclosed gearbox type operators

with handwheel, position indicator and travel stops for valves 8 inches and larger, unless otherwise indicated on Drawings or specified herein.

2. Type V-100 Butterfly Valve, Water Works Service

- a. Size: 3 inches to 72 inches
- b. AWWA C504, Class 150B
- c. Short body type, flanged ends
- d. Cast-iron body, cast or ductile iron disc, Type 304 stainless steel shafts, rubber seat, and stainless steel seating surface
- e. Provide epoxy lining in compliance with AWWA C550.
- f. Manufacturers and Products:
 - 1) Pratt; Model 2FII or Triton XR-70
 - 2) DeZurik; AWWA Valve

3. Type V-102 Butterfly Valve, General Service

- a. Size: 3 inches to 20 inches
- b. AWWA C504, Class 150B
- c. Wafer style type
- d. Buna-N rubber seat
- e. Manufacturers and Products:
 - 1) Pratt Monoflange Mark II

4. Type V-103 Butterfly Valve, Low Pressure Process Air Service Isolation

- a. Size: 24 inches to 48 inches
- b. Resilient Seated
- c. Flanged style cast-iron body, aluminum bronze discs, Type 304 stainless steel one-piece stem, self-lubricating bronze sleeve type bearing, ethylene propylene diene methylene (EPDM) replaceable resilient seat suitable for operating temperatures up to 250 degrees F, 150 pounds per square inch (psi) working pressure, rating, bubble-tight at 50 psi differential pressure, externally

adjustable bronze packing gland with Buna-N packing, valve body to fit between ASME B16.1 Class 125/150 flanges.

- d. Manufacturers and Products:
 - 1) Bray Controls; Series 35.
 - 2) Approved Equal
- 5. Type V-104 Butterfly Valve, Low Pressure Process Air Service Modulating
 - a. Size: 1 inch to 24 inches
 - b. Resilient Seated
 - c. Wafer or lug style with epoxy coated ductile iron body for use with ANSI class 125/150 flanges. Valve rated for service to 150psi.
 - d. Material
 - 1) The valve body shall be one-piece wafer lug design for 2 inch through 24 inch, with extended neck to allow for 2" of piping insulation, have flange hole drilling per international flange standards and be provided with a non-corrosive bushing and self-adjusting stem seal. Body material shall be ductile iron with epoxy coating.
 - 2) The valve seat shall totally encapsulate the body isolating the body from the line media and no flange gaskets shall be required. Seat material shall be EPDM, suitable for 250 degrees Fahrenheit service.
 - 3) Valve bearing shall be of self-lubricating, nonmetallic material to effectively isolate the disc-shaft assembly from the valve body. Metal-to-metal thrust bearing in the flow stream are not allowed.
 - 4) Valve disc and stem shall be 316 stainless steel. The disc-to-stem connection shall be an internal square design with no possible leak paths in the disc-to-stem connection. External disc-to-stem connections such as screws or pins are not allowed. The valve stem shall be one-piece blow out proof design, mechanically retained in the body neck and no part of the stem shall be exposed to the media.
 - 5) The valve disc shall offer the following features:
 - a) Equal percent flow characteristics.
 - b) Identical flow pattern in either flow direction.
 - c) Unaffected by fluid induced dynamic torque problems.
 - d) Low breakaway torque.

e. Actuators

- 1) Actuators shall be per the requirements of Section 40 05 57 – Actuators For Process Valves And Gates.

f. Manufacturers and Products:

- 1) DeZurik; BOS Series
- 2) Millken
- 3) Val-Matic
- 4) Approved Equal

B. Ball Valves (V-200+ Series)

1. Type V-200 Metal Ball Valves, General Water and Air Service

- a. Size: 4 inches and smaller
- b. Body: Ball valves up to 1-1/2-inch (included) in size shall have bronze or carbon steel 2- or 3-piece bodies with screwed ends for a pressure rating of not less than 600 psi water, oil, gas (WOG). Valves 2-inch to 4-inch in size shall have bronze or carbon steel 2- or 3-piece bodies with flanged ends for a pressure rating of ANSI 125 psi or 150 psi unless otherwise indicated.
- c. Balls: The balls shall be solid chrome plated brass or bronze, or stainless steel, with standard port (single reduction) or full port openings.
- d. Stems: The valve stems shall be of the blow-out proof design, of bronze, stainless steel, or other acceptable construction, with reinforced Teflon seal.
- e. Seats: The valve seats shall be of Teflon or Buna-N, for bi-directional service and easy replacement.
- f. Manufacturers:
 - 1) Conbraco Industries, Inc. (Apollo)
 - 2) ITT Engineered Valves
 - 3) Neles-Jamesbury, Inc.
 - 4) Nibco
 - 5) Watts Regulator
 - 6) Worchester Controls
 - 7) Flow-Tek

2. Type V-201 Plastic Ball Valves, Chemical Service

- a. Size: 4 inches and smaller

- b. Plastic ball valves for corrosive fluids shall be made of polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), polypropylene (PP), or polyvinylidene fluoride (PVDF), as recommended by the Manufacturer for the specific application.
- c. Plastic ball valves with a vented ball shall be installed so that the vent is directed back upstream
- d. Construction
 - 1) Plastic ball valves shall have union ends or flanged ends to mate with ANSI B 16.5, class 150 flanges, for easy removal. The balls shall have full size ports and Teflon seats. Body seals, union O-ring seals, and stem seals shall be in accordance with the corrosion resistance requirements of respective valve manufacturer. External (without entering into the wetted area) seat packing adjustment is preferred. Metal reinforced stems to prevent accidental breakage are preferred. The valves shall be suitable for a maximum working non-shock pressure of 150 psi at 73 degrees F for PVC and CPVC, with decreasing ratings for higher temperatures and other plastics.
 - 2) Ball valves for chemical solutions that produce off-gas, such as sodium hypochlorite, shall be provided with vented balls with pressure relief hole drilled on low pressure side by the ball valve manufacturer.
- e. Manufacturers:
 - 1) ASAHI-America
 - 2) Nibco
 - 3) George Fischer, Inc.
 - 4) Plast-O-Matic Valves, Inc.
 - 5) Spears Mfg Co.

C. Plug Valves (V-300+ Series)

- 1. Type V-300 Plug Valves, General Water and Sludge Service
 - a. Size: All
 - b. Flanged, non-lubricated, resilient seated eccentric type.
 - c. Drip-tight shutoff up to full pressure rating of valve, with pressure in either direction.
 - d. Pressure rating:

- 1) Valves 12-inch and smaller: 175 psi gauge (psig)
 - 2) Valves 14-inch and larger: 150 psig
- e. Cast iron body, ASTM A 126, Grade B.
- f. Buna-V packing or O-ring seals.
- g. Nickel seats.
- h. Balanced plug coated with Hycar.
- i. End Style:
 - 1) Non-buried service: Flanged ends, 150-pound ANSI standard.
 - 2) Buried service: Mechanical joint.
- j. Bearings:
 - 1) Valves 20-inch and smaller: Stainless steel.
 - 2) Valves 24-inch and larger: Bronze or stainless steel.
- k. Manufacturers:
 - 1) DeZurik Series 100, Figure 118
 - 2) Milliken, Millcentric Series 600
 - 3) Pratt, Ballcentric
 - 4) Val-Matic, Series 5000
- 2. Type V-305 3-way Plug Valves, General Water and Sludge Service
 - a. Concentric, non-lubricated with resilient faced plug capable of 360-degree rotation to shut off any of the three ports.
 - b. Port areas are 100 percent of pipe area.
 - c. Drip-tight shutoff up to full pressure rating of valve, with pressure in any direction.
 - d. Pressure Rating 175 psi.
 - e. Body of ASTM A536 Ductile Iron
 - f. Fusion bonded epoxy coating interior/exterior
 - g. Flanges per ANSI B16.1, Class 125
 - h. Radial bearings shall be self-lubricating type 316 SST

- i. Externally adjustable 2 way thrust bearing shall be bronze
- j. Shaft seals shall be “V” type packing in a fixed gland with an adjustable follower
- k. Manufacturers
 - 1) DeZurik
 - 2) Milliken
 - 3) Val-Matic

D. Check Valves (V-400+ Series)

1. Type V-400 Check Valves, General Service

- a. Size: 2 inches and smaller
- b. All bronze
- c. Threaded cap, threaded ends
- d. Swing type
- e. Replaceable Teflon disc and bronze disc holder
- f. Rated 125-pound SWP, 200-pound WOG
- g. Manufacturers:
 - 1) Walworth
 - 2) Approved Equal

2. Type V-401 Check Valve, General Service

- a. Size: 2-1/2 inches to 12 inches
- b. Cast-iron body
- c. Flanged end
- d. Bronze mounted swing type
- e. Solid bronze or cast-iron disc
- f. Bronze seat ring
- g. Rated 125-pound SWG, 200-pound WOG
- h. Manufacturers:

- 1) Stockham
 - 2) Crane Co.
3. Type V-405 Cushioned Swing Check Valve, General Service
 - a. Size: 2 inches to 48 inches
 - b. Swing check valves are of self-contained, free-swinging disc style, allowing a clear waterway. Valve disc swings freely open and is keyed to valve hinge pin without the use of pins.
 - c. Cast iron body and cover
 - d. Ductile iron hinge and disc
 - e. Buna-N, stainless steel, or bronze disc seating surface
 - f. Bronze or stainless steel seat rings
 - g. Two-component epoxy internal and external coatings
 - h. Manufacturer or equal:
 - 1) APCO
 - 2) Val-Matic
4. Type V-406 PVC Ball Check Valve, Chemical Service
 - a. Size: 4 inches and smaller
 - b. ASTM D1784, Type I, Grade 1 PVC body
 - c. Single or dual union socket weld ends
 - d. Rated 150 psi at 73 degrees F, 110 psi at 140 degrees F
 - e. Viton seat and seal
 - f. Manufacturers:
 - 1) Nibco; Chemtrol Tru Union
 - 2) ASAHI/America
 - 3) Spears; True Union
5. Type V-407 CPVC Ball Check Valve, Chemical Service
 - a. Size: 4 inches and smaller

- b. ASTM D1784 Cell Class 23477B CPVC body
 - c. Single or dual union socket weld ends
 - d. Rated 150 psi at 73 degrees F, 110 psi at 140 degrees F
 - e. Viton seat and seal
 - f. Manufacturers:
 - 1) Nibco; Chemtrol Tru Union
 - 2) ASAHI/America
 - 3) Spears; True Union
6. Type V-408 Double Check Valve Backflow Prevention Assembly
- a. Size: 3/4-inch to 10 inches
 - b. Two resilient seated check valves, two nonrising stem resilient-seated isolation valves, test cocks, in accordance with AWWA C510
 - c. Rated 175 psi maximum working pressure
 - d. Meets requirements of University of Southern California (USC) Foundation for Cross-Connection Control and Hydraulic Research
 - e. Manufacturers:
 - 1) FEBCO
 - 2) Danfoss Flomatic
 - 3) Watts Regulator Company
7. Type V-409 Reduced Pressure Principle Backflow Prevention Assembly
- a. Size: 3/4-inch to 10 inches
 - b. Backflow preventers shall work on the reduced pressure principle. They shall consist of two spring-loaded check valves, automatic differential pressure relief valve, drain valves, and shut-off valves. The body material shall be bronze or cast iron for a working pressure of not less than 150 psi, with bronze or stainless steel trim. Drain lines with air gaps shall be provided. The backflow preventer valves shall be in accordance with AWWA C511 standard.
 - c. Manufacturers:
 - 1) Cla-Val Company
 - 2) FEBCO

- 3) Hersey Products, Inc.
- 4) Watts Regulator Company
- 5) Wilkins Regulator Company (Division of Zurn Industries)

8. Type V-410 Check Valve, Duckbill Type

- a. Size: 1-inch to 48 inches
- b. Elastomer type flanged or slip-on as shown on Drawings.
- c. Round entry area to match pipe, contoured duckbilled shaped exit, flat bottom and off-set bill design, curved bill for 18 inches and larger
- d. Valve open and rated 333 gpm flow at 1 foot head differential, difference of upstream water elevation and downstream water elevation, and rate zero flow at 6 inches head differential.
- e. Rated for 50 psi minimum operating pressure
- f. Flanges steel backing flange type, drilled to ASME B16.1, Class 125, plain-end valve attached with two Type 316 stainless steel adjustable bands
- g. Elastomer nylon-reinforced neoprene or Buna-N
- h. Manufacturer:
 - 1) Red Valve Co.; Tideflex Check Valve.

9. Type V-411 Check Valve, Rubber Wall-mounted Backflow Prevention Type

- a. Size: 18-inch
- b. Wall back plate set flush on the wall of pipe penetration and outlet, unit invert aligned to the pipe invert to prevent any gap in the flow pattern, anchor holes drilled through the flange
- c. Buna-N rubber or neoprene flap, Type 304 stainless steel back plate and hardware
- d. Manufacturer:
 - 1) Hydrovex Check Valve CCV
 - 2) Whipps Series 451 Rubber Flap Gate

E. Gate Valves (V-500+ Series)

1. Type-500 Gate Valves

- a. The resilient seat gate valves shall fully comply with the latest revision of AWWA C509 and shall also be Underwriters Laboratories (UL) listed and Factory Mutual (FM) approved.
- b. The gate valve shall have a 250 psig working pressure.
- c. The valve type shall be non-rising stem (NRS) or outside screw and yoke (OS&Y) as specified.
- d. The valve shall have an arrow cast on the operating nut or handwheel showing opening direction. The direction of opening shall be as specified.
- e. The NRS valves shall be provided with a 2-inch square operating nut and OS&Y valves shall be provided with a handwheel. The bolt that attaches the operating nut to the stem shall be recessed into the operating nut so as not to interfere with valve wrench operation.
- f. The valves shall have bolts and nuts for the stuffing box and bonnet with one of the following compositions:
 - 1) Steel, ASTM A-307, Grade B zinc plated.
 - 2) Type 304 stainless steel.
 - 3) Type 316 stainless steel
- g. The gate valve stem shall be made of bronze ASTM B-132 alloy C67600 bar stock material. The stem shall have at least one "anti-friction" thrust washer above and below the stem collar to reduce operating torque. The design of the NRS valve stem shall be such that if excessive input torque is applied, stem failure shall occur above the stuffing box at such a point as to enable the operation of the valve with a pipe wrench or other readily available tool. The stem material shall provide a minimum 70,000 psi tensile strength with 15 percent elongation and yield strength of 30,000 psi. Valves with cast stems or two-piece stem collars are not acceptable.
- h. The NRS valves shall have a stuffing box that is O-ring sealed. Two O-rings shall be placed above and one O-ring below the stem thrust collar. The thrust collar shall be factory lubricated. The thrust collar and its lubrication shall be isolated by the O-rings from the waterway and from outside contamination providing permanent lubrication for long term ease of operation. Valves without a stuffing box are unacceptable. Valves without at least three stem O-rings are also unacceptable.
- i. The gate valve body, bonnet, stuffing box, and disc shall be composed of ASTM A-126 Class B grey iron or ASTM A395 or A536 ductile iron. The body and

bonnet shall also adhere to the minimum wall thickness as set forth in Table 2, section 4.3.1 of AWWA C509.

- j. The valve disc and guide lugs must be fully (100 percent) encapsulated in SBR ASTM D2000 rubber material. The peel strength shall not be less than 75 pounds per inch. Guide caps of an acetal bearing material shall be placed over solid guide lugs to prevent abrasion and to reduce the operating torque.
- k. The valves shall have all internal and external ferrous surfaces coated with a fusion bonded thermosetting powder epoxy coating of 10 mils nominal thickness. The coating shall conform to AWWA C550.
- l. The tapping valves shall have an inlet flange conforming to ANSI B16.1 Class 125 for attachment to a tapping sleeve or cross. In addition, the valve inlet flange shall have a machined projection or raised face complying with MSS SP-60 for accurate alignment to the mating recess in the tapping sleeve flange. The seat opening of the tapping valves shall be at least 0.30 inches larger than the nominal pipe size to permit full diameter cuts.
- m. The valves shall be warranted by the manufacturer against defects in materials or workmanship for a period of 10 years from the date of manufacture. The manufacturing facility for the valves must have current ISO certification.
- n. Manufacturers:
 - 1) Mueller A2360 series
 - 2) American Flow Control 2500 Series
 - 3) Or approved equal

F. Needle Valves (V-600+ Series)

- 1. Type V-600 Metal Needle Valve, Water Service
 - a. Size: 3/4 inches and smaller
 - b. PVC
 - c. Threaded bonnet, packed gland, rising stem, bronze body, and stem
 - d. Class 200 rated 200 psi Steam Working Pressure (SWP)/400 psi Cold Working Pressure (CWP), complies with MSS SP-80
 - e. Manufacturers:
 - 1) Crane Cat
 - 2) Stockham

2. Type V-601 Plastic Needle Valve, Gas and Chemical Service
 - a. Size: 1-inch and smaller
 - b. Injection molded in PVC, CPVC, Polypropylene, or high purity polyvinylidene fluoride (HP PVDF) with PTFE seals
 - c. Globe pattern and angle pattern
 - d. Threaded ends or solvent socket, compression tube assessor fittings
 - e. Rated 200 psi minimum
 - f. Manufacturers:
 - 1) ASAHI-America
 - 2) Marquest Scientific

G. Globe Valves (V-700+ Series)

1. Type V-700 Globe Valve, Water Service
 - a. Size: 3 inches and smaller
 - b. All-bronze
 - c. National pipe thread (NPT) threaded ends, union bonnet, packed gland, inside screw, rising stem, tetrafluoroethylene (TFE) disc
 - d. Up to Class 200 rated 200 psi SWP/400 psi CWP, complies with MSS SP-80
 - e. Manufacturers:
 - 1) Stockham
 - 2) Crane Co.
2. Type V-701 Globe Valve, General Service
 - a. Size: 2 inches to 10 inches
 - b. Iron body, bronze mounted
 - c. Flanged ends, bronze seat, OS&Y, bolted bonnet, Class 125 rated 125 psi SWP/200 psi CWP, complies with MSS SP-85 Type 1.
 - d. Manufacturers:
 - 1) Stockham

- 2) Crane Co.
3. Type V-704 Hose Valve
 - a. Size: 1-inch to 3 inches
 - b. Angle Pattern or Globe Style
 - c. All-bronze, NPT threaded ends, inside screw-type rising stem, TFE disc, complies with MSS SP-80, rated 300 WOG.
 - d. Manufacturers:
 - 1) Stockham
 - 2) Crane Co.
 - 3) Nibco
- H. Regulating and Release Valves (V-800+ Series)
 1. Type V-800 Pressure-Reducing Valve, Water Service
 - a. Size: 2-1/2 inches and smaller
 - b. Direct diaphragm operated, spring controlled, bronze body, NPT threaded ends, 200-psig rated minimum.
 - c. Size/Rating: As shown in Valve Schedule.
 - d. Manufacturers and Products:
 - 1) Fisher
 - 2) Watts
 2. Type V-810 PVC Pressure Relief, By-Pass Relief, Back-Pressure Regulator, Back-Pressure, Anti-Siphon Valve, Chemical Service
 - a. Size: 1/2-inch to 2 inches
 - b. Direct acting diaphragm, spring controlled, in-line pattern, NPT threaded inlet and outlet, 150 psi design pressure.
 - c. PVC body, Teflon or Viton diaphragm, PVC or Teflon piston, high-density polyethylene or stainless steel adjusting bolt and locknut, stainless steel or coated steel spring, stainless steel fasteners.
 - d. Designed to open when upstream pressure reaches setpoint; set pressure adjustable from 10 psi to 100 psi, minimum.

- e. Manufacturers:
 - 1) Plast-O-Matic; Series RVD
 - 2) Griffco; Series BPV
 - 3) Primary Fluid Systems; TOP Valve
- 3. Type V-820 Wastewater Air and Vacuum Valves
 - a. Air and vacuum valves shall be capable of venting large quantities of air while pipelines are being filled and allowing air to re-enter while pipelines are being drained. Valves shall be suitable for wastewater with high solids content.
 - b. Size: 16 inches and small
 - c. Flanged or screwed ends to match piping. Bodies shall be of high-strength cast iron. The float, seat, and all moving parts shall be constructed of Type 316 stainless steel. Seat washers and gaskets shall be of a material insuring water tightness with a minimum of maintenance. Valves shall be designed for minimum 150 psi water-working pressure, unless otherwise shown. Isolation valve shall be provided.
 - d. Manufacturers:
 - 1) APCO (Valve and Primer Corporation)
 - 2) Crispin (Multiplex Manufacturing Company)
 - 3) Golden-Anderson Valve Division (GA Industries, Inc.)
 - 4) Val-Matic (Valve and Manufacturing Corporation)
- 4. Type V-821 Wastewater Air-Release Valves
 - a. Air-release valves shall vent accumulating air while system is in service and under pressure and be of the size shown and shall meet the same general requirements as specified for air and vacuum valves except that the vacuum feature will not be required. Valves shall be suitable for wastewater with high solids content.
 - b. Minimum water-working pressure of 150 psi, unless otherwise shown. Isolation valve shall be provided.
 - c. Manufacturers:
 - 1) APCO (Valve and Primer Corporation)
 - 2) Crispin (Multiplex Manufacturing Company)
 - 3) Golden-Anderson Valve Division (GA Industries, Inc.)
 - 4) Val-Matic (Valve and Manufacturing Corporation)

5. Type V-822 Wastewater Combination Air Valves

- a. Combination air valves shall combine the characteristics of air and vacuum valves and air release valves by exhausting accumulated air in systems under pressure and releasing or re-admitting large quantities of air while a system is being filled or drained, respectively. They shall have the same general requirements as specified for air and vacuum valves. Isolation valve shall be provided. Valves shall be suitable for wastewater with high solids content. Single body unit with air and vacuum valve and an air release valve in a single housing.
- b. Materials: Cast-iron or ductile iron body and covers, NTP threaded inlet and outlet, with concave or skirted stainless steel float and trim.
- c. Manufacturers:
 - 1) APCO (Valve and Primer Corporation)
 - 2) Crispin (Multiplex Manufacturing Company)
 - 3) Golden-Anderson Valve Division (GA Industries, Inc.)
 - 4) Val-Matic (Valve and Manufacturing Corporation)

I. Miscellaneous Valves (V-900+ Series)

1. Type V-900 Telescoping Valve

- a. The valve shall utilize a low friction seal to mount to engage the slip tube and mount to the flange of the receiving pipe.
- b. All welds shall be performed by welders with American Welding Society (AWS) certification.
- c. Finish: Mill finish on stainless steel. Welds shall be sandblasted to remove weld burn and scale.

1) Materials:

<u>Components</u>	<u>Materials</u>
Slip Tube and Bail	Stainless Steel, Type 316L, ASTM A240
Stem	Stainless Steel, Type 316, ASTM A276
Fasteners, Nuts, and Bolts	Stainless Steel, Type 316, ASTM A276
Seal	Urethane or Neoprene
Lift Nuts	Bronze ASTM B584
Pedestals and Wall Brackets	Stainless Steel, Type 316L, ASTM A276
Operator Housing	Cast aluminum

- d. ANCHOR BOLTS: minimum diameter of 1/2-inch, Type 316 stainless steel
 - e. Manufacturers:
 - 1) Whipps, Inc., Series 310
 - 2) Link-Belt Division of FMC Corp.
 - 3) Envirex Division of Rexnord Corp
2. Type V-901 Mud Valve
- a. Size: 4 Inches to 24 Inches
 - b. Cast-iron frame, yoke, and gate; heavy-duty 125-pound flange style, bronze seat, Buna-N seal, NRS, bronze stem and stem nut, 2-inch square operating nut, cast-iron floor box, Type 304 stainless steel extension stem; stem guides spaced for L/R of 200 maximum.
 - c. Manufacturers:
 - 1) Clow Valve Company
 - 2) Troy Valve
 - 3) Trumbull Industries, Inc.
 - 4) Whipps, Inc.
3. Type V-903 Solenoid Valve
- a. Size: 1/4-inch to 2 inches
 - b. Two-way internal pilot operated diaphragm type, brass body, resilient seat suitable for air or water, solenoid coil molded epoxy, National Electrical Manufacturers Association (NEMA) insulation Class F, 120 volts alternating current (AC), 60-Hertz, unless otherwise indicated. Solenoid enclosure NEMA 250, Type 4 unless otherwise indicated. Size and normal position (when de-energized) as indicated on Valve Schedule.
 - c. Minimum operating pressure differential no greater than 5 psig, maximum operating pressure differential not less than 125 psig.
 - d. Manufacturers and Products:
 - 1) ASCO
 - 2) Skinner

PART 3 EXECUTION

3.1 VALVE INSTALLATION

- A. General: All valves, actuating units, stem extensions, valve boxes, and accessories shall be installed in accordance with the Manufacturer's written instructions and as indicated. All gates shall be adequately braced to prevent warpage and bending under the intended use. Valves shall be firmly supported to avoid undue stresses on the pipe.
- B. Access: All valves shall be installed with easy access for actuation, removal, and maintenance and to avoid interference between valve actuators and structural members, handrails, or other equipment.
- C. Valve Accessories: Where combinations of valves, sensors, switches, and controls are indicated, the Contractor shall properly assemble and install such items so that all systems are compatible and operating properly. The relationship between interrelated items shall be clearly noted on shop drawing submittals.
- D. Backflow preventers shall be installed in potable water lines where required by applicable codes or regulations, or wherever there is any danger of contamination, and where shown.
- E. All backflow preventers, as well as air and vacuum release valves, shall have piped outlets to the nearest acceptable drain, firmly supported, and installed in such a way as to avoid splashing and wetting of floors

3.2 FIELD QUALITY CONTROL

- A. Tests:
 - 1. Pressure test valves at same time connected piping is tested.
 - 2. Repair leaking joints.
 - 3. Protect parts of valves and actuators that could be damaged by test.

3.3 INSPECTION, STARTUP, AND FIELD ADJUSTMENT

- A. The Contractor shall demonstrate that all equipment meets the specified performance requirements. As necessary, an experienced, competent, and authorized service representative of the manufacturer of each valve type shall visit the site to perform the following tasks:
 - 1. Assist the Contractor in the installation of the equipment, as necessary.
 - 2. To inspect, check, adjust if necessary, and approve the installation.
 - 3. To start-up and field-test the valves for proper operation.

4. To perform necessary field adjustments during the test period until the equipment installation and operation are satisfactory to the Engineer.

END OF SECTION

SECTION 40 05 57 - ACTUATORS FOR PROCESS VALVES AND GATES

PART 1 GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide all valve and gate actuators and appurtenances, complete and operable, in accordance with the Contract Documents.
- B. The provisions of this Section shall apply to all valves and gates, except where otherwise indicated in the Contract Documents.
- C. Unit Responsibility: A single manufacturer shall be made responsible for furnishing the WORK and for coordination of design, assembly, testing, and installation of the WORK of each type of valve and gate; however, the CONTRACTOR shall be responsible to the OWNER for compliance with the requirements of each valve and gate section. Unless otherwise indicated, the single manufacturer shall be the Manufacturer of the valve or gate.
- D. Single Manufacturer: All electric actuators supplied will be from the same Manufacturer. The actuators and valves shall be furnished and installed by the valve supplier as a unit assembly, complete in all respects. The actuators and gates shall be furnished and installed by the gate supplier as a unit assembly, complete in all respects.

1.2 CONTRACTOR SUBMITTALS

- A. General: Submittals shall be furnished in accordance with Section 01 33 00 – Contractor Submittals.
- B. Shop Drawings: Shop Drawings of all actuators shall be submitted together with the valve and gate submittals as a complete package.

1.3 QUALITY ASSURANCE

- A. Qualifications
 - 1. Technologies and devices used in the actuator must have a minimum of five (5) years of commercial operating experience for that specific manufacturer.
- B. Testing
 - 1. Electric actuators shall be listed by a testing agency acceptable to the Owner in accordance with the latest version of the National Electrical Code, with the stamped or mark of that agency on the outside housing. Acceptable agencies include but are not limited to, UL, FM, and CSA.

PART 2 PRODUCTS

2.1 GENERAL

- A. General: Unless otherwise indicated, all shut-off and throttling valves, and externally-actuated valves and gates, shall be provided with manual or power actuators. The CONTRACTOR shall furnish all actuators complete and operable with mounting hardware, motors, gears, controls, wiring, solenoids, handwheels, levers, chains, and extensions, as applicable. All actuators shall be capable of holding the valve in any intermediate position between fully-open and fully-closed without creeping or fluttering. All wires of motor-driven actuators shall be identified by unique numbers.
- B. Manufacturers: Where indicated, certain valves and gates may be provided with actuators manufactured by the valve or gate Manufacturer. Where actuators are furnished by different manufacturers, the CONTRACTOR shall coordinate selection to have the fewest number of manufacturers possible.
- C. Materials: All actuators shall be current models of the best commercial quality materials and liberally-sized for the maximum expected torque. All materials shall be suitable for the environment in which the valve or gate is to be installed.
- D. Mounting: All actuators shall be securely mounted by means of brackets or hardware specially designed and sized for this purpose and of ample strength. The word "open" shall be cast on each valve or actuator with an arrow indicating the direction to open in the counter-clockwise direction. All gear and power actuators shall be equipped with position indicators.
- E. Standard: Unless otherwise indicated and where applicable, all actuators shall be in accordance with ANSI/AWWA C 540 - Standard for Power-Actuating Devices for Valves and Sluice Gates.
- F. Functionality: Electric, pneumatic, and hydraulic actuators shall be coordinated with power and instrumentation equipment indicated elsewhere in the Contract Documents.

2.2 MANUAL ACTUATORS

- A. General: Unless otherwise indicated, all valves and gates shall be furnished with manual actuators. Valves in sizes up to and including 4 inches shall have direct acting lever or handwheel actuators of the Manufacturer's best standard design. Larger valves and gates shall have gear-assisted manual actuators, with an operating pull of maximum 60 pounds on the rim of the handwheel. All buried and submerged gear-assisted valves, all gates, all gear-assisted valves for pressures higher than 250 psi, all valves 30 inches in diameter and larger, and where so indicated, shall have worm-gear actuators, hermetically-sealed and grease-packed, where buried or submerged. All

other valves 6 inches to 24 inches in diameter may have traveling-nut actuators, worm-gear actuators, spur- or bevel-gear actuators, as appropriate for each valve.

- B. Buried Valves: Unless otherwise indicated, all buried valves shall have stainless steel extension stems to grade, with square nuts or floor stands, position indicators, and cast-iron or steel pipe extensions with valve boxes, covers, and operating keys. Where so indicated, buried valves shall be in cast-iron, concrete, or similar valve boxes with covers of ample size to allow operation of the valve actuators. Covers of valve boxes shall be permanently labeled as requested by the local Utility Company or the ENGINEER. Wrench-nuts shall have a minimum of 2 operating keys, or one key per 10 valves, whichever is greater, shall be furnished.
- C. Chain Actuator: Manually-activated valves with the stem located more than 6 feet above the floor or operating level shall be furnished with chain drives consisting of sprocket-rim chain wheels, chain guides, and operating chains, and be provided by the valve Manufacturer. The wheel and guide shall be of ductile-iron, cast-iron, or steel, and the chain shall be hot-dip galvanized steel or stainless steel, extending to 4 feet above the operating floor level. The valve stem of chain-actuated valves shall be extra strong to allow for the extra weight and chain pull. Hooks shall be provided for chain storage where chains interfere with pedestrian traffic.
- D. Floor Boxes: Hot-dip galvanized cast-iron or steel floor boxes and covers to fit the slab thickness shall be provided for all operating nuts in or below concrete slabs. For operating nuts in the concrete slab, the cover shall be bronze-bushed.
- E. Manual Worm-Gear Actuator: The actuator shall consist of a single or double reduction gear unit contained in a weather-proof cast-iron or steel body with cover and minimum 12-inch diameter handwheel. The actuator shall be capable of 90-degree rotation and shall be equipped with travel stops capable of limiting the valve opening and closing. The actuator shall consist of spur or helical gears and worm-gearing. The spur or helical gears shall be of hardened alloy steel and the worm-gear shall be alloy bronze. The worm-gear shaft and the handwheel shaft shall be of 17-4 PH or similar stainless steel. All gearing shall be accurately cut with hobbing machines. Ball or roller bearings shall be used throughout. Actuator output gear changes shall be mechanically possible by simply changing the exposed or helical gearset ratio without further disassembly of the actuator. All gearing shall be designed for a 100 percent overload.

2.3 ELECTRIC MOTOR ACTUATORS

A. General

- 1. Actuators for FCV-701 and FCV-708 (12" RAS plug valves) shall be non-intrusive, intelligent quarter-turn type, suitable for use on a nominal 480 VAC, three phase, 60 Hertz power supply and are to incorporate motor, integral reversing starter,

local control facilities, and terminals for remote control and indication connections within a self-contained, sealed enclosure.

2. All other electric motor actuators shall be non-intrusive, intelligent quarter-turn type, suitable for use on a nominal 120 VAC, single phase, 60 Hertz power supply and are to incorporate motor, integral reversing starter, local control facilities, and terminals for remote control and indication connections.
3. The actuator shall include a device to ensure that the motor runs with the correct rotation for the required direction of valve travel with either phase sequence of the three-phase power supply connected to the actuator.
4. It shall be possible to carry out the setting of the torque, turns, and configuration of the indication contacts without opening or removing any electrical compartment covers.
5. Diagnostic information shall be available from both an integrally mounted display window and through non-intrusive means of reading and writing data to the actuator.
6. Two-way communication must be possible to facilitate downloading actuator setup.
7. During loss of electric power supply, fail in last valve position.
8. Operate from Full Closed to Full Open position or the reverse so that stem travel speed is 1 foot per minute.

B. Actuator Sizing

1. The actuator shall be sized to guarantee valve closure at the specified differential pressure. The safety margin of motor power available for seating and unseating the valve shall be sufficient to ensure torque switch trip at maximum valve torque with the supply voltage 10% below nominal.

C. Temperature

1. The actuator shall be capable of functioning in an ambient temperature ranging from minus 13 F (-25° C) to plus 160° F (+ 70° C).

D. Torque Controller

1. The motor control PCB shall monitor and control the amount of torque output produced by the motor. Motor current shall be measured via a sensing resistor mounted on the PCB, which is digitally filtered and then temperature compensated to produce the final calibrated output torque of the actuator. Torque setting shall

be able to be set between 40% and 100% of rated torque and shall be adjustable via a non-intrusive setting tool using Infrared Data Access (IrDA) technology.

E. Motor

1. Motors shall be sized for a minimum 25 percent duty and a rated running torque equal to 35 percent of the operator capacity at a rated running time of 15 minutes, without exceeding the allowable NEMA temperature rise for class F insulation.
2. Motors shall be totally-enclosed, non-ventilated, direct current motor.
3. The electric motor shall be a low inertia motor. The motor shall be controlled by a toroidal transformer unit, which shall also include a thermostat for motor circuit protection. Motors shall be specifically designed and built by the actuator manufacturer for electric actuator service.
4. If three phase-powered actuators are provided, the actuator shall include automatic detection and correction of 3-phase power supply to assure proper open/close directions.
5. The motor control PCB shall restrict the amount of current to prevent damage to the motor, integral switching devices or toroid transformer. A 20A fuse in the transformer secondary circuit and anti-surge fuse in the primary circuit shall provide further protection.
6. Motor removal shall be possible without loss of lubricant.

F. Gearing and Gearbox

1. The actuator gearing shall be totally enclosed in a lubricant filled gearcase suitable for operation at any angle. Food grade lubricants approved by the manufacturer shall be used to lubricate the gearcase. Special or exotic lubricants shall not be used as they may be expensive or difficult to source in some locations.
2. Gearbox shall house and operate an appropriate coupling as follows:
 - a. Coupling of operator to a multi-turn threaded rising stem valve shall be by means of threaded high tensile bronze top entry stem nut installed in a declutchable thrust base. Stem nut shall be keyed to mate with the internal bore and keyway of the operator sleeve.
 - b. Coupling of operator to a multi-turn non-rising stem shaft shall be by a high-tensile aluminum/bronze drive bushing that is easily replaceable.
3. Final stage of the operator gear train shall consist of a steel worm and a bronze alloy worm gear. Other gears shall be heat treated alloy steel or high tensile

bronze. Gear train shall be supported throughout by antifriction ball or roller bearings. The operator shall be self-locking in either motor or handwheel mode.

G. Hand Operation

1. A handwheel shall be provided for emergency operation engaged when the motor is declutched by a lever or similar means; the drive being restored to power automatically by starting the motor. The handwheel declutch mechanism shall include an output contact to indicate actuator manual operation. The hand/auto selection lever should be padlockable in both "Hand" and "Auto" positions. It should be possible to select hand operation while the actuator is running or start the actuator motor while the hand/auto selection lever is locked in "Hand" without damage to the drive train.
2. Handwheel shall be disengaged by motor operation.
3. Actuator shall incorporate a mechanism to track valve position while operated with the handwheel when electric power is off.

H. Position Setting Range

1. An intelligent micro controller on the motor PCB shall monitor and control two Hall Effect position sensors. Incremental encoders requiring batteries to retain settings upon loss of power shall not be accepted. The sensors shall employ a magnetic pulse system to measure the accuracy of the actuator's stroke. Position limits shall be factory set to 90° degrees stop bolt position, with a limit setting range of 10° to 1800°, and maximum angular resolution to 0.1°.

I. Controls

1. Control power shall be provided from an integral 24 VDC or 120 VAC supply unless a separate power source is shown on the electrical drawings. The transformer shall be sized to operate at not more than 80 percent of rating with the connected load shown. The transformer shall have protective secondary fusing. Operators shall be provided with an integral control station. The control station shall include "LOCAL/OFF/REMOTE" and "OPEN/STOP/CLOSE" switches. Open and Close positions shall be configurable for momentary or maintained-operation. Open, Close, and Stop
2. Connections for external remote controls shall be suitable for any one or more of the following methods of control:
 - a. Open and Close
 - b. Overriding Emergency, Shutdown to Close (or Open) Valve from a "Make" Contact.

c. Two-Wire Control, Energize to Close (or Open), De-Energize to Open (or Close)

J. Set Up, Monitoring and Diagnostics

1. Facilities shall be provided for monitoring actuator operation and availability as follows:
2. Monitor (availability) relay, having one change-over contact, the relay being energized from the control transformer only when the Local/Off/Remote selector is in the "Remote" position and thermostat is not "tripped" to indicate that the actuator is available for remote (control room) operation.
3. Where required, it shall be possible to provide indication of thermostat trip and "Remote" selected as discrete signals.
4. A non-intrusive hand-held computer must be available, capable of two-way communication for uploading and downloading all variables for the actuator as well as performing detailed diagnostics.
5. Actuators shall include a diagnostic data logger module, which will store and enable download of historical actuator data logger information to permit analysis of changes in actuator or valve performance. It shall be possible for customer to access data via non-intrusive infrared means using either a notebook PC or hand-held windows CE based 'Personal Digital Assistant (PDA)' capable of duplex IrDA communications. Appropriate diagnostic software shall be provided to allow configuration and diagnostic information to be reviewed, analyzed and reconfigured.
6. Provision shall be made to display valve torque demand as a percent of rated actuator torque and position simultaneously, so as to facilitate valve troubleshooting and diagnostics. The data logger shall also enable the retrieval of all configurable actuator date and time-stamped events, including the ability to search for occurrences of any particular event. Valve torque profiles shall be available in 1° positional increments. The diagnostics shall also enable retrieval of at least three types of alarms – actuator alarms, valve alarms and control system alarms.
7. A Setting Tool shall be provided and used for non-intrusive calibration and interrogation of the actuator. This Setting Tool will provide speedy interrogation capabilities as well as security in a non-intrusive intrinsically safe watertight casing. The Setting Tool shall enable the user to extract and store actuator configuration and data logger files within the Tool. The Setting Tool shall store up to ten (10) configuration and four (4) data logger files. Stored configuration and data logger files shall also be able to be uploaded to both the actuators and to diagnostic software provided by the actuator manufacturer.

K. Actuators for Modulation Duty

1. Use the above specification with the following changes and additions. The actuator shall incorporate a fast switching main control board that responds to signal changes within 100ms for modulating duty. The starter shall be suitable for 1500 starts per hour. If shown on the valve schedule, the actuator shall be capable of responding to a remote 4-20 mA control signal and positioning itself accordingly between 0-100% valve travel as well as providing a contactless transmitter to give a 4-20 mA analog signal corresponding to valve travel for remote indication. It shall be possible to adjust Dead Band (0-9.9% of travel) and a Motion Inhibit Timer (2-99 secs), and select action upon loss of signal.

L. Enclosure

1. Double-sealed 'O' Ring design shall provide a termination chamber that is separate and sealed from the control chamber. Control components shall remain sealed and protected when the termination cover is removed. Actuators shall be sealed, watertight to NEMA 6, and shall at the same time have an inner watertight and dustproof 'O' ring seal between the terminal compartment and the internal electrical elements of the actuator fully protecting the motor and all other internal electrical elements of the actuator from ingress of moisture and dust when the terminal cover is removed on site for cabling.
2. Enclosure must allow for temporary site storage without the need for electrical supply connection.
3. All external fasteners shall be stainless steel.
 - a. Actuators for explosion/hazardous applications shall in addition be certified flameproof for Zones 1 and 2 (Divisions 1 and 2) Group C, D, E, F, G hazardous areas.
 - b. Double-sealed design shall provide a termination chamber that is separate and sealed from the control chamber. Control components shall remain sealed and protected when the termination cover is removed.

M. Remote Valve Position

1. In the event of a (main) power (supply) loss or failure, the position contacts must continue to be able to supply remote position feedback and maintain interlock capabilities.
2. A backup power source must be provided in the actuator to ensure correct remote indication should the actuator be moved manually when the power supply is interrupted.

3. The position of the actuator and valve must be updated contemporaneously, even when the power supply is not present.
4. Four contacts shall be provided which can be selected to indicate any position of the valve with each contact selectable as normally open or normally closed. The contacts shall be rated at 5A, 250V AC, 30V DC.
5. As an alternative to providing valve position, any of the four above contacts shall be selectable to signal one of the following:
 - a. Valve Opening or Closing
 - b. Valve Moving (Continuous or Pulsing)
 - c. Motor Tripped on Torque in Mid-Travel
 - d. Motor Stalled
 - e. Actuator Being Operated by Handwheel
 - f. Open or Close Interlock Active
 - g. ESD Active
 - h. Motor Tripped on Torque in Mid-Travel
 - i. Motor Tripped on Torque Going Open
 - j. Motor Tripped on Torque Going Closed
 - k. Pre-Set Torque Exceeded
 - l. Valve Jammed
 - m. Actuator Being Operated by Handwheel
 - n. Lost Main Power Phase
 - o. Customer 24V DC or 24V AC Supply Lost
 - p. Battery Low
 - q. Internal Failure Detected
 - r. Thermostat Tripped

N. Local Position Indication

1. The actuator must provide a local display of the position of the valve, even when the power supply is not present. The display shall be able to be rotated in 90 degree increments in order to provide easy viewing regardless of actuator mounting position.
2. The local display should be large enough to be readable from a distance of six feet (6') when the actuator is powered up. In addition to valve position, the local display shall also display torque in percent of rated value as well as customer-configurable multilingual text.
3. The actuator shall include a digital position indicator with a display from fully open to fully closed in 1% increments. Red, green, and yellow lights corresponding to Open, Closed, and Intermediate positions shall be included on the actuator. The digital display shall be maintained even when the power to the actuator is isolated.

O. Integral Push Button and Selector

1. Integral to the actuator shall be local controls for Open, Close, and Stop, and a local/remote selector switch padlockable in any one of the following three positions:
 - a. Local Control Only
 - b. Off (No Electrical Operation)
 - c. Remote Control plus Local Stop Only.
2. It shall be possible to select maintained or non-maintained local control.
3. The local controls shall be arranged so that the direction of valve travel can be reversed without the necessity of stopping the actuator. It shall be possible to program the actuator without removal of any covers.

P. Acuator Networking

1. Provisions shall be made for connectivity with the following interfaces available:
 - a. Ethernet/IP

Q. Special Features

1. An LCD indicator panel shall provide continuous position and torque information as well as valve status, alarm, and diagnostic information.
2. Actuators shall include a diagnostic data logger module, which will store and enable download of historical actuator data logger information to permit analysis of changes in actuator or valve performance. It shall be possible for customer to setup, calibrate and access actuator data via non-intrusive infrared means using any of three methods: Setting Tool, Laptop PC or hand-held Windows CE-based 'Personal Digital Assistant (PDA)' capable of duplex IrDA communications. Appropriate diagnostic software shall be provided by the actuator manufacturer to allow configuration and diagnostic information to be reviewed, analyzed and reconfigured. One hand-held programming setting tool shall be provided for every 10 actuators shipped. Data download shall be carried out without removing any actuator covers.
3. Actuator calibration, setup, and communications settings shall be stored in non-volatile memory and shall be retained in the event of loss of power. In addition, battery power shall ensure that local indication of valve position is provided under power-failure conditions.
4. Non-intrusive local control switches shall communicate switch position to the microprocessor without penetrations in the actuator housing.

5. Actuator's microprocessor shall continuously accept control signals (when in Remote) and communicate position, torque, status, alarm, and diagnostic data to the plant process control system via a data network connection.

R. Performance Test Certificate

1. Each actuator must be performance tested and individual test certificates shall be supplied free-of-charge. The test equipment should simulate a typical valve load and the following parameters should be recorded:
 - a. Current at maximum torque setting
 - b. Torque sensing tripping points in both the open and closed directions of travel
 - c. Actuator Output Speed or Operating Time
2. In addition, the test certificate should record details of specification, such as gear ratios for both manual and automatic drive, closing direction, and wiring diagram code number.

S. Warranty

1. Each actuator shall be warranted for a minimum of 12 months of operation up to a maximum of 24 months from shipment. This warranty shall be held in effect regardless of pre-commissioning conditions in a typical indoor or outdoor environment as long as the actuator is not abused or disassembled. This warranty shall not require the use of special storage procedures (such as the use of indoor storage, plastic bags, desiccants, and the energization of heater(s) in order to be maintained.

T. Manufacturers

1. Rotork IQ Series
2. Limitorque Accutronix MX Series
3. Approved Equal

PART 3 EXECUTION

3.1 SERVICES OF MANUFACTURER

A. Field Adjustments

1. Field representatives of manufacturers of valves or gates with pneumatic, hydraulic, or electric actuators shall adjust actuator controls and limit-switches in the field for the required function.

3.2 INSTALLATION

- A. It shall be the responsibility of the CONTRACTOR to handle, store and install the equipment specified in this Section in strict accordance with the manufacturer's recommendations.
- B. The CONTRACTOR shall review the installation drawings and installation instruction prior to installing the actuators.

3.3 FIELD TESTING

- A. After installation, all actuators shall be field tested in the presence of the ENGINEER and OWNER to ensure that all items of equipment are in full compliance with this Section.
- B. Each actuator shall be cycled to confirm that they operate without binding, scraping, or distorting. The effort to open and close manual operators shall be measured, and shall not exceed the maximum operating effort specified above. Electric motor actuators shall function smoothly and without interruption

END OF SECTION

SECTION 40 05 59 – HYDRAULIC GATES

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes complete, tested and operating weir and slide gate equipment as shown on the Drawings and as specified herein.
- B. Work Included in This Section:
 - 1. Weir and slide gates and all appurtenances described within this section are to be furnished and installed by the General Contractor.
- C. Standards Referenced
 - 1. AWWA C513 and C561

1.2 SUBMITTALS

- A. Shop Drawings and Product Data: Submit the following as a single complete initial submittal in accordance with Section 01 33 00:
 - 1. Product data fully describing all items proposed for use to demonstrate that the equipment conforms to the specifications, including drawings, specifications, installation and design details, catalogue cut sheets. Include a list of materials of construction for all components.
 - 2. System layouts and/or schematics, including connection and installation details.
- B. Shop Drawings: Submit signed and sealed structural calculations and detailed drawings for the attachments and anchorage to the structure of the equipment and appurtenances in this section.
- C. Submit certification from the manufacturer that the equipment is capable of resisting seismic loads. Loading shall be as described in Section 01 41 20 .
- D. Manuals: Furnish manufacturer's installation, lubrication, and maintenance manuals, bulletins, and spare parts lists.
- E. Affidavits: Furnish affidavits from the manufacturer stating that the gates and operators have been properly installed and tested and are ready for full time operation.

1.3 QUALITY ASSURANCE

- A. All equipment furnished under this Section shall be of a manufacturer who has been regularly engaged in the design and manufacture of the equipment for at least five years. Demonstrate to the satisfaction of the Engineer that the quality is equal to equipment made by those manufacturers specifically named herein.

1.4 WARRANTY

- A. The Manufacturer of the equipment shall warrant for 1-year from date of startup, not to exceed 18 months from date of shipment, that all equipment provided by the Manufacturer will be free from defects in material and workmanship. In the event a component fails to perform as specified or is proven defective in service during the warranty period, the Manufacturer shall repair or replace, at his discretion, such defective part.

PART 2 PART 2 PRODUCTS

2.1 SLIDE GATES

- A. General: Provide aluminum or stainless-steel slide gates complete with slide, guides, seals, stems, operators, and all appurtenances to provide complete operational slide gates as shown in the Drawings, Gate Schedule, and as specified herein.
 - 1. The complete system comprising the gate, slide, guides and appurtenances shall be furnished by the gate manufacturer, who shall be responsible for the compatibility of components and functional integrity. The size of each slide gate shall be suitable for the clear opening shown on the Drawings and in the Gate Schedule.
 - 2. The slide gates as a whole and all their components shall be suitable for service in raw sewage. The gate shall be designed for manual and/or motor operation.
 - 3. Slide gates shall conform to AWWA C513 and C561 except as modified herein.
- B. Slide Gate Type: The slide gate shall be self-contained upward-opening, flush bottom channel embedded per the Gate Schedule and as shown on the drawings.
- C. Slide Gates to be manufactured by Golden Harvest, Whipps, Rodney Hunt; Waterman; Hydrogate Corporation; Orbinox; or equal.
- D. Slide Gate Construction:
 - 1. Frame and guides: The gate frame shall be a rigid unit made of plates and structural shapes. The yoke supporting the operator shall not deflect more than 1/360th of

the yoke span under the design thrust. The frame shall be constructed of aluminum (ASTM 8209 Alloy 6061 or ASTM 8308 Alloy 6061) or 304 stainless steel.

2. Slide (Disk): The slide shall be plate reinforced with structural shapes welded to the plate. The slide shall not deflect more than 1/360th of the maximum dimension of the gate under the heads indicated in the Gate Schedule. The slide shall be constructed of same material of the frame.
3. Fasteners and anchor bolts: ASTM F593 and 594, Type 304 or 316 stainless steel.
4. Stem: The stem shall be ASTM A276, Type 304 or ASTM A582, Type 303 stainless steel with a diameter capable of withstanding in compression twice the rated output of the operator at 40-pound pull. The stem shall be supported so that the unsupported L/R ratio does not exceed 200.
5. Seals: Provide UHMW and neoprene seating faces and seals along the invert, top, and sides of the gate. Mount side seals to the frame guides. Bottom seal may be mounted on the slide or the frame.
6. Slide gates shall be unpainted.

2.2 WEIR GATES

- A. General: Provide aluminum or stainless-steel weir gates complete with slide, guides, seals, stems, operators, and all appurtenances to provide complete operational weir gates as shown in the Drawings, Gate Schedule, and as specified herein.
 1. The complete system comprising the gate, slide, guides, and appurtenances shall be furnished by the gate manufacturer, who shall be responsible for the compatibility of components and functional integrity. The size of each slide gate shall be suitable for the clear opening shown on the Drawings and in the Gate Schedule.
 2. The weir gates as a whole and all their components shall be suitable for service in raw sewage. The gate shall be designed for manual and/or motor operation.
 3. Weir gates shall conform to AWWA C561 except as modified herein.
- B. Weir Gate Type: Weir gates shall be downward opening face-mounted, self-contained type as specified in the Gate Schedule. Weir Gates to be manufactured by Golden Harvest, Whipps, Rodney Hunt; Waterman; Hydrogate Corporation, Orbinox; or equal.
- C. Weir Gate Construction:
 1. Frame and guides: The gate frame shall be a rigid unit made of plates and structural shapes. The yoke supporting the operator shall not deflect more than 1/360th of

the yoke span under the design thrust. The frame shall be constructed of aluminum (ASTM 8209 Alloy 6061 or ASTM 8308 Alloy 6061) or 304 stainless steel.

2. Slide (Disk): The slide shall be plate reinforced with structural shapes welded to the plate. The slide shall not deflect more than $\frac{1}{1360}$ th of the maximum dimension of the gate under the heads indicated in the Gate Schedule. The slide shall be constructed of same material of the frame.
3. Fasteners and anchor bolts: ASTM F593 and 594, Type 304 or 316 stainless steel.
4. Stem: The stem shall be ASTM A276, Type 304 or ASTM A582, Type 303 stainless steel with a diameter capable of withstanding in compression twice the rated output of the operator at 40-pound pull. The stem shall be supported so that the unsupported UR ratio does not exceed 200.
5. Seals: Provide UHMW and neoprene seating faces and seals along the invert, top and sides of the gate. Mount side seals to the frame guides. Bottom seal may be mounted on the slide or the frame.
6. All machined or bearing surfaces, including drilled and tapped holes, shall be coated with water-resistant protective grease and shall not be painted.
7. Rails and Toeboards: Provide Rails and Toeboards for gates spanning openings adjacent to handrails as shown in the drawings. Chain closures will not be acceptable.

2.3 MANUAL OPERATORS

- A. Manually operated lifts shall be of the hand wheel type or single speed, removable crank type as shown in the Gate Schedule, conforming to applicable provisions of AWWA Standard C560 or C561 as amended herein. The handwheel or crank will be mounted atop the self-contained gate frame. After the gate has been "cracked" from its wedging devices, a maximum hand pull of 25 pounds shall be required to open the gate under the specified operating heads.
- B. Provide hand wheel lift units with cast iron cap, hand wheel and a cast bronze lift nut. The lift nut shall be flanged and shall have ball thrust bearings above and below it to take the thrust developed during opening and closing of the gate. Adequate grease fittings shall be provided to lubricate the bearings and other moving parts. The rim of the hand wheel shall be cast smooth and be free of sharp edges. An arrow shall be cast in the rim of the hand wheel with the word "open" to indicate direction of rotation to open the gate.
- C. Hand cranks shall have a maximum 15-inch operating radius and shall be provided with a revolving sleeve. All gears, sprockets and pinions shall be of steel and have cut teeth. Sufficient grease fittings shall be provided to allow lubrication of all moving parts, such

as bearings, gears, etc. Ball thrust bearings shall be provided above and below the flange on the lift nut to take the normal thrust developed during opening and closing of the gate under the maximum specified operating heads. All other bearings shall be provided with bronze sleeves. An arrow shall be cast in the lift housing to indicate the direction of opening. It shall be readily visible to the operator. Lift nuts shall be of cast bronze.

- D. All lifts shall be equipped with a transparent rigid butyrate stem cover with permanent marking to indicate full open, full closed, and gate level in 1-inch graduations. Lift nut shall be threaded with left hand threads for standardized valve operation.

2.4 MOTORIZED GATE OPERATORS

- A. Motorized gate operators where called for in the gate schedules shall be electric motor driven.
 - 1. All gearing shall be enclosed. Operator shall be equipped with auxiliary hand operator (side handwheel), stem cover, and shall be installed on a floor mounted operating pedestal. Each operator shall be designed with ample strength and power to operate the sluice gate under maximum heads as shown in the gate schedule, at a minimum speed of 1-foot per minute, without overloading the motor and shall be for indoor service.
 - 2. Provide integral electric controls for open-close service including reversing starter, limit switches, torque switch, indicating lights and local-off-remote switch. Comply with AWWA C540. The motor shall be reversible, squirrel cage induction rated for 460 volts, 3 phase, 60 Hz with Class "F" insulating system. The motor shall be totally enclosed and nonventilated with all leads terminating within the limit switch compartment. The motor shall be of sufficient size to open or close the valve at 200 percent of maximum required breakaway torque. The motor shall operate at ± 10 percent of rated voltage and shall be sufficient for one complete cycle without exceeding its temperature rating.
 - 3. Units shall be equipped with hammer blow device to assist in opening the gate and permit motor to reach full speed before delivering torque.
 - 4. Provide auxiliary contacts for remote monitoring of position and "ready" indication. Ready indication shall be indicated when the valve selector is in the "remote" position. At a minimum, contacts shall be provided for remote confirmation of the fully open and fully closed positions.
 - 5. Manufacturer: Rotork or approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Equipment shall be installed in strict conformance with the manufacturer's installation instructions. Installation of slide and weir gates shall be in accordance with the requirements of AWWA C560 and C561 and as amended herein. The manufacturer of the slide gates shall furnish all gates, suitably designed, so that anchorage to thimble can be performed at the designed locations.

3.2 FIELD SERVICE

- A. The manufacturer of the gates shall supply a competent field service engineer to thoroughly check and inspect the slide and weir gates after installation, place the gates in operation and make necessary adjustments, and instruct plant personnel in proper operating and maintenance procedures. Provide of minimum of 16 hours field service.

3.3 FIELD PAINTING

- A. Non-submerged ferrous metal shall be painted in accordance with Section 09 97 00. Submerged surfaces need not be field painted but shall be touched up if required.

3.4 FIELD LEAKAGE TESTS

- A. All slide gates and weir gates shall be given a field leakage test under the head conditions listed on the Drawings or in the gate schedule in these specifications. A qualified representative of the manufacturer shall be present to direct any adjustments required to reduce leakage to the specified amounts.
- B. Allowable Leakage:
 - 1. Slide and Weir Gates: The permitted leakage for the gates shall not exceed 0.1 gpm per foot of seating perimeter at the specified design seating head called for in the Schedule. The leakage shall not exceed 0.1 gpm per foot of seating perimeter at the specified design unseating head called for in the Schedule for heads of 10 feet or less.
- C. For individual gates, the absence of a leakage test requirement for either seating or unseating head in the Schedule or the fact that the test heads are lower than the expected operating heads shall not relieve the requirement for satisfactory functioning at operating conditions. The tests and test levels are limited by expected limitations on water levels that will be available at the time the tests must be performed.

END OF SECTION

SECTION 40 05 97.13 - PIPING IDENTIFICATION

PART 1 GENERAL

1.1 WORK INCLUDED

- A. The CONTRACTOR shall provide identification for exposed piping and valves, complete and in place, in accordance with the Contract Documents.
- B. All mechanical pipe systems shall have protective coatings applied in accordance with Section 09 90 00 – Mechanical Coating.

1.2 REFERENCE STANDARDS

- A. Commercial Standards:
ANSI A13.1 Scheme for the Identification of Piping Systems

1.3 SUBMITTALS

- A. Submittals shall be in accordance with Section 01 33 00 – Submittals.
- B. Shop Drawings: A list of suggested labels for each valve tag and pipe system prior to fabrication.
- C. The CONTRACTOR shall submit one sample of all types of identification devices to be used in the work.

PART 2 PRODUCTS

2.1 IDENTIFICATION OF PIPING

- A. Except as indicated below for very short pipe lengths, identify exposed piping larger than 2-inches nominal size for the pipe contents and direction of flow. Pipe identification shall be as manufactured by Brady, Seton, or equal approved by engineer.
- B. Marker Type: Adhesive – Vinyl or polyester sheet with UV-resistant ink, shaped similar to pipe curvature and coated with pressure sensitive adhesive.
- C. Marker Area: Sized per pipe size according to ANSI A13.1; color from the Pipe Schedule on Drawings.
- D. Lettering: Sized per pipe size according to ANSI A13.1; color from the Pipe Schedule on Drawings.

- E. Arrows: At least 2 arrows at each marker area, showing direction of flow.
- F. Pipe 2-inches and smaller shall be identified by plastic plates made from laminated 3-layer plastic with engraved black letters on white background.
- G. New piping colors shall match existing when connecting to existing pipe.
- H. Standard Piping Colors: Paint piping to be in accordance with Piping Schedule shown on Drawings and in accordance with the requirements of the Specifications for type and quality of paint as hereafter specified. This schedule is to be used only for color and identification purposes.

2.2 IDENTIFICATION OF VALVES AND SHORT PIPE LENGTHS

- A. Identifying devices for valves and the sections of pipe that are too short to be identified with markers and arrows shall be identified with metal or plastic tags.
- B. Metal tags shall be stainless steel with embossed lettering. Plastic tags shall be solid black plastic laminate with white embossed letters. Tags shall be designed to be firmly attached to the valves or short pipes or to the structure immediately adjacent to such valves or short pipes.

PART 3 EXECUTION

3.1 GENERAL

- A. All markers and identification tags shall be installed in accordance with the manufacturer's printed instructions, and shall be neat and uniform in appearance. Tags and markers shall be readily visible from all normal working locations.

3.2 VALVE TAGS

- A. Valve tags shall be permanently attached to the valve or structure by means of two (2) stainless steel bolts or screws.
- B. Wording on the valve tags shall describe the exact function of each valve, e.g., "HWR-BALANCING," "CLS THROTTLING", "PUMP SHUT-OFF," etc.

3.3 MARKER LOCATIONS

- A. Each pipe shall be marked at:
 - 1. Intervals of 20-feet in straight runs.
 - 2. At least one in every room.
 - 3. Within 2-feet of turns, elbows, and valves.
 - 4. On the upstream side of tees, branches, and other distribution points.
 - 5. On both sides of walls and floors through which the piping passes.

END OF SECTION

SECTION 40 06 70

Schedules of Instrumentation for Process Systems

Tag Number	Component Description	Options	P&ID	Supplied with Packaged Equipment	Spec. Section
HS-601	HAND SWITCH		PID-201	X	
PT-601A	PRESSURE TRANSMITTER		PID-201	X	
TT-601A	TEMPERATURE TRANSMITTER		PID-201	X	
TT-601C	TEMPERATURE TRANSMITTER		PID-201	X	
TT-601D	TEMPERATURE TRANSMITTER		PID-201	X	
TT-601E	TEMPERATURE TRANSMITTER		PID-201	X	
VT-601	VIBRATION TRANSMITTER		PID-201	X	
TT-601F	TEMPERATURE TRANSMITTER		PID-201	X	
FIT-601	FLOW INDICATING TRANSMITTER		PID-201	X	
DPT-601	DIFFERENTIAL PRESSURE TRANS.		PID-201	X	
PT-601B	PRESSURE TRANSMITTER		PID-201	X	
TT-601B	TEMPERATURE TRANSMITTER		PID-201	X	
HS-602	HAND SWITCH		PID-201	X	
PT-602A	PRESSURE TRANSMITTER		PID-201	X	
TT-602A	TEMPERATURE TRANSMITTER		PID-201	X	
DPT-602	DIFFERENTIAL PRESSURE TRANS.		PID-201	X	
TT-602C	TEMPERATURE TRANSMITTER		PID-201	X	
TT-602D	TEMPERATURE TRANSMITTER		PID-201	X	
TT-602E	TEMPERATURE TRANSMITTER		PID-201	X	
VT-602	VIBRATION TRANSMITTER		PID-201	X	
TT-602F	TEMPERATURE TRANSMITTER		PID-201	X	
FIT-602	FLOW INDICATING TRANSMITTER		PID-201	X	
PT-602B	PRESSURE TRANSMITTER		PID-201	X	
TT-602B	TEMPERATURE TRANSMITTER		PID-201	X	
FIT-605	FLOW INDICATING TRANSMITTER		PID-201		40 71 76
FE-605	FLOW TUBE	30" Insertion	PID-201		40 71 76
PIT-606	PRESSURE INDICATING TRANS.		PID-201		40 72 43
PE-606	PRESSURE ELEMENT		PID-201		40 72 43
HS-603	HAND SWITCH		PID-201	EXISTING	
DPT-603	DIFFERENTIAL PRESSURE TRANS.		PID-201	EXISTING	
PT-603A	PRESSURE TRANSMITTER		PID-201	EXISTING	
TT-603A	TEMPERATURE TRANSMITTER		PID-201	EXISTING	
TT-603C	TEMPERATURE TRANSMITTER		PID-201	EXISTING	
TT-603D	TEMPERATURE TRANSMITTER		PID-201	EXISTING	

Tag Number	Component Description	Options	P&ID	Supplied with Packaged Equipment	Spec. Section
TT-603E	TEMPERATURE TRANSMITTER		PID-201	EXISTING	
VT-603	VIBRATION TRANSMITTER		PID-201	EXISTING	
TT-603F	TEMPERATURE TRANSMITTER		PID-201	EXISTING	
FIT-603	FLOW INDICATING TRANSMITTER		PID-201	EXISTING	
PT-603B	PRESSURE TRANSMITTER		PID-201	EXISTING	
TT-603B	TEMPERATURE TRANSMITTER		PID-201	EXISTING	
HS-604	HAND SWITCH		PID-201	EXISTING	
DPT-604	DIFFERENTIAL PRESSURE TRANS.		PID-201	EXISTING	
PT-604A	PRESSURE TRANSMITTER		PID-201	EXISTING	
TT-604A	TEMPERATURE TRANSMITTER		PID-201	EXISTING	
TT-604C	TEMPERATURE TRANSMITTER		PID-201	EXISTING	
TT-604D	TEMPERATURE TRANSMITTER		PID-201	EXISTING	
TT-604E	TEMPERATURE TRANSMITTER		PID-201	EXISTING	
VT-604	VIBRATION TRANSMITTER		PID-201	EXISTING	
TT-604F	TEMPERATURE TRANSMITTER		PID-201	EXISTING	
FIT-604	FLOW INDICATING TRANSMITTER		PID-201	EXISTING	
PT-604B	PRESSURE TRANSMITTER		PID-201	EXISTING	
TT-604B	TEMPERATURE TRANSMITTER		PID-201	EXISTING	
TSH-511	TEMPERATURE SWITCH HIGH		PID-301	X	
AE-511	ANALYZING ELEMENT - ORP	Hach - DRD1R5	PID-301		40 75 13
CMP-511	AIR BLAST COMPRESSOR		PID-301		40 75 09
TSH-512	TEMPERATURE SWITCH HIGH		PID-301	X	
TSH-513	TEMPERATURE SWITCH HIGH		PID-301	X	
CMP-513	AIR BLAST COMPRESSOR		PID-301		40 75 09
AE-513A	ANALYZING ELEMENT - ORP	Hach - DRD1R5	PID-301		40 75 13
AE-513B	ANALYZING ELEMENT - NO3	Hach - AMTAX sc	PID-301		40 75 29
AE-513C	ANALYZING ELEMENT - pH	Hach - pH D sc	PID-301		40 75 13
AIT-514	ANALYZING INDICATING TRANS.	Hach SC-1000	PID-301		40 75 05
AE-514A	ANALYZING ELEMENT - DO	Hach - LDO	PID-301		40 75 43
AE-514B	ANALYZING ELEMENT - TSS	Hach SOLITAX	PID-301		40 75 56
ZSO-514	LIMIT SWITCH		PID-301	X	
ZSC-514	LIMIT SWITCH		PID-301	X	
ZIT-514	POSITIONING INDICATING TRANS.		PID-301	X	
FCV-514	FLOW CONTROL VALVE	8" Flange Mount	PID-301		40 05 57
FIT-514	FLOW INDICATING TRANSMITTER		PID-301		40 71 76
FE-514	FLOW TUBE	8" Flange Mount	PID-301		40 71 76
AIT-515	ANALYZING INDICATING TRANS.	Hach SC-1000	PID-301		40 75 05
AE-515	ANALYZING ELEMENT - DO/TEMP	Hach - LDO	PID-301		40 75 43

Tag Number	Component Description	Options	P&ID	Supplied with Packaged Equipment	Spec. Section
ZSO-515	LIMIT SWITCH		PID-301	X	
ZSC-515	LIMIT SWITCH		PID-301	X	
ZIT-515	POSITIONING INDICATING TRANS.		PID-301	X	
FCV-515	FLOW CONTROL VALVE	8" Flange Mount	PID-301		40 05 57
FIT-515	FLOW INDICATING TRANSMITTER		PID-301		40 71 76
FE-515	FLOW TUBE	8" Flange Mount	PID-301		40 71 76
TS-516	TEMP SWITCH		PID-301	X	
MS-516	MOISTURE SWITCH		PID-301	X	
AE-516	ANALYZING ELEMENT - DO/TEMP	Hach - LDO	PID-301		40 75 43
ZSO-516	LIMIT SWITCH		PID-301	X	
ZSC-516	LIMIT SWITCH		PID-301	X	
ZIT-516	POSITIONING INDICATING TRANS.		PID-301	X	
FCV-516	FLOW CONTROL VALVE	8" Flange Mount	PID-301		40 05 57
FIT-516	FLOW INDICATING TRANSMITTER		PID-301		40 71 76
FE-516	FLOW TUBE	8" Flange Mount	PID-301		40 71 76
AE-520	ANALYZING ELEMENT - pH	Hach -pHD sc	PID-302		40 75 13
TSH-521	TEMPERATURE SWITCH HIGH		PID-302		46 41 50
CMP-521	AIR BLAST COMPRESSOR		PID-302	X	
AE-521	ANALYZING ELEMENT - ORP	Hach - DRD1R5	PID-302		40 75 13
TSH-522	TEMPERATURE SWITCH HIGH		PID-302	X	
TSH-523	TEMPERATURE SWITCH HIGH		PID-302	X	
CMP-523	AIR BLAST COMPRESSOR		PID-302		40 75 09
AE-523A	ANALYZING ELEMENT - ORP	Hach - DRD1R5	PID-302		40 75 13
AE-523B	ANALYZING ELEMENT - NO3	Hach - AMTAX sc	PID-302		40 75 29
AE-523C	ANALYZING ELEMENT - pH	Hach -pHD sc	PID-302		40 75 13
AIT-524	ANALYZING INDICATING TRANS.	Hach SC-1000	PID-302		40 75 05
AE-524A	ANALYZING ELEMENT - DO/TEMP	Hach - LDO	PID-302		40 75 43
AE-524B	ANALYZING ELEMENT - TSS	Hach SOLITAX	PID-302		40 75 56
ZSO-524	LIMIT SWITCH		PID-302	X	
ZSC-524	LIMIT SWITCH		PID-302	X	
ZIT-524	POSITIONING INDICATING TRANS.		PID-302	X	
FCV-524	FLOW CONTROL VALVE	8" Flange Mount	PID-302		40 05 57
FIT-524	FLOW INDICATING TRANSMITTER		PID-302		40 71 13
FE-524	FLOW TUBE	8" Flange Mount	PID-302		40 71 13
AIT-525	ANALYZING INDICATING TRANS.	Hach SC-1000	PID-302		40 75 05
AE-525	ANALYZING ELEMENT - DO/TEMP	Hach - LDO	PID-302		40 75 43
ZSO-525	LIMIT SWITCH		PID-302	X	
ZSC-525	LIMIT SWITCH		PID-302	X	

Tag Number	Component Description	Options	P&ID	Supplied with Packaged Equipment	Spec. Section
ZIT-525	POSITIONING INDICATING TRANS.		PID-302	X	
FCV-525	FLOW CONTROL VALVE	8" Flange Mount	PID-302		40 05 57
FIT-525	FLOW INDICATING TRANSMITTER		PID-302		40 71 76
FE-525	FLOW TUBE	8" Flange Mount	PID-302		40 71 76
AE-526	ANALYZING ELEMENT - DO/TEMP	Hach - LDO	PID-302		40 75 43
TS-526	TEMP SWITCH		PID-302	X	
MS-526	MOISTURE SWITCH		PID-302	X	
ZSO-526	LIMIT SWITCH		PID-302	X	
ZSC-526	LIMIT SWITCH		PID-302	X	
ZIT-526	POSITIONING INDICATING TRANS.		PID-302	X	
FCV-526	FLOW CONTROL VALVE	8" Flange Mount	PID-302		40 05 57
FIT-526	FLOW INDICATING TRANSMITTER		PID-302		40 71 76
FE-526	FLOW TUBE	8" Flange Mount	PID-302		40 71 76
TSH-531	TEMPERATURE SWITCH HIGH		PID-303	X	
CMP-531	AIR BLAST COMPRESSOR		PID-303		40 75 09
AE-531	ANALYZING ELEMENT - ORP	Hach - DRD1R5	PID-303		40 75 13
TSH-532	TEMPERATURE SWITCH HIGH		PID-303	X	
TSH-533	TEMPERATURE SWITCH HIGH		PID-303	X	
CMP-533	AIR BLAST COMPRESSOR		PID-303		40 75 09
AE-533A	ANALYZING ELEMENT - ORP	Hach - DRD1R5	PID-303		40 75 13
AE-533B	ANALYZING ELEMENT - NO3	Hach - AMTAX sc	PID-303		40 75 29
AE-533C	ANALYZING ELEMENT - pH	Hach -pHD sc	PID-303		40 75 13
AIT-534	ANALYZING INDICATING TRANS.	Hach SC-1000	PID-303		40 75 05
AE-534A	ANALYZING ELEMENT - DO/TEMP	Hach - LDO	PID-303		40 75 43
AE-534B	ANALYZING ELEMENT - TSS	Hach SOLITAX	PID-303		40 75 56
ZSO-534	LIMIT SWITCH		PID-303	X	
ZSC-534	LIMIT SWITCH		PID-303	X	
ZIT-534	POSITIONING INDICATING TRANS.		PID-303	X	
FCV-534	FLOW CONTROL VALVE		PID-303		40 05 57
FIT-534	FLOW INDICATING TRANSMITTER		PID-303		40 71 76
FE-534	FLOW TUBE	8" Flange Mount	PID-303		40 71 76
AIT-535	ANALYZING INDICATING TRANS.	Hach SC-1000	PID-303		40 75 05
AE-535	ANALYZING ELEMENT - DO/TEMP	Hach - LDO	PID-303		40 75 43
ZSO-535	LIMIT SWITCH		PID-303	X	
ZSC-535	LIMIT SWITCH		PID-303	X	
ZIT-535	POSITIONING INDICATING TRANS.		PID-303	X	
FCV-535	FLOW CONTROL VALVE	8" Flange Mount	PID-303		40 05 57
FIT-535	FLOW INDICATING TRANSMITTER		PID-303		40 71 76

Tag Number	Component Description	Options	P&ID	Supplied with Packaged Equipment	Spec. Section
FE-535	FLOW TUBE	8" Flange Mount	PID-303		40 71 76
TS-536	TEMP SWITCH		PID-303	X	
MS-536	MOISTURE SWITCH		PID-303	X	
AE-536	ANALYZING ELEMENT - DO/TEMP	Hach - LDO	PID-303		40 75 43
ZSO-536	LIMIT SWITCH		PID-303	X	
ZSC-536	LIMIT SWITCH		PID-303	X	
ZIT-536	POSITIONING INDICATING TRANS.		PID-303	X	
FCV-536	FLOW CONTROL VALVE	8" Flange Mount	PID-303		40 05 57
FIT-536	FLOW INDICATING TRANSMITTER		PID-303		40 71 76
FE-536	FLOW TUBE	8" Flange Mount	PID-303		40 71 76
AE-537A	ANALYZING ELEMENT - pH	Hach -pHD sc	PID-303		40 75 13
AE-537B	ANALYZING ELEMENT - NO3	Hach - AMTAX sc	PID-303		40 75 29
TSH-541	TEMPERATURE SWITCH HIGH		PID-304	X	
CMP-541	AIR BLAST COMPRESSOR		PID-304		40 75 09
AE-541	ANALYZING ELEMENT - ORP	Hach - DRD1R5	PID-304		40 75 13
TSH-542	TEMPERATURE SWITCH HIGH		PID-304	X	
TSH-543	TEMPERATURE SWITCH HIGH		PID-304	X	
CMP-543	AIR BLAST COMPRESSOR		PID-304		40 75 09
AE-543A	ANALYZING ELEMENT - ORP	Hach - DRD1R5	PID-304		40 75 13
AE-543B	ANALYZING ELEMENT - NO3	Hach - AMTAX sc	PID-304		40 75 29
AE-543C	ANALYZING ELEMENT - pH	Hach -pHD sc	PID-304		40 75 13
AIT-544	ANALYZING INDICATING TRANS.	Hach SC-1000	PID-304		40 75 05
AE-544A	ANALYZING ELEMENT - DO/TEMP	Hach - LDO	PID-304		40 75 43
AE-544B	ANALYZING ELEMENT - TSS	Hach SOLITAX	PID-304		40 75 56
ZSO-544	LIMIT SWITCH		PID-304	X	
ZSC-544	LIMIT SWITCH		PID-304	X	
ZIT-544	POSITIONING INDICATING TRANS.		PID-304	X	
FCV-544	FLOW CONTROL VALVE	8" Flange Mount	PID-304		40 05 57
FIT-544	FLOW INDICATING TRANSMITTER		PID-304		40 71 76
FE-544	FLOW TUBE	8" Flange Mount	PID-304		40 71 76
AIT-545	ANALYZING INDICATING TRANS.	Hach SC-1000	PID-304		40 75 05
AE-545	ANALYZING ELEMENT - DO/TEMP	Hach - LDO	PID-304		40 75 43
ZSO-545	LIMIT SWITCH		PID-304	X	
ZSC-545	LIMIT SWITCH		PID-304	X	
ZIT-545	POSITIONING INDICATING TRANS.		PID-304	X	
FCV-545	FLOW CONTROL VALVE	8" Flange Mount	PID-304		40 05 57
FIT-545	FLOW INDICATING TRANSMITTER		PID-304		40 71 76
FE-545	FLOW TUBE	8" Flange Mount	PID-304		40 71 76

Tag Number	Component Description	Options	P&ID	Supplied with Packaged Equipment	Spec. Section
AE-546	ANALYZING ELEMENT - DO/TEMP	Hach - LDO	PID-304		40 75 43
TS-546	TEMP SWITCH		PID-304	X	
MS-546	MOISTURE SWITCH		PID-304	X	
ZSO-546	LIMIT SWITCH		PID-304	X	
ZSC-546	LIMIT SWITCH		PID-304	X	
ZIT-546	POSITIONING INDICATING TRANS.		PID-304	X	
FCV-546	FLOW CONTROL VALVE	8" Flange Mount	PID-304		40 05 57
FIT-546	FLOW INDICATING TRANSMITTER		PID-304		40 71 76
FE-546	FLOW TUBE	8" Flange Mount	PID-304		40 71 76
PI-701B	PRESSURE GAUGE		PID-401	EXISTING	
PI-701A	PRESSURE GAUGE		PID-401	EXISTING	
PI-702B	PRESSURE GAUGE		PID-401	EXISTING	
PI-702A	PRESSURE GAUGE		PID-401	EXISTING	
PI-703B	PRESSURE GAUGE		PID-401	EXISTING	
PI-703A	PRESSURE GAUGE		PID-401	EXISTING	
FE-701	FLOW TUBE	12" Flange Mount	PID-401		40 71 13
FIT-701	FLOW INDICATING TRANSMITTER		PID-401		40 71 13
FE-702	FLOW TUBE	12" Flange Mount	PID-401	EXISTING	
FIT-702	FLOW INDICATING TRANSMITTER		PID-401	EXISTING	
FE-707	FLOW TUBE	12" Flange Mount	PID-401	EXISTING	
FIT-707	FLOW INDICATING TRANSMITTER		PID-401	EXISTING	
FE-708	FLOW TUBE	12" Flange Mount	PID-401		40 71 13
FIT-708	FLOW INDICATING TRANSMITTER		PID-401		40 71 13
FCV-701	FLOW CONTROL VALVE	12" Flange Mount	PID-401		40 05 57
ZSO-701	LIMIT SWITCH		PID-401	X	
ZSC-701	LIMIT SWITCH		PID-401	X	
FCV-702	FLOW CONTROL VALVE	12" Flange Mount	PID-401	EXISTING	
ZSO-702	LIMIT SWITCH		PID-401	EXISTING	
ZSC-702	LIMIT SWITCH		PID-401	EXISTING	
FCV-707	FLOW CONTROL VALVE	12" Flange Mount	PID-401	EXISTING	
ZSO-707	LIMIT SWITCH		PID-401	EXISTING	
ZSC-707	LIMIT SWITCH		PID-401	EXISTING	
FCV-708	FLOW CONTROL VALVE	12" Flange Mount	PID-401		40 05 57
ZSO-708	LIMIT SWITCH		PID-401	X	
ZSC-708	LIMIT SWITCH		PID-401	X	
HS-801A	HAND SWITCH		PID-501	EXISTING	
HS-801B	HAND SWITCH		PID-501	EXISTING	
ZSO-801	LIMIT SWITCH		PID-501	EXISTING	

Tag Number	Component Description	Options	P&ID	Supplied with Packaged Equipment	Spec. Section
ZSC-801	LIMIT SWITCH		PID-501	EXISTING	
HS-802A	HAND SWITCH		PID-501	EXISTING	
HS-802B	HAND SWITCH		PID-501	EXISTING	
ZSO-802	LIMIT SWITCH		PID-501	EXISTING	
ZSC-802	LIMIT SWITCH		PID-501	EXISTING	
LS-801	LEVEL SWITCH		PID-501	EXISTING	
LSL-801	LEVEL SWITCH LOW		PID-501	EXISTING	
FIT-811	FLOW INDICATING TRANSMITTER		PID-501		40 71 13
FE-811	FLOW TUBE		PID-501		41 71 13

END OF SECTION

SECTION 40 42 13 – PROCESS PIPING INSULATION

PART 1 GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society of Heating, Refrigerating and Air Conditioning Engineers Inc. (ASHRAE): 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
2. ASTM International (ASTM):
 - a. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - b. C165, Standard Test Method for Measuring Compressive Properties of Thermal Insulations.
 - c. C177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
 - d. C518, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
 - e. C534/C534M, Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
 - f. C547, Standard Specification for Mineral Fiber Pipe Insulation.
 - g. C552, Standard Specification for Cellular Glass Thermal Insulation.
 - h. C585, Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing.
 - i. C1136, Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
 - j. C1729, Standard Specification for Aluminum Jacketing for Insulation.
 - k. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
 - l. E96/E96M, Standard Test Methods for Water Vapor Transmission of Materials.

3. International Energy Conservation Code (IECC).
4. Underwriters Laboratories Inc. (UL).

1.2 SUBMITTALS

- A. Manufacturer's descriptive literature including insulation and jacket thickness, heat transfer coefficient, and methods of installation.
- B. Samples of each insulation material type and of typical jackets and covers for fittings, valves, and appurtenances.
- C. Maintenance information.

PART 2 PRODUCTS

2.1 PIPE AND FITTING INSULATION

- A. Type 1—Elastomeric:
 1. Material: Flexible elastomeric pipe insulation, closed-cell structure in accordance with ASTM C534/C534M.
 2. Temperature Rating: Minus 297 degrees F to 220 degrees F.
 3. Nominal Density: 3 pcf to 6 pcf.
 4. Conductivity in accordance with ASHRAE 90.1 and maximum numerical value of 0.25 Btu-in./hr-square foot degrees F at 75 degrees F per ASTM C177 or ASTM C518.
 5. Maximum water vapor transmission of 0.06 perm-inch per ASTM E96/E96M, Procedure A.
 6. Joints: Manufacturer's adhesive.
 7. Flame Spread Rating: Less than 25 per ASTM E84.
 8. Smoke Developed Index: Less than 50 per ASTM E84.
 9. Manufacturers and Products:
 - a. Nomaco; K-Flex.
 - b. Armacell; AP Armaflex.

B. Type 2—Fiberglass:

1. Material: UL rated, preformed, sectional bonded fiberglass per ASTM C585 with factory applied, Kraft paper with aluminum foil vapor barrier jacket with pressure-sensitive, self-sealing lap.
2. Insulation Temperature Rating: Zero to 850 degrees F.
3. Conductivity in accordance with ASHRAE 90.1 and maximum numerical value of 0.23 Btu-in./hr-square foot degrees F at 75 degrees F.
4. Jacketing per ASTM C1136 with minimum water vapor transmission for jacket of 0.02 perm-inch per ASTM E96/E96M. Furnish with no jacket if field finish system specified.
5. Joints: Matching pressure-sensitive butt strips for sealing circumferential joints.
6. Flame Spread Rating: Less than 25 per ASTM E84.
7. Smoke Developed Index: Less than 50 per ASTM E84.
8. Manufacturers and Products:
 - a. Owens Corning Fiberglass; ASJ/SSL-11.
 - b. John Manville; Micro-Lok with Jacket.

C. Type 3—Foamglass:

1. Material: Cellular glass per ASTM C552.
2. Nominal Density: 7.5 pcf.
3. Compressive Strength: 90 psi per ASTM C165.
4. Temperature Rating: Minus 290degrees F to 900 degrees F.
5. Conductivity in accordance with ASHRAE 90.1 and maximum numerical value of 0.29 Btu-in./hr-square foot degrees F.
6. Minimum water vapor transmission for insulation of 0.00 perm-inch per ASTM E96/E96M.
7. Joints: Matching pressure-sensitive butt strips for sealing circumferential joints.
8. Flame Spread Rating: 0 per ASTM E84.
9. Smoke Developed Index: 0 per ASTM E84.

10. Follow manufacturer's recommendation, based upon temperature of piping to be insulated.

11. Manufacturer and Product: Pittsburgh Corning; Foamglas One.

D. Type 4—Mineral Wool Fiber:

1. Material: Mineral wool fiber insulation made from rock and slag.

2. Insulation shall meet the following:

- a. ASTM C 547: Type I, II, IV
- b. ASTM C 795: Conforms
- c. ASTM C 356: < 1.3% @ 1200 oF
- d. ASTM C 1104: < 0.1%
- e. ASTM C 585: Complies
- f. ASTM C 800: Zero

3. Manufacture and Product: Roxul; Techton 1200

2.2 ROOF DRAIN AND OVERFLOW DRAIN SUMP INSULATION

A. Type 1: 1-inch thick.

2.3 INSULATION AT PIPE HANGERS AND SUPPORTS

A. Copper, Ductile Iron, and Nonmetallic Pipe: High-density insert, thickness equal to adjoining insulation of Type 3 or other rigid insulation or manufactured pre-insulated pipe hanger and insulation shield. Extend insert beyond shield.

B. Steel Pipe: Insulation saddle or high-density insert, thickness equal to adjoining insulation of Type 3 or other rigid insulation or manufactured pre-insulated pipe hanger and insulation shield at support location. Extend insert beyond shield.

2.4 INSULATION FINISH SYSTEMS

A. Type F1—PVC:

1. Polyvinyl chloride (PVC) jacketing, minimum 20 mils indoors and 30 mils outdoors, for straight run piping and fitting locations, temperatures to 140 degrees F.

2. Color: PVC jacketing shall be color coded to match colors listed in pipe schedule where suitable matching colors are available. If no suitable colors are available jacketing shall be white.

3. Flame Spread Rating: 25 per ASTM E84.

4. Smoke Developed Index: 50 per ASTM E84.
 5. Manufacturers and Products:
 - a. Knauf Insulation; Proto 1000.
 - b. Johns Manville; Zeston 2000 or 300.
 - c. Speedline; 25/50 Smoke-Safe.
- B. Type F2—Paint:
1. Type 1 Insulation: Acrylic latex paint, white, and suitable for outdoor use.
 - a. Manufacturer and Product: Armacell; WB Armaflex finish.
 2. Type 2 Insulation: In accordance with Section 09 90 00, Painting and Coating.
- C. Type F3—Aluminum:
1. Aluminum Roll Jacketing: For straight run piping, wrought aluminum Alloy 3003, 5005, 1100, or 3105 to ASTM B209 with H-14 temper, in accordance with ASTM C1729, minimum 0.020-inch thickness, with smooth mill finish.
 2. Vapor Barrier: Provide a 3-mil factory applied vapor barrier, heat and pressure bonded to inner surface of aluminum jacketing.
 3. Fitting Covers: Material as for aluminum roll jacketing, premolded, one- or two-piece covers, which includes elbows, tee/valves, end caps, mechanical line couplings, and specialty fittings.
 4. Manufacturers:
 - a. RPR Products; Insul-Mate.
 - b. ITW, Pabco-Childers.
- D. Type F4—Foamglass Jacketing:
1. Type 3 Insulation—Buried and Up to 1-Foot Above Grade: 70-mil bituminous resin with woven, glass fabric, aluminum foil layer, and plastic film coating, self-sealing manual pressure seals; Pittsburgh Corning Pittwrap SS.
 2. Type 3 Insulation—Greater than 1-Foot Above Grade: 30-mil modified bituminous membrane with self-sealing manual pressure seals; Pittsburgh Corning Pittwrap CW30.

PART 3 EXECUTION

3.1 APPLICATION

A. General:

1. Insulate valve bodies, flanges, and pipe couplings.
2. Insulate and vapor seal hangers, supports, anchors, and other piping appurtenances that are secured directly to cold surfaces.
3. Do not insulate flexible pipe couplings and expansion joints.
4. Service and Insulation Thickness: Refer to Supplement Service and Insulation Thickness table following "End of Section" and to Piping Schedule.

3.2 INSTALLATION

A. General:

1. Install in accordance with manufacturer's instructions and as specified herein.
2. Install after piping system has been pressure tested and leaks corrected.
3. Install over clean dry surfaces.
4. Use insulating cements, lagging adhesives, and weatherproof mastics recommended by insulation manufacturer.
5. Do not allow insulation to cover nameplates or code inspection stamps.
6. Run insulation or insulation inserts continuously through pipe hangers and supports, wall openings, ceiling openings, and pipe sleeves, unless otherwise shown.
7. Install removable insulation sections on devices that require access for maintenance of equipment or removal, such as unions and strainer end plates.
8. Personnel Protection: Install on pipes from floor to 8 feet high. Install on pipes within 4 feet of platforms and to 8 feet high above platforms.

B. Connection to Existing Piping: Cut back existing insulation to remove portion damaged by piping revisions. Install new insulation.

C. Cold Surfaces: Provide continuous vapor seal on insulation on cold surfaces where vapor barrier jackets are used.

- D. Placement:
 - 1. Insulate valves and fittings with sleeved or cut pieces of same material.
 - 2. Seal and tape joints.
- E. Heat Traced Piping: Apply insulation after heat-tracing work is completed and inspected.
- F. Roof Drains: Insulate vertical drops from roof drains to horizontal pipe, exposed and concealed horizontal piping, and 2 feet down on vertical risers from horizontal pipe.
- G. Roof Drains and Overflow Drains: Insulate entire pipe runs. Where roof and overflow drains exist through an exterior wall ensure annular space between pipes and walls are properly sealed prior to insulating.
- H. Roof Drain and Overflow Drain Sumps: Insulate entire sumps.
- I. Vapor Barrier:
 - 1. Provide continuous vapor barrier at joints between rigid insulation and pipe insulation.
 - 2. Install vapor barrier jackets with pipe hangers and supports outside jacket.
 - 3. Do not use staples and screws to secure vapor sealed system components.
- J. Aluminum Jacket:
 - 1. Use continuous friction type joint to hold jacket in place, providing positive weatherproof seal over entire length of jacket.
 - 2. Secure circumferential joints with preformed snap straps containing weatherproof sealant.
 - 3. On exterior piping, apply coating over insulation and vapor barrier to prevent damage when aluminum fitting covers are installed.
 - 4. Do not use screws or rivets to fasten fitting covers.
 - 5. Install removable prefabricated aluminum covers on exterior flanges and unions.
 - 6. Caulk and seal exterior joints to make watertight.

3.3 FIELD FINISHING

- A. Apply coating of insulating cement where needed to obtain smooth and continuous appearance.

- B. Where pipe labels or banding are specified, apply to finished insulation, not to pipe.
- C. Painting Piping Insulation (Exposed to View):
 - 1. Aluminum or color-coded PVC jacketing does not require painting.
 - 2. If insulated piping system is indicated to be painted, piping shall receive the following:
 - a. Prime coat in accordance with Section 09 90 00, Painting and Coating.
 - b. Finished insulation (and not pipe) shall be painted in accordance with Section 09 90 00, Painting and Coating.

END OF SECTION

Service and Insulation Thickness

Pipe Legend	Thickness	Fluid Temperature (degrees F)	Insulation	Finish Systems			
				Concealed from View	Indoors Exposed	Outdoors	Buried
LPA – Blower Discharge Piping Only	Pipe Size: Insulation Thickness Inches: 1/4-3: 1 3.5-10: 1.5 12-16: 2 18-24: 2.5	130 F	Type 2	None	F3	None	None

SECTION 40 61 13

PROCESS CONTROL SYSTEM GENERAL PROVISIONS

PART 1 GENERAL

1.1 SUMMARY

- A. This section specifies general requirements which are applicable to providing instrumentation and controls for the process system
- B. The requirements of this section are applicable to all work to be completed by the System Integrator and as specified in all sections of 40 61 XX, 40 63 XX, 40 67 XX, 40 68 XX, 40 71 XX, 40 72 XX, 40 75 XX, 40 78 XX and 40 80 XX. Where XX refers to any specification section beginning with the preceding section numbers.
- C. Electrical requirements applicable to this work are specified in Division 26.
- D. Section includes:
 - 1. Quality Assurance.
 - 2. Submittals.
 - 3. Performance Requirements.
 - 4. Functional Requirements.
 - 5. Products.
 - 6. Installation.
 - 7. Testing.
 - 8. Manufacturers Services.

1.2 SCOPE

- A. The work consists of a qualified System Integrator to provide the requirements on this specification section as well as those listed or referenced herein.
 - 1. New primary process measurement devices, instrumentation and new process auxiliary devices.
 - 2. New SCADA system hardware including digital process controllers (PLC based), IO modules, power modules, communication modules, network switches, UPS, and fiber optic patch panels.
 - 3. New custom control panels, control stations, junction boxes, and control power distribution panels.
 - 4. Process control system networking.

5. Modification of existing instrumentation and control for process systems.
 6. Submittal documentation for process systems instrumentation and control including schedules, drawings, product manuals.
 7. Maintaining construction RECORD/AS BUILT of submittal documentation and incorporating interconnection detail from other sections submittals to show accurately process systems instrumentation and control wiring as complete from circuits start and end connections.
 8. Configuration set up, calibration, testing process systems instrumentation and controls.
 9. Training.
 10. Collaboration with System Programmer to provide a fully integrated PLC based SCADA system.
 11. Assemble process control hardware into customized fabricated process control panel(s).
 12. Factory test process control panel customized fabrication(s).
 13. Deliver and install process control panel customized fabrication(s) on site.
- B. PROGRAMMING: The Owner's Programmer provides process control system PLC, SCADA and OIT application programming under a separate contract.

1.3 DEFINITIONS

- A. GENERAL: Definitions of terminology related to Instrumentation and Industrial Electronic Systems used in the specifications as defined in IEEE 100, ISA S51.1, and NEMA ICS 1.
- B. VENDOR PACKAGE PROCESS CONTROL SYSTEM: A system of equipment and hardware provided by a vendor used for control, monitoring process conditions, control feedback and process performance for an associated vendor package equipment system which interfaces to the control system.
- C. TWO-WIRE TRANSMITTER: An instrument which derives operating power supply from the signal transmission circuit and requires no separate power supply connections. A two-wire transmitter produces a 4 to 20 milliampere current regulated signal in a series circuit from a 24-volt direct current driving potential and a maximum circuit resistance of 600 ohms. A two-wire transmitter is also referred to as looped power.

- D. **FOUR-WIRE TRANSMITTER:** An instrument which derives operating power from separate power supply connections. A four-wire transmitter produces a 4 to 20 milliampere current regulated signal in a series circuit with a maximum circuit resistance of 600 ohms. Four-wire transmitters typically require 120Vac or 24Vdc input power supply.
- E. **GALVANIC ISOLATION:** Electrical node having no direct current path to another electrical node. Galvanic isolation refers to a device with electrical inputs and/or outputs which are isolated from ground, the device case, the process fluid, and separate power supply terminals. Inputs and/or outputs may be externally grounded without affecting the characteristics of the devices or providing path for circulation of ground currents.
- F. **PANEL:** An instrument support system which may be a flat surface, a partial enclosure, or a complete enclosure for instruments and other devices used in process control systems including consoles, cabinets and racks. Panels provide mechanical protection, electrical isolation, and protection from dust, dirt, moisture, and chemical contaminants which may be pre- sent in the atmosphere.
- G. **DATA SHEETS:** Data sheets shall refer to ISA S20 or ISA TR20.00.01 latest version.
- H. **SIGNAL TYPES:**
 - 1. **LOW-LEVEL ANALOG:** Signal with full output level of 100 millivolts or less including thermocouples and resistance temperature detectors.
 - 2. **HIGH-LEVEL ANALOG:** Signals with full output level greater than 100 millivolts but less than 30 volts, including 4 to 20 mA transmission.
 - 3. **PULSE FREQUENCY:** Counting pulses emitted from speed or flow transmitters.
 - 4. **DISCRETE CONTROL OR EVENTS:** Dry contact closures and signals monitored by solid state equipment, relays, or control circuits typically rated for 120 volts AC or 24 volts DC.
- I. **SYSTEMS INTEGRATOR:** A firm engaged in the business of detailed control system design and engineering, custom panel fabrication, instrumentation component purchase, instrumentation tuning, system and panel assembly, and testing the specified process control and industrial automation systems.
- J. **SYSTEMS PROGRAMMER:** The Owner's hired programmer providing the PLC and SCADA application programming.
- K. **OIT:** Acronym for Operator Interface Terminal
- L. **SCADA:** Acronym for Supervisory Control And Data Acquisition

- M. PLC: Acronym for Programmable Logic Controller – synonymous with Programmable Automation Controller (PAC) for purposes of this project

1.4 QUALITY ASSURANCE

- A. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
- B. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Reference	Title
IEEE 100	Standard Dictionary of Electrical and Electronics Terms
ISA S5.4	Instrument Loop Diagrams
ISA S20	Specification Forms For Process Measurement and Control Instrumentation, Primary Elements, and Control Valves
ISA S51.1	Process Instrumentation Terminology
ISA TR20.00.01	Specification Forms for Process Measurement and Control Instruments Part 1: General Considerations
NEMA ICS 1	General Standards for Industrial Control and Systems

1.5 SYSTEMS INTEGRATOR RESPONSIBILITY

A. GENERAL

1. The specified control system and instrumentation integration including panel modifications, instrument calibration, testing, startup, operational testing, and training shall be performed by a Systems Integrator staffed with qualified personnel, possessing necessary equipment and experience in performing similar installations.
2. The control system components shall, as far as practical, be of one manufacturer.
3. The components, modules, devices, and control system equipment shall be recognized industrial quality products. Recognized commercial or office grade products are prohibited.

4. The specified system performance shall be demonstrated to and accepted by the Owner, the Systems Programmer and the Engineer.
- B. PRE-SUBMITTAL CONFERENCE:
1. Schedule a pre-submittal conference with the Owner and Engineer within 30-calendar days after Contract award to discuss the work equipment, submittal format, and establish the framework for project coordination and communication.
 - a. Provide materials 10-days prior to the conference:
 - b. Instrument Schedule specified in Section 40 06 70 with manufacturer and model number added.
 - c. Product descriptive literature with a statement that the item is as specified.
 - d. Proposed equal products with comparative listing of the published specifications for the specified item and the pro- posed item.
 - e. A copy of this specification section, with addendum up- dates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
 2. The pre-submittal conference will not replace the Product and Shop Drawing Submittal review process.
- C. PROCESS EQUIPMENT COORDINATION
1. Systems Integrator shall provide wiring interconnect diagrams for the plant process control system to interface with submitted vendor equipment panels and devices. The wiring diagrams shall be a complete representation of the process control requirements for specific equipment. Systems Integrator coordinates to collect equipment wiring information from other Sections to show a totally wired integrated control system.
 2. Integrate, furnish, and install equipment in conformance with the drawings, specifications, and the recommendations of the equipment manufacturer and the related processes equipment manufacturers.
 3. Systems Integrator shall obtain manufacturer's technical information for items of equipment not provided with, but directly connected to, the control system. Provide the necessary coordination and components for correct signal interfaces between specified equipment and the control system.

4. Systems Integrator shall coordinate with project subcontractors and equipment suppliers.
5. Systems Integrator shall provide installation supervision for the duration of the project.
6. Conflicts between the plans, specifications, manufacturer/vendor drawings and installation instructions, etc., shall be presented to the Owner for resolution before proceeding.

1.6 SUBMITTALS

- A. PROCEDURES: Section 01 33 00
- B. Product Data: For each type of device and system:
 1. Include product data sheets and equipment brochures showing standard products and specified accessories.
 - a. Mark data sheets to clearly show exact product and options being provided.
 2. Provide Seismic calculations for anchoring and support of equipment as required in Section 01 41 20.
 3. Manufacturer's installation instruction excerpts that apply to this project:
 - a. Mounting requirements
 - b. Electrical connection diagrams
 - c. Calibration procedures
 - d. Operation and maintenance information
 - e. Warranty information
- C. SUBMITTAL DRAWINGS
 1. GENERAL
 - a. Prepare drawings in AutoCAD version 2018 or later with borders and titleblocks identifying the project and system.
 - b. Diagrams shall carry a uniform and coordinated set of wire numbers and terminal block numbers
 - c. The drawing numbers and file names are to be based on equipment tag numbers
 - d. Provide the following submittal drawings

1) Arrangement and layout drawings

- a) Contract document's drawings are typical illustrations of panel hardware/component arrangement and layouts representing one or more than one panel with similar interconnection requirements. Provide the unique panel arrangement, layout and outline drawings. Show arrangement and layout to scale. Add components and wiring to the unique panel drawings as required to complete a fully integrated operation. Include on the drawings a Bill of Material that identifies all components in the arrangement and layout.

2) Schematic diagrams

- a) Show components of a control panel in an arrangement similar to the actual layout of the panel including internal wiring between devices include IO module layout connections. Show terminal blocks used for internal wiring or field wiring, identified as such

3) Loop diagrams

- a) Provide the unique loop diagram for each piece of equipment.

4) Network block diagram

- a) A network block diagram is a diagram of the control system, with annotated boxes to show the primary network components (controllers, hubs, switches, computers, displays), and annotated interconnecting lines that show the system communication media and communication protocols].

PART 2 PRODUCTS

2.1 GENERAL

A. MATERIALS AND QUALITY:

1. Provide process control hardware new, free from defects, and industrial-grade, as specified. Each type of instrument, instrument accessory, and device used throughout the work shall be manufactured by one firm, where possible.
2. Electronic process control hardware shall be of solid-state construction with printed or etched circuit boards of glass epoxy of sufficient thickness to prevent warping.

- B. ENCLOSURES: NEMA rating for the location and application shown herein and as specified in Section 40 67 16, 40 67 19, Division 26, and as shown on the drawings.

Location	Enclosure Material and NEMA Rating
Indoor Dry	NEMA 12: mild steel
Indoor Wet	NEMA 12: mild steel when specified with mounting pad or legs for minor splash resistance) or NEMA 4X: 316 Stainless Steel
Outdoor	NEMA 4X: 316 Stainless Steel
Process Corrosive	NEMA 4X: 316 Stainless Steel
Chemical Corrosive	NEMA 4X: 316 Stainless Steel
Hazardous Area:	NEMA 7: Galvanized Malleable Iron or Aluminum or NEMA 4X and UL listed or FM Approved for the Hazardous Area.

2.2 NAMEPLATES

- A. Provide nameplates for all field mounted instrument, analyzer, or equipment. Include the equipment title, the equipment tag number, and power source(s) in the nameplate inscription. Provide machine engraved laminated black phenolic nameplates with white lettering for equipment identification with 1/8-inch high lettering.

2.3 SPARES:

- A. Provide 10% spare for most components or at least one spare for each panel component unless a larger specific requirement is listed herein.
1. Power Supplies – 1 of each type used
 2. Terminal Blocks – 5 of each type used
 3. Fuse – 5 of each type used
 4. Circuit Breakers – 2 of each type and size used
 5. Surge Protection Devices – 1 of each type used
 6. Relays – 2 of each type used
 7. Relays Bases – 1 of each type used
 8. UPS - 1 of each type used
 9. PLC Modules – 1 of each type used

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install process control hardware in locations that are accessible for operation and maintenance services. Process control hardware not accessible shall be reinstalled at no cost to the Owner.
- B. Install process control hardware in accordance with product manufacturer's requirements.
- C. Ensure process control hardware is grounded per NEC and manufacturer's requirements.
- D. Provide proper clearance for process control hardware for heat dissipation and access.
- E. Ensure UL/FM or equal listings/markings/labels are viewable after installation.
- F. Provide secure mounting of all process control hardware (such as DIN rail mount).
- G. Provide electrical circuit protection for process control hardware if not integral.

3.2 TESTING

- A. DELIVERY INSPECTION: Notify the Owner upon arrival of any material or equipment to be incorporated into the work. Remove protective covers or otherwise provide access in order that the Owner may inspect such items.
- B. REQUIREMENTS: Section 40 61 21.

3.3 MANUFACTURER'S SERVICES

- A. TRAINING: Provide a factory-trained manufacturer's representative or System Integrator skilled in equipment use at the Site for the following activities. Specified durations do not include travel time to or from the Site.
- B. Coordinate training with operations and maintenance staff schedules to ensure all required staff can attend.
- C. Training to include configuration, operation, trouble shooting, wiring, calibration, testing, installation, safety, and warranty coverage for each process control hardware type.
- D. Certify completion of training.

END OF SECTION

SECTION 40 61 21 - PROCESS CONTROL SYSTEM TESTING

PART 1 GENERAL

1.1 SUMMARY

- A. This section specifies Contractor and Systems Integrator requirements for testing and documenting the process instrumentation and control system (PICS) for automation integration with SCADA in conjunction with the Owner's Systems Programmer.
- B. The term instrumentation covers field and panel instruments, analyzers, primary sensing elements, transmitters, power supplies, and monitoring devices.
- C. Provide the labor, tools, material, power, and services necessary to provide the process instrumentation and control system inspection and testing specified herein. Coordinate all test procedures with the requirements of Section 01 75 16.
 - 1. Include the following action items
 - a. Develop test plan.
 - b. Develop record keeping system.
 - c. Coordinate testing with Vendor package equipment.
 - d. Coordinate testing with the Owner's Systems Programmer.
- D. Testing to include:
 - 1. Pre-Operational - Factory Acceptance Testing (FAT)
 - 2. Component Testing Sequence:
 - a. Wiring Testing
 - b. Network and Bus Cable System Inspection and Testing
 - c. Piping Testing
 - d. Installation Inspection
 - e. Instrumentation Calibration
 - f. Loop Testing
 - g. Network Testing
 - 3. System (Functional) Testing Sequence:
 - a. Process Control Strategy/Sequence Testing
 - b. Control System Closed Loop
 - c. Functional Checkout

- 4. Operational Testing:
 - a. System Acceptance Testing (SAT)
- E. Definitions: Section 40 61 13 and for definition of System Integrator and Owner's Programmer.

1.2 QUALITY ASSURANCE

- A. TESTING MANAGER:
 - 1. The Contractor or Systems Integrator shall appoint a qualified specialist as process control system testing manager to manage, coordinate, and supervise the testing work.
 - 2. The Testing Manager requires at least 5 years of total experience, or experience on at least five separate projects, in managing the testing and startup of electrical and instrumentation control systems of equal or greater scope and complexity. Testing Manager to provide a quality assurance program which includes:
 - a. Definition of process areas and systems, with testing executed on an area by area basis, based on the P&ID drawings.
 - b. Sequential list of the test phases required for each process area and system.
 - c. Completion status tracking form by process area, system, and test phase.
- B. REFERENCES: Section 40 61 13 and 40 70 00.

1.3 SUBMITTALS

- A. PROCEDURES: Section 01 33 00.
- B. Organize the submittal items in the following manner for review.
 - 1. Qualifications
 - a. Testing Manager Qualifications and resume
 - b. Network testing entity qualifications and staff performing inspections and testing
 - 2. Test Plans and forms
 - a. I/O Interface Summary in accordance with the requirements of paragraph 40 61 21-2.02 D.

- b. Testing status spreadsheet in accordance with the requirements of paragraph 40 61 21-2.02 A. 3.
 - c. Test procedures in accordance with the requirements of paragraph 40 61 21-3.01 D.
 - d. Proposed test forms per PART 3 of this Section 40 61 21, detailed for each test for this project.
 - e. Certified Factory Calibration Reports.
 - f. Provide a copy of this specification and the referenced and applicable sections with addenda updates included with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
 - g. Provide Contractor's adapted version of Section 40 06 70 Schedules of Instrumentation. This list is to be maintained throughout construction to reflect as-built conditions.
 - h. Provide Contractor's adapted version of Section 40 61 93 Process Control System Input Output List. Lists maintained throughout construction to reflect as-built conditions.
3. Factory Acceptance Test Information
- a. Submit location, time, date and duration for Factory Acceptance Testing.
 - 1) Update scheduling of this test periodically. Do not change location and date of test less than two week prior to commencing.
4. Completed Test Forms:
- a. Completed test forms per PART 3. Separate submittals may be provided for each process area.
 - b. List of factory calibrated items and calibration certificates.
 - c. Documentation of network data communication nodes for networked controllers, remote I/O and related devices.
 - d. Final Test Report assembled in a three-ring binder and submitted at the completion of the inspection and testing activities for a facility.
 - 1) Label the binder cover and spine to identify the project name and facility. Test report includes the applicable test procedures for the facility and the

completed inspection and test report forms associated with the equipment and systems of that area.

- 2) Organize test results by equipment item or system with individual, labeled tab dividers to identify each. System deficiencies and non-compliant test results identified in the final test report and acknowledged by the responsible party as having been corrected.

PART 2 PRODUCTS

2.1 GENERAL

- A. The Testing Manager shall provide test forms, documentation, and records as specified in the following paragraphs.

2.2 TESTING DOCUMENTATION

- A. DOCUMENTATION RECORDS: The Testing Manager shall develop a records keeping system to document progress and completion for each task in each process area or system. Keep the following current and available for inspection on-site at all times in a location designated by the Owner:
 1. Testing Manager's qualifications, project startup and testing history, including resume as specified in this Section.
 2. List of names of Contractor's and System Integrator's personnel associated with final construction and testing, and normal and emergency contact telephone numbers
 3. Testing Status spreadsheet with breakdown for each process area and process system, with percentage complete on each testing sequence task.
 4. Test Report Volumes.
- B. TEST REPORT VOLUMES: The Contractor develops and maintains testing documentation for each area of the facility in separate volumes. Keep each volume current and available for inspection on-site at all times in a location designated by the Owner. Each volume includes the following as a minimum:
 1. Three-ring binder with front cover and spine labeled: "Testing Documentation For Process Area / Process System" including Owner's name, facility name, project name, and project number.
 2. Table of Contents with same labeling as the volume cover with tabs for each section:

- a. Section 1 – Control Description
 - b. Section 2 – I/O Interface Summary
 - c. Section 3 – Schedules for Integrated Automation Instrumentation and Terminal Devices
 - d. Section 4 – Test Forms
 - e. Section 5 – Certified Factory Calibration Reports
 - f. Section 6 – Final Test Report
- C. I/O INTERFACE SUMMARY: Provide I/O spreadsheets for each area of the facility based on the submittal IO lists in Section 40 61 93. Spreadsheets to include the following for each I/O point:
- 1. Signal number/tag
 - 2. Annotation description that may be logically abbreviated and that is subject to approval.
 - 3. Complete physical I/O channel designation and addressing or communication I/O register designation.
 - 4. True/False status designations for digital I/O.
 - 5. Process range; engineering units and any multipliers; and raw signal range count for analog I/O.
 - 6. Signals: Fixed point and scaled at the Controller with minimum four significant implied digits of scaling. E.g.: 0 to 1400 at Controller for a pH range of 0 to 14 at Operator Interface.
 - 7. Provide Operator Interface scaling to display decimal digits required.
 - 8. Test result- pass or fail and date of test.
 - 9. Maintain in Excel with electronic updates to Owner issued within 2 days after each test after any updates or changes by Contractor.
- D. SCHEDULES FOR INTEGRATED AUTOMATION INSTRUMENTATION AND TERMINAL DEVICES: Provide a detailed Schedule for Integrated Automation Instrumentation and Terminal Devices. Use the as-built Schedules for Integrated Automation Instrumentation and Terminal Devices submitted in Section 40 06 70. Provide details on calibration ranges, set points, and dead bands.

PART 3 EXECUTION

3.1 GENERAL

A. GENERAL REQUIREMENTS:

1. Prior to testing, provide notice to the Owner. Provide notice between 60 and 70 days before starting any testing activity, and include a detailed step-by-step test procedure complete with forms for the recording of test results, testing equipment used, and a place for identification of the individual performing or, if applicable, witnessing the test.
2. System integrator to provide detail assistance to the Contractor in generating test forms, customized for this project.

END OF SECTION

SECTION 40 61 26 - PROCESS CONTROL SYSTEM TRAINING

PART 1 GENERAL

1.1 SUMMARY

- A. CONTRACTOR shall provide operator training on the operation and maintenance of the control system and all components.
- B. The process instrumentation and control Work for which training is to be provided includes, but is not limited to, the following:
 - 1. Field-mounted instruments and devices.
 - 2. Programmable logic controllers (PLC)
 - 3. Personal computers and human-machine interface (HMI) software.
 - 4. Local area network hardware and software.
 - 5. Field instruments network communication hardware and software required for interfacing various systems to provide a fully-integrated system.
- C. Coordination
 - 1. Some panels and equipment are furnished under other Specification Sections. Under this Contract the PCS contractor shall coordinate the training for the use and maintenance of equipment they provide with control equipment provided with packaged equipment and with the PLC and SCADA system programming that will be provided by the OWNER's Programmer. CONTRACTOR shall coordinate with Suppliers of panels and equipment to provide fully functional system complying with the Contract Documents and that interfaces with the process control network.

1.2 SCOPE

- A. Process Instrumentation and Control System Work for which training is to be provided is specified under the following Specification sections:
 - 1. Section 40 63 43 – Programmable Logic Controllers
 - 2. Section 40 62 63 – Operator Interface Unit
 - 3. Section 40 66 13 – Switches & Routers
 - 4. Section 40 67 00 – Control System Equipment Panels & Racks

5. Section 40 71 13 and 40 71 76 – For Flow Meters
6. Section 40 72 43 and 40 72 76 – For various process monitoring probes and sensors
7. Section 40 73 26 – For process monitoring probes and sensors
8. Section 40 75 05 – Multi-Parameter Analyzer Systems
9. Section 40 75 09, 40 75 16, 40 75 29, 40 75 43, 40 75 56, 40 7589 – For various process monitoring probes and sensors

1.3 REFERENCES

- A. Underwriters Laboratory (UL).
- B. National Electrical Manufacturers Association (NEMA).
- C. Instrument Society of America (ISA).
- D. ISA 5.4, Instrument Loop Diagrams.
- E. ISA 20, Specification Forms for Process Measurement & Control Instruments, Primary Elements & Control Valves.
- F. ANSI/ASQ Z1.4, Sampling Procedures and Tables For Inspection By Attributes.
- G. NFPA 79, Electrical Standard for Industrial Machinery.

1.4 SUBMITTALS

- A. Operator Training plan and schedule
- B. Maintenance Training and schedule

1.5 TRAINING

- A. General:
 1. Provide an integrated training program for Owner's personnel.
 2. Perform training to meet specific needs of Owner's personnel.
 3. Include training sessions, classroom and field, for managers, engineers, operators, and maintenance personnel.
 4. Provide instruction on two working shift(s) as needed to accommodate the Owner's personnel schedule.
 5. Owner reserves the right to reuse videotapes of training sessions.

B. Management Seminar:

1. Length: 2 days.
2. Location: Owner's facility.
3. Objective: Provide overview for nonoperations and maintenance personnel for understanding the PIC.
4. Attended by management, engineering, and other nonoperations and nonmaintenance personnel.
5. Primary Topics:
 - a. PIC Overview: How hardware and software are used for operation and control of facilities.
 - b. Block Diagram Presentation of PIC: How and what information flows within system and what is done by each functional unit.
 - c. Process/Operator Interface: Explanation and demonstration of how to use HMI PC to access displays, reports, and controls.
 - d. Management-oriented explanation of data management displays and printouts.
 - e. Walk-through of installed systems.

C. Operations and Maintenance Training:

1. General:
 - a. Refer to specific requirements specified in PIC Subsections.
 - b. Include review of O&M data and survey of spares, expendables, and test equipment.
 - c. Use equipment similar to that provided.
 - d. Unless otherwise specified in PIC subsections, provide training suitable for instrument technicians with at least a 2-year associate engineering or technical degree, or equivalent education and experience in electronics, instrumentation, or digital systems.
2. Operations Training: For Owner's operations personnel on operation of I&C components.

- a. Training Session Duration: 1/2 instructor days.
 - b. Number of Training Sessions: Two.
 - c. Location: Project Site.
 - d. Course Objective: Develop skills needed to use I&C components and functions to monitor and control the plant on a day-to-day basis.
 - e. Content: Conduct training on loop-by-loop basis.
 - 1) Loop Functions: Understanding of loop functions, including interlocks for each loop.
 - 2) Loop Operation: For example, adjusting process variable setpoints, AUTO/MANUAL control transfer, AUTO and MANUAL control, annunciator acknowledgement and resetting.
 - 3) Interfaces with PIC subsystems.
3. Maintenance Training:
- a. Training Session Duration: 1/2 instructor days.
 - b. Number of Training Sessions: Two.
 - c. Location: Project Site
 - d. Course Objective: Develop skills needed for routine maintenance of PIC.
 - e. Content: Provide training for each type of component and function provided.
 - 1) Loop Functions: Understanding details of each loop and how they function.
 - 2) Component calibration.
 - 3) Adjustments: For example, controller tuning constants, current switch trip points, and similar items.
 - 4) Troubleshooting and diagnosis for equipment and software.
 - 5) Replacing lamps, chart paper, and fuses.
 - 6) I&C components removal and replacement.
 - 7) Periodic preventive maintenance.

PART 2 PRODUCTS

2.1 NOT USED

PART 3 EXECUTION

3.1 CLASSROOM TRAINING

- A. Provide a minimum of 4 hours of classroom training on process control system components for each training session. Conduct one training session per week on two consecutive weeks to accommodate the shift schedules of operation and maintenance staff. Certify completion of training.
- B. Training session will present and review the procedures and information that will be used in the field training sessions in addition to information required for obtaining service and replacement parts.

3.2 FIELD TRAINING

- A. Training sessions to be 1 hour duration and do not repeat a device training if covered in multiple Facility areas; provide reference to the training session where the device was covered. Conduct one training session for each device type per week on two consecutive weeks to accommodate the shift schedules of operation and maintenance staff.
- B. Training to include a demonstration of configuration, operation, trouble shooting, wiring, calibration, testing, installation, safety, and warranty coverage for each device type.

3.3 MANUFACTURER'S SERVICES

- A. TRAINING: Provide a factory-trained manufacturer's representative or System Integrator skilled in equipment use at the Site for the following activities. Specified durations do not include travel time to or from the Site.
- B. Coordinate training with operations and maintenance staff schedules to ensure all required staff can attend.
- C. Training to include configuration, operation, trouble shooting, wiring, calibration, testing, installation, safety, and warranty coverage for each process control hardware type.
- D. Certify completion of training on form provided herein.

END OF SECTION

SECTION 40 61 93

Process Control Systems – Input / Output List

Item	Description	I/O Type	PLC	Rack/Slot/Point
1	AB1 AC1 MIX-511 RUNNING	DISCRETE INPUT	LCP-601	1/01/00
2	AB1 AC1 MIX-511 FAULT	DISCRETE INPUT	LCP-601	1/01/01
3	AB1 AC1 MIX-511 HIGH TEMPERATURE	DISCRETE INPUT	LCP-601	1/01/02
4	AB1 AC2 MIX-512 RUNNING	DISCRETE INPUT	LCP-601	1/01/03
5	AB1 AC2 MIX-512 FAULT	DISCRETE INPUT	LCP-601	1/01/04
6	AB1 AC2 MIX-512 HIGH TEMPERATURE	DISCRETE INPUT	LCP-601	1/01/05
7	AB1 AC3 MIX-513 RUNNING	DISCRETE INPUT	LCP-601	1/01/06
8	AB1 AC3 MIX-513 FAULT	DISCRETE INPUT	LCP-601	1/01/07
9	AB1 AC3 MIX-513 HIGH TEMPERATURE	DISCRETE INPUT	LCP-601	1/01/08
10	AB1 AZ1 ZSO-514 OPEN	DISCRETE INPUT	LCP-601	1/01/09
11	AB1 AZ1 ZSC-514 CLOSED	DISCRETE INPUT	LCP-601	1/01/10
12	AB1 AZ2 ZSO-515 OPEN	DISCRETE INPUT	LCP-601	1/01/11
13	AB1 AZ2 ZSC-515 CLOSED	DISCRETE INPUT	LCP-601	1/01/12
14	AB1 AZ3 ZSO-516 OPEN	DISCRETE INPUT	LCP-601	1/01/13
15	AB1 AZ3 ZSC-516 CLOSED	DISCRETE INPUT	LCP-601	1/01/14
16	AB1 MIX LIQUOR PMP-516 RUNNING	DISCRETE INPUT	LCP-601	1/01/15
17	AB1 MIX LIQUOR PMP-516 FAULT	DISCRETE INPUT	LCP-601	1/01/16
18	AB1 MIX LIQUOR PMP-516 HI TEMP	DISCRETE INPUT	LCP-601	1/01/17
19	AB1 MIX LIQUOR PMP-516 SEAL FAIL	DISCRETE INPUT	LCP-601	1/01/18
20	AB2 AC1 MIX-521 RUNNING	DISCRETE INPUT	LCP-601	1/01/19
21	AB2 AC1 MIX-521 FAULT	DISCRETE INPUT	LCP-601	1/01/20
22	AB2 AC1 MIX-521 HIGH TEMPERATURE	DISCRETE INPUT	LCP-601	1/01/21
23	AB2 AC2MIX-522 RUNNING	DISCRETE INPUT	LCP-601	1/01/22
24	AB2 AC2 MIX-522 FAULT	DISCRETE INPUT	LCP-601	1/01/23
25	AB2 AC2 MIX-522 HIGH TEMPERATURE	DISCRETE INPUT	LCP-601	1/01/24
26	AB2 AC3 MIX-523 RUNNING	DISCRETE INPUT	LCP-601	1/01/25
27	AB2 AC3 MIX-523 FAULT	DISCRETE INPUT	LCP-601	1/01/26
28	AB2 AC3MIX-523 HIGH TEMPERATURE	DISCRETE INPUT	LCP-601	1/01/27
29	AB2 AZ1 ZSO-524 OPEN	DISCRETE INPUT	LCP-601	1/01/28
30	AB2 AZ1 ZSC-524 CLOSED	DISCRETE INPUT	LCP-601	1/01/29
31	AB2 AZ2 ZSO-525 OPEN	DISCRETE INPUT	LCP-601	1/01/30
32	AB2 AZ2 ZSC-525 CLOSED	DISCRETE INPUT	LCP-601	1/01/31
33	AB2 AZ3 ZSO-526 OPEN	DISCRETE INPUT	LCP-601	1/02/00
34	AB2 AZ3 ZSC-526 CLOSED	DISCRETE INPUT	LCP-601	1/02/01
35	AB2 MIX LIQUOR PMP-526 RUNNING	DISCRETE INPUT	LCP-601	1/02/02
36	AB2 MIX LIQUOR PMP-526 FAULT	DISCRETE INPUT	LCP-601	1/02/03

Item	Description	I/O Type	PLC	Rack/Slot/Point
37	AB2 MIX LIQUOR PMP-526 HI TEMP	DISCRETE INPUT	LCP-601	1/02/04
38	AB2 MIX LIQUOR PMP-526 SEAL FAIL	DISCRETE INPUT	LCP-601	1/02/05
39	AB3 AC1 MIX-531 RUNNING	DISCRETE INPUT	LCP-601	1/02/06
40	AB3 AC1 MIX-531 FAULT	DISCRETE INPUT	LCP-601	1/02/07
41	AB3 AC1 MIX-531 HIGH TEMPERATURE	DISCRETE INPUT	LCP-601	1/02/08
42	AB3 AC2MIX-532 RUNNING	DISCRETE INPUT	LCP-601	1/02/09
43	AB3 AC2 MIX-532 FAULT	DISCRETE INPUT	LCP-601	1/02/10
44	AB3 AC2 MIX-532 HIGH TEMPERATURE	DISCRETE INPUT	LCP-601	1/02/11
45	AB3 AC3 MIX-533 RUNNING	DISCRETE INPUT	LCP-601	1/02/12
46	AB3 AC3 MIX-533 FAULT	DISCRETE INPUT	LCP-601	1/02/13
47	AB3 AC3MIX-533 HIGH TEMPERATURE	DISCRETE INPUT	LCP-601	1/02/14
48	AB3 AZ1 ZSO-534 OPEN	DISCRETE INPUT	LCP-601	1/02/15
49	AB3 AZ1 ZSC-534 CLOSED	DISCRETE INPUT	LCP-601	1/02/16
50	AB3 AZ2 ZSO-535 OPEN	DISCRETE INPUT	LCP-601	1/02/17
51	AB3 AZ2 ZSC-535 CLOSED	DISCRETE INPUT	LCP-601	1/02/18
52	AB3 AZ3 ZSO-536 OPEN	DISCRETE INPUT	LCP-601	1/02/19
53	AB3 AZ3 ZSC-536 CLOSED	DISCRETE INPUT	LCP-601	1/02/20
54	AB3 MIX LIQUOR PMP-536 RUNNING	DISCRETE INPUT	LCP-601	1/02/21
55	AB3 MIX LIQUOR PMP-536 FAULT	DISCRETE INPUT	LCP-601	1/02/22
56	AB3 MIX LIQUOR PMP-536 HI TEMP	DISCRETE INPUT	LCP-601	1/02/23
57	AB3 MIX LIQUOR PMP-536 SEAL FAIL	DISCRETE INPUT	LCP-601	1/02/24
58	AB4 AC1 MIX-541 RUNNING	DISCRETE INPUT	LCP-601	1/02/25
59	AB4 AC1 MIX-541 FAULT	DISCRETE INPUT	LCP-601	1/02/26
60	AB4 AC1 MIX-541 HIGH TEMPERATURE	DISCRETE INPUT	LCP-601	1/02/27
61	AB4 AC2MIX-542 RUNNING	DISCRETE INPUT	LCP-601	1/02/28
62	AB4 AC2 MIX-542 FAULT	DISCRETE INPUT	LCP-601	1/02/29
63	AB4 AC2 MIX-542 HIGH TEMPERATURE	DISCRETE INPUT	LCP-601	1/02/30
64	SPARE	DISCRETE INPUT	LCP-601	1/02/31
65	AB4 AC3 MIX-543 RUNNING	DISCRETE INPUT	LCP-601	1/03/00
66	AB4 AC3 MIX-543 FAULT	DISCRETE INPUT	LCP-601	1/03/01
67	AB4 AC3MIX-543 HIGH TEMPERATURE	DISCRETE INPUT	LCP-601	1/03/02
68	AB4 AZ1 ZSO-544 OPEN	DISCRETE INPUT	LCP-601	1/03/03
69	AB4 AZ1 ZSC-544 CLOSED	DISCRETE INPUT	LCP-601	1/03/04
70	AB4 AZ2 ZSO-545 OPEN	DISCRETE INPUT	LCP-601	1/03/05
71	AB4 AZ2 ZSC-545 CLOSED	DISCRETE INPUT	LCP-601	1/03/06
72	AB4 AZ3 ZSO-546 OPEN	DISCRETE INPUT	LCP-601	1/03/07
73	AB4 AZ3 ZSC-546 CLOSED	DISCRETE INPUT	LCP-601	1/03/08
74	AB4 MIX LIQUOR PMP-546 RUNNING	DISCRETE INPUT	LCP-601	1/03/09
75	AB4 MIX LIQUOR PMP-546 FAULT	DISCRETE INPUT	LCP-601	1/03/10
76	AB4 MIX LIQUOR PMP-546 HI TEMP	DISCRETE INPUT	LCP-601	1/03/11

Item	Description	I/O Type	PLC	Rack/Slot/Point
77	AB4 MIX LIQUOR PMP-546 SEAL FAIL	DISCRETE INPUT	LCP-601	1/03/12
78	BLOWER BLW-601 RUNNING	DISCRETE INPUT	LCP-601	1/03/13
79	BLOWER BLW-601 FAULT	DISCRETE INPUT	LCP-601	1/03/14
80	BLOWER BLW-602 RUNNING	DISCRETE INPUT	LCP-601	1/03/15
81	BLOWER BLW-602 FAULT	DISCRETE INPUT	LCP-601	1/03/16
82	BLOWER BLW-603 RUNNING	DISCRETE INPUT	LCP-601	1/03/17
83	BLOWER BLW-603 FAULT	DISCRETE INPUT	LCP-601	1/03/18
84	BLOWER BLW-604 RUNNING	DISCRETE INPUT	LCP-601	1/03/19
85	BLOWER BLW-604 FAULT	DISCRETE INPUT	LCP-601	1/03/20
86	SD-601 FIRE/SMOKE ALARM	DISCRETE INPUT	LCP-601	1/03/21
87	BLOWER ROOM LAB - MAN IN TROUBLE	DISCRETE INPUT	LCP-601	1/03/22
88	BLOWER BUILDING INTRUSION	DISCRETE INPUT	LCP-601	1/03/23
89	SPARE	DISCRETE INPUT	LCP-601	1/03/24
90	SPARE	DISCRETE INPUT	LCP-601	1/03/25
91	SPARE	DISCRETE INPUT	LCP-601	1/03/26
92	SPARE	DISCRETE INPUT	LCP-601	1/03/27
93	SPARE	DISCRETE INPUT	LCP-601	1/03/28
94	SPARE	DISCRETE INPUT	LCP-601	1/03/29
95	MCC 640C PHASE/POWER FAIL	DISCRETE INPUT	LCP-601	1/03/30
96	MCC 640D PHASE/POWER FAIL	DISCRETE INPUT	LCP-601	1/03/31
97	SPARE	DISCRETE INPUT	LCP-601	1/04/00
98	SPARE	DISCRETE INPUT	LCP-601	1/04/01
99	SPARE	DISCRETE INPUT	LCP-601	1/04/02
100	SPARE	DISCRETE INPUT	LCP-601	1/04/03
101	SPARE	DISCRETE INPUT	LCP-601	1/04/04
102	SPARE	DISCRETE INPUT	LCP-601	1/04/05
103	SPARE	DISCRETE INPUT	LCP-601	1/04/06
104	SPARE	DISCRETE INPUT	LCP-601	1/04/07
105	SPARE	DISCRETE INPUT	LCP-601	1/04/08
106	SPARE	DISCRETE INPUT	LCP-601	1/04/09
107	SPARE	DISCRETE INPUT	LCP-601	1/04/10
108	SPARE	DISCRETE INPUT	LCP-601	1/04/11
109	SPARE	DISCRETE INPUT	LCP-601	1/04/12
110	SPARE	DISCRETE INPUT	LCP-601	1/04/13
111	SPARE	DISCRETE INPUT	LCP-601	1/04/14
112	SPARE	DISCRETE INPUT	LCP-601	1/04/15
113	SPARE	DISCRETE INPUT	LCP-601	1/04/16
114	SPARE	DISCRETE INPUT	LCP-601	1/04/17
115	SPARE	DISCRETE INPUT	LCP-601	1/04/18
116	SPARE	DISCRETE INPUT	LCP-601	1/04/19

Item	Description	I/O Type	PLC	Rack/Slot/Point
117	SPARE	DISCRETE INPUT	LCP-601	1/04/20
118	SPARE	DISCRETE INPUT	LCP-601	1/04/21
119	SPARE	DISCRETE INPUT	LCP-601	1/04/22
120	SPARE	DISCRETE INPUT	LCP-601	1/04/23
121	SPARE	DISCRETE INPUT	LCP-601	1/04/24
122	SPARE	DISCRETE INPUT	LCP-601	1/04/25
123	SPARE	DISCRETE INPUT	LCP-601	1/04/26
124	SPARE	DISCRETE INPUT	LCP-601	1/04/27
125	SPARE	DISCRETE INPUT	LCP-601	1/04/28
126	SPARE	DISCRETE INPUT	LCP-601	1/04/29
127	SPARE	DISCRETE INPUT	LCP-601	1/04/30
128	SPARE	DISCRETE INPUT	LCP-601	1/04/31
129	AB1 MIX-511 RUN	DISCRETE OUTPUT	LCP-601	1/05/00
130	AB1 MIX-511 FAULT RESET	DISCRETE OUTPUT	LCP-601	1/05/01
131	AB1 MIX-512 RUN	DISCRETE OUTPUT	LCP-601	1/05/02
132	AB1 MIX-512 FAULT RESET	DISCRETE OUTPUT	LCP-601	1/05/03
133	AB1 MIX-513 RUN	DISCRETE OUTPUT	LCP-601	1/05/04
134	AB1 MIX-513 FAULT RESET	DISCRETE OUTPUT	LCP-601	1/05/05
135	AB1 MIX LIQUOR PMP-516 RUN	DISCRETE OUTPUT	LCP-601	1/05/06
136	AB1 MIX LIQUOR PMP-516 FAULT RESET	DISCRETE OUTPUT	LCP-601	1/05/07
137	AB2 MIX-521 RUN	DISCRETE OUTPUT	LCP-601	1/05/08
138	AB2 MIX-521 FAULT RESET	DISCRETE OUTPUT	LCP-601	1/05/09
139	AB2 MIX-522 RUN	DISCRETE OUTPUT	LCP-601	1/05/10
140	AB2 MIX-522 FAULT RESET	DISCRETE OUTPUT	LCP-601	1/05/11
141	AB2 MIX-523 RUN	DISCRETE OUTPUT	LCP-601	1/05/12
142	AB2 MIX-523 FAULT RESET	DISCRETE OUTPUT	LCP-601	1/05/13
143	AB2 MIX LIQUOR PMP-526 RUN	DISCRETE OUTPUT	LCP-601	1/05/14
144	AB2 MIX LIQUOR PMP-526 FAULT RESET	DISCRETE OUTPUT	LCP-601	1/05/15
145	AB3 MIX-531 RUN	DISCRETE OUTPUT	LCP-601	1/05/16
146	AB3 MIX-531 FAULT RESET	DISCRETE OUTPUT	LCP-601	1/05/17
147	AB3 MIX-532 RUN	DISCRETE OUTPUT	LCP-601	1/05/18
148	AB3 MIX-532 FAULT RESET	DISCRETE OUTPUT	LCP-601	1/05/19
149	AB3 MIX-533 RUN	DISCRETE OUTPUT	LCP-601	1/05/20
150	AB3 MIX-533 FAULT RESET	DISCRETE OUTPUT	LCP-601	1/05/21
151	AB3 MIX LIQUOR PMP-536 RUN	DISCRETE OUTPUT	LCP-601	1/05/22
152	AB3 MIX LIQUOR PMP-536 FAULT RESET	DISCRETE OUTPUT	LCP-601	1/05/23
153	AB4 MIX-541 RUN	DISCRETE OUTPUT	LCP-601	1/05/24
154	AB4 MIX-541 FAULT RESET	DISCRETE OUTPUT	LCP-601	1/05/25
155	AB4 MIX-542 RUN	DISCRETE OUTPUT	LCP-601	1/05/26
156	AB4 MIX-542 FAULT RESET	DISCRETE OUTPUT	LCP-601	1/05/27

Item	Description	I/O Type	PLC	Rack/Slot/Point
157	AB4 MIX-543 RUN	DISCRETE OUTPUT	LCP-601	1/05/28
158	AB4 MIX-543 FAULT RESET	DISCRETE OUTPUT	LCP-601	1/05/29
159	AB4 MIX LIQUOR PMP-546 RUN	DISCRETE OUTPUT	LCP-601	1/05/30
160	AB4 MIX LIQUOR PMP-546 FAULT RESET	DISCRETE OUTPUT	LCP-601	1/05/31
161	BLOWER BLW-601 RUN	DISCRETE OUTPUT	LCP-601	1/06/00
162	BLOWER BLW-601 FAULT RESET	DISCRETE OUTPUT	LCP-601	1/06/01
163	BLOWER BLW-602 RUN	DISCRETE OUTPUT	LCP-601	1/06/02
164	BLOWER BLW-602 FAULT RESET	DISCRETE OUTPUT	LCP-601	1/06/03
165	BLOWER BLW-603 RUN	DISCRETE OUTPUT	LCP-601	1/06/04
166	BLOWER BLW-603 FAULT RESET	DISCRETE OUTPUT	LCP-601	1/06/05
167	BLOWER BLW-604 RUN	DISCRETE OUTPUT	LCP-601	1/06/06
168	BLOWER BLW-604 FAULT RESET	DISCRETE OUTPUT	LCP-601	1/06/07
169	ALARM HORN	DISCRETE OUTPUT	LCP-601	1/06/08
170	SPARE	DISCRETE OUTPUT	LCP-601	1/06/09
171	SPARE	DISCRETE OUTPUT	LCP-601	1/06/10
172	SPARE	DISCRETE OUTPUT	LCP-601	1/06/11
173	SPARE	DISCRETE OUTPUT	LCP-601	1/06/12
174	SPARE	DISCRETE OUTPUT	LCP-601	1/06/13
175	SPARE	DISCRETE OUTPUT	LCP-601	1/06/14
176	SPARE	DISCRETE OUTPUT	LCP-601	1/06/15
177	SPARE	DISCRETE OUTPUT	LCP-601	1/06/16
178	SPARE	DISCRETE OUTPUT	LCP-601	1/06/17
179	SPARE	DISCRETE OUTPUT	LCP-601	1/06/18
180	SPARE	DISCRETE OUTPUT	LCP-601	1/06/19
181	SPARE	DISCRETE OUTPUT	LCP-601	1/06/20
182	SPARE	DISCRETE OUTPUT	LCP-601	1/06/21
183	SPARE	DISCRETE OUTPUT	LCP-601	1/06/22
184	SPARE	DISCRETE OUTPUT	LCP-601	1/06/23
185	SPARE	DISCRETE OUTPUT	LCP-601	1/06/24
186	SPARE	DISCRETE OUTPUT	LCP-601	1/06/25
187	SPARE	DISCRETE OUTPUT	LCP-601	1/06/26
188	SPARE	DISCRETE OUTPUT	LCP-601	1/06/27
189	SPARE	DISCRETE OUTPUT	LCP-601	1/06/28
190	SPARE	DISCRETE OUTPUT	LCP-601	1/06/29
191	SPARE	DISCRETE OUTPUT	LCP-601	1/06/30
192	SPARE	DISCRETE OUTPUT	LCP-601	1/06/31
193	AB1 AIT-514/AE-513A ORP	ANALOG INPUT	LCP-601	1/07/00
194	AB1 AIT-514/AE-513B NO3	ANALOG INPUT	LCP-601	1/07/01
195	AB1 AIT-514/AE-513C pH	ANALOG INPUT	LCP-601	1/07/02
196	AB1 AIT-514/AE-514A DO	ANALOG INPUT	LCP-601	1/07/03

Item	Description	I/O Type	PLC	Rack/Slot/Point
197	AB1 AIT-514/AE-514A TEMP	ANALOG INPUT	LCP-601	1/07/04
198	AB1 AIT-514/AE-514B TSS	ANALOG INPUT	LCP-601	1/07/05
199	AB1 AIT-514/AE-516 DO	ANALOG INPUT	LCP-601	1/07/06
200	AB1 AIT-514/AE-516 TEMP	ANALOG INPUT	LCP-601	1/07/07
201	AB1 AIT-515/AE-511 ORP	ANALOG INPUT	LCP-601	1/08/00
202	AB1 AIT-515/AE-515 DO	ANALOG INPUT	LCP-601	1/08/01
203	AB1 AIT-515/AE-515 TEMP	ANALOG INPUT	LCP-601	1/08/02
204	AB1 AZ1 ZI-514 POSITION FEEDBACK	ANALOG INPUT	LCP-601	1/08/03
205	AB1 AZ1 FIT-514 AIRFLOW	ANALOG INPUT	LCP-601	1/08/04
206	AB1 AZ2 ZI-515 POSITION FEEDBACK	ANALOG INPUT	LCP-601	1/08/05
207	AB1 AZ2 FIT-515 AIRFLOW	ANALOG INPUT	LCP-601	1/08/06
208	AB1 AZ3 ZI-516 POSITION FEEDBACK	ANALOG INPUT	LCP-601	1/08/07
209	AB1 AZ3 FIT-516 AIRFLOW	ANALOG INPUT	LCP-601	1/09/00
210	AB2 AIT-515/AE-521 ORP	ANALOG INPUT	LCP-601	1/09/01
211	AB2 AIT-515/AE-525 DO	ANALOG INPUT	LCP-601	1/09/02
212	AB2 AIT-515/AE-525 TEMP	ANALOG INPUT	LCP-601	1/09/03
213	AB2 AIT-524/AE-520 pH	ANALOG INPUT	LCP-601	1/09/04
214	AB2 AIT-524/AE-523A ORP	ANALOG INPUT	LCP-601	1/09/05
215	AB2 AIT-524/AE-523B NO3	ANALOG INPUT	LCP-601	1/09/06
216	AB2 AIT-524/AE-523C pH	ANALOG INPUT	LCP-601	1/09/07
217	AB2 AIT-524/AE-524A DO	ANALOG INPUT	LCP-601	1/10/00
218	AB2 AIT-524/AE-524A TEMP	ANALOG INPUT	LCP-601	1/10/01
219	AB3 AIT-524/AE-524B TSS	ANALOG INPUT	LCP-601	1/10/02
220	AB2 AIT-524/AE-526 DO	ANALOG INPUT	LCP-601	1/10/03
221	AB2 AIT-524/AE-526 TEMP	ANALOG INPUT	LCP-601	1/10/04
222	AB2 AZ1 ZI-524 POSITION FEEDBACK	ANALOG INPUT	LCP-601	1/10/05
223	AB2 AZ1 FIT-524 AIRFLOW	ANALOG INPUT	LCP-601	1/10/06
224	AB2 AZ2 ZI-525 POSITION FEEDBACK	ANALOG INPUT	LCP-601	1/10/07
225	AB2 AZ2 FIT-525 AIRFLOW	ANALOG INPUT	LCP-601	1/11/00
226	AB2 AZ3 ZI-526 POSITION FEEDBACK	ANALOG INPUT	LCP-601	1/11/01
227	AB2 AZ3 FIT-526 AIRFLOW	ANALOG INPUT	LCP-601	1/11/02
228	AB3 AIT-534/AE-533A ORP	ANALOG INPUT	LCP-601	1/11/03
229	AB3 AIT-534/AE-533B NO3	ANALOG INPUT	LCP-601	1/11/04
230	AB3 AIT-534/AE-533C pH	ANALOG INPUT	LCP-601	1/11/05
231	AB3 AIT-534/AE-534A DO	ANALOG INPUT	LCP-601	1/11/06
232	AB3 AIT-534/AE-534A TEMPERATURE	ANALOG INPUT	LCP-601	1/11/07
233	AB3 AIT-534/AE-534B TSS	ANALOG INPUT	LCP-601	1/12/00
234	AB3 AIT-534/AE-536 DO	ANALOG INPUT	LCP-601	1/12/01
235	AB3 AIT-534/AE-536 TEMPERATURE	ANALOG INPUT	LCP-601	1/12/02
236	AB3 AIT-534/AE-537A pH	ANALOG INPUT	LCP-601	1/12/03

Item	Description	I/O Type	PLC	Rack/Slot/Point
237	AB3 AIT-534/AE-537B NO3	ANALOG INPUT	LCP-601	1/12/04
238	AB3 AIT-535/AE-531 ORP	ANALOG INPUT	LCP-601	1/12/05
239	AB3 AIT-535/AE-535 DO	ANALOG INPUT	LCP-601	1/12/06
240	AB3 AIT-535/AE-535 TEMPERATURE	ANALOG INPUT	LCP-601	1/12/07
241	AB3 AZ1 ZI-534 POSITION FEEDBACK	ANALOG INPUT	LCP-601	2/01/00
242	AB3 AZ1 FIT-534 AIRFLOW	ANALOG INPUT	LCP-601	2/01/01
243	AB3 AZ2 ZI-535 POSITION FEEDBACK	ANALOG INPUT	LCP-601	2/01/02
244	AB3 AZ2 FIT-535 AIRFLOW	ANALOG INPUT	LCP-601	2/01/03
245	AB3 AZ3 ZI-536 POSITION FEEDBACK	ANALOG INPUT	LCP-601	2/01/04
246	AB3 AZ3 FIT-536 AIRFLOW	ANALOG INPUT	LCP-601	2/01/05
247	AB4 AIT-545/AE-541 ORP	ANALOG INPUT	LCP-601	2/01/06
248	AB4 AIT-545/AE-545 DO	ANALOG INPUT	LCP-601	2/01/07
249	AB4 AIT-545/AE-545 TEMPERATURE	ANALOG INPUT	LCP-601	2/02/00
250	AB4 AIT-544/AE-543A ORP	ANALOG INPUT	LCP-601	2/02/01
251	AB4 AIT-544/AE-543B NO3	ANALOG INPUT	LCP-601	2/02/02
252	AB4 AIT-544/AE-543C pH	ANALOG INPUT	LCP-601	2/02/03
253	AB4 AIT-544/AE-544A DO	ANALOG INPUT	LCP-601	2/02/04
254	AB4 AIT-544/AE-544A TEMPERATURE	ANALOG INPUT	LCP-601	2/02/05
255	AB4 AIT-544/AE-544B TSS	ANALOG INPUT	LCP-601	2/02/06
256	AB4 AIT-544/AE-546 DO	ANALOG INPUT	LCP-601	2/02/07
257	AB4 AIT-544/AE-546 TEMPERATURE	ANALOG INPUT	LCP-601	2/03/00
258	AB4 AZ1 ZI-544 POSITION FEEDBACK	ANALOG INPUT	LCP-601	2/03/01
259	AB4 AZ1 FIT-544 AIRFLOW	ANALOG INPUT	LCP-601	2/03/02
260	AB4 AZ2 ZI-545 POSITION FEEDBACK	ANALOG INPUT	LCP-601	2/03/03
261	AB4 AZ2 FIT-545 AIRFLOW	ANALOG INPUT	LCP-601	2/03/04
262	AB4 AZ3 ZI-546 POSITION FEEDBACK	ANALOG INPUT	LCP-601	2/03/05
263	AB4 AZ3 FIT-546 AIRFLOW	ANALOG INPUT	LCP-601	2/03/06
264	FIT-605 AERATION HEADER AIR FLOW	ANALOG INPUT	LCP-601	2/03/07
265	PIT-606 BLOWER DISCHARGE PRESSURE	ANALOG INPUT	LCP-601	2/04/00
266	BL-604 TEMP SPEED CONTROL	ANALOG INPUT	LCP-601	2/04/01
267	BL-603 TEMP SPEED CONTROL	ANALOG INPUT	LCP-601	2/04/02
268	ACH-601 SPEED CONTROL	ANALOG INPUT	LCP-601	2/04/03
269	SPARE	ANALOG INPUT	LCP-601	2/04/04
270	SPARE	ANALOG INPUT	LCP-601	2/04/05
271	SPARE	ANALOG INPUT	LCP-601	2/04/06
272	SPARE	ANALOG INPUT	LCP-601	2/04/07
273	SPARE	ANALOG INPUT	LCP-601	2/05/00
274	SPARE	ANALOG INPUT	LCP-601	2/05/01
275	SPARE	ANALOG INPUT	LCP-601	2/05/02
276	SPARE	ANALOG INPUT	LCP-601	2/05/03

Item	Description	I/O Type	PLC	Rack/Slot/Point
277	SPARE	ANALOG INPUT	LCP-601	2/05/04
278	SPARE	ANALOG INPUT	LCP-601	2/05/05
279	SPARE	ANALOG INPUT	LCP-601	2/05/06
280	SPARE	ANALOG INPUT	LCP-601	2/05/07
281	SPARE	ANALOG INPUT	LCP-601	2/06/00
282	SPARE	ANALOG INPUT	LCP-601	2/06/01
283	SPARE	ANALOG INPUT	LCP-601	2/06/02
284	SPARE	ANALOG INPUT	LCP-601	2/06/03
285	SPARE	ANALOG INPUT	LCP-601	2/06/04
286	SPARE	ANALOG INPUT	LCP-601	2/06/05
287	MCC 640C POWER INDICATION	ANALOG INPUT	LCP-601	2/06/06
288	MCC 640D POWER INDICATION	ANALOG INPUT	LCP-601	2/06/07
289	AB1 AZ1 ZSO-514 POSITION SETPOINT	ANALOG OUTPUT	LCP-601	2/08/00
290	AB1 AZ2 ZSO-515 POSITION SETPOINT	ANALOG OUTPUT	LCP-601	2/08/01
291	AB1 AZ3 ZSO-516 POSITION SETPOINT	ANALOG OUTPUT	LCP-601	2/08/02
292	AB2 AZ1 ZSO-524 POSITION SETPOINT	ANALOG OUTPUT	LCP-601	2/08/03
293	AB2 AZ2 ZSO-525 POSITION SETPOINT	ANALOG OUTPUT	LCP-601	2/08/04
294	AB2 AZ3 ZSO-526 POSITION SETPOINT	ANALOG OUTPUT	LCP-601	2/08/05
295	AB3 AZ1 ZSO-534 POSITION SETPOINT	ANALOG OUTPUT	LCP-601	2/08/06
296	AB3 AZ2 ZSO-535 POSITION SETPOINT	ANALOG OUTPUT	LCP-601	2/08/07
297	AB3 AZ3 ZSO-536 POSITION SETPOINT	ANALOG OUTPUT	LCP-601	2/09/00
298	AB4 AZ1 ZSO-544 POSITION SETPOINT	ANALOG OUTPUT	LCP-601	2/09/01
299	AB4 AZ2 ZSO-545 POSITION SETPOINT	ANALOG OUTPUT	LCP-601	2/09/02
300	AB4 AZ2 ZSO-546 POSITION SETPOINT	ANALOG OUTPUT	LCP-601	2/09/03
301	SPARE			2/09/04
302	SPARE			2/09/05
303	SPARE			2/09/06
304	SPARE			2/09/07
305	SPARE			2/10/00
306	SPARE			2/10/01
307	SPARE			2/10/02
308	SPARE			2/10/03
309	SPARE			2/10/04
310	SPARE			2/10/05
311	SPARE			2/10/06
312	SPARE			2/10/07
313	SPARE			2/11/00
314	SPARE			2/11/01
315	SPARE			2/11/02
316	SPARE			2/11/03

Item	Description	I/O Type	PLC	Rack/Slot/Point
317	SPARE			2/11/04
318	SPARE			2/11/05
319	SPARE			2/11/06
320	SPARE			2/11/07

END OF SECTION

SECTION 40 62 63 - OPERATOR INTERFACE

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Scope
 - 2. Reference Standards
 - 3. Quality Assurance.
 - 4. Submittals.
 - 5. Product Requirements.
 - 6. Installation.
 - 7. Testing.

1.2 SCOPE

- A. This Section specifies requirements for supply and installation of an Operator Interface Terminal.
- B. The Operator interface panel shall be Allen Bradley "PanelView Plus 6 1000 Color" series with touchscreen, model 2711P-T10C4A8.

1.3 REFERENCE STANDARDS

- A. ASTM – American Society for Testing and Materials
- B. NEMA – National Electrical Manufacturer's Association
- C. NEC – National Electrical Code

1.4 QUALITY ASSURANCE

- A. REQUIREMENTS: Section 40 67 00 Control System Equipment Panels and Racks and 40 61 13 Process Control System General Provisions
- B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials

1.5 SUBMITTALS

- A. Submittals requirements specified in: Section 01 33 00 and 40 61 13.
- B. Product Data: For each type of device and system:

1. Include product data sheets and equipment brochures showing standard products and specified accessories.

- a. Mark data sheets to clearly show exact product and options being provided

- C. Manufacturer's installation instructions.

- D. Operation and Maintenance Manual if applicable.

1.6 PERFORMANCE REQUIREMENTS

- A. REQUIREMENTS: Section 40 70 00.

- B. OPERATING CONDITIONS: Section 40 06 70 – Schedule of Instrumentation for Process System.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Candidate manufacturers and models include the following

1. Rockwell Automation
 2. Automation Direct
 3. Approved Equal

2.2 ENVIRONMENTAL REQUIREMENTS

- A. Operating Temperature of 32 to 131 degrees F.
- B. Vibration tolerance of 57 to 500 hertz at 2 G peak acceleration
- C. Shock withstand during operation of 11 G at 11 milliseconds
- D. NEMA/UL Type 12, 13, 4X (indoor use) and IEC IP66

2.3 FEATURES

- A. 512 MB RAM
- B. 2 USB ports
- C. Windows CE 6.0 or newer operating system.
- D. 800 X 600 18 bit color graphics
- E. Battery backed real time clock
- F. Torch screen shall be 8 wire analog resistive

2.4 ELECTRICAL REQUIREMENTS

- A. FM for Class I, Div. 1 Groups A, B, C &D; Class II, Div. 1, Groups E, F, & G.
- B. Supply Voltage 120 VAC, single phase. Or 18 – 32 VDC as shown on the drawings

2.5 COMMUNICATION REQUIREMENTS

- A. Ethernet TCP/IP 100 MB
- B. Optional USB in addition to Ethernet

PART 3 EXECUTION

3.1 INSTALLATION

- A. REQUIREMENTS: Section 40 70 00 and Install in accordance with manufacturer's instructions for the specified functional requirements.
- B. Install Operator Interface panel per manufacturer's instructions.
- C. The screens for the operator interface shall copy the layout of the existing operator interface screens within the system. The City shall provide access to those stations for preview. The City may provide a copy of the current programming of one of the stations.

3.2 TESTING

- A. REQUIREMENTS: Section 40 61 21.
- B. Ensure proper installation per manufacturers recommendations

3.3 MANUFACTURER'S SERVICES

- A. REQUIREMENTS: Section 40 70 00 and 40 61 26

END OF SECTION

SECTION 40 63 43 - PROGRAMMABLE LOGIC CONTROLLERS

PART 1 GENERAL

1.1 SUMMARY

- A. Programmable logic process controllers are also known as programmable logic controllers (PLCs) and central processing unit (CPU). This section specifies general requirements for programmable logic process controllers and I/O Modules
- B. Section includes:
 - 1. Scope.
 - 2. Quality Assurance.
 - 3. Submittals.
 - 4. Performance Requirements.
 - 5. Products.
 - 6. Installation.
 - 7. Testing.
 - 8. Manufacturer's Services.

1.2 SCOPE

- A. Provide and test programmable logic process controllers with other process control hardware specified to form a functional process control system (PCS) integrated into the existing Plant's supervisory control and data acquisition (SCADA) system.
- B. Provide programmable logic process controllers sized for the input/output requirements as specified in Section 40 61 93's Input/ Output Lists and as specified on the drawings. Provide programmable logic process controllers sized for executing the control sequences PLC and SCADA logic.

1.3 QUALITY ASSURANCE

- A. REQUIREMENTS: Section 40 61 13 Process Control System General Provisions
- B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials

1.4 SUBMITTALS

- A. Submittals requirements specified in: Section 01 33 00 and 40 61 13.
- B. Product Data: For each type of device and system:

1. Include product data sheets and equipment brochures showing standard products and specified accessories.
 - a. Mark data sheets to clearly show exact product and options being provided
- C. Manufacturer's installation instructions.
- D. Operation and Maintenance Manual if applicable.

PART 2 PRODUCTS

2.1 CANDIDATE MANUFACTURERS

- A. Rockwell Automation, (Allen-Bradley PLC), ControlLogix System processor unless otherwise specified.

2.2 MATERIALS

- A. Provide new, free from defects, and industrial-grade processor as specified within this Section.
 1. PROCESSOR – Allen-Bradley - 1756-L75
 2. POWER SUPPLY - Allen-Bradley - 1756-PA75
 3. DISCRETE INPUT - Allen-Bradley - 1756-PA75
 4. DISCRETE OUTPUT- Allen-Bradley - 1756-OA16
 5. ANALOG INPUT- Allen-Bradley - 1756-IF8I
 6. ANALOG OUTPUT- Allen-Bradley - 1756-OF8I
 7. COMMUNICATION MODULE- Allen-Bradley - 1756-EN2T
 8. 10 SLOT CHASSIS- Allen-Bradley - 1756-A10
 9. 7 SLOT CHASSIS- Allen-Bradley - 1756-A7
- B. Provide appropriate screw type terminal connector for each type of I/O module required or listed herein.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Installation requirements: Processor and I/O to be rack mounted inside control cabinets as specified in Section 40 67 00 and on the drawings

3.2 TESTING

- A. Testing requirements specified in: Section 40 61 21.

3.3 MANUFACTURER'S SERVICES

A. REQUIREMENTS: Section 40 70 00 and 40 61 26

END OF SECTION

SECTION 40 67 00 - CONTROL SYSTEM EQUIPMENT PANES AND RACKS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Scope.
 - 2. Panel Information.
 - 3. Panel Design.
 - 4. Quality Assurance.
 - 5. Submittals.
 - 6. Performance Requirements.
 - 7. Products.
 - 8. General.

1.2 SCOPE

- A. This section specifies requirements for process control panels and hardware required for custom fabrication.
- B. Provide the instrument, control, and monitoring features indicated on the electrical drawings. Panels shall be arranged to separate control and instrument devices from power wiring. Panel shall be arranged for dedicated field wiring terminations rated for 600 Vac or less for power, control, and instrument signal wiring shall be fabricated by a UL-508A recognized facility and shall bear the appropriate UL 508A Industrial Control Panel label. Panels for Hazardous (Classified) Locations shall bear the appropriate UL 698A label.
- C. Panels that contain programmable logic controllers (PLC) are as shown on the drawings.
- D. Comply with the specified products in Sections 40 67 16, 40 67 19, 40 78 00 and 40 67 63. Panels that do not comply with the specified products and specified logic method, hardwired or PLC logic, shall not be accepted. Cost to retrofit the panel as specified shall be borne by the panel supplier. Corrections or modifications to UL 508A Industrial Control Panels shall be transported to the panel supplier's facility for corrections, testing, relabeling and inspection.
- E. Field modifications require a UL inspector site inspection for approval of panel corrections and to re-label the panel after the field modifications are completed.
- F. Refer to Local Control Panels - Section 26 27 16 that specifies requirements for manufacturer, vendor, and Contractor provided panels that include motor

controllers, combination motor starters, control devices, and logic devices as shown on the electrical drawings. These requirements apply to this section as well.

- G. Submittal drawing requirements specified in Section 01 33 00 and 40 61 13.
- H. Label panels with fault current rating per NEC article 409.110.

1.3 DEFINITIONS

- A. GENERAL: Definitions of terminology related to Instrumentation and Industrial Electronic Systems used in the specifications as defined in IEEE 100, ISA S51.1, and NEMA ICS 1.
- B. OIT: Acronym for Operator Interface Terminal.
- C. SCADA: Acronym for Supervisory Control And Data Acquisition
- D. PLC: Acronym for Programmable Logic Controller – synonymous with Programmable Automation Controller (PAC) for purposes of this project.
- E. DATA SHEETS: Data sheets shall refer to ISA S20 or ISA TR20.00.01 latest version.

1.4 PANEL INFORMATION:

- A. Panel information is provided on drawings. The drawings indicate enclosure NEMA rating required, panel nameplate inscription, and other accessories, etc.

1.5 PANEL DESIGN

- A. GENERAL: Panel control system hardware is specified in other Division 40 sections and as shown on the drawings.
- B. CONTROL POWER DISTRIBUTION: Panel containing 120-volt powered equipment use the din-rail power distribution method with fuses and blown fuse indication. Power is restricted to 120 Vac and 24 Vdc.
- C. POWER SUPPLIES: Panel containing direct current powered instruments or serving as the termination point for transmission loop powered field instruments contain direct current power supply system as specified herein or shown on the drawings.
- D. ELECTRICAL CONTROL DEVICES: Comply with requirements of Section 40 78 16 and 40 78 19 and the drawings for pushbuttons, indicating lights, relays, and similar equipment located in panels specified in this section.
- E. 5. UNINTERRUPTIBLE POWER SUPPLIES: Panel mounted 120 Vac input, 120 Vac and 24 Vdc outputs are specified herein or shown on the drawings

1.6 QUALITY ASSURANCE

- A. REQUIREMENTS: Section 40 61 13 Process Control System General Provisions
- B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials
- C. REFERENCE STANDARDS:
1. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.
 2. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Reference	Title
NEMA 250	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 94	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 508A	Industrial Control Panels
UL 698A	Industrial Control Panels Relating to Hazardous (Classified) Locations

- D. LISTED PRODUCTS
1. Equipment and components to be Underwriters Laboratory (UL) listed for the purpose per Section 40 61 13 or UL recognized.
 2. Provide factory applied UL 508A labels for control panels. Where intrinsic safety barriers are used within a control panel, provide UL 698A factory applied label as required by UL.

E. FACTORY TESTING:

1. Prior to shipment, the manufacturer test the functional operation of the control panels as described in Section 40 61 21.
2. The Owner requires the factory test to be a witnessed test. The Contractor shall include in the bid price the expense for travel and accommodations for one (1) representative from the Owner to witness the factory test at the manufacturer's facility. If test results require the testing to be redone, the additional costs for additional testing shall be borne by the Contractor.

F. SHIPMENT, PROTECTION AND STORAGE:

1. Equipment shipment, protection and storage shall conform to the requirements specified in Section 01 66 00.

1.7 SUBMITTALS

A. Comply with applicable Submittal requirements specified in: Section 01 33 00.

B. Submittal items required include:

1. Submit items specified in Section 40 61 13
2. Arrangement and Layout Drawings
3. Exterior panel layout
4. Interior panel layout
5. Door-in-door construction devices, where required
6. Sections showing clearances between face and rear mounted equipment.
7. Connection Diagrams.
8. Nameplate engraving schedule:
9. Indicate engraving by line
10. Character size
11. Nameplate size
12. Panel and equipment tag number and description
13. Heat load calculations for each cabinet based on the highest ambient temperature for the area in which the subject panel will be located.
14. Power supply calculations.
15. Manufacturer's operation and maintenance information as specified in Section 01 78 23. Manual shall include final reviewed submittal redlined to show AS BUILT

conditions; and separate record of all final configuration, jumper, and switch settings.

16. Test results as specified in Section 40 61 13

PART 2 PRODUCTS

2.1 FABRICATION

A. GENERAL

1. Provide all electrical and/or pneumatic components and devices, support hardware, fasteners, interconnecting wiring, and/or piping required to make the control panels and/or enclosures complete and operational.
2. Design panels for the seismic requirements of Section 40 61 13. Brace structures, equipment, and devices to prevent damage from specified forces. Equipment panels to be capable of operation following a disturbance.
3. Identify face-mounted devices with nameplates including tag number and equipment description. Mount instruments for access to components and ease of removal. Components for installation on panel exterior locate a minimum of 36 inches above the operating floor level and no greater than 60 inches above the operating floor level. Blank off cutouts for future equipment with suitable covers. Identify device tag numbers on the panel rear as well as the panel front.
4. Install face-mounted devices flush or semi-flush with flat-black escutcheons. Face-mounted devices that are more than 6 inches deep, weigh more than 10 pounds, or exert more than a 4 ft-lb moment force on the face of the panel support underneath at the rear by a 1-inch x 1/8-inch thick steel angle.
5. Provide panels less than 60 inches high with floor stands to raise the top of the panel to 60 inches above the floor or work platform. Wall mount panels that weigh less than 100 pounds.
6. Panels with specified requirements including stainless steel or aluminum mounting requirements that are indicated on the project drawings or on the project details take precedence over the panel types or panel features indicated herein.
7. Locate and install all devices and components so that connections can be easily made and ample room is provided for servicing each item. Provide at least 20 percent internal free space inside the panel.
8. Terminate all wiring to panel connections from field instruments, devices, and other panels at master numbered terminal strips.

9. Provide copper grounding bars.
 10. Panel doors shall be hung on full-length continuous hinges. Panel hardware (door hinges, screw clamps, door handles, latches, hasps, fasteners, etc.) shall be Type 316 stainless steel. Three-point latch hardware shall be provided for doors exceeding 30 inches height.
 11. Face-mounted devices shall be the same NEMA rating as the associated panel.
 12. Panels shall be arranged to separate control and instrument devices from power wiring. AC, DC, and digital circuits shall be arranged to be physically separated inside the panel. Digital circuits shall follow the network installation protocol requirements.
 13. Provide a minimum of 2 ½ inches between wire ways and terminals.
 14. Provide corrosive gas and moisture inhibitors in all panels.
- B. PANEL LAYOUT:
1. Provide 20 percent spare contiguous sub-panel area for future expansion.
 2. Provide minimum of 20 percent spare terminal blocks, with a minimum of 10 analog, discrete, power.
 3. Provide minimum of 12 inches clear space from the bottom of the panel to the bottom of the subpanel.

2.2 HEATING, VENTILATING AND COOLING

- A. Provide forced air ventilation for panels where indicated on the drawings. Forced air ventilation shall also be provided if the cabinet's heat load calculations indicate that the interior temperature of the cabinet will exceed 115 degrees-F, under worst case conditions.
- B. When not specified or shown elsewhere, ventilation for panel racks shall be venturi fans provided on 5-1/2-inch high-notched panel. Ventilation for consoles shall be similar to that for panel racks except EIA RS-310 mounting is not required. Fans shall be equipped with UL-approved washable filters and provide at least 240 cubic feet per minute (CFM). Fans shall be thermostatically controlled. Noise level at 3 feet from exterior wall and 30 degrees off axis shall not exceed 60 NC units.
- C. Provide outdoor panels with thermostatically controlled space heaters. Space heater surface temperature that exceeds 120 degrees F requires an expanded metal guard. Thermostats: Honeywell T631B1013, Penn Controls A28AA-4, or approved equal.

- D. Panel air conditioning cooling requirements a cooling system that does not exchange cabinet interior air with ambient air. The cooling system either a closed glycol loop heat exchange system or a CFC-free refrigeration system as required for the specified equipment and instrument complement and ambient temperature conditions.
- E. Panel air conditioner NEMA rated based on the installed area environment and the coils shall be Heresite, or approved equal coated and protected from corrosion.

2.3 PROTECTION COATING AND FINISH

- A. Panels located outdoors or located in corrosive areas shall be bottom coated with waterproof coatings.

2.4 NAMEPLATES

- A. Identify external door-mounted components and the panel description with nameplates. Machine embossed metallic adhesive labels shall identify tag number of instruments inside panels. Nameplates shall be attached to panel surfaces, not to instruments.
- B. The machine engraved laminated black phenolic nameplates with white lettering shall be provided for panel-mounted equipment. Nameplate engraving shall include the panel title, panel tag number and power source(s) in 3/32-inch minimum size lettering.
- C. The machine embossed metallic adhesive labels shall identify tag number of instruments inside panels. Nameplates shall be attached to panel surfaces, not to instruments.
- D. Attach nameplates to the panel with a minimum of two self-tapping 316 stainless steel screws. Provide RTV sealant for nameplates for NEMA-4X stainless steel panels.
- E. The nameplate wording may be changed without additional cost or time prior to commencement of engraving. Submit nameplate legend with the panel submittal.

2.5 PANEL FEATURES

- A. Refer to the project drawings for features to be provided for each control panel.

2.6 PANEL DRAWING PROTECTION

- A. Provide wiring diagrams in accordance with Section 01 33 00. Provide a panel- wiring diagram and schematic for each panel in a plastic bag or plastic container to avoid water damage and aging.

2.7 DIRECT-CURRENT POWER SUPPLIES

- A. Power supplies shall be as specified in 40 78 59

2.8 CONTROL DEVICES

- A. Selector switches, push buttons, potentiometers, hand stations (control stations) and indicating lights specified in Section 40 78 16 and 40 17 19.
- B. Signal Isolator: Accepts an active current input 0 to 20 mA or 4 to 20 mA (4 wire) and provides a passive 4 to 20 mA current output. DIN rail mounted with no external power required. As shown on the drawings, and as specified in 40 78 56 or approved equal.
- C. Universal Converter: Provide UL recognized, DIN rail mountable universal signal conditioning module with electrically isolated input and output powered from 24 Vdc. Input and output signal range and type easily configurable via DIP switch settings. Module with field calibration functionality for custom scaling of input and output signals. Linear input to output conversion with accuracy of + 0.2% of selected span and resolution of + 0.01% of full scale. Red Lion Model IAMA, or approved equal or as specified in 40 78 56.

2.9 SPARE PARTS

- A. Spare parts are to be provided in accordance with 40 61 13
- B. Tag and store spare parts in accordance with Section 40 61 13.

2.10 EXECUTION

- A. Mount and shim to precise alignment floor mounted control panels so doors operate without binding. Provide sealant for conduit entering the panels.
- B. Floor-mounted panels except in dry control rooms or electrical equipment rooms shall be mounted on 3-1/2-inch minimum height concrete pads or grouted bases as specified. Coating shall be provided for outdoor panels in contact on concrete. Field panels and cabinets shall be mounted in compliance with 26 27 16
- C. Spray terminals and terminal blocks after all terminations have been completed with a silicone resin similar to Dow Corning R-4-3117 conformal coating. Spray coating only required for control panels in corrosive or classified installation environments.
- D. Provide panels with the Record As-built schematic, connection, and interconnection diagrams mounted behind Plexiglas holder on the inside of the door. Place documentation in a water proof clear bag in the panel document holder.
- E. Vacuum clean control panels and cabinets.

2.11 TESTING

- A. PROCEDURES: Section 40 61 21
- B. The following testing is in addition to Section 40 61 21 requirements for the preoperational test phase and component test phase.
- C. PREOPERATIONAL TEST PHASE: Assemble, interconnect, and functionally factory test at the assembly shop prior to shipment the control panel as specified in Section 40 61 21
- D. COMPONENT TEST PHASE: Field verify the following for Process Control Panels:
 - 1. Control circuits grounded with one terminal of each load device connected to the grounded conductor.

END OF SECTION

SECTION 40 67 16 – FREE-STANDING PANELS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Scope.
 - 2. Panel Information.
 - 3. Panel Design.
 - 4. Quality Assurance.
 - 5. Submittals.
 - 6. Performance Requirements.
 - 7. Products.
 - 8. General.

1.2 SCOPE

- A. This section specifies requirements for process control panels and hardware required for custom fabrication.
- B. Provide the instrument, control, and monitoring features indicated on the electrical drawings. Panels shall be arranged to separate control and instrument devices from power wiring. Panel shall be arranged for dedicated field wiring terminations rated for 600 Vac or less for power, control, and instrument signal wiring shall be fabricated by a UL-508A recognized facility and shall bear the appropriate UL 508A Industrial Control Panel label. Panels for Hazardous (Classified) Locations shall bear the appropriate UL 698A label.
- C. Panels that contain programmable logic controllers (PLC) are as shown on the drawings.
- D. Comply with the specified products in Sections 40 67 16, 40 67 19, 40 78 00 and 40 67 63. Panels that do not comply with the specified products and specified logic method, hardwired or PLC logic, shall not be accepted. Cost to retrofit the panel as specified shall be borne by the panel supplier. Corrections or modifications to UL 508A Industrial Control Panels shall be transported to the panel supplier's facility for corrections, testing, relabeling and inspection.
- E. Field modifications require a UL inspector site inspection for approval of panel corrections and to re-label the panel after the field modifications are completed.
- F. Refer to Local Control Panels - Section 26 27 16 that specifies requirements for manufacturer, vendor, and Contractor provided panels that include motor

controllers, combination motor starters, control devices, and logic devices as shown on the electrical drawings. These requirements apply to this section as well.

- G. Submittal drawing requirements specified in Section 01 33 00 and 40 61 13.
- H. Label panels with fault current rating per NEC article 409.110.

1.3 DEFINITIONS

- A. GENERAL: Definitions of terminology related to Instrumentation and Industrial Electronic Systems used in the specifications as defined in IEEE 100, ISA S51.1, and NEMA ICS 1.
- B. OIT: Acronym for Operator Interface Terminal.
- C. SCADA: Acronym for Supervisory Control And Data Acquisition
- D. PLC: Acronym for Programmable Logic Controller – synonymous with Programmable Automation Controller (PAC) for purposes of this project.
- E. DATA SHEETS: Data sheets shall refer to ISA S20 or ISA TR20.00.01 latest version.

1.4 PANEL INFORMATION:

- A. Panel information is provided on drawings. The drawings indicate enclosure NEMA rating required, panel nameplate inscription, and other accessories, etc.

1.5 PANEL DESIGN

- A. GENERAL: Panel control system hardware is specified in other Division 40 sections and as shown on the drawings.
- B. CONTROL POWER DISTRIBUTION: Panel containing 120-volt powered equipment use the din-rail power distribution method with fuses and blown fuse indication. Power is restricted to 120 Vac and 24 Vdc.
- C. POWER SUPPLIES: Panel containing direct current powered instruments or serving as the termination point for transmission loop powered field instruments contain direct current power supply system as specified herein or shown on the drawings.
- D. ELECTRICAL CONTROL DEVICES: Comply with requirements of Section 40 78 16 and 40 78 19 and the drawings for pushbuttons, indicating lights, relays, and similar equipment located in panels specified in this section.
- E. 5. UNINTERRUPTIBLE POWER SUPPLIES: Panel mounted 120 Vac input, 120 Vac and 24 Vdc outputs are specified herein or shown on the drawings

1.6 QUALITY ASSURANCE

- A. REQUIREMENTS: Section 40 61 13 Process Control System General Provisions
- B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials
- C. REFERENCE STANDARDS:
1. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.
 2. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Reference	Title
NEMA 250	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 94	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 508A	Industrial Control Panels
UL 698A	Industrial Control Panels Relating to Hazardous (Classified) Locations

- D. LISTED PRODUCTS
1. Equipment and components to be Underwriters Laboratory (UL) listed for the purpose per Section 40 61 13 or UL recognized.
 2. Provide factory applied UL 508A labels for control panels. Where intrinsic safety barriers are used within a control panel, provide UL 698A factory applied label as required by UL.
- E. FACTORY TESTING:
1. Prior to shipment, the manufacturer test the functional operation of the control panels as described in Section 40 61 21.

2. The Owner requires the factory test to be a witnessed test. The Contractor shall include in the bid price the expense for travel and accommodations for one (1) representative from the Owner to witness the factory test at the manufacturer's facility. If test results require the testing to be redone, the additional costs for additional testing shall be borne by the Contractor.

F. SHIPMENT, PROTECTION AND STORAGE:

1. Equipment shipment, protection and storage shall conform to the requirements specified in Section 01 66 00.

1.7 SUBMITTALS

- A. Comply with applicable Submittal requirements specified in: Section 01 33 00.

- B. Submittal items required include:

1. Submit items specified in Section 40 61 13
2. Arrangement and Layout Drawings
3. Exterior panel layout
4. Interior panel layout
5. Door-in-door construction devices, where required
6. Sections showing clearances between face and rear mounted equipment.
7. Connection Diagrams.
8. Nameplate engraving schedule:
9. Indicate engraving by line
10. Character size
11. Nameplate size
12. Panel and equipment tag number and description
13. Heat load calculations for each cabinet based on the highest ambient temperature for the area in which the subject panel will be located.
14. Power supply calculations.
15. Manufacturer's operation and maintenance information as specified in Section 01 78 23. Manual shall include final reviewed submittal redlined to show AS BUILT conditions; and separate record of all final configuration, jumper, and switch settings.
16. Test results as specified in Section 40 61 13

PART 2 PRODUCTS

2.1 FABRICATION

A. GENERAL

1. Provide all electrical and/or pneumatic components and devices, support hardware, fasteners, interconnecting wiring, and/or piping required to make the control panels and/or enclosures complete and operational.
2. Design panels for the seismic requirements of Section 40 61 13. Brace structures, equipment, and devices to prevent damage from specified forces. Equipment panels to be capable of operation following a disturbance.
3. Identify face-mounted devices with nameplates including tag number and equipment description. Mount instruments for access to components and ease of removal. Components for installation on panel exterior locate a minimum of 36 inches above the operating floor level and no greater than 60 inches above the operating floor level. Blank off cutouts for future equipment with suitable covers. Identify device tag numbers on the panel rear as well as the panel front.
4. Install face-mounted devices flush or semi-flush with flat-black escutcheons. Face-mounted devices that are more than 6 inches deep, weigh more than 10 pounds, or exert more than a 4 ft-lb moment force on the face of the panel support underneath at the rear by a 1-inch x 1/8-inch thick steel angle.
5. Provide panels less than 60 inches high with floor stands to raise the top of the panel to 60 inches above the floor or work platform. Wall mount panels that weigh less than 100 pounds.
6. Panels with specified requirements including stainless steel or aluminum mounting requirements that are indicated on the project drawings or on the project details take precedence over the panel types or panel features indicated herein.
7. Locate and install all devices and components so that connections can be easily made and ample room is provided for servicing each item. Provide at least 20 percent internal free space inside the panel.
8. Terminate all wiring to panel connections from field instruments, devices, and other panels at master numbered terminal strips.
9. Provide copper grounding bars.
10. Panel doors shall be hung on full-length continuous hinges. Panel hardware (door hinges, screw clamps, door handles, latches, hasps, fasteners, etc.) shall be Type

316 stainless steel. Three-point latch hardware shall be provided for doors exceeding 30 inches height.

11. Face-mounted devices shall be the same NEMA rating as the associated panel.
12. Panels shall be arranged to separate control and instrument devices from power wiring. AC, DC, and digital circuits shall be arranged to be physically separated inside the panel. Digital circuits shall follow the network installation protocol requirements.
13. Provide a minimum of 2 ½ inches between wire ways and terminals.
14. Provide corrosive gas and moisture inhibitors in all panels.

B. PANEL LAYOUT:

1. Provide 20 percent spare contiguous sub-panel area for future expansion.
2. Provide minimum of 20 percent spare terminal blocks, with a minimum of 10 analog, discrete, power.
3. Provide minimum of 12 inches clear space from the bottom of the panel to the bottom of the subpanel.

2.2 HEATING, VENTILATING AND COOLING

- A. Provide forced air ventilation for panels where indicated on the drawings. Forced air ventilation shall also be provided if the cabinet's heat load calculations indicate that the interior temperature of the cabinet will exceed 115 degrees-F, under worst case conditions.
- B. When not specified or shown elsewhere, ventilation for panel racks shall be venturi fans provided on 5-1/2-inch high-notched panel. Ventilation for consoles shall be similar to that for panel racks except EIA RS-310 mounting is not required. Fans shall be equipped with UL-approved washable filters and provide at least 240 cubic feet per minute (CFM). Fans shall be thermostatically controlled. Noise level at 3 feet from exterior wall and 30 degrees off axis shall not exceed 60 NC units.
- C. Provide outdoor panels with thermostatically controlled space heaters. Space heater surface temperature that exceeds 120 degrees F requires an expanded metal guard. Thermostats: Honeywell T631B1013, Penn Controls A28AA-4, or approved equal.
- D. Panel air conditioning cooling requirements a cooling system that does not exchange cabinet interior air with ambient air. The cooling system either a closed glycol loop heat exchange system or a CFC-free refrigeration system as required for the specified equipment and instrument complement and ambient temperature conditions.

- E. Panel air conditioner NEMA rated based on the installed area environment and the coils shall be Heresite, or approved equal coated and protected from corrosion.

2.3 PROTECTION COATING AND FINISH

- A. Panels located outdoors or located in corrosive areas shall be bottom coated with waterproof coatings.

2.4 NAMEPLATES

- A. Identify external door-mounted components and the panel description with nameplates. Machine embossed metallic adhesive labels shall identify tag number of instruments inside panels. Nameplates shall be attached to panel surfaces, not to instruments.
- B. The machine engraved laminated black phenolic nameplates with white lettering shall be provided for panel-mounted equipment. Nameplate engraving shall include the panel title, panel tag number and power source(s) in 3/32-inch minimum size lettering.
- C. The machine embossed metallic adhesive labels shall identify tag number of instruments inside panels. Nameplates shall be attached to panel surfaces, not to instruments.
- D. Attach nameplates to the panel with a minimum of two self-tapping 316 stainless steel screws. Provide RTV sealant for nameplates for NEMA-4X stainless steel panels.
- E. The nameplate wording may be changed without additional cost or time prior to commencement of engraving. Submit nameplate legend with the panel submittal.

2.5 PANEL FEATURES

- A. Refer to the project drawings for features to be provided for each control panel.

2.6 PANEL DRAWING PROTECTION

- A. Provide wiring diagrams in accordance with Section 01 33 00. Provide a panel- wiring diagram and schematic for each panel in a plastic bag or plastic container to avoid water damage and aging.

2.7 DIRECT-CURRENT POWER SUPPLIES

- A. Power supplies shall be as specified in 40 78 59

2.8 CONTROL DEVICES

- A. Selector switches, push buttons, potentiometers, hand stations (control stations) and indicating lights specified in Section 40 78 16 and 40 17 19.
- B. Signal Isolator: Accepts an active current input 0 to 20 mA or 4 to 20 mA (4 wire) and provides a passive 4 to 20 mA current output. DIN rail mounted with no external power required. As shown on the drawings, and as specified in 40 78 56 or approved equal.
- C. Universal Converter: Provide UL recognized, DIN rail mountable universal signal conditioning module with electrically isolated input and output powered from 24 Vdc. Input and output signal range and type easily configurable via DIP switch settings. Module with field calibration functionality for custom scaling of input and output signals. Linear input to output conversion with accuracy of + 0.2% of selected span and resolution of + 0.01% of full scale. Red Lion Model IAMA, or approved equal or as specified in 40 78 56.

2.9 SPARE PARTS

- A. Spare parts are to be provided in accordance with 40 61 13
- B. Tag and store spare parts in accordance with Section 40 61 13.

2.10 EXECUTION

- A. Mount and shim to precise alignment floor mounted control panels so doors operate without binding. Provide sealant for conduit entering the panels.
- B. Floor-mounted panels except in dry control rooms or electrical equipment rooms shall be mounted on 3-1/2-inch minimum height concrete pads or grouted bases as specified. Coating shall be provided for outdoor panels in contact on concrete. Field panels and cabinets shall be mounted in compliance with paragraph 40 90 00-B.
- C. Spray terminals and terminal blocks after all terminations have been completed with a silicone resin similar to Dow Corning R-4-3117 conformal coating. Spray coating only required for control panels in corrosive or classified installation environments.
- D. Provide panels with the Record As-built schematic, connection, and interconnection diagrams mounted behind Plexiglas holder on the inside of the door. Place documentation in a water proof clear bag in the panel document holder.
- E. Vacuum clean control panels and cabinets.

2.11 TESTING

- A. PROCEDURES: Section 40 61 21

- B. The following testing is in addition to Section 40 61 21 requirements for the preoperational test phase and component test phase.
- C. PREOPERATIONAL TEST PHASE: Assemble, interconnect, and functionally factory test at the assembly shop prior to shipment the control panel as specified in Section 40 61 21
- D. COMPONENT TEST PHASE: Field verify the following for Process Control Panels:
 - 1. Control circuits grounded with one terminal of each load device connected to the grounded conductor.

END OF SECTION

SECTION 40 67 19 - WALL-MOUNTED PANELS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Scope.
 - 2. Panel Information.
 - 3. Panel Design.
 - 4. Quality Assurance.
 - 5. Submittals.
 - 6. Performance Requirements.
 - 7. Products.
 - 8. General.

1.2 SCOPE

- A. This section specifies requirements for process control panels and hardware required for custom fabrication.
- B. Provide the instrument, control, and monitoring features indicated on the electrical drawings. Panels shall be arranged to separate control and instrument devices from power wiring. Panel shall be arranged for dedicated field wiring terminations rated for 600 Vac or less for power, control, and instrument signal wiring shall be fabricated by a UL-508A recognized facility and shall bear the appropriate UL 508A Industrial Control Panel label. Panels for Hazardous (Classified) Locations shall bear the appropriate UL 698A label.
- C. Panels that contain programmable logic controllers (PLC) are as shown on the drawings.
- D. Comply with the specified products in Sections 40 67 16, 40 67 19, 40 78 00 and 40 67 63. Panels that do not comply with the specified products and specified logic method, hardwired or PLC logic, shall not be accepted. Cost to retrofit the panel as specified shall be borne by the panel supplier. Corrections or modifications to UL 508A Industrial Control Panels shall be transported to the panel supplier's facility for corrections, testing, relabeling and inspection.
- E. Field modifications require a UL inspector site inspection for approval of panel corrections and to re-label the panel after the field modifications are completed.
- F. Refer to Local Control Panels - Section 26 27 16 that specifies requirements for manufacturer, vendor, and Contractor provided panels that include motor

controllers, combination motor starters, control devices, and logic devices as shown on the electrical drawings. These requirements apply to this section as well.

- G. Submittal drawing requirements specified in Section 01 33 00 and 40 61 13.
- H. Label panels with fault current rating per NEC article 409.110.

1.3 DEFINITIONS

- A. GENERAL: Definitions of terminology related to Instrumentation and Industrial Electronic Systems used in the specifications as defined in IEEE 100, ISA S51.1, and NEMA ICS 1.
- B. OIT: Acronym for Operator Interface Terminal.
- C. SCADA: Acronym for Supervisory Control And Data Acquisition
- D. PLC: Acronym for Programmable Logic Controller – synonymous with Programmable Automation Controller (PAC) for purposes of this project.
- E. DATA SHEETS: Data sheets shall refer to ISA S20 or ISA TR20.00.01 latest version.

1.4 PANEL INFORMATION:

- A. Panel information is provided on drawings. The drawings indicate enclosure NEMA rating required, panel nameplate inscription, and other accessories, etc.

1.5 PANEL DESIGN

- A. GENERAL: Panel control system hardware is specified in other Division 40 sections and as shown on the drawings.
- B. CONTROL POWER DISTRIBUTION: Panel containing 120-volt powered equipment use the din-rail power distribution method with fuses and blown fuse indication. Power is restricted to 120 Vac and 24 Vdc.
- C. POWER SUPPLIES: Panel containing direct current powered instruments or serving as the termination point for transmission loop powered field instruments contain direct current power supply system as specified herein or shown on the drawings.
- D. ELECTRICAL CONTROL DEVICES: Comply with requirements of Section 40 78 16 and 40 78 19 and the drawings for pushbuttons, indicating lights, relays, and similar equipment located in panels specified in this section.
- E. 5. UNINTERRUPTIBLE POWER SUPPLIES: Panel mounted 120 Vac input, 120 Vac and 24 Vdc outputs are specified herein or shown on the drawings

1.6 QUALITY ASSURANCE

- A. REQUIREMENTS: Section 40 61 13 Process Control System General Provisions
- B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials
- C. REFERENCE STANDARDS:
1. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.
 2. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Reference	Title
NEMA 250	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 94	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 508A	Industrial Control Panels
UL 698A	Industrial Control Panels Relating to Hazardous (Classified) Locations

- D. LISTED PRODUCTS
1. Equipment and components to be Underwriters Laboratory (UL) listed for the purpose per Section 40 61 13 or UL recognized.
 2. Provide factory applied UL 508A labels for control panels. Where intrinsic safety barriers are used within a control panel, provide UL 698A factory applied label as required by UL.
- E. FACTORY TESTING:
1. Prior to shipment, the manufacturer test the functional operation of the control panels as described in Section 40 61 21.

2. The Owner requires the factory test to be a witnessed test. The Contractor shall include in the bid price the expense for travel and accommodations for one (1) representative from the Owner to witness the factory test at the manufacturer's facility. If test results require the testing to be redone, the additional costs for additional testing shall be borne by the Contractor.

F. SHIPMENT, PROTECTION AND STORAGE:

1. Equipment shipment, protection and storage shall conform to the requirements specified in Section 01 66 00.

1.7 SUBMITTALS

- A. Comply with applicable Submittal requirements specified in: Section 01 33 00.

- B. Submittal items required include:

1. Submit items specified in Section 40 61 13
2. Arrangement and Layout Drawings
3. Exterior panel layout
4. Interior panel layout
5. Door-in-door construction devices, where required
6. Sections showing clearances between face and rear mounted equipment.
7. Connection Diagrams.
8. Nameplate engraving schedule:
9. Indicate engraving by line
10. Character size
11. Nameplate size
12. Panel and equipment tag number and description
13. Heat load calculations for each cabinet based on the highest ambient temperature for the area in which the subject panel will be located.
14. Power supply calculations.
15. Manufacturer's operation and maintenance information as specified in Section 01 78 23. Manual shall include final reviewed submittal redlined to show AS BUILT conditions; and separate record of all final configuration, jumper, and switch settings.
16. Test results as specified in Section 40 61 13

PART 2 PRODUCTS

2.1 FABRICATION

A. GENERAL

1. Provide all electrical and/or pneumatic components and devices, support hardware, fasteners, interconnecting wiring, and/or piping required to make the control panels and/or enclosures complete and operational.
2. Design panels for the seismic requirements of Section 40 xx 00. Brace structures, equipment, and devices to prevent damage from specified forces. Equipment panels to be capable of operation following a disturbance.
3. Identify face-mounted devices with nameplates including tag number and equipment description. Mount instruments for access to components and ease of removal. Components for installation on panel exterior locate a minimum of 36 inches above the operating floor level and no greater than 60 inches above the operating floor level. Blank off cutouts for future equipment with suitable covers. Identify device tag numbers on the panel rear as well as the panel front.
4. Install face-mounted devices flush or semi-flush with flat-black escutcheons. Face-mounted devices that are more than 6 inches deep, weigh more than 10 pounds, or exert more than a 4 ft-lb moment force on the face of the panel support underneath at the rear by a 1-inch x 1/8-inch thick steel angle.
5. Provide panels less than 60 inches high with floor stands to raise the top of the panel to 60 inches above the floor or work platform. Wall mount panels that weigh less than 100 pounds.
6. Panels with specified requirements including stainless steel or aluminum mounting requirements that are indicated on the project drawings or on the project details take precedence over the panel types or panel features indicated herein.
7. Locate and install all devices and components so that connections can be easily made and ample room is provided for servicing each item. Provide at least 20 percent internal free space inside the panel.
8. Terminate all wiring to panel connections from field instruments, devices, and other panels at master numbered terminal strips.
9. Provide copper grounding bars.
10. Panel doors shall be hung on full-length continuous hinges. Panel hardware (door hinges, screw clamps, door handles, latches, hasps, fasteners, etc.) shall be Type

316 stainless steel. Three-point latch hardware shall be provided for doors exceeding 30 inches height.

11. Face-mounted devices shall be the same NEMA rating as the associated panel.
12. Panels shall be arranged to separate control and instrument devices from power wiring. AC, DC, and digital circuits shall be arranged to be physically separated inside the panel. Digital circuits shall follow the network installation protocol requirements.
13. Provide a minimum of 2 ½ inches between wire ways and terminals.
14. Provide corrosive gas and moisture inhibitors in all panels.

B. PANEL LAYOUT:

1. Provide 20 percent spare contiguous sub-panel area for future expansion.
2. Provide minimum of 20 percent spare terminal blocks, with a minimum of 10 analog, discrete, power.
3. Provide minimum of 12 inches clear space from the bottom of the panel to the bottom of the subpanel.

2.2 HEATING, VENTILATING AND COOLING

- A. Provide forced air ventilation for panels where indicated on the drawings. Forced air ventilation shall also be provided if the cabinet's heat load calculations indicate that the interior temperature of the cabinet will exceed 115 degrees-F, under worst case conditions.
- B. When not specified or shown elsewhere, ventilation for panel racks shall be venturi fans provided on 5-1/2-inch high-notched panel. Ventilation for consoles shall be similar to that for panel racks except EIA RS-310 mounting is not required. Fans shall be equipped with UL-approved washable filters and provide at least 240 cubic feet per minute (CFM). Fans shall be thermostatically controlled. Noise level at 3 feet from exterior wall and 30 degrees off axis shall not exceed 60 NC units.
- C. Provide outdoor panels with thermostatically controlled space heaters. Space heater surface temperature that exceeds 120 degrees F requires an expanded metal guard. Thermostats: Honeywell T631B1013, Penn Controls A28AA-4, or approved equal.
- D. Panel air conditioning cooling requirements a cooling system that does not exchange cabinet interior air with ambient air. The cooling system either a closed glycol loop heat exchange system or a CFC-free refrigeration system as required for the specified equipment and instrument complement and ambient temperature conditions.

- E. Panel air conditioner NEMA rated based on the installed area environment and the coils shall be Heresite, or approved equal coated and protected from corrosion.

2.3 PROTECTION COATING AND FINISH

- A. Panels located outdoors or located in corrosive areas shall be bottom coated with waterproof coatings.

2.4 NAMEPLATES

- A. Identify external door-mounted components and the panel description with nameplates. Machine embossed metallic adhesive labels shall identify tag number of instruments inside panels. Nameplates shall be attached to panel surfaces, not to instruments.
- B. The machine engraved laminated black phenolic nameplates with white lettering shall be provided for panel-mounted equipment. Nameplate engraving shall include the panel title, panel tag number and power source(s) in 3/32-inch minimum size lettering.
- C. The machine embossed metallic adhesive labels shall identify tag number of instruments inside panels. Nameplates shall be attached to panel surfaces, not to instruments.
- D. Attach nameplates to the panel with a minimum of two self-tapping 316 stainless steel screws. Provide RTV sealant for nameplates for NEMA-4X stainless steel panels.
- E. The nameplate wording may be changed without additional cost or time prior to commencement of engraving. Submit nameplate legend with the panel submittal.

2.5 PANEL FEATURES

1. MANUFACTURERS:

- a. Phoenix Contact, or approved equal.

- B. FIELD WIRING: Field wiring shall be connected to separate dedicated terminal blocks in a dedicated part of the panel where the field cables enter the panel.

C. FUSE AND FUSE HOLDERS:

1. FEATURES:

- a. Fuses for 120 Vac Circuits: Minimum of 12,000-amperes interrupting capacity and blown fuse indicators.

- b. Fuses for 24 Vdc Loop Circuits: Fast acting glass tube type rated 1/8 or 1/10 amp for 4-20 mA loops.
 - c. Fuses for 24 Vdc Power Supply Circuits: 1/2 amp for the power supply to individual instruments.
 - d. Fuse holders shall be tip-out or draw-out type.
- 2. MANUFACTURERS: Allen-Bradley, Phoenix Contact or approved equal.
- D. CIRCUIT BREAKERS:
 - 1. FEATURES: Provide circuit breaker for branch circuit protection. Circuit breaker UL rated, DIN rail mounted, and trip current rating to be determined based on the circuit load by System Integrator.
 - 2. MANUFACTURERS: Altech, or approved equal.
- E. CONTROL POWER:
 - 1. Provide control power transformers, as required for the load.
 - 2. Provide direct current power supplies, as required for the load.
 - 3. Provide UPS for PLC, RIO and derived loop power as defined above, as required for the load.
- F. PANEL POWER:
 - 1. Provide a 120 Vac circuit for the panel light, receptacle, heating, fan, heat exchanger, or air conditioner] cooling load as required.
 - 2. Provide a 240 Vac circuit for air conditioning load as required.
- G. ACCESSORIES:
 - 1. Provide 120 V AC utility light fixtures with 40-watt (W) lamp and protective plastic shield. Lights to cover the whole width of panel for good illumination inside panel.
 - 2. Provide 120 V AC, 20A, door switches, to turn on the utility light fixtures.
 - 3. Provide one 120 V AC, 20A duplex, ground fault interrupting type receptacle for every 36 inches of panel width.
 - 4. Do not power receptacles and utility light by the UPS, where included.

5. Provide print pocket.
6. Provide fold-up shelf of 18 x 18 or 24 x 24 size (larger size is preferable), sufficient weight capacity, and the proper angle for supporting a laptop computer.
7. Provide dedicated circuit breaker and separate power feed for utility light fixture with switch and duplex receptacle.

2.6 PANEL DRAWING PROTECTION

- A. Provide wiring diagrams in accordance with Section 01 33 00. Provide a panel- wiring diagram and schematic for each panel in a plastic bag or plastic container to avoid water damage and aging.

2.7 DIRECT-CURRENT POWER SUPPLIES

- A. Power supplies shall be as specified in 40 78 59.

2.8 CONTROL DEVICES

- A. Selector switches, push buttons, potentiometers, hand stations (control stations) and indicating lights specified in Section 40 78 16 and 40 17 19.
- B. Signal Isolator: Accepts an active current input 0 to 20 mA or 4 to 20 mA (4 wire) and provides a passive 4 to 20 mA current output. DIN rail mounted with no external power required. As shown on the drawings, and as specified in 40 78 56 or approved equal.
- C. Universal Converter: Provide UL recognized, DIN rail mountable universal signal conditioning module with electrically isolated input and output powered from 24 Vdc. Input and output signal range and type easily configurable via DIP switch settings. Module with field calibration functionality for custom scaling of input and output signals. Linear input to output conversion with accuracy of + 0.2% of selected span and resolution of + 0.01% of full scale. Red Lion Model IAMA, or approved equal or as specified in 40 78 56.

2.9 SPARE PARTS

- A. Spare parts are to be provided in accordance with 40 61 13.
- B. Tag and store spare parts in accordance with Section 40 61 13.

2.10 EXECUTION

- A. Mount and shim to precise alignment wall mounted control panels so doors operate without binding. Provide sealant for conduit entering the panels.

- B. Spray terminals and terminal blocks after all terminations have been completed with a silicone resin similar to Dow Corning R-4-3117 conformal coating. Spray coating only required for control panels in corrosive or classified installation environments.
- C. Provide panels with the Record As-built schematic, connection, and interconnection diagrams mounted behind Plexiglas holder on the inside of the door. Place documentation in a water proof clear bag in the panel document holder.
- D. Vacuum clean control panels and cabinets.

2.11 TESTING

- A. PROCEDURES: Section 40 61 21
- B. The following testing is in addition to Section 40 61 21 requirements for the preoperational test phase and component test phase.
- C. PREOPERATIONAL TEST PHASE: Assemble, interconnect, and functionally factory test at the assembly shop prior to shipment the control panel as specified in Section 40 61 21.
- D. COMPONENT TEST PHASE: Field verify the following for Process Control Panels:
 - 1. Control circuits grounded with one terminal of each load device connected to the grounded conductor.

END OF SECTION

SECTION 40 67 33 - PANEL WIRING

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Scope
 - 2. Reference Standards
 - 3. Quality Assurance.
 - 4. Submittals.
 - 5. Installation.
 - 6. Testing.

1.2 SCOPE

- A. This section specifies wiring requirements for wiring of process control panels.
- B. Comply with the specified products in Sections 40 61 13, 40 67 16, 40 67 19 and 40 78 00. Panels that do not comply with the specified products and specified logic method, hardwired or PLC logic, shall not be accepted. Cost to retrofit the panel as specified shall be borne by the panel supplier. Corrections or modifications to UL 508A Industrial Control Panels shall be transported to the panel supplier's facility for corrections, testing, relabeling and inspection.
- C. All panel wiring is to be completed within a UL 508A certified fabrication facility. Field modifications require a UL inspector site inspection for approval of panel corrections and to re-label the panel after the field modifications are completed.
- D. Refer to Local Control Panels - Section 26 27 16 that specifies requirements for manufacturer, vendor, and Contractor provided panels that may include motor controllers, combination motor starters, control devices, and logic devices as shown on the electrical drawings. These requirements apply to this section as well.
- E. Submittals as specified in Section 01 33 00 and Section 40 61 13.

1.3 QUALITY ASSURANCE

- A. REQUIREMENTS: Section 40 61 13 Process Control System General Provisions
- B. The manufacturer shall warranty workmanship for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials.
- C. REFERENCE STANDARDS:

1. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued,

Reference	Title
NEMA 250	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 94	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 508A	Industrial Control Panels
UL 698A	Industrial Control Panels Relating to Hazardous (Classified) Locations

D. LISTED PRODUCTS

1. Equipment and components to be Underwriters Laboratory (UL) listed for the purpose per Section 40 61 13 or UL recognized.
2. Provide factory applied UL 508A labels for control panels. Where intrinsic safety barriers are used within a control panel, provide UL 698A factory applied label as required by UL.

1.4 SUBMITTALS

- A. Comply with applicable Submittal requirements specified in: Section 01 33 00 and 40 61 13
- B. Submittal items required include:
 1. Wire Types
 2. Labeling materials and methods
 3. Wiring lugs
 4. Wireways
 5. Hinge wiring method description

PART 2 PRODUCTS – Not Used

PART 3 EXECUTION

3.1 INTERNAL PANEL WIRING

- A. Panel control wiring: Single conductor stranded copper NFPA No. 70 Type MTW No. 16 AWG minimum, with an exception for factory supplied PLC wiring harnesses that are U.L. approved.
- B. Panel instrument wiring: Twisted No. 18 AWG shielded pair or tri conductors.
- C. Panel power wiring: Conductors specified in Division 26 and meet the NFPA No. 70 NEC requirements for power including phase, grounded, and grounding conductors.
- D. Arrange wiring neatly, cut to proper length, and remove surplus wire.
- E. No more than two connections made to one terminal.
- F. Wiring shall be supported independently of terminations by lacing to panel support structure or by slotted flame-retardant plastic wiring channels.
- G. Power and control wiring carried in covered channels separate from low voltage signal circuits.
 - 1. Wiring channel fill not to exceed 40 percent per NFPA 70.
- H. Restrain by plastic ties or ducts or metal raceways.
- I. Provide abrasion protection for wire bundles that pass-through holes or across edges of sheet metal.
- J. Hinge Wiring: Secure at each end so bending or twisting will be around longitudinal axis of wire. Protect bend area with sleeve.
- K. Connections to Screw Type Terminals:
 - 1. Locking-fork-tongue or ring-tongue lugs.
 - 2. Use manufacturer's recommended tool with required sized anvil to make crimp lug terminations.
 - 3. Splicing and tapping of wires, allowed only at device terminals or terminal blocks.
 - 4. Wires terminated in a crimp lug, maximum of one.

5. Lugs installed on a screw terminal, maximum of two.
- L. Connections to Compression Clamp Type Terminals:
1. Strip, prepare, and install wires in accordance with terminal manufacturer's recommendations.
 2. Wires installed in a compression screw and clamp, maximum of one for field wires entering enclosure, otherwise maximum of two.
- M. Harness Wiring:
1. 120V ac: No. 14 AWG, MTW.
 2. 24V dc: No. 16 AWG, MTW where individual conductors are used and Type TC shielded tray cable where shielded wire is used.
- N. Plastic Wire Ducts Color:
1. 120V ac: White.
 2. 24V dc: Gray.
 3. Communications Cables and Fiber Optic Jumpers: Orange.
- O. Provide a minimum of 1-1/2 inches between plastic wire ducts and terminal blocks.
- P. Control Relay Arrangement: Install control relays associated with specific loops in same panel section as corresponding terminal blocks or side panels. Provide 20 percent space for future relays. Locate spare space in same sections as spare terminal blocks.
- Q. CONDUCTOR IDENTIFICATION:
1. Wiring colors per NFPA 79.
 2. Wire tag numbers to indicate to/from termination points and the associated equipment.
 3. Wire tag numbers to be machine printed on white sleeves with text 1/8 inches high minimum in permanent black ink.
- R. FIELD WIRING:
1. Field wiring shall be connected to separate dedicated terminal blocks in a dedicated part of the panel where the field cables enter the panel.
- S. PANEL GROUNDING
1. Provide each control panel with two copper ground bars.

- a. Bond one bar (NEC required) to the panel or panel frame or back-plate and to the facility grounding system.
- b. Mount on insulated stand-offs second (signal) ground bar and bond to the panel ground bar only at one point.
 - 1) Bond signal circuits, signal cable shields, and low-voltage DC power supply commons to the signal ground bar.
 - 2) Ground field analog wiring shields at the signal ground bar. Test to verify that single ground point at panel signal ground bar.
2. Bond surge protectors and separately derived AC power supplies to the frame ground bar.
3. Panels exceeding 36-inches width shall contain ground bars shall be 1/4- by 1-inch copper bars extending the entire length of the panel interior at the bottom of the panel.

3.2 TESTING

A. FACTORY TESTING:

1. Prior to shipment, the manufacturer tests the functional operation of the control panels as described in Section 40 61 21.
2. Complete point to point testing and verification of each wire.
3. The Owner requires the factory test to be a witnessed test. The Contractor shall include in the bid price the expense for travel and accommodations for one (1) representative from the Owner to witness the factory test at the manufacturer's facility. If test results require the testing to be redone, the additional costs for additional testing shall be borne by the Contractor.

B. SHIPMENT, PROTECTION AND STORAGE:

1. Equipment shipment, protection and storage shall conform to the requirements specified in Section 01 66 00

END OF SECTION

SECTION 40 67 63

CONTROL PANEL-MOUNTED UNINTERRUPTIBLE POWER SUPPLY

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Scope.
 - 2. Quality Assurance.
 - 3. Submittals.
 - 4. Performance Requirements.
 - 5. Products.
 - 6. General.

1.2 SCOPE

- A. This section specifies requirements for Panel mounted 120 VAC input, 120 VAC and 24 VDC outputs are specified herein or shown on the drawings
- B. Submittal requirements specified in Section 40 61 13 and 01 33 00

1.3 QUALITY ASSURANCE

- A. REQUIREMENTS: Section 40 61 13 Process Control System General Provisions
- B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials
- C. REFERENCE STANDARDS:
 - 1. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.
 - 2. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Reference	Title
NEMA 250	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 94	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 508A	Industrial Control Panels
UL 698A	Industrial Control Panels Relating to Hazardous (Classified) Locations

D. LISTED PRODUCTS

1. Equipment and components to be Underwriters Laboratory (UL) listed for the purpose per Section 40 61 13 or UL recognized.

1.4 SUBMITTALS

- A. Comply with applicable Submittal requirements specified in: Section 40 61 13 and Section 01 33 00.
- B. Submittal items required include:
 1. Connection Diagrams.
 2. Power supply calculations.
 3. Manufacturer's operation and maintenance information. Manual shall include final reviewed submittal redlined to show AS BUILT conditions; and separate record of all final configuration, jumper, and switch settings.

PART 2 PRODUCTS

2.1 120VAC UNINTERRUPTIBLE POWER SYSTEM (UPS)

- A. FEATURES:
 1. Provide on-line, computer-grade UPS with electrical isolation including output neutral.
 - a. Nominal input voltage: 120VAC.
 - b. Nominal output voltage: 120VAC.
 2. Provide UPS with integral sealed no maintenance batteries, sized to provide full capacity backup power for 10 minute minimum at connected load with integral battery charger.

3. Calculate the required kVA rating at 150 percent of connected load. Submit load calculations, schematic diagrams, and wiring connection diagrams. Provide battery cabling and other required cabling for a complete system.
4. Mount UPS within the panel on DIN rail or a pedestal or tray with stainless-steel legs to provide space for wire entry and passage.
5. Provide contacts for remote monitoring of POWER FAIL and LOW BATTERY as specified on Drawings.

B. MANUFACTURERS:

1. APC DIN Rail – Panel Mount UPS - SUA series
2. SolaHD – SDU series
3. Allen-Bradley Bulletin 1609-B
4. Or Approved Equal

2.2 24 VDC UNINTERRUPTIBLE POWER SYSTEM (UPS)

C. FEATURES:

1. Provide industrial-grade UPS with electrical isolation. UPS shall consist of direct current power supply, charge controller, and sealed backup battery pack.
 - a. Nominal input voltage: 120VAC.
 - b. Nominal output voltage: 24VDC.
2. Provide battery pack with sealed no maintenance batteries, sized to provide 20 AH or better backup power for a current range of 0 to 20A at connected load with battery charger.
3. Calculate dead battery recharge time, recharge after drain cycle, runtime for connected load as specified. Ensure to include inrush current associated with the connected load in calculations. Submit calculations (ensure power cabling has less than 3% voltage drop at the connected load), schematic diagrams, and wiring connection diagrams. Coordinate with battery cabling requirements for wire size required to terminate. Power cabling to be less than 3% voltage drop at the connected load.
4. House UPS assembly in a NEMA 12 enclosure. DIN rail mount UPS within enclosure with circuit breakers for 24 V dc load distribution. Provide a 120 Vac power disconnect on face of panel. Provide power protection/conditioning as required for UL 508A fabrication.
5. Provide dry contacts rated for 120Vac @ at least 0.5 amps for remote monitoring of DC OK, BATTERY FAIL and BATTERY DISCHARGE as specified on Drawings. The

use of interposing relays if dry contacts are rated for another voltage can be provided.

- D. MANUFACTURERS: As shown on the drawings, or approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

- A. REQUIREMENTS: Section 40 61 13 and Install in accordance with manufacturer's instructions for the specified functional requirements.
- B. Install UPS in panel per manufacturer's instructions.

3.2 TESTING

- A. REQUIREMENTS: Section 40 61 21.
- B. Ensure proper installation per manufacturers recommendations
- C. Ensure fully charged UPS batteries provide Volt Amp Hours consistent with ratings

END OF SECTION

SECTION 40 70 00 - INSTRUMENTATION FOR PROCESS SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. This section specifies general requirements which are applicable to providing instrumentation for the process control systems.
- B. The requirements of this section are applicable to all work to be completed by the System Integrator and as specified in all sections of Division 40.
- C. Electrical requirements applicable to this work are specified in Division 26.
- D. Instrumentation schedules, and commissioning applicable to this work are specified elsewhere in Division 40.
- E. Section Includes:
 - 1. Scope.
 - 2. Definitions.
 - 3. Quality Assurance.
 - 4. Submittals.
 - 5. Performance Requirements.
 - 6. Functional Requirements.
 - 7. Products.
 - 8. Installation.
 - 9. Testing and Inspections.

1.2 SCOPE

- A. INSTRUMENTATION AND CONTROL SYSTEM: The work consists of a qualified System Integrator to provide requirements specified in herein:
 - 1. New primary process measurement devices, instrumentation and new process auxiliary devices.
 - 2. New control system hardware including digital process controllers (PLC based), IO modules, power supply modules and communication modules.
 - 3. New custom control panels and remote telemetry panels.
 - 4. Process control system networking.
 - 5. Submittal documentation for process systems instrumentation and control including schedules, drawings, product manuals.

6. Maintaining construction RECORD/AS BUILT of submittal documentation and incorporating interconnection detail from other sections submittals to show accurately process systems instrumentation and control wiring as complete from circuits start and end connections.
7. Configuration set up, calibration, testing process systems instrumentation and controls.
8. Training.
9. Collaboration with System Programmer to provide a fully integrated PLC based control system.

1.3 DEFINITIONS

- A. GENERAL: Definitions of terminology related to Instrumentation and Industrial Electronic Systems used in the specifications as defined in IEEE 100, ISA S51.1, and NEMA ICS 1.
- B. TWO-WIRE TRANSMITTER: An instrument which derives operating power supply from the signal transmission circuit and requires no separate power supply connections. A two-wire transmitter produces a 4 to 20 milliampere current regulated signal in a series circuit from a 24-volt direct current driving potential and a maximum circuit resistance of 600 ohms. A two-wire transmitter is also referred to as looped power.
- C. FOUR-WIRE TRANSMITTER: An instrument which derives operating power from separate power supply connections. A four-wire transmitter produces a 4 to 20 milliampere current regulated signal in a series circuit with a maximum circuit resistance of 600 ohms. Four-wire transmitters typically require 120Vac or 24Vdc input power supply.
- D. GALVANIC ISOLATION: Electrical node having no direct current path to another electrical node. Galvanic isolation refers to a device with electrical inputs and/or outputs which are isolated from ground, the device case, the process fluid, and separate power supply terminals. Inputs and/or outputs may be externally grounded without affecting the characteristics of the devices or providing path for circulation of ground currents.
- E. PANEL: An instrument support system which may be a flat surface, a partial enclosure, or a complete enclosure for instruments and other devices used in process control systems including consoles, cabinets and racks. Panels provide mechanical protection, electrical isolation, and protection from dust, dirt, moisture, and chemical contaminants which may be pre- sent in the atmosphere.
- F. DATA SHEETS: Data sheets shall refer to ISA S20 or ISA TR20.00.01 latest version.

G. SIGNAL TYPES:

1. LOW-LEVEL ANALOG: Signal with full output level of 100 millivolts or less including thermocouples and resistance temperature detectors.
2. HIGH-LEVEL ANALOG: Signals with full output level greater than 100 millivolts but less than 30 volts, including 4 to 20 mA transmission.
3. DIGITAL CODE: Coded information from the output of an analog to digital converter or digital transmission terminal.
4. PULSE FREQUENCY: Counting pulses emitted from speed or flow transmitters.
5. DISCRETE CONTROL OR EVENTS: Dry contact closures and signals monitored by solid state equipment, relays, or control circuits typically rated for 120 volts AC, 12- or 24-volts DC.
6. LOW VOLTAGE DISCRETE CONTROL OR EVENTS: Dry contact closures and signals monitored by solid state equipment, relays, or control circuits operating at less than 30 volts and 250 milliamperes.

H. SCADA: Acronym for Supervisory Control and Data Acquisition

I. PLC: Acronym for Programmable Logic Controller – synonymous with Programmable Automation Controller (PAC) for purposes of this project.

1.4 QUALITY ASSURANCE:

A. REFERENCES

1. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Reference	Title
IEEE 100	Standard Dictionary of Electrical and Electronics Terms
ISA S5.4	Instrument Loop Diagrams
ISA S20	Specification Forms For Process Measurement and Control Instrumentation, Primary Elements, and Control Valves
ISA S51.1	Process Instrumentation Terminology
ISA TR20.00.01	Specification Forms for Process Measurement and Control Instruments Part 1: General Considerations
NEMA ICS 1	General Standards for Industrial Control and Systems

1.5 SYSTEMS INTEGRATOR RESPONSIBILITY:

A. GENERAL

1. The specified control system and instrumentation integration including panel modifications, instrument calibration, testing, startup, operational testing, and training shall be performed by a Systems Integrator staffed with qualified personnel, possessing necessary equipment and experience in performing similar installations.
2. The control system components shall, as far as practical, be of one manufacturer.
3. The components, modules, devices, and control system equipment shall be recognized industrial quality products. Recognized commercial or office grade products are prohibited.
4. The specified system performance shall be demonstrated to and accepted by the Owner, the Systems Programmer and the Engineer.

B. PRE-SUBMITTAL CONFERENCE:

1. Schedule a pre-submittal conference with the Owner and Engineer within 30-calendar days after Contract award to discuss the work, equipment, submittal format, and establish the framework for project coordination and communication.
2. Provide materials 10-days prior to the conference:
 - a. Instrument Schedule specified in Section 40 06 70 with manufacturer and model number added.
 - b. Product descriptive literature with a statement that the item is as specified.
 - c. Proposed equal products with comparative listing of the published specifications for the specified item and the proposed item.

- d. Project schedule with deliverables and milestones.
 - e. A copy of this specification section, with addendum up- dates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements.
3. The pre-submittal conference will not replace the Product and Shop Drawing Submittal review process.

C. PROCESS EQUIPMENT COORDINATION

- 1. Systems Integrator shall provide wiring interconnect diagrams for the plant process control system to interface with submitted vendor equipment panels and devices. The wiring diagrams shall be a complete representation of the process control requirements for specific equipment. Systems Integrator coordinates to collect equipment wiring information from other Sections to show a totally wired integrated control system.
- 2. Integrate, furnish, and install equipment in conformance with the drawings, specifications, and the recommendations of the equipment manufacturer and the related processes equipment manufacturers.
- 3. Systems Integrator shall obtain manufacturer's technical information for items of equipment not provided with, but directly connected to, the control system. Provide the necessary coordination and components for correct signal interfaces between specified equipment and the control system.
- 4. Systems Integrator shall coordinate with project subcontractors and equipment suppliers.
- 5. Systems Integrator shall provide installation supervision for the duration of the project.
- 6. Systems Integrator shall provide installation supervision for the duration of the project. Conflicts between the plans, specifications, manufacturer/vendor drawings and installation instructions, etc., shall be presented to the Owner for resolution before proceeding.

1.6 SUBMITTALS

- A. PROCEDURES: Section 01 33 00 and 40 61 13.
- B. Provide Seismic calculations for anchoring and support of equipment as required in Section 01 41 20.

C. Product Data: For each type of device and system:

1. Include product data sheets and equipment brochures showing standard products and specified accessories.
 - a. Mark data sheets to clearly show exact product and options being provided.
2. Manufacturer's installation instruction excerpts that apply to this project:
 - a. Mounting requirements
 - b. Electrical connection diagrams
 - c. Calibration procedures
 - d. Operation and maintenance information
 - e. Warranty information

1.7 FUNCTIONAL REQUIREMENTS

A. GENERAL:

1. The instrumentation and control system functions are shown on the drawings and specified in subsequent sections of Divisions 26 and 40. The Systems Integrator drawings and integration practices shall be as defined in IEEE 100, ISA S51.1, and NEMA ICS 1.
2. All equipment with power; control and/or signal electrical interconnections require drawings to be submitted as either elementary if motorized or loop if instrument. All equipment must have a unique drawing reflecting only that equipment's power; control and/or signal electrical interconnections (no typical are permissible).
3. All process control panels and instrument power distribution panels require drawings to be submitted for arrangement, layout and connections. All process control panels and instrument power distribution panels must have a unique drawing with its own Bill of Material reflecting only that panel components and wiring (no typical are permissible).
4. Each communication system requires a network diagram to be submitted.

PART 2 PRODUCTS

2.1 GENERAL

A. MATERIALS AND QUALITY:

1. Provide equipment material new, free from defects, and industrial-grade, as specified. Each type of instrument, instrument accessory, and device used throughout the work to be manufactured by one firm, where possible.
 2. Provide electronic equipment solid-state construction with printed or etched circuit boards of glass epoxy of sufficient thickness to prevent warping.
- B. ENCLOSURES: Table A specifies the instrument and control panel enclosure material and minimum NEMA rating for the location and application.

Table A

Location	Enclosure Material and NEMA Rating
Indoor Dry	NEMA 12: mild steel
Indoor Wet	NEMA 12: mild steel when specified with mounting pad or legs for minor splash resistance) or NEMA 4X: 316 Stainless Steel
Outdoor	NEMA 4X: 316 Stainless Steel
Process Corrosive	NEMA 4X: 316 Stainless Steel
Chemical Corrosive	NEMA 4X: 316 Stainless Steel
Hazardous Area:	NEMA 7: Galvanized Malleable Iron or Aluminum or NEMA 4X and UL listed or FM Approved for the Hazardous Area.
Hazardous and Corrosive Area	NEMA 4X/7: Iron or Aluminum with factory applied corrosion resistant coating or NEMA 4X and UL listed or FM Approved for the Hazardous Area.

2.2 TRANSMITTER

- A. Comply with the following for primary process measurement transmitters:
1. Any transmitter that does not include an integral indicator, provide output indicators. Configure indicator display readout, whether integral or separate, in process measuring units over the calibrated range of the transmitter. Display process measurement as a digital LED or LCD readout with process measuring units on the face of the indicator. Provide indicator with accuracy within two percent of span. Provide loop powered unless otherwise specified. Provide output indicator housing with the same NEMA rating as the transmitter, unless otherwise specified.
 - a. Maintain transmitter's loop continuity for indicator removal. Manufacturer: Global Detection System, GDS; Moore Industries, PSD; MJK; or approved equal.

- b. Hart transparent where transmitter has the 4-20 mA signal with Hart. Manufacturer: Precision Digital or approved equal.
- 2. Operating power derived from the signal transmission circuit for two-wire type transmitters.
- 3. Provide load variations within the range of 0 to 600 ohms with the power supply at a nominal 24 volts DC with the default range of 0 to 100% corresponding to 4 to 20 mAdc for the transmitter.
- 4. Configure transmitter output to increase with increasing measurement unless otherwise noted.
- 5. Provide adjustable time constant from 0.5 to 5.0 seconds for transmitters used for flow, level transmitters used for flow measurement, or pressure measurement.
- 6. Galvanically isolate via electro-mechanical or optical technology the transmitter output. If transmitter is not galvanically isolated then provide transmitter output with a loop-powered signal current isolator.
 - a. Provide galvanic isolation of milliampere transmission signals from transmitters. Locate isolator inside panel and DIN rail mount. Derive operating power from the signal input circuit or as specified on the drawings.
 - b. Input and output signals 4 to 20 milliamperes with error not exceeding 0.1 percent of span. Input resistance not to exceed 550 ohms with an output load of 250 ohms.
 - c. Manufacturer: Phoenix Contact or approved equal.
- 7. Provide transmitter enclosures as rated NEMA 250, Type 4X, unless otherwise specified.
- 8. Surge protect power and output signals for transmitters located outdoors:
 - a. Signal: Provide internal surge protector as a product option. If transmitter does not include an internal surge protector then provide an external surge protector: Emerson/Rosemount Model 470 D, Emerson/EDCO SS64-036-2, CCI SPN-42 FS28 Series, or approved equal.
 - b. AC Power: Provide internal surge protector as a product option. If transmitter does not include an internal surge protector then provide an external surge protector. External surge protector UL 1449, LED indicator, screw terminal connections, NEMA 4X, EDCO HSP121A or approved equal.

- c. Provide a terminal junction box for housing external surge protector. Box to match NEMA rating of the transmitter.
- 9. Provide intrinsic safety barrier with two-wire transmitter located in a facility area classified as hazardous per the NEC when instrument is not available as explosion proof (Class I, Division 1) or an alternative protection method recognized by NEC (Class I, Division 2). Require the two-wire transmitter product manufacturer to list intrinsic safety barriers as an acceptable method for installation in a hazardous classified area.
 - a. Intrinsic safety barriers for two-wire transmitters to be of the active, isolating, loop powered type. Barrier shall be as recommended by the two-wire transmitter product manufacturer, or accepted equal.

2.3 SWITCH

- A. Comply with the following for primary process measurement switches:
 - 1. Contact outputs used for alarm actuation to be normally-closed or normally-opened as required by the process condition to open to initiate the alarm.
 - 2. Contact outputs used to control equipment to be normally-opened, and close to start the equipment.
 - 3. Contacts monitored by solid state equipment such as programmable controllers or annunciators to be hermetically sealed and rated for switching currents from 20 to 100 mA at 24 volts DC.
 - 4. Contacts, monitored by electromagnetic devices such as mechanical relays, to be rated as NEMA ICS 2, designation B300.
 - 5. Double barriers provided between switch elements and process fluids such that failure of one barrier will not permit process fluids into electrical enclosures.
 - 6. Switch electrical enclosures rated as NEMA 250, Type 4X unless otherwise specified.
 - 7. Provide intrinsic safety barrier with switch located in a facility area classified as hazardous per the NEC when instrument is not available as explosion proof (Class I, Division 1) or an alternative protection method recognized by NEC (Class I, Division 2). Intrinsic safety barrier to be dual type to prevent grounding circuit at the barrier; MTL 787, or approved equal.
 - 8. Select switch range so that the specified set point is at least 30 percent but not more than 70 percent of the span, between the upper range limit and the lower range limit.

2.4 NAMEPLATES

- A. Provide nameplates for all field mounted instrument, analyzer, or equipment specified in Divisions 40, 41, 43, and 46. Include the equipment title, the equipment tag number, and power source(s) in the nameplate inscription. Provide machine engraved laminated black phenolic nameplates with white lettering for equipment identification with 1/8-inch high lettering, as minimum, unless otherwise specified or shown. Nameplate wording may be changed without additional cost or time, if changes are made prior to commencement of engraving.
- B. Nameplates shall be attached to support hardware with a minimum of two self- tapping type 316 stainless steel screws in a readily visible location, so the nameplate will remain to identify the service when the device is removed.

PART 3 EXECUTION

3.1 INSTALLATION

- A. GENERAL:
 - 1. Install equipment in locations that are accessible for operation and maintenance services. Equipment not accessible shall be reinstalled at no cost to the Owner.
 - 2. Installation, calibration, settings, and testing procedures are specified in Section 01 75 16, 40 61 31 and 40 61 21.
- B. FIELD EQUIPMENT:
 - 1. Provide equipment with ports and adjustable items accessible for in-place testing and calibration. Install equipment between 50 inches and 60 inches above the floor or permanent work platform. Mount equipment to avoid shock or vibration that may impair operation. Mount equipment for unobstructed access and walkways. Equipment support systems not to be attached to hand- rails, process piping or mechanical equipment.
 - 2. Space instruments and cabinets supported by concrete walls by 5/8 inch using framing channel between instrument or cabinet and wall. Block wall shall have additional installation supports, as required, to avoid damage to the wall. Equipment supports shall be hot-dip galvanized after fabrication or shall be 316L stainless steel, as shown or specified.
 - 3. Design support systems for panels to prevent deformation greater than 1/8 inch in any direction under the attached equipment load and under an external load of 200 pounds.

4. In wet or outdoor areas, conduit penetrations into instrument housing shall be made through the bottom (preferred) or side of enclosures to minimize water entry from around or from inside of conduits. Provide conduit hubs for connections and waterproof mastic for moisture sealant.
5. Provide nameplates for all primary process measurement devices. Attach nameplates to support hardware with a minimum of two self-tapping Type 316 stainless steel screws in a readily visible location, but such that if the field device is changed out, the nameplate will remain to identify the service.
6. The transmitter's output indicator or the switch's status lights must be viewable from floor or permanent work platform without obstruction.
7. Provide configuration equipment including cables and software to communicate with and configure instruments specified in Division 40.

C. ELECTRICAL POWER CONNECTIONS:

1. Equipment electric power wiring shall comply with Division 26. Power disconnect switches shall be provided within sight of equipment and labeled to indicate the specific equipment served and the power source location (including circuit breaker number). "Within sight of" is defined as having an unobstructed view from the equipment served and within 50 feet of the equipment served.
2. Equipment power disconnect switches shall be mounted between 36 inches and 72 inches above the floor or permanent work platform. Where equipment location requirements cannot be met by a single disconnect switch, provide two disconnect switches: one at the equipment and one at the work platform.
3. Provide a surge arrestor on each 120-volt AC disconnect switch serving primary process measurement device located outdoors.

D. CONTROL AND SIGNAL CONNECTIONS:

1. Equipment electric signal connections shall be made on terminal blocks or by locking plug and receptacle assemblies. Flexible cable, receptacle and plug assemblies shall be used where shown or specified.
2. Jacketed flexible conduit shall be used between equipment and rigid race- way systems (Section 26 05 33). Flexible cable assemblies may be used where plug and receptacle assemblies are provided and the installation is not subject to mechanical damage in normal use. The length of flexible conduit or cord assemblies shall not exceed 3 feet except where sufficient length is required to allow withdrawal of instruments for maintenance or calibration without disconnection of conduit or cord assemblies.

3.2 TESTING

- A. DELIVERY INSPECTION: Notify the Owner upon arrival of any material or equipment to be incorporated into the work. Remove protective covers or otherwise provide access in order that the Owner may inspect such items.
- B. REQUIREMENTS: Section 40 61 21.

3.3 MANUFACTURER'S SERVICES

- A. TRAINING: Provide a factory-trained manufacturer's representative or System Integrator skilled in equipment use at the Site for the following activities. Specified durations do not include travel time to or from the Site.
- B. Procedures specified in section 01 75 16.
- C. Training sessions to be 3-hour duration and do not repeat a device training if covered in multiple process areas; provide reference to the training session where the device was covered.
- D. Coordinate training with operations and maintenance staff schedules to ensure all required staff can attend.
- E. Training to include configuration, operation, trouble shooting, wiring, calibration, testing, installation, safety, and warranty coverage for each process control hardware type.
- F. Certify completion of training.

SAMPLE - MANUFACTURER'S INSTRUCTION CERTIFICATION FORM:

Contract No: _____

Specification section: _____

Equipment name: _____

Contractor: _____

Manufacturer of equipment item: _____

The undersigned manufacturer certifies that a service engineer has instructed the wastewater treatment plant operating personnel in the proper maintenance and operation of the equipment designated herein.

<u>Operations Check List</u> (check appropriate spaces)	
Start-up procedure reviewed	
Shutdown procedure reviewed	
Normal operation procedure reviewed	
Others:	

<u>Maintenance Check List</u> (check appropriate spaces)	
Described normal maintenance (frequency)	
Described special tools required	
Described normal items to be reviewed for wear	
Described preventive maintenance instructions	
Described calibration procedures	
Others:	

Date

Manufacturer

Signature of Authorized Representative

Date

Signature of Owner's Representative

Date

Signature of Contractor's Representative

END OF SECTION

SECTION 40 71 13 - MAGNETIC FLOW METERS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Scope
 - 2. Reference Standards
 - 3. Quality Assurance
 - 4. Submittals
 - 5. Performance Requirements
 - 6. Product Requirements
 - 7. Installation
 - 8. Testing
 - 9. Manufacturer's Services

1.2 SCOPE

- A. This Section specifies requirements for supply and installation of the Magnetic Flow Meters measuring system(s). This includes testing, documenting, and start up.
- B. CONTRACTOR shall provide all components, piping, wiring, accessories and labor required for a complete, workable and integrated system.
- C. Instruments shall be mounted as shown on the plans. All metal mounting hardware shall be stainless steel.

1.3 REFERENCE STANDARDS

- A. UL – Underwriters Laboratory approved
- B. ASTM – American Society for Testing and Materials
- C. NEMA – National Electrical Manufacturer's Association
- D. NEC – National Electrical Code

1.4 QUALITY ASSURANCE

- A. REQUIREMENTS: Section 40 61 13 Process Control System General Provisions
- B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials.

1.5 SUBMITTALS

- A. Submittals requirements specified in: Section 01 33 00.
- B. Product Data: For each type of device and system:
 - 1. Include product data sheets and equipment brochures showing standard products and specified accessories.
 - a. Mark data sheets to clearly show exact product and options being provided.
 - 1) Must include:
 - a) Dimensional Drawings
 - b) Materials of Construction
 - (1) Sensor
 - (2) Liner
 - (3) Electrodes
 - (4) Process Connection
 - 2) Accuracy
 - 3) Range
 - 4) Enclosure Rating
 - 5) Classification Rating
 - 6) Power Requirements
 - 7) Output Options
- C. Manufacturer's installation instructions, including mounting requirements.
- D. Operation and maintenance information.
- E. Warranty information.

1.6 PERFORMANCE REQUIREMENTS

- A. REQUIREMENTS: Section 40 70 00.
- B. OPERATING CONDITIONS: Section 40 06 70 instrument schedules.
- C. This section specifies requirements for supply and installation of Magnetic Flow Meters listed in Section 40 06 70 Schedules of Instrumentation for Process Systems.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Flow Meter candidate manufacturers and models:
 - 1. Endress+Hauser Promag W500 – Full Pipe Flow Meters
 - 2. Krohne TIDALFLUX – Partial Pipe Meters
 - 3. Approved equal by Project Engineer
 - 4. To conform to specified requirements, the manufacturer's standard product may require modification.

2.2 GENERAL

- A. Magnetic flow meter provided as a system consisting of a flow tube with locally or remotely mounted converter / indicating transmitter as listed in the instrument schedule or as shown on the drawings. Meters to be provided with all required interconnecting cables between flow tube and transmitter.
- B. Transmitter specified is to comply with Section 40 70 00 transmitter requirements.

2.3 FULL PIPE FLOW METERS

- A. Flow Tube:
 - 1. The flow meter shall be microprocessor based and possess a method in which to store the sensor calibration and transmitter setup information in non-volatile memory. The electronics shall be interchangeable for meters sizes 1" – 120"
 - 2. The sensor shall consist of a stainless-steel flow tube with ANSI B16.5 or AWWA C207 carbon steel or stainless-steel flanges. The flanges shall carry Class 150 or 300 for 24" and smaller, and AWWA Class D for 28" and larger as specified.
 - 3. The sensor tube shall be lined with polyurethane.
 - 4. The sensor shall house two measuring electrodes, a grounding electrode, and one for physical empty pipe detection. The electrodes shall be made of 316L SS.
 - 5. The full-bore magnetic flowmeter in sizes 1"-120" shall maintain zero pressure loss while achieving 0.5% of rate accuracy even when mounted directly before or after a piping elbow, T-fitting or insertion device. This flow tube shall have four measuring electrodes (sizes 1-2.5") and six measuring electrodes (sizes 3"-120") plus a grounding electrode and an empty pipe electrode.

6. The external sensor housing shall enclose the coil assemblies and internal wiring. The materials shall be designed and constructed to prevent moisture ingress and promote corrosion resistance.
7. Process Connection: Flange, ANSI B16.5, Class 150, raised face.
8. Flow tubes shall be pressure rated from full vacuum to 300 psig, unless otherwise noted.
9. Flow tube sizes below 2 inches may be wafer-style ductile-iron or full-body flanged construction.
10. Grounding Ring required and must be provided with flow meter.
11. The sensor shall be rated for NEMA 6P/IP68 service and shall allow for permanent immersion in water depths up to 10 feet.
12. Materials:
 - a. Flow Tube: Stainless steel.
 - b. Flange: Stainless steel or epoxy coated steel
 - c. Electrodes: 316 L stainless steel
 - d. Grounding Rings: Same metal as for the electrodes
 - e. Liner: Polyurethane

B. Indicating Transmitter:

1. The transmitter shall be a three-stage microprocessor controller mounted remotely as specified in the instrument schedule. The transmitter shall operate on AC (100 to 240V) or DC (24 V) via a dedicated or universal power supply as specified. The transmitter housing will carry a NEMA 4X rating and shall be constructed to prevent moisture ingress, promote corrosion resistance, and be impervious to saline environments.
2. The measurement signals from the sensor shall be conducted up to 1,000 feet to the transmitter.
3. The transmitter display shall indicate simultaneous flow rate and total flow with three Totalizers (eg. forward, reverse and net total) and user-selectable engineering units, readout of diagnostic remedy messages.
4. 4-20 MA output proportioned to flow range.
5. The transmitter shall internally retain all setup parameters, calibration parameters and accumulated measurements in non-volatile memory in the event of power failure.

6. Pules output selectable settable for flows from 1 to 500 gallons per pulse.
7. Hazardous Approval for installation is Class I Div 1 areas.
 - a. FM & CSA approved
8. Internal circuitry to drive flow signal to zero upon flow meter determined empty pipe condition.

2.4 PARTIAL PIPE FLOW METERS

A. Flow Tube:

1. Flow meter shall operate on electromagnetic induction principle for velocity and capacitance principle for level measurement. Output signal shall be directly proportional to the liquid rate of flow at pipe filling levels between 10% and 100% of pipe cross-section.
 - a. When partly filled: $v @ \text{Full Scale} \geq 1 \text{ m/s} / 3.3 \text{ ft/s} : \leq 1\% \text{ of FS}$
 - b. When fully filled: $v \geq 1 \text{ m/s} / 3.3 \text{ ft/s} : \leq 1\% \text{ of MV}$; $v < 1 \text{ m/s} / 3.3 \text{ ft/s} : \leq 0.5\% \text{ of MV} + 5 \text{ mm/s} / 0.2 \text{ inch/s}$
 - c. Minimum Level: 10% of inner diameter
2. The sensor shall consist of a stainless-steel flow tube with ANSI B16.5 or AWWA C207 carbon steel or stainless-steel flanges. The flanges shall carry Class 150 or 300 for 24" and smaller, and AWWA Class D for 28" and larger as specified.
3. Flow tube sizes below 2 inches may be wafer-style ductile-iron or full-body flanged construction.
4. Grounding Ring required.
5. Materials:
 - a. Flow Tube: Austenitic Stainless steel.
 - b. Flange: Stainless steel or polyurethane coated steel.
 - c. Electrodes: Hastelloy
 - d. Grounding Rings: Stainless Steel – made to match inner diameter of pipe
 - e. Liner: Polyurethane

B. Indicating Transmitter:

1. Transmitter to be remotely mounted as shown on the plans.
2. Power Supply standard 12 to 24 VDC @ 12 W

3. System error shall not exceed the greater of +/- 0.5% of flow rate or 0.1 foot per second from 3 to 30 feet per second.
4. IP 68 enclosure
5. 4-20 MA output proportioned to flow range and capable of supporting a 100-ohm load
6. Pulse output selectable from 1 to 5000 gallons per pulse.
 - a. Pulse output shall be a dry contact compatible with PLC input module.
7. Provide Ethernet/IP communication port that makes available all flow meter data.
8. FM & CSA approved
9. Contain electronics associated with the magnetic flow meter system. Enclosure rating NEMA-4X, cast aluminum or metal compartment for power, field connections and calibration adjustments separate from digital circuitry.
10. Cable: Signal cable between the flow tube and transmitter provided by the system manufacturer with sufficient length of cable for continuous installation between the flow tube and the transmitter.
11. 4-digit LCD flow indication calibrated in process units. Data retained in non-volatile memory.

PART 3 EXECUTION

3.1 INSTALLATION

- A. REQUIREMENTS: Section 40 70 00.
- B. Install all components of Magnetic Flow Meters system in accordance with manufacturer's specifications and instructions for the specified functional requirements.
- C. Ensure proper installation of the Magnetic Flow Meters system so as to not result in false reading due to ambient conditions or equipment at the installation site.
- D. Comply with mounting details provided on the drawings.

3.2 TESTING

- A. REQUIREMENTS: Section 40 61 21.

- B. Instruments shall be calibrated and tested on site in accordance with the requirements of Section 40 61 21 and in accordance with the manufacturer's recommendations. Field calibration shall be conducted by a technical representative, factory trained and certified by the manufacturer.
- C. In addition, the instruments shall be operationally tested in conjunction with the functional acceptance test of the complete system of Instrumentation and Controls for the completed system.

3.3 MANUFACTURER'S SERVICES

- A. REQUIREMENTS: Section 40 70 00 and 40 61 26
- B. CONTRACTOR shall provide the services of the manufacturer's representative for a minimum of one day to evaluate the installation of the instruments, testing and calibration, certification of proper installation, and training.

END OF SECTION

SECTION 40 71 76 - THERMAL FLOW METERS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Scope
 - 2. Reference Standards
 - 3. Quality Assurance
 - 4. Submittals
 - 5. Performance Requirements
 - 6. Product Requirements
 - 7. Installation
 - 8. Testing
 - 9. Manufacturer's Services

1.2 SCOPE

- A. This Section specifies requirements for supply and installation of the thermal flow measuring system(s). This includes testing, documenting, and start up.
- B. CONTRACTOR shall provide all components, piping, wiring, accessories and labor required for a complete, workable and integrated system.
- C. Instruments shall be mounted as shown on the plans. All metal mounting hardware shall be stainless steel.

1.3 REFERENCE STANDARDS

- A. UL – Underwriters Laboratory approved
- B. ASTM – American Society for Testing and Materials
- C. NEMA – National Electrical Manufacturer's Association
- D. NEC – National Electrical Code

1.4 QUALITY ASSURANCE

- A. REQUIREMENTS: Section 40 61 13 Process Control System General Provisions
- B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials

1.5 SUBMITTALS

- A. Comply with applicable Submittal requirements specified in: Section 01 33 00.
- B. Product Data: For each type of device and system:
 - 1. Include product data sheets and equipment brochures showing standard products and specified accessories.
 - a. Mark data sheets to clearly show exact product and options being provided
- C. Manufacturer's installation instructions.
- D. Operation and Maintenance Manual
- E. Warranty information.

1.6 PERFORMANCE REQUIREMENTS

- A. REQUIREMENTS: Section 40 70 00.
- B. OPERATING CONDITIONS: Section 40 06 70 instrument schedules.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Flow Meter candidate manufacturers and models:
 - 1. Endress & Hauser Proline t-mass B 150
 - 2. Fluid Components, Inc. Model ST98
 - 3. Approved equal by Project Engineer.
 - 4. To conform to specified requirements, the manufacturer's standard product may require modification.

2.2 GENERAL

- A. Product Requirements: Thermal flow meter shall be provided as a system consisting of flow sensing element, pipe mounting hardware and locally mounted converter / indicating transmitter unless otherwise noted. Meters to be provided with all required interconnecting cables.

2.3 FEATURES

- A. Suitable for Air, nitrogen, carbon dioxide and argon in circular pipe or rectangular ducts.
- B. Signal Output: 4 – 20 mA Analog plus HART.
 - 1. Pulse output signal optional if specified in 40 60 70.
- C. Process Connection: ½" NPT.
- D. Insertion length: 3" to 60".
- E. Accuracy: 3% of reading not to exceed 5% of full scale.
- F. Measuring Range: 200 to 500 CFM (see 40 06 70).
- G. Calibrated in process units: (CFM).
- H. Probe Material: 316L stainless.
- I. Enclosure: IP 66/67 NEMA 4X
- J. Max Pressure: 290 psi g.
- K. Temperature Range: -40 to + 140° F.
- L. Indicating transmitter for full-scale flow rates as specified in Section 40 06 70. System error shall not exceed the greater of 3% of flow rate or 5% of full scale.
- M. Provide means to calibrate the metering system without use of external calibration units. Transmitter shall have self-diagnostics capability with error status display. Traceability certificate of actual flow lab certification provided with each flow tube.

2.4 ELECTRICAL REQUIREMENTS

- A. Supply Voltage 18 to 30 VDC
- B. 4 wire connection – two for supply voltage and two for 4-20mA analog output. Additional wires may be required if pulse output option is specified.
- C. Contain electronics associated with the thermal flow meter system. Enclosure rating NEMA-4X, cast aluminum or metal compartment for power.
- D. 4-line display with push buttons will allow configuration via local display.
- E. Calibrated in process units. (CFM) Configuration Data retained in non-volatile memory.

PART 3 EXECUTION

3.1 INSTALLATION

- A. REQUIREMENTS: Section 40 70 00.
- B. Install all components of Ultrasonic level measuring system in accordance with manufacturer's specifications and instructions for the specified functional requirements.
- C. Ensure proper installation of the Ultrasonic level measuring system so as to not result in false reading due to ambient conditions or equipment at the installation site.
- D. Comply with mounting details provided on the drawings.

3.2 TESTING

- A. REQUIREMENTS: Section 40 61 21.
- B. Instruments shall be calibrated and tested on site in accordance with the requirements of Section 40 61 21 and in accordance with the manufacturer's recommendations. Field calibration shall be conducted by a technical representative, factory trained and certified by the manufacturer.
- C. In addition, the instruments shall be operationally tested in conjunction with the functional acceptance test of the complete system of Instrumentation and Controls for the completed system.

3.3 MANUFACTURER'S SERVICES

- A. REQUIREMENTS: Section 40 70 00 and 40 61 26
- B. CONTRACTOR shall provide the services of the manufacturer's representative for a minimum of one day to evaluate the installation of the instruments, testing and calibration, certification of proper installation, and training.

END OF SECTION

SECTION 40 72 43 - PRESSURE AND DIFFERENTIAL PRESSURE TYPE LEVEL METERS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Scope
 - 2. Reference Standards
 - 3. Quality Assurance.
 - 4. Submittals.
 - 5. Performance requirements
 - 6. Products Requirements.
 - 7. Installation.
 - 8. Testing.

1.2 SCOPE

- A. This Section specifies requirements for supply and installation of Pressure and Differential type level measuring system(s). This includes testing, documenting, and start up.
- B. CONTRACTOR shall provide all components, piping, wiring, accessories and labor required for a complete, workable and integrated system.
- C. Instruments shall be mounted as shown on the plans. All metal mounting hardware shall be stainless steel.

1.3 REFERENCE STANDARDS

- A. UL – Underwriters Laboratory approved
- B. ASTM – American Society for Testing and Materials
- C. NEMA – National Electrical Manufacturer's Association
- D. NEC – National Electrical Code

1.4 QUALITY ASSURANCE

- A. REQUIREMENTS: Section 40 61 13 and 40 70 00
- B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials.

1.5 SUBMITTALS

- A. Submittals requirements specified in: Section 01 33 00 and 40 61 13.
- B. Product Data: For each type of device and system:
 - 1. Include product data sheets and equipment brochures showing standard products and specified accessories.
 - a. Mark data sheets to clearly show exact product and options being provided
- C. Manufacturer's installation instructions, including mounting requirements.
- D. Operation and maintenance information.
- E. Warranty information.

1.6 PERFORMANCE REQUIREMENTS

- A. REQUIREMENTS: Section 40 70 00.
- B. OPERATING CONDITIONS: Section 40 06 70 instrument schedules.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Pressure Transmitter candidate manufacturers and models:
 - 1. TE Connectivity KPSI 750 series,
 - 2. Druck, model PTX 1830,
 - 3. Approved equal by Project Engineer.
 - 4. To conform to specified requirements, the manufacturer's standard product may require modification.

2.2 GENERAL

- A. Level shall be sensed and transmitted by a submersible type pressure transmitter. Level measurement provided as a system consisting of a pressure transmitter, sensor termination enclosure with desiccant and waterproof vent, integral cable, hanger and weight.
- B. Transmitter specified is to comply with Section 40 70 00 transmitter requirements.

- C. The Contractor shall supply weights as necessary to ensure that the pressure transducer will hang straight down the well and not float in the well water column.
- D. The unit shall be purchased with sufficient length to set the transmitter at 1 foot above the pump as indicated on the Drawings and extend to the junction box as shown on the Plans, with a spare 10 feet of cable.

2.3 FEATURES

- A. Process Connection: Sealed/Submersible in media.
- B. System error shall not exceed $\pm 0.25\%$ of level range
- C. Combined non-linearity, hysteresis, and repeatability accuracy of 0.1% of full scale.
- D. Non-fouling, integral protective cage, non-clogging 2.75" PTFE coated Elastomeric diaphragm.
- E. Temperature Range: -20 to 60 °C (Operating), 0 to 50°C (Compensated).
- F. Environmental Ratings:
 - 1. Transmitter and cable: IP 68, NEMA 6P.
 - 2. Junction Box: IP 66, NEMA 4.
- G. Transmitter Materials:
 - 1. Body: Welded 316 stainless steel.
 - 2. Cable: FMK Polyurethane or ETFE.
- H. Cable Hanger Materials: 304 stainless steel.
- I. Weight Materials: Stainless steel, brass, or other material that will not corrode, and will not contaminate the water supply well. Lead weights are not acceptable.
- J. Transmitter to be FM approved for Class I & II, Div. 1 Groups A, B, C & D.

2.4 ELECTRICAL REQUIREMENTS

- A. Input current: 20 mA max (loop Power)
- B. Signal Output: 4-20mA, 0-5 VDC, 0-2.5VDC Analog signal. Signal shall change in direct linear proportional to changes in measured level.
- C. Insulation resistance: 100 Mega Ω @ 500 VDC Capable of withstanding a 600 Volt spike in accordance with ENV 50142 without damage.

- D. Circuit protection: polarity, surge/ shorted output.

PART 3 EXECUTION

3.1 INSTALLATION

- A. REQUIREMENTS: Section 40 70 00.
- B. Install all instruments and components of level measuring system in accordance with manufacturer's specifications and instructions for the specified functional requirements.
- C. Comply with mounting details provided on the drawings and or recommendations of the manufacturer.

3.2 TESTING

- A. REQUIREMENTS: Section 40 61 21.
- B. Instruments shall be calibrated and tested on site in accordance with the requirements of Section 40 61 21 and in accordance with the manufacturer's recommendations. Field calibration shall be conducted by a technical representative, factory trained and certified by the manufacturer.
- C. In addition, the instruments shall be operationally tested in conjunction with the functional acceptance test of the complete system of Instrumentation and Controls for the completed system.

END OF SECTION

SECTION 40 72 76 - LEVEL SWITCHES

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Scope
 - 2. Reference Standards
 - 3. Quality Assurance.
 - 4. Submittals.
 - 5. Product Requirements.
 - 6. Installation.
 - 7. Testing.

1.2 SCOPE

- A. This Section specifies requirements for supply and installation of process level sensing devices listed in section 40 06 70 Schedules of Instrumentation for Process Systems.

1.3 REFERENCE STANDARDS

- A. ASTM – American Society for Testing and Materials
- B. NEMA – National Electrical Manufacturer's Association
- C. NEC – National Electrical Code

1.4 QUALITY ASSURANCE

- A. REQUIREMENTS: Section 40 61 13 Process Control System General Provisions
- B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials.

1.5 SUBMITTALS

- A. Submittals requirements specified in: Section 01 33 00.
- B. Product Data: For each type of device and system:
 - 1. Include product data sheets and equipment brochures showing standard products and specified accessories.
 - a. Mark data sheets to clearly show exact product and options being provided

- C. Manufacturer's installation instructions.
- D. Operation and Maintenance Manual if applicable.

1.6 PERFORMANCE REQUIREMENTS

- A. REQUIREMENTS: Section 40 70 00.
- B. OPERATING CONDITIONS: Section 40 06 30's instrument schedules.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Level Switches candidate manufactures and models:
 - 1. Flygt ENM-10
 - 2. Warrick Controls Inc. Series M.
 - 3. Pulsar Inc., Model 800-70 Signal Master
 - 4. STI Corp. Series KA
 - 5. Approved equal

2.2 GENERAL

- A. Float switches shall be provided where indicated, specified, or required to meet the functional requirements of the System, as specified.
- B. Unit shall be suspended type, and provided with length of cable required to reach panel or junction box without splicing. Contractor to verify length of cable required for each float switch before ordering.
- C. Float switches shall be provided with necessary brackets and clamps to suspend the unit where required. The suspended type shall include an integral or attached weight assembly for stabilization and positive operation of the unit. All mounting clamps shall be PVC or Neoprene.

2.3 FEATURES

- A. Direct-acting float type consisting of a mechanically activated (non-mercury) SPDT switch enclosed in a float and connected to a multi-conductor combination support and signal cable. The entire assembly shall form a completely watertight and impact-resistant unit.
- B. Chemical-resistant polypropylene or other corrosion-resistant float material suitable for use in water and wastewater applications.
- C. Cable shall be rugged and flexible with heavy neoprene or PVC jacket.

- D. The suspended type shall include an integral or attached weight assembly for stabilization and positive operation of the unit.
- E. Actuation/deactivation differential shall be 1 inch minimum.

2.4 ELECTRICAL REQUIREMENTS

- A. Switch shall be SPDT, form C, rated at 5 amps (minimum) at 120 VAC.
- B. The conductors shall be a minimum size of 18 AWG.

PART 3 EXECUTION

3.1 INSTALLATION

- A. REQUIREMENTS: Section 40 70 00 and Install in accordance with manufacturer's instructions for the specified functional requirements.
- B. Install all components of chlorine monitoring system in accordance with manufactures specifications and instructions.
- C. Instruments shall be installed, calibrated and tested on site in accordance with the requirements of Section 40 61 21 and 40 61 26 and in accordance with the manufacturer's recommendations. Field calibration shall be conducted by a technical representative, factory trained and certified by the manufacturer. CONTRACTOR shall provide the services of the manufacturer's representative for a minimum of one day got the installation of the instruments and for certification of proper installation.
- D. CONTRACTOR shall provide the services of the manufacturer's representative for a minimum of one day for the calibration and testing of the instruments after certification of proper installation.
- E. In addition, the instruments shall be operationally tested in conjunction with the functional acceptance test of the complete system of Instrumentation and Controls for the completed well system.
- F. Verify size and type of mounting hardware required for each float switch to be installed.

3.2 TESTING

- A. REQUIREMENTS: Section 40 61 21.
- B. Ensure proper installation per manufacturers recommendations.
- C. In addition, the devices shall be operationally tested in conjunction with the functional acceptance test of the complete system of Instrumentation and Controls for the completed well system.

- D. Verify float switch is using the correct contact – normally open or normally closed – required for the specific application.

END OF SECTION

SECTION 40 73 26 - GAUGE PRESSURE TRANSMITTERS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Scope
 - 2. Reference Standards
 - 3. Quality Assurance.
 - 4. Submittals.
 - 5. Performance requirements
 - 6. Products Requirements.
 - 7. Installation.
 - 8. Testing.
 - 9. Manufacturer's Services.

1.2 SCOPE

- A. This Section specifies requirements for supply and installation of Pressure and measuring system(s). This includes testing, documenting, and start up.
- B. CONTRACTOR shall provide all components, piping, wiring, accessories and labor required for a complete, workable and integrated system.
- C. Instruments shall be mounted as shown on the plans. All metal mounting hardware shall be stainless steel.

1.3 REFERENCE STANDARDS

- A. ASTM – American Society for Testing and Materials
- B. NEMA – National Electrical Manufacturer's Association
- C. NEC – National Electrical Code
- D. NFPA No. 70, NEC - National Electrical Code
- E. NFPA No. 79, Electrical Standard for Industrial Machinery.
- F. ICS-1 – General Standards for Industrial Control and System
- G. ICS-2 – Standards for Industrial Control Devices, Controllers and
- H. ICS-3 – Industrial Systems.

- I. UL – Underwriter’s Laboratory UL (Note: Other Nationally Recognized Testing Laboratories [NRTL], such as ETL, may be used in lieu of UL.)

1.4 1.4 QUALITY ASSURANCE

- A. REQUIREMENTS: Section 40 61 13 Process Control System General Provisions.
- B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials.

1.5 SUBMITTALS

- A. Submittals requirements specified in: Section 01 33 00.
- B. Product Data: For each type of device and system:
 - 1. Include product data sheets and equipment brochures showing standard products and specified accessories.
 - a. Mark data sheets to clearly show exact product and options being provided.
- C. Manufacturer's installation instructions, including mounting requirements.
- D. Operation and maintenance information.
- E. Warranty information.

1.6 PERFORMANCE REQUIREMENTS

- A. REQUIREMENTS: Section 40 70 00.
- B. OPERATING CONDITIONS: Section 40 06 70 instrument schedules.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Pressure Transmitter candidate manufacturers and models:
 - 1. TE Connectivity KPSI 750 series,
 - 2. Druck, model PTX 1830,
 - 3. Approved equal by Project Engineer.
 - 4. To conform to specified requirements, the manufacturer’s standard product may require modification.

2.2 GENERAL

- A. Level shall be sensed and transmitted by a process connected pressure transmitter. Pressure measurement provided as a system consisting of a pressure transmitter with integral process connection.
- B. Transmitter specified is to comply with Section 40 70 00 transmitter requirements.
- C. The Contractor shall supply weights as necessary to ensure that the pressure transducer will hang straight down the well and not float in the well water column.
- D. The unit shall be purchased with sufficient length to set the transmitter at 1 foot above the pump as indicated on the Drawings and extend to the junction box as shown on the Plans, with a spare 10 feet of cable.

2.3 FEATURES

- A. Process Connection: as shown on the drawings and in Section 40 06 70.
- B. System error shall not exceed $\pm 0.25\%$ of level range
- C. Combined non-linearity, hysteresis, and repeatability accuracy of 0.1% of full scale.
- D. Non-fouling, integral protective cage, non-clogging 2.75" PTFE coated Elastomeric diaphragm.
- E. Temperature Range: -20 to 60 °C (Operating), 0 to 50°C (Compensated).
- F. Environmental Ratings:
 - 1. Transmitter and cable: IP 68, NEMA 6P.
 - 2. Junction Box: IP 66, NEMA 4.
- G. Transmitter Materials:
 - 1. Body: Welded 316 stainless steel.
- H. Transmitter to be FM approved for Class I & II, Div. 1 Groups A, B, C & D.

2.4 ELECTRICAL REQUIREMENTS

- A. Input current: 20 mA max (loop Power)
- B. Signal Output: 4-20mA, 0-5 VDC, 0-2.5VDC Analog signal. Signal shall change in direct linear proportional to changes in measured level.

- C. Insulation resistance: 100 Mega Ω @ 500 VDC Capable of withstanding a 600 Volt spike in accordance with ENV 50142 without damage.
- D. Circuit protection: polarity, surge/ shorted output.

PART 3 EXECUTION

3.1 INSTALLATION

- A. REQUIREMENTS: Section 40 70 00.
- B. Install all components of level measuring system in accordance with manufacturer's specifications and instructions for the specified functional requirements.
- C. Comply with mounting details provided on the drawings.

3.2 TESTING

- A. REQUIREMENTS: Section 40 61 21.
- B. Instruments shall be calibrated and tested on site in accordance with the requirements of Section 40 61 21 and in accordance with the manufacturer's recommendations. Field calibration shall be conducted by a technical representative, factory trained and certified by the manufacturer.
- C. In addition, the instruments shall be operationally tested in conjunction with the functional acceptance test of the complete system of Instrumentation and Controls for the completed system.

3.3 MANUFACTURER'S SERVICES

- A. REQUIREMENTS: Section 40 70 00 and 40 61 26
- B. CONTRACTOR shall provide the services of the manufacturer's representative for a minimum of one day to evaluate the installation of the instruments, testing and calibration, certification of proper installation, and training.

END OF SECTION

SECTION 40 75 05 - MULTI-PARAMETER ANALYZER SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Scope.
 - 2. Reference Standards.
 - 3. Quality Assurance.
 - 4. Submittals.
 - 5. Product Requirements.
 - 6. Installation.
 - 7. Testing.
 - 8. Manufacturer's Services.

1.2 SCOPE

- A. This Section specifies requirements for supply and installation a modular single or dual channel controller that works with analog sensor modules and/or digital sensors. It includes testing, documenting, and start up.
- B. CONTRACTOR shall provide all components, piping, wiring, accessories and labor required for a complete, workable and integrated system.
- C. Instruments shall be mounted as shown on the plans. All metal mounting hardware shall be stainless steel.

1.3 REFERENCE STANDARDS

- A. UL/CSA 61010-1
- B. ASTM – American Society for Testing and Materials
- C. NEMA – National Electrical Manufacturer's Association
- D. NEC – National Electrical Code

1.4 QUALITY ASSURANCE

- A. REQUIREMENTS: Section 40 61 13 Process Control System General Provisions.
- B. Certifications
 - 1. EMC: CE compliant for conducted and radiated emissions CISPR 11 (Class A limits), EMC Immunity EN 61326-1 (Industrial limits)
 - 2. Safety: General Purpose UL/CSA 61010-1 with cTUVus safety mark

3. Australian C-TICK and Korean KC Markings
 4. FCC ID QIPMC56/IC ID 267W-MC56
 5. IP65 dust and water ingress ratings
- C. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials.

1.5 SUBMITTALS

- A. Submittals requirements specified in: Section 01 33 00.
- B. Product Data: For each type of device and system:
 1. Include product data sheets and equipment brochures showing standard products and specified accessories.
 - a. Mark data sheets to clearly show exact product and options being provided
- C. Manufacturer's installation instructions, including mounting requirements.
- D. Operation and maintenance information.
- E. Warranty information.

1.6 PERFORMANCE REQUIREMENTS

- A. REQUIREMENTS: Section 40 70 00.
- B. OPERATING CONDITIONS: Section 40 06 30 instrument schedules.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Multi-Parameter Analyzer System candidate manufactures and models:
 1. Hach Company, Loveland, Colorado and Hach Lange GmbH, Berlin, Germany
 - a. Hach model sc1000 controller
 2. Approved equal

2.2 GENERAL

- A. The sc1000 controller is microprocessor-based and is housed in an IP65 rated enclosure.
- B. The sc1000 controller is a modular system consisting of:
 - 1. Display Module
 - 2. Probe Module (Consisting of)
 - a. Probe Module Housing
 - b. Power Supply
 - c. 4 available slots for I/O cards
- C. Ability to change digital sensors connected to the controller by unplugging and plugging in sensors as necessary.
- D. Probe modules of the controller can be networked together to accommodate more than eight sensors on one network.
- E. The controller shall accept up to eight sensor inputs from the following digital sensors in any combination
 - 1. Hach 1200-S sc Digital pH sensor
 - 2. Hach 1720E sc Turbidimeter
 - 3. Hach 5740 sc Membrane Dissolved Oxygen Sensor
 - 4. Hach 9184 sc Free Chlorine Amperometric Sensor
 - 5. Hach Amtax sc Ammonia Analyzer
 - 6. Hach A-ISE Ammonium Sensor
 - 7. Hach AN-ISE combination Ammonium and Nitrate Sensor
 - 8. Hach ClF10 Free Chlorine Amperometric Sensor
 - 9. Hach ClT10 Total Chlorine Amperometric Sensor
 - 10. Hach Digital PC sc and RC sc Combination pH and ORP Sensors
 - 11. Hach Evita Insitu 4100 sc Ammonium and Orthophosphate Sensors
 - 12. Hach FilterTrak 660 sc Laser Nephelometer
 - 13. Hach FP360 Oil in Water Sensor
 - 14. Hach LDO Luminescent Dissolved Oxygen Sensor
 - 15. Hach LDO Model 2 Luminescent Dissolved Oxygen Sensor
 - 16. Hach NH4D sc Ammonium Sensor
 - 17. Hach N-ISE Nitrate Sensor
 - 18. Hach NO3D Nitrate Sensor
 - 19. Hach Nitratax sc Nitrate Sensor
 - 20. Hach PHD sc Differential pH and ORP Sensors

21. Hach Phosphax sc Low and High Range Phosphate Analyzer
22. Hach Solitax sc Turbidity and Suspended Solids Sensor
23. Hach Sonatax sc Sludge Level Probe
24. Hach Surface Scatter 7 sc High Range Turbidimeter
25. Hach TSS sc Suspended Solids/Turbidity Sensor
26. Hach Ultraturb sc Turbidimeter (Including plus and seawater versions)
27. Hach UVAS sc SAC sensor

2.3 FEATURES

- A. The controller is available with the following power requirements:
 1. AC powered: 100 to 240 Vac \pm 10%, 50/60 Hz; maximum 1000 VA, Category II
 2. 24 VDC powered: 18 to 30 VDC, maximum 75 W
- B. The controller uses a menu-driven operation system.
- C. The controller display is a ¼ VGA graphical backlit TFT Color Glass/Glass-Touch Screen
 1. Screen size is 4.5 x 3.4 in (11.4 x 8.6 cm)
 2. Screen resolution is 320 x 240 pixels
- D. The controller is equipped with a real-time clock.
- E. The controller is equipped with two security levels.
- F. The controller is equipped with a data logger that can output to a storage card or directly to a computer hard drive.
- G. The controller can be equipped with an SD card reader for data download and controller software upload.
- H. The controller can have software updated through a direct network connection
- I. Four electromechanical, UL rated, SPDT relays (Form C) can be installed for user-configurable contacts rated 100 to 250 Vac, 5 Amp at 30 VDC resistive maximum.
 1. The following can be programmed:
 - a. Alarm
 - b. Feeder Control
 - c. Two Point Control
 - d. Pulse Width Modulation Control
 - e. Frequency Control
 - f. Timer
 - g. System Error

2. The following can be assigned:
 - a. Primary value measurement I
 - b. Secondary value measurement I
 - c. Tertiary value measurement I
 - d. Quaternary value measurement I
 - e. Primary value Measurement II
 - f. Secondary value measurement II
 - g. Tertiary value measurement II
 - h. Quaternary value measurement II
 - i. Real time clock
 - j. Calculated values
- J. The controller can be equipped with up to twelve 0/4-20mA outputs with a maximum impedance of 500 ohms per probe module.
 1. The following can be programmed:
 - a. Alarms:
 - 1) Low alarm point
 - 2) Low alarm point deadband
 - 3) High alarm point
 - 4) High alarm point deadband
 - 5) Off delay
 - 6) On delay
 - b. Controls:
 - 1) Linear
 - 2) PID
 - 3) High/Low Phasing
 - 4) Set-Point
 - 5) Deadband
 - 6) Overfeed timer
 - 7) Off Delay
 - 8) On Delay
- K. The Display Module can be equipped with the following forms of communication:
 1. Ethernet (standard)
 2. Modbus
 3. Modbus TCP/IP with the use of a GSM/GPRS modem
 4. Additional communication options are available on the sc1000 Display Module.
- L. The Probe Module can be equipped with the following forms of communication:

1. Modbus RS232/RS485
 2. Profibus DP
 3. RTC Communications
- M. All user settings of the controller are retained for 10 years in non-volatile EEPROM memory.
- N. The controller is equipped with a system check for:
1. Power up test (monitoring and shutdown)
 2. Total power draw
 3. Memory devices
 4. Temperature mother board
- O. The controller has the option of graphical measurement that tracks measurement values over time.

2.4 COMPONENTS

- A. Standard Equipment
1. sc1000 Display Module
 2. sc1000 Probe Module
 3. User Manual
- B. Dimensions:
1. sc1000 Display Module 9.5 x 2 x 7.8 in (242 x 50 x 200 mm)
 2. sc1000 Probe Module 9.5 x 4.7 x 12.3 in (242 x120 x315 mm)
- C. Weight:
1. sc1000 Display Module 5.1 lbs (2.3 kg)
 2. sc1000 Probe Module 14.6 lbs (6.6 kg)

PART 3 EXECUTION

3.1 INSTALLATION

- A. REQUIREMENTS: Section 40 70 00 and Install in accordance with manufacturer's instructions for the specified functional requirements.
- B. Install all components of chlorine monitoring system in accordance with manufactures specifications and instructions.

- C. Instruments shall be installed, calibrated and tested on site in accordance with the requirements of Section 40 61 21 and 40 61 26 and in accordance with the manufacturer's recommendations. Field calibration shall be conducted by a technical representative, factory trained and certified by the manufacturer. CONTRACTOR shall provide the services of the manufacturer's representative for a minimum of one day got the installation of the instruments and for certification of proper installation.
- D. CONTRACTOR shall provide the services of the manufacturer's representative for a minimum of one day for the calibration and testing of the instruments after certification of proper installation.
- E. In addition, the instruments shall be operationally tested in conjunction with the functional acceptance test of the complete system of Instrumentation and Controls for the completed well system.

3.2 TESTING

- A. REQUIREMENTS: Section 40 61 21.
- B. Ensure proper installation of the analyzer system so as to not be result in false reading due to ambient conditions or equipment at the installation site.

3.3 MANUFACTURER'S SERVICES

- A. REQUIREMENTS: Section 40 70 00 and 40 61 26
- B. The contractor shall provide for a manufacturer's representative to be onsite for 1 day during start-up for the start-up and calibration of the analyzer system.

END OF SECTION

SECTION 40 75 09 - AIR BLAST CLEANING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. High Output Air Blast (HOAB). Compressed air will be provided to make possible to clean a probe. A probe specific cleaning head needs to be used to fit with the specific probe involved. Probe specific cleaning head is not a part of the HOAB.

1.2 MEASUREMENT PROCEDURES

- A. Compressed air generated from a compressor will be let to a cleaning device (cleaning head). The design of the probe specific cleaning head makes sure that the surface of the measuring part of the probe remains clean.

1.3 ALTERNATES

- A. Manual cleaning of the measuring part of the probe are not acceptable.

1.4 SYSTEM DESCRIPTION

- A. Performance Requirements
 - 1. Air pressure (at compressor outlet): 115VAC 3.1 bar (45psi) / 230VAC 2.8 bar (40 psi)
 - 2. Air flow (at compressor outlet): 115VAC 2.1 m³/hour / 230VAC 1.8m³/hour

1.5 CERTIFICATIONS

- A. UL, CSA, cETLus, CE

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Operational Criteria
 - 1. Operating temperature -20 to 50 °C (-4 to 122 °F) 95% rel. humidity non-considering.

1.7 WARRANTY

- A. The product includes a one-year warranty from date of shipment. (excluding wear parts)

1.8 MAINTENANCE SERVICE

A. Scheduled maintenance:

1. Weekly / Monthly: visual inspection, if necessary, cleaning of the air intake, depending on location

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Hach Company, Loveland, CO

1. HOAB, High Output Air Blast system

2.2 MANUFACTURED UNIT

- #### A.
- The HOAB -consist out of a non-metallic cabinet (enclosure) including a compressor- which needs be installed along the probe equipped with a cleaning head at the basin and approx. 9m (27ft) air hose.

2.3 EQUIPMENT

- #### A.
- The HOAB is a stand-alone system (AC powered), including a controller relay fuse (T, 0.25 A, 250 V).
- #### B.
- The enclosure is made of Polycarbonate and is suitable for outdoor installation.
- #### C.
- The air hose is suitable for outdoor installation.

2.4 COMPONENTS

A. Standard equipment:

1. Control unit
 - a. Polycarbonate
2. Air hose
 - a. Tygon style, braided
3. Mounting accessories
 - a. Stainless Steel
4. Manual

B. Dimensions:

1. Control unit: (W x H x D) 351.6 x 186.9 x 409.7 mm (13.84 x 7.36 x 16.13 inches)

C. Weight:

1. Control unit: 11.2 kg 24.7 lbs

2.5 ACCESSORIES

A. Probe specific cleaning head (kits)

PART 3 EXECUTION

3.1 PREPARATION

- A. The HOAB enclosure module must be mounted steady on side of the basin. The HOAB must be installed nearby the probe with the cleaning head.

3.2 INSTALLATION

- A. Contractor will install the probe in strict accordance with the manufacturer's instructions and recommendation.
- B. Manufacturer's representative will include a half-day of start-up service by a factory-trained technician, if requested.
1. Contractor will schedule a date and time for start-up.
 2. Contractor will require the following people to be present during the start-up procedure.
 - a. General contractor
 - b. Electrical contractor
 - c. Hach Company factory trained representative
 - d. Owner's personnel
 - e. Engineer

END OF SECTION

SECTION 40 75 13 - pH/ORP ANALYZERS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Scope.
 - 2. Reference Standards.
 - 3. Quality Assurance.
 - 4. Submittals.
 - 5. Product Requirements.
 - 6. Installation.
 - 7. Testing.
 - 8. Manufacturer's Services.

1.2 SCOPE

- A. This Section specifies requirements for supply and installation of the pH/ORP probes and analyzers including testing, documenting, and start up.
- B. CONTRACTOR shall provide all components, piping, wiring, accessories and labor required for a complete, workable and integrated system.
- C. Probes shall be mounted as shown on the plans. All metal mounting hardware shall be stainless steel.
- D. Units to be compatible with Multi-Parameter Analyzer System specified in 40 75 05.
 - 1. Hach SC-1000 or approved equal

1.3 REFERENCE STANDARDS

- A. UL – Underwriters Laboratory approved
- B. ASTM – American Society for Testing and Materials
- C. NEMA – National Electrical Manufacturer's Association
- D. NEC – National Electrical Code

1.4 MEASUREMENT METHOD

- A. pH probe shall use three electrodes instead of the two normally used in conventional pH sensors. Process and reference electrodes measure the pH differentially with respect to a third ground electrode.

- B. The units shall include a replaceable salt bridge with large supply of buffer to extend the working life of the sensor by protecting the reference electrode from harsh process conditions.

1.5 QUALITY ASSURANCE

- A. REQUIREMENTS: Section 40 61 13 Process Control System General Provisions.
- B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials.

1.6 SUBMITTALS

- A. Submittals requirements specified in: Section 01 33 00.
- B. Product Data: For each type of device and system:
 - 1. Include product data sheets and equipment brochures showing standard products and specified accessories.
 - a. Mark data sheets to clearly show exact product and options being provided.
- C. Manufacturer's installation instructions, including mounting requirements.
- D. Operation and maintenance information.
- E. Warranty information.

1.7 PERFORMANCE REQUIREMENTS

- A. REQUIREMENTS: Section 40 70 00.
- B. OPERATING CONDITIONS: Section 40 06 30 instrument schedules.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Ph and ORP Monitoring candidate manufactures and models:
 - 1. Hach Digital pHD sc sensors
 - a. pH part number DPD1R1
 - b. ORP part number DRD1R5
 - 2. Approved equal

2.2 GENERAL

- A. pH and ORP probes shall provide analog or digital signals to the Multi-Parameter Analyzer System.
- B. Probes shall be encapsulated to protect built in preamp circuitry from moisture and humidity,
- C. Probes must be available in four mounting styles—convertible, insertion, immersion, and sanitary.

2.3 FEATURES

- A. The sensor will continuously measure pH or ORP
- B. pH Sensors
 - 1. Measuring Range: -2 to 14 pH
 - 2. Sensitivity: +/- 0.01 pH
 - 3. Stability 0.03 pH for 24 hours
 - 4. Operating Temperature
 - a. Digital Sensor: 23 to 158°F
 - b. Analog Sensor: 5 to 105°F
 - c. Immersion Sensor: 32 to 122°F
 - 5. Flow Rate: 10 ft per second maximum
 - 6. Sensor Pressure:
 - a. Digital: 100 psi at 158°F
 - b. Analog: 100 psi at 221°F
 - 7. Temperature Compensation: NTC 300-ohm thermistor for automatic temperature compensation and analyzer temperature readout
 - 8. Signal Strength shall accommodate wiring of up to 328 feet to the system analyzer
 - 9. Integral Signal Cable:
 - a. 4 conductor cable with shield and polyurethane jacket
 - b. Temperature up to 221°F
 - c. 33 ft. standard length

10. Wetted Materials shall be PEEK or PVDF with Kynar junction, glass process electrode and titanium ground electrical and Viton O ring seals.

C. ORP Sensors

1. Measuring Range: -1500 to +1500 mV

2. Sensitivity: +/- 0.5 mV

3. Stability: 2 mV per 24 hours

4. Operating Temperature

a. Digital Sensor: 23 to 158°F

b. Analog Sensor: 5 to 105°F

c. Immersion Sensor: 32 to 122°F

5. Flow Rate: 10 ft per second maximum

6. Sensor Pressure:

a. Digital: 100 psi at 158°F

b. Analog: 100 psi at 221°F

7. Temperature Compensation: NTC 300-ohm thermistor for automatic temperature compensation and analyzer temperature readout

8. Signal Strength shall accommodate wiring of up to 328 feet to the system analyzer

9. Integral Signal Cable:

a. 4 conductor cable with shield and polyurethane jacket

b. Temperature up to 221°F

c. 33 ft. standard length

10. Wetted Materials shall be PEEK or PVDF with Kynar junction, glass and platinum process electrode and titanium ground electrical and Viton O ring seals.

PART 3 EXECUTION

3.1 INSTALLATION

A. REQUIREMENTS: Section 40 70 00 and Install in accordance with manufacturer's instructions for the specified functional requirements.

- B. Install all components of chlorine monitoring system in accordance with manufactures specifications and instructions.
- C. Instruments shall be installed, calibrated and tested on site in accordance with the requirements of Section 40 61 21 and 40 61 26 and in accordance with the manufacturer's recommendations. Field calibration shall be conducted by a technical representative, factory trained and certified by the manufacturer. CONTRACTOR shall provide the services of the manufacturer's representative for a minimum of one day got the installation of the instruments and for certification of proper installation.
- D. CONTRACTOR shall provide the services of the manufacturer's representative for a minimum of one day for the calibration and testing of the instruments after certification of proper installation.
- E. In addition, the instruments shall be operationally tested in conjunction with the functional acceptance test of the complete system of Instrumentation and Controls for the completed well system.

3.2 TESTING

- A. REQUIREMENTS: Section 40 61 21.
- B. Ensure proper installation of the Ph/ORP analyzer transmitter so as to not be result in false reading due to ambient conditions or equipment at the installation site.

3.3 MANUFACTURER'S SERVICES

- A. REQUIREMENTS: Section 40 70 00 and 40 61 26
- B. The contractor shall provide for a manufacturer's representative to be onsite for 1 day during start-up for the start-up and calibration of the Ph/ORP analyzer system.

END OF SECTION

SECTION 40 75 29 - DISSOLVED AMMONIA ANALYZERS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Scope.
 - 2. Reference Standards.
 - 3. Quality Assurance.
 - 4. Submittals.
 - 5. Product Requirements.
 - 6. Installation.
 - 7. Testing.
 - 8. Manufacturer's Services.

1.2 SCOPE

- A. This Section specifies requirements for supply and installation of an Analyzer to monitor ammonium in water including testing, documenting, and start up.
- B. CONTRACTOR shall provide all components, piping, wiring, accessories and labor required for a complete, workable and integrated system.
- C. Instruments shall be mounted as shown on the plans. All metal mounting hardware shall be stainless steel.

1.3 REFERENCE STANDARDS

- A. UL – Underwriters Laboratory approved
- B. ASTM – American Society for Testing and Materials
- C. NEMA – National Electrical Manufacturer's Association
- D. NEC – National Electrical Code

1.4 MEASUREMENT METHOD

- A. The method of measuring ammonium will be by gas sensitive electrode (GSE) that uses liquid to gas- phase conversion.
 - 1. Sample is mixed with sodium hydroxide that converts all ammonium to ammonia which is expelled from the sample.
 - 2. Ammonia gas is re-dissolved in an indicator reagent, changing the pH value to produce a color change.

3. A colorimeter measures the color change of the solution and the reading is converted to ammonia concentration.

1.5 QUALITY ASSURANCE

- A. REQUIREMENTS: Section 40 61 13 Process Control System General Provisions.
- B. The manufacturer shall warranty the above specified equipment for twelve months from date of shipment to be free from defects in design workmanship or materials.

1.6 SUBMITTALS

- A. Submittals requirements specified in: Section 01 33 00 and 40 61 13.
- B. Product Data: For each type of device and system:
 1. Include product data sheets and equipment brochures showing standard products and specified accessories.
 - a. Mark data sheets to clearly show exact product and options being provided.
 2. Manufacturer's installation instructions, including mounting requirements.
 3. Operation and maintenance information.
 4. Warranty information.

1.7 PERFORMANCE REQUIREMENTS

- A. REQUIREMENTS: Section 40 70 00.
- B. OPERATING CONDITIONS: Section 40 06 30 instrument schedules.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Dissolved Ammonia Monitoring candidate manufactures and models:
 1. Hach Company - Model AMTAX sc Ammonium Analyzer
 2. Approved equal

2.2 GENERAL

- A. The Sensor shall continuously measure dissolved ammonia in the process liquid.
- B. Performance Requirements

1. Measurement Range: 0.05 to 20 mg/L
 2. Lower detection limit: 0.05 mg/L
 3. Accuracy: 3% +/- 0.05 mg/L
 4. Reproducibility: 2% \pm 0.05 mg/L
 5. Response Time: Less than 5 minutes (T90), including sample preparation (in combination with Hach Filtrax sc)
 6. Measurement Interval: 5 to 120 minutes adjustable.
- C. Environmental Requirement
1. Operating Temperature 4 to 40 degrees C
 2. Sample pH: 5.0 to 9.0
 3. Sample temperature: 0 to 40 degrees C
 4. Operating humidity 95%

2.3 FEATURES

- A. The analyzer calibrates and cleans itself automatically.
- B. The analyzer is equipped with self-diagnostic routines.
- C. The required power supply is 230 Vac/50Hz or optional 115 Vac/50-60Hz connected to a Hach model sc1000 multi-parameter universal controller.
- D. Data transmission is made with a data cable with the controller.
- E. Outputs include relay, current outputs, and bus interface via the controller.

2.4 ACCESSORIES

- A. Hach Filtrax
- B. Hach sc 1000
- C. Mounting kits for rail mounting

2.5 ELECTRICAL REQUIREMENTS

- A. The ammonia probe shall include an Integral Signal Cable available in length from 10 to 100 meters. Cable shall include an M12 5 pin connector that is compatible with the SC-1000 analyzer specified in 40 75 05.

PART 3 EXECUTION

3.1 INSTALLATION

- A. REQUIREMENTS: Section 40 70 00 and Install in accordance with manufacturer's instructions for the specified functional requirements.
- B. Install all components of chlorine monitoring system in accordance with manufactures specifications and instructions.
- C. Contractor will schedule a date and time for start-up and will have the following people present.
 - 1. General Contractor
 - 2. Electrical Contractor
 - 3. Hach Company factory trained personnel
 - 4. Owners representative
 - 5. Engineer
- D. Instruments shall be installed, calibrated and tested on site in accordance with the requirements of Section 40 61 21 and 40 61 26 and in accordance with the manufacturer's recommendations. Field calibration shall be conducted by a technical representative, factory trained and certified by the manufacturer. CONTRACTOR shall provide the services of the manufacturer's representative for a minimum of one day got the installation of the instruments and for certification of proper installation.
- E. CONTRACTOR shall provide the services of the manufacturer's representative for a minimum of one day for the calibration and testing of the instruments after certification of proper installation.
- F. In addition, the instruments shall be operationally tested in conjunction with the functional acceptance test of the complete system of Instrumentation and Controls for the completed well system.

3.2 TESTING

- A. REQUIREMENTS: Section 40 61 21.
- B. Ensure proper installation of the chlorine analyzer transmitter so as to not be result in false reading due to ambient conditions or equipment at the installation site.

3.3 MANUFACTUREER'S SERVICES

- A. REQUIREMENTS: Section 40 70 00 and 40 61 26

- B. The contractor shall provide for a manufacturer's representative to be onsite for 1 day during start-up for the start-up and calibration of the chlorine analyzer system.

END OF SECTION

SECTION 40 75 43 - DISSOLVED OXYGEN ANALYZERS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Scope.
 - 2. Reference Standards.
 - 3. Quality Assurance.
 - 4. Submittals.
 - 5. Product Requirements.
 - 6. Installation.
 - 7. Testing.
 - 8. Manufacturer's Services.

1.2 SCOPE

- A. This Section specifies requirements for supply and installation of the Luminescent Dissolved Oxygen probes and analyzers including testing, documenting, and start up.
- B. CONTRACTOR shall provide all components, piping, wiring, accessories and labor required for a complete, workable and integrated system.
- C. Probes shall be mounted as shown on the plans. All metal mounting hardware shall be stainless steel.
- D. Units to be compatible with Multi-Parameter Analyzer System specified in 40 75 05.
 - 1. Hach SC-200 or approved equal

1.3 REFERENCE STANDARDS

- A. ASTM – American Society for Testing and Materials
- B. NEMA – National Electrical Manufacturer's Association
- C. NEC – National Electrical Code
- D. UL 61010A-1
- E. CSA C22.2 No. 1010.1

1.4 MEASUREMENT METHOD

- A. The method of measuring dissolved oxygen will be a probe using luminescent sensor technology.

1. Blue LED light excites platinum based luminescent material in the probe. Red light is emitted by luminescent material with characteristics that are directly proportional to the amount of dissolved oxygen present. The red light is measured with a photo detector.
 2. Red LED light is used to zero the instrument between measuring cycles
- B. Other methods of dissolved oxygen measurement such as galvanic, polarographic, or luminescent measurements using Ruthenium are not acceptable.
 - C. Other probes that require membranes, electrolytes, or electrodes are not acceptable.

1.5 QUALITY ASSURANCE

- A. REQUIREMENTS: Section 40 61 13 Process Control System General Provisions.
- B. The manufacturer shall warranty the above specified equipment for thirty-six months from date of shipment.

1.6 SUBMITTALS

- A. Submittals requirements specified in: Section 01 33 00 and 40 61 13.
- B. Product Data: For each type of device and system:
 1. Include product data sheets and equipment brochures showing standard products and specified accessories.
 - a. Mark data sheets to clearly show exact product and options being provided
- C. Manufacturer's installation instructions, including mounting requirements.
- D. Operation and maintenance information.
- E. Warranty information.

1.7 PERFORMANCE REQUIREMENTS

- A. REQUIREMENTS: Section 40 70 00.
- B. OPERATING CONDITIONS: Section 40 06 30 instrument schedules.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Dissolved Oxygen Monitoring candidate manufactures and models:

1. Hach LDO Model 2 Probe - Dissolved Oxygen sensors
2. Hach SC1000 transmitter
3. Approved equal

2.2 GENERAL

- A. Dissolved Oxygen probes shall provide digital signals to the Multi-Parameter Analyzer System.
- B. The DO sensor is to be coated with a luminescent material. Blue light from an LED is transmitted to the sensor surface. The blue light excites the luminescent material. As the material relaxes it emits red light. The time it takes for the red light to be emitted is measured. Between the flashes of blue light, a red LED is flashed on the sensor and used as an internal reference. Increased oxygen in the sample decreases the time it takes for the red light to be emitted. The time measurements correlate to the oxygen concentration.
- C. DO Probes shall be equipped with a replaceable sensor cap. Caps shall have a 2-year life expectancy

2.3 FEATURES

- A. The sensor will continuously measure Dissolved Oxygen.
- B. The DO sensor is to be coated with a luminescent material. Blue light from an LED is transmitted to the sensor surface. The blue light excites the luminescent material. As the material relaxes it emits red light. The time it takes for the red light to be emitted is measured. Between the flashes of blue light, a red LED is flashed on the sensor and used as an internal reference. Increased oxygen in the sample decreases the time it takes for the red light to be emitted. The time measurements correlate to the oxygen concentration
- C. Calibration shall be maintained for the life of the probe. Units requiring period calibration are not be acceptable
- D. Probes shall communicate with the SC-1000 analyzer to notify operations staff when cleaning is required.
- E. Dissolved Oxygen Sensors Characteristics
 1. Measurement range: 0.01 to 20.00 mg/L
 2. Resolution: 0.01 mg/L
 3. Accuracy

- a. Less than 5 ppm: ± 0.1 ppm
 - b. Greater than 5 ppm: ± 0.2 ppm
- 4. Repeatability: ± 0.1 ppm
- 5. Response Time:
 - a. Less than 40 seconds to 90% at 20 °C
 - b. Less than 60 seconds to 95% at 20 °C
- 6. Temperature sensor: PT100 integrated, external sensor
- 7. Temperature range: 0 to 50 °C
- 8. Temperature accuracy: $\pm 0.2^{\circ}\text{C}$
- 9. Optional Self-cleaning wiper shall be included for open tank applications

2.4 CERTIFICATIONS

- A. General Purpose CSA/CSANRTL and FM when used with an approved controller.
- B. Class 1, Div 2 Groups A thru D CSA/CSANRTL and FM when used with an approved controller.

2.5 OPERATIONAL CRITERIA

- A. Operating temperature: 0 to 50 °C
- B. Relative humidity: 95%, non-condensing
- C. Immersion depth: 15 meters (50 ft.), maximum
- D. Immersion pressure: 345 kPa, maximum
- E. Sample pH range: 0.0 to 12.0
- F. Distance, analyzer to sensor: 1000 meters, maximum

2.6 ELECTRICAL REQUIREMENTS

- A. The DO probes shall include an Integral Signal Cable available in length from 10 to 100 meters. Cable shall include an M12 5 pin connector that is compatible with the SC-1000 analyzer specified in 40 75 05

2.7 ACCESSORIES

- A. SC-1000 controller with 8 channels
- B. Plug in extension cables to extend the distance between the sensor and controller up to 985 ft. (10 m).

- C. Junction box for extension cables for lengths greater than 100 m.
- D. Extension cables
- E. Pole mount kit
- F. Ball float mount kit
- G. In-line union mount kit
- H. Flow cell mount kit
- I. Economy probe mounting hardware
- J. Air blast cleaning assembly

2.8 MOUNTING KITS & REQUIREMENTS

- A. Units shall be available with optional mounting hardware to provide for the following installation options.
- B. Mounting:
 - 1. The sensor must be mounted to a Hach mounting assembly directly in the solution to be measured.
 - 2. Pole or ball-float mount
- C. Distance, analyzer to sensor: 300 meters, maximum

PART 3 EXECUTION

3.1 INSTALLATION

- A. REQUIREMENTS: Section 40 70 00 and Install in accordance with manufacturer's instructions for the specified functional requirements.
- B. Install all components of DO monitoring system in accordance with manufactures specifications and instructions.
- C. Contractor will schedule a date and time for start-up and will have the following people present.
 - 1. General Contractor
 - 2. Electrical Contractor
 - 3. Hach Company factory trained personnel

- 4. Owners representative
- 5. Engineer

- D. Instruments shall be installed, calibrated and tested on site in accordance with the requirements of Section 40 61 21 and 40 61 26 and in accordance with the manufacturer's recommendations. Field calibration shall be conducted by a technical representative, factory trained and certified by the manufacturer.

- E. CONTRACTOR shall provide the services of the manufacturer's representative for a minimum of one day for the calibration and testing of the instruments after certification of proper installation.

- F. In addition, the instruments shall be operationally tested in conjunction with the functional acceptance test of the complete system of Instrumentation and Controls for the completed well system.

3.2 TESTING

- A. REQUIREMENTS: Section 40 61 21.

- B. Ensure proper installation of the dissolved oxygen analyzer transmitter so as to not be result in false reading due to ambient conditions or equipment at the installation site.

3.3 MANUFACTURER'S SERVICES

- A. REQUIREMENTS: Section 40 70 00 and 40 61 26

- B. The contractor shall provide for a manufacturer's representative to be onsite for 1 day during start-up for the start-up and calibration of the dissolved oxygen analyzer system.

END OF SECTION

SECTION 40 75 56 - SUSPENDED SOLIDS – SLUDGE DENSITY ANALYZERS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Scope
 - 2. Reference Standards
 - 3. Quality Assurance.
 - 4. Submittals.
 - 5. Product Requirements.
 - 6. Installation.
 - 7. Testing.
 - 8. Manufacturer's Services.

1.2 SCOPE

- A. This Section specifies requirements for supply and installation of the TSS probes and analyzers including testing, documenting, and start up.
- B. CONTRACTOR shall provide all components, piping, wiring, accessories and labor required for a complete, workable and integrated system.
- C. Probes shall be mounted as shown on the plans. All metal mounting hardware shall be stainless steel.
- D. Units to be compatible with Multi-Parameter Analyzer System specified in 40 75 05.
 - 1. Hach SC-1000 or approved equal

1.3 REFERENCE STANDARDS

- A. UL – Underwriters Laboratory approved
- B. ASTM – American Society for Testing and Materials
- C. NEMA – National Electrical Manufacturer's Association
- D. NEC – National Electrical Code

1.4 MEASUREMENT METHOD

- A. The method of measuring turbidity and suspended solids will be with a dual-beam infrared/scattered light photometer. LED light source transmits light at 45 degrees to the sensor face.

1. Nephelometric photoreceptors will detect scattered light at 90 degrees to the transmitted beam for turbidity.
2. Back-scatter photoreceptors will detect scattered light at 140 degrees to the transmitted beam for suspended solids.

1.5 QUALITY ASSURANCE

- A. REQUIREMENTS: Section 40 61 13 Process Control System General Provisions
- B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials.

1.6 SUBMITTALS

- A. Submittals requirements specified in: Section 01 33 00.
- B. Product Data: For each type of device and system:
 1. Include product data sheets and equipment brochures showing standard products and specified accessories.
 - a. Mark data sheets to clearly show exact product and options being provided
- C. Manufacturer's installation instructions, including mounting requirements.
- D. Operation and maintenance information.
- E. Warranty information.

1.7 PERFORMANCE REQUIREMENTS

- A. REQUIREMENTS: Section 40 70 00.
- B. OPERATING CONDITIONS: Section 40 06 30 instrument schedules.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Turbidity and Suspended Solids Monitoring candidate manufactures and models:
 1. Hach Solitax t-line sc Turbidity and Suspended Solids sensors:
 - a. Part Number DPD1Pa
 2. Approved equal

2.2 GENERAL

- A. Turbidity and Suspended Solids probes shall provide analog or digital signals to the Multi-Parameter Analyzer System specified in Section 40 75 05
- B. The SOLITAX Turbidity and Suspended Solids Sensor consists of a sensor contained in stainless steel or PVC, depending on model, with a silicon wiper blade and integral cable. Built in predictive diagnostics capability which increases available operation time.
- C. Probes must be available in four mounting styles—convertible, insertion, immersion, and sanitary.

2.3 FEATURES

- A. The sensor shall continuously measure Turbidity or Suspended solids in the process liquid.
- B. Performance Requirements
 - 1. Measurements Range
 - a. Turbidity: 0.001 to 4000 NTU
 - b. Suspended solids: 0.001 mg/l to 50 g/L
 - 2. Accuracy
 - a. Turbidity: Less than 1% of reading or ± 0.001 NTU
 - b. Suspended solids: Less than 3% of reading
 - 3. Repeatability
 - a. Turbidity: Less than 1% of reading
 - b. Suspended solids: Less than 3% of reading
 - 4. Detection Limit
 - a. Turbidity: 0.001 NTU
 - b. Suspended solids: 0.001 mg/L
 - 5. Response time
 - a. 1 second
 - 6. Signal Averaging Time
 - a. User selectable from 1 to 300 seconds.

7. Units of Measure

- a. Turbidity - User Selectable for NTU, FNU, EBD, FTU or YE/F
 - b. Suspended Solids – User Selectable for g/L, mg/L, ppm or % solids
8. When connected to a multi-parameter digital controller the overall status of the instrument performance is displayed as a percentage value via a measurement indicator
 9. When connected to a multi-parameter digital controller the overall time remaining until maintenance tasks are due is displayed in days

C. Environmental Requirement

1. Sample flow velocity: 3 m/s (9.8 ft./s) maximum
2. Sample pressure: 6 bar (87 psi) maximum
3. Sample temperature: 0 to 40 degrees C
4. Operating temperature: 0 to 40 degrees C

2.4 ELECTRICAL REQUIREMENTS

- A. Transmitter and probe(s) for the TSS system shall meet/provide following standards/requirements:
 1. Integral Signal Cable:
 - a. 4 conductor cable with shield and polyurethane jacket
 - b. Temperature up to 221°F
 - c. 33 ft. standard length
 - d. Quick connectors for ease of field service
 2. CE Certified to EN 61326-1

2.5 ACCESSORIES

- A. Calibration kit
- B. Wiper blades
- C. Sun shield for controller
- D. Installation:
 1. Fixed point installation kit for immersion
 2. Insertion mounting kit
 3. Sensor adapters

- 4. Handrail mounting kit
- E. Extension cables

PART 3 EXECUTION

3.1 INSTALLATION

- A. REQUIREMENTS: Section 40 70 00 and Install in accordance with manufacturer's instructions for the specified functional requirements.
- B. Contractor will install the analyzer in strict accordance with the manufacturer's instructions and recommendation.
- C. Instruments shall be installed, calibrated and tested on site in accordance with the requirements of Section 40 61 21 and 40 61 26 and in accordance with the manufacturer's recommendations. Field calibration shall be conducted by a technical representative, factory trained and certified by the manufacturer. CONTRACTOR shall provide the services of the manufacturer's representative for a minimum of one day got the installation of the instruments and for certification of proper installation.
- D. CONTRACTOR shall provide the services of the manufacturer's representative for a minimum of one day for the calibration and testing of the instruments after certification of proper installation.
- E. In addition, the instruments shall be operationally tested in conjunction with the functional acceptance test of the complete system of Instrumentation and Controls for the completed well system.

3.2 TESTING

- A. REQUIREMENTS: Section 40 61 21.
- B. Ensure proper installation of the sludge density analyzer transmitter so as to not be result in false reading due to ambient conditions or equipment at the installation site.

3.3 MANUFACTURER'S SERVICES

- A. REQUIREMENTS: Section 40 70 00 and 40 61 26
- B. The contractor shall provide for a manufacturer's representative to be onsite for 1 day during start-up for the start-up and calibration of the sludge density analyzer system.

END OF SECTION

SECTION 40 78 16

INDICATING LIGHTS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Scope
 - 2. Reference Standards
 - 3. Quality Assurance.
 - 4. Submittals.
 - 5. Product Requirements.
 - 6. Installation.
 - 7. Testing.

1.2 SCOPE

- A. This Section specifies requirements for supply and installation of indicating lights

1.3 REFERENCE STANDARDS

- A. ASTM – American Society for Testing and Materials
- B. NEMA – National Electrical Manufacturer’s Association
- C. NEC – National Electrical Code
- D. NFPA No. 70, NEC - National Electrical Code
- E. NFPA No. 79, Electrical Standard for Industrial Machinery.
- F. ISA – Instrumentation, Systems, and Automation Society.
- G. ICS-1 – General Standards for Industrial Control and System
- H. ICS-2 – Standards for Industrial Control Devices, Controllers and
- I. ICS-3 – Industrial Systems.
- J. UL – Underwriter’s Laboratory UL (Note: Other Nationally Recognized Testing Laboratories [NRTL], such as ETL, may be used in lieu of UL.)
 - 1. Standard 508 (Industrial Control Panels for General Use).

2. Standard 698 (Industrial Control Panels Relating to Hazardous (Classified) Locations)
3. Standard 913 (Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations)

K. NETA – National Electrical Testing Association.

1.4 QUALITY ASSURANCE

- A. REQUIREMENTS: Section 40 67 00 Control System Equipment Panels and Racks and 40 61 13 Process Control System General Provisions
- B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials

1.5 SUBMITTALS

- A. Submittals requirements specified in: Section 01 33 00.
- B. Product Data: For each type of device and system:
 1. Include product data sheets and equipment brochures showing standard products and specified accessories.
 - a. Mark data sheets to clearly show exact product and options being provided
- C. Manufacturer's installation instructions.
- D. Operation and Maintenance Manual if applicable.

PART 2 PRODUCTS

2.1 GENERAL

- A. Pilot Devices shall be provided as a Panel Assembly component where indicated, specified, or required to perform the functional requirements of the System, as specified. All Pilot Devices shall meet the following minimum specifications, unless otherwise noted.
 1. All pilot devices shall be of heavy-duty, metallic, type 4/13, watertight/oiltight construction. Units shall mount through a 30.5 mm round hole.
 2. All pilot devices shall have custom legends as shown. Legends shall be black with white letters, and letter height shall be minimum 3/16-inch high characters.

3. All button and lens colors shall be as shown. Color code is as follows:
 4. A = Amber, B = Blue, G = Green, R = Red, Y = Yellow, W = White
 5. All pilot devices shall be equipped with a sufficient number of contact blocks to accomplish the switching functions specified.
- B. Indicating lights shall meet the following minimum specifications, unless otherwise noted.
1. All indicating lights shall be full voltage type with LED lamps. Units shall be rated for the voltage shown.
 2. All indicating lights shall be "push-to-test" type.
 3. All indicating light lenses shall be plastic.
- C. Candidate manufacturers and models include the following
1. Allen-Bradley, Bulletin 800T.
 2. Square D. Co., Type T.A
 3. Approved Equal

PART 3 EXECUTION

3.1 INSTALLATION

- A. REQUIREMENTS: Section 40 70 00 and Install in accordance with manufacturer's instructions for the specified functional requirements.
- B. Install Operator Interface panel per manufacturer's instructions.
- C. The screens for the operator interface shall copy the layout of the existing operator interface screens within the system. The City shall provide access to those stations for preview. The City may provide a copy of the current programming of one of the stations.

3.2 TESTING

- A. REQUIREMENTS: Section 40 61 21.
- B. Ensure proper installation per manufacturers recommendations

3.3 MANUFACTURER'S SERVICES

- A. REQUIREMENTS: Section 40 70 00 and 40 61 26

END OF SECTION

SECTION 40 78 19
SWITCHES AND PUSH BUTTONS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Scope
 - 2. Reference Standards
 - 3. Quality Assurance.
 - 4. Submittals.
 - 5. Product Requirements.
 - 6. Installation.
 - 7. Testing.

1.2 SCOPE

- A. This Section specifies requirements for supply and installation of push buttons and indicating lights

1.3 REFERENCE STANDARDS

- A. ASTM – American Society for Testing and Materials
- B. NEMA – National Electrical Manufacturer’s Association
- C. NEC – National Electrical Code
- D. NFPA No. 70, NEC - National Electrical Code
- E. NFPA No. 79, Electrical Standard for Industrial Machinery.
- F. ISA – Instrumentation, Systems, and Automation Society.
- G. ICS-1 – General Standards for Industrial Control and System
- H. ICS-2 – Standards for Industrial Control Devices, Controllers and
- I. ICS-3 – Industrial Systems.
- J. UL – Underwriter’s Laboratory UL (Note: Other Nationally Recognized Testing Laboratories [NRTL], such as ETL, may be used in lieu of UL.)

1. Standard 508 (Industrial Control Panels for General Use).
 2. Standard 698 (Industrial Control Panels Relating to Hazardous (Classified) Locations)
 3. Standard 913 (Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations)
- K. NETA – National Electrical Testing Association.

1.4 QUALITY ASSURANCE

- A. REQUIREMENTS: Section 40 61 13 Process Control System General Provisions
- B. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials

1.5 SUBMITTALS

- A. Submittals requirements specified in: Section 01 33 00.
- B. Product Data: For each type of device and system:
 1. Include product data sheets and equipment brochures showing standard products and specified accessories.
 - a. Mark data sheets to clearly show exact product and options being provided
- C. Manufacturer's installation instructions.
- D. Operation and Maintenance Manual if applicable.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Candidate manufacturers and models include the following
 1. Allen-Bradley, Bulletin 800T.
 2. Square D. Co., Type T.A
 3. Approved Equal

2.2 GENERAL

- A. Pilot Devices shall be provided as a Panel Assembly component where indicated, specified, or required to perform the functional requirements of the System, as specified. All Pilot Devices shall meet the following minimum specifications, unless otherwise noted.
 - 1. All pilot devices shall be of heavy-duty, metallic, type 4/13, watertight/oiltight construction. Units shall mount through a 30.5 mm round hole.
 - 2. All pilot devices shall have custom legends as shown. Legends shall be black with white letters, and letter height shall be minimum 3/16-inch high characters.
 - 3. All button and lens colors shall be as shown. Color code is as follows:
 - 4. A = Amber, B = Blue, G = Green, R = Red, Y = Yellow, W = White
 - 5. All pilot devices shall be equipped with a sufficient number of contact blocks to accomplish the switching functions specified.
 - 6. All selector switches shall be knob type.
 - 7. Illuminated selector switches shall be 120-volt AC, full voltage type with LED lamps where specified.
- B. Pushbuttons shall meet the following minimum specifications, unless otherwise noted.
 - 1. All pushbuttons shall be flush type.
 - 2. All emergency stop pushbuttons shall be red colored, jumbo mushroom head, push operate / twist release type, with one form C contact, minimum. Emergency stop pushbutton legends shall be red with white letters, and letter height shall be minimum 3/16-inch high characters.
 - 3. Unless otherwise shown, all other pushbuttons shall be black in color.
 - 4. Illuminated push buttons shall be 120-volt AC, full voltage type with LED lamps where specified.
- C. Indicating lights shall meet the following minimum specifications, unless otherwise noted.
 - 1. All indicating lights shall be full voltage type with LED lamps. Units shall be rated for the voltage shown.
 - 2. All indicating lights shall be "push-to-test" type.

3. All indicating light lenses shall be plastic.

PART 3 EXECUTION

3.1 INSTALLATION

- A. REQUIREMENTS: Section 40 61 13 and Install in accordance with manufacturer's instructions for the specified functional requirements.
- B. Install all components in accordance with manufactures specifications and instructions.
- C. Components shall be installed and tested on site in accordance with the requirements of Section 40 61 13 and in accordance with the manufacturer's recommendations.

3.2 TESTING

- A. REQUIREMENTS: Section 40 61 21.
- B. Ensure proper installation per manufacturers recommendations

END OF SECTION

SECTION 40 78 53 - RELAYS/TERMINAL BLOCKS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Scope
 - 2. Quality Assurance.
 - 3. Reference Standards
 - 4. Submittals.
 - 5. Performance Requirements.
 - 6. Products.
 - 7. Installation.
 - 8. Testing.

1.2 SCOPE

- A. This section specifies requirements for Auxiliary Relays used for control signal isolation and Terminal Blocks used for control conductor termination installed in control panels. And junction boxes.

1.3 REFERENCE STANDARDS

- A. ASTM – American Society for Testing and Materials
- B. NEMA – National Electrical Manufacturer’s Association
- C. NEC – National Electrical Code
- D. NFPA No. 70, NEC - National Electrical Code
- E. NFPA No. 79, Electrical Standard for Industrial Machinery.
- F. ICS-1 – General Standards for Industrial Control and System
- G. ICS-2 – Standards for Industrial Control Devices, Controllers and
- H. ICS-3 – Industrial Systems.
- I. UL – Underwriter’s Laboratory UL (Note: Other Nationally Recognized Testing Laboratories [NRTL], such as ETL, may be used in lieu of UL.)
 - 1. Standard 508 (Industrial Control Panels for General Use).

2. Standard 698 (Industrial Control Panels Relating to Hazardous (Classified) Locations)
 3. Standard 913 (Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations)
- J. NETA – National Electrical Testing Association.

1.4 QUALITY ASSURANCE

- A. REQUIREMENTS: Section 40 61 13 Process Control System General Provisions
- B. The manufacturer shall warranty the specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials.

1.5 SUBMITTALS

- A. Submittals requirements specified in: Section 01 33 00.
- B. Product Data: For each type of device and system:
1. Include product data sheets and equipment brochures showing standard products and specified accessories.
 - a. Mark data sheets to clearly show exact product and options being provided
- C. Manufacturer's installation instructions.
- D. Operation and Maintenance Manual if applicable.

1.6 PERFORMANCE REQUIREMENTS

- A. RELAYS:
1. OPERATING CONDITIONS: Environmental and Hazardous Location ratings shall be determined by the ratings of the control apparatus for the installation where used. Where Relay does not meet these requirements a suitable enclosure shall be provided to meet the requirements.
- B. TERMINAL BLOCKS:
1. OPERATING CONDITIONS: Environmental and Hazardous Location ratings shall be determined by the ratings of the control apparatus for the installation where used. Where Terminal block does not meet these requirements a suitable enclosure must be provided that meets the requirements.

2. Terminal block shall be rated for the Voltage, Amperage, and Conductor size for the application requirements.

PART 2 PRODUCTS

2.1 RELAY CANDIDATE MANUFACTURERS

- A. Power and Master Control Relays
 1. Allen Bradley 700P/PK
 2. Square D 8501X/XM
 3. Approved equal by Project Engineer
- B. Plug-in Interposing/Auxiliary Relays
 1. Idec RR/RJ Series
 2. Allen Bradley, Bulletin 700-HA/700-HB/700-HK
 3. Phoenix PLC-RIF/RSC
 4. Approved equal by Project Engineer
- C. Terminal Block Style Interposing/Auxiliary Relays
 1. Idec RV8H series
 2. Allen Bradley, Bulletin 700-HLT
 3. Phoenix DEK
 4. Approved equal by Project Engineer
- D. Timing Relays for Auxiliary Control
 1. Allen Bradley 700-FS/HR
 2. Approved equal by Project Engineer
- E. Submersible Pump Thermal/Leakage Relay
 1. Flygt Panel Mountable Mini CAS 120
 2. Approved equal by Project Engineer

2.2 RELAYS GENERAL

- A. Relay contact ratings shall be evaluated for rated Voltage and Amperage per application needs to obtain minimum operational cycles:
 1. Power and Master Control Relays
 - a. 10,000,000 mechanical operations and 1,000,000 electrical operations at rated load.

2. Plug-in Interposing/Auxiliary Relays
 - a. 10,000,000 mechanical operations and 1,000,000 electrical operations at rated load.
 3. Terminal Block Style Interposing/Auxiliary Relays
 - a. 10,000,000 mechanical operations and 1,000,000 electrical operations at rated load.
 4. Timing Relays for Auxiliary Control
 - a. 10,000,000 mechanical operations and 1,000,000 electrical operations at rated load.
 5. Submersible Pump Thermal/Leakage Relay
 - a. 10,000,000 mechanical operations and 1,000,000 electrical operations at rated load.
- B. Plug-in and Terminal Block Style Interposing/Auxiliary relays shall be equipped with a push-to-test button and indicator light.
- C. Coil voltage shall match the control circuit voltage.

PART 3 EXECUTION

3.1 INSTALLATION

- A. REQUIREMENTS: Section 40 61 13 and install in accordance with manufacturer's instructions for the specified functional requirements.
- B. Components shall be installed and tested on site in accordance with the requirements of Section 40 61 13 and in accordance with the manufacturer's recommendations.

3.2 TESTING

- A. REQUIREMENTS: Section 40 61 21.
- B. Relays shall be tested in accordance with the requirements of Section 40 61 21 and in accordance with the manufacturer's recommendations. Field calibration shall be conducted by a technical representative, factory trained and certified by the manufacturer.

- C. In addition, the units shall be operationally tested in conjunction with the functional acceptance test of the complete system of Instrumentation and Controls for the completed system.

END OF SECTION

SECTION 40 78 56 - ISOLATORS, INTRINSICALLY-SAFE BARRIERS, AND SURGE SUPPRESSORS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Scope
 - 2. Reference Standards
 - 3. Quality Assurance.
 - 4. Submittals.
 - 5. Performance requirements
 - 6. Products Requirements.
 - 7. Installation.
 - 8. Testing.
 - 9. Manufacturer's Services.

1.2 SCOPE

- A. This Section covers the requirements for signal isolators, intrinsically safe barriers, intrinsically safe relays and surge suppressors.

1.3 REFERENCE STANDARDS

- A. ASTM – American Society for Testing and Materials
- B. NEMA – National Electrical Manufacturer's Association
- C. NEC – National Electrical Code
- D. NFPA No. 70, NEC - National Electrical Code
- E. NFPA No. 79, Electrical Standard for Industrial Machinery.
- F. ICS-1 – General Standards for Industrial Control and System
- G. ICS-2 – Standards for Industrial Control Devices, Controllers and
- H. ICS-3 – Industrial Systems.
- I. UL – Underwriter's Laboratory UL (Note: Other Nationally Recognized Testing Laboratories [NRTL], such as ETL, may be used in lieu of UL.)
 - 1. Standard 508 (Industrial Control Panels for General Use).

2. Standard 698 (Industrial Control Panels Relating to Hazardous (Classified) Locations)
 3. Standard 913 (Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations)
- J. NETA – National Electrical Testing Association.

1.4 QUALITY ASSURANCE

- A. REQUIREMENTS: Section 40 61 13 Process Control System General Provisions
- B. The manufacturer shall warranty the specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials.

1.5 SUBMITTALS

- A. Comply with applicable Submittal requirements specified in: Section 01 33 00.
- B. Product Data: For each type of device and system:
 1. Include product data sheets and equipment brochures showing standard products and specified accessories.
 - a. Mark data sheets to clearly show exact product and options being provided
- C. Manufacturer's installation instructions.
- D. Operation and Maintenance Manual

1.6 PERFORMANCE REQUIREMENTS

- A. REQUIREMENTS: Section 40 70 00.
- B. OPERATING CONDITIONS: Section 40 06 70 instrument schedules.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. MTL Series 7700.
- B. Phoenix Contact.
- C. Weidmuller.
- D. Diversified Electronics.
- E. Pepperl + Fuchs
- F. Approved equal

2.2 GENERAL

- A. Intrinsically Safe Barrier specified is to comply with Section 40 70 00 requirements as well as those specified herein.
- B. Intrinsically safe devices (barriers/relays) shall be provided as a Panel Assembly component where indicated, specified, or required to perform the functional requirements of the System, as specified.
- C. General: All intrinsically safe devices shall be installed in accordance with applicable section of the NEC. Intrinsically safe wiring shall be separated from non-intrinsically safe wiring by at least 2-inches or by other means acceptable per the NEC. Intrinsically safe wiring must be identified, either by color coding, with light blue jacketed cable, or by tagging, at regular intervals, up to 25 feet. Non-intrinsically safe wiring shall not be connected to intrinsically safe terminations of intrinsically safe devices.

2.3 INTRINSICALLY SAFE BARRIERS:

- A. Transformer isolated barrier
 - 1. Containing a transformer to provide:
 - a. Complete isolation between safe and hazardous areas for loop powered devices.
 - b. 3 way isolation between safe area, hazardous area and power supply powered devices.
 - c. Resistor for current limitation.
 - d. Fuses for short circuit protection.
 - e. Provide barriers with pluggable connectors that are coded for easy replacement.
 - f. Transmission error shall be less than or equal to 0.1 percent of full scale.
 - g. DIN rail mounted on 35 millimeters DIN rail
 - h. Approvals:
 - 1) FM.
 - 2) UL 913.
- B. Intrinsically safe barriers shall conform to UL-913 or FM-3610 standards as approved by ETL, FM, MSHA, or UL features

1. Provide and install intrinsically safe barriers/relays acceptable for use in Class I, Division 2, Group D, as required or indicated.
2. Intrinsically safe barriers shall meet the following minimum specifications, unless otherwise noted.
 - a. Barrier designed to be used with 4-20 ma DC signals.
 - b. Solid State construction
 - c. DIN rail mounted.
 - d. FM approved
3. Transmitter and converters for use with 4 to 20 milliamperes signals without Hart® communications capability:
 - a. Designed and approved for use with 4 to 20 milliamperes analog signals.
 - b. Designed for powering 2 and/or 3 wire transmitters in hazardous locations and repeating and/or generating the current to the safe area.
 - c. Supply voltage: 20 to 30 VDC.
4. Transmitter and converters for use with 4 to 20 milliamperes signals with Hart® communications capability:
 - a. Designed and approved for use with 4 to 20 milliamperes analog signals.
 - b. Designed for powering 2 and/or 3 wire transmitters in hazardous locations and repeating and/or generating the current to the safe area.
 - c. Transfer digital signals from the hazardous area to the safe area.
 - d. Complete bi-directional communication between a smart transmitter located in the field and the suitable equipment located in the safe area.
 - e. Supply voltage: 20 to 30 VDC.

2.4 INTRINSICALLY SAFE RELAYS

- A. Intrinsically safe relays shall be fixed sensitivity type U/L approved for use with a remote pilot device (dry contact) located in Hazardous (Classified) areas.
 1. Provide and install intrinsically safe barriers/relays acceptable for use in Class I, Division 1, Group C or D, as required or indicated.
 - a. Designed and approved for use with discrete inputs.
 - b. Supply power: 20 to 30 VDC.
 - c. Output to track input.

- d. LED in the cover to indicate the status of the input.
- e. Selector switch to change the logic of the input.
- f. Input: Dry contact.
- g. Output: SPDT relay.

2.5 SURGE PROTECTION DEVICES

1. Control panel power:

a. 120-volt control power source: Non-UPS powered:

1) Provide surge protection device (SPD) for panel power entrances:

- a) Nominal 120 VAC with a nominal clamping voltage of 200 volts.
- b) Non-faulting and non-interrupting design.
- c) A response time of not more than 5 nanoseconds.

2) Control panel power system level protection, non-UPS powered:

- a) Design to withstand a maximum 10 kA test current of a 8/20 μ s waveform according to IEEE C62.41.1 Category C Area.
- b) For panels receiving power at 120 VAC, provide surge protection at secondary of main circuit breaker.
- c) Provide both normal mode noise protection (line to neutral) and common mode (neutral to ground) surge protection.
- d) DIN rail mounting.
- e) Attach wiring to the SPD by means of a screw type cable-clamping terminal block:
 - (1) Gas-tight connections.
 - (2) The terminal block: Fabricated of non-ferrous, non-corrosive materials.
- f) Visual status indication of MOV status on the input and output circuits.
- g) Dry contact rated for at least 250 VAC, 1 Amp for remote status indication.
- h) Meeting the following requirements:
 - (1) Response time: Less than or equal to 100 ns.

- (2) Attenuation: Greater than or equal to -40 dB at 100 kilovolt-hertz as determined by a standard 50 ohms insertion test.
 - (3) Safety approvals:
 - (a) UL 1283 (EMI/RFI Filter).
 - (b) UL 1449 2nd Edition.
 - i) Manufacturer: One of the following or equal:
 - (1) Phoenix Contact type SFP TVSS/Filter.
 - (2) Liebert Accuvar series.
 - (3) Islatrol.
- b. 120-volt control power source: UPS powered.
 - 1) Provide surge protection on the control power source at each panel containing power supplies, or electronic components including PLCs, I/O, HMI, and digital meters.
 - 2) Location:
 - a) For panels with a UPS, install surge protection ahead of UPS and maintenance bypass switch.
 - (1) Surge protection is not required for 120 VAC circuits that are only used for panel lights and receptacles.
 - b) For panels receiving power at 480 VAC, provide surge protection on the 120 VAC control power transformer secondary.
 - 3) MCOV: 150 VAC.
 - 4) Surge capability (8/20 microsecond wave): 10 kA.
 - 5) Peak let-through: 620V L-N, 850V L-G.
 - 6) Manufacturer: One of the following or equal:
 - a) Phoenix Contact Plugtrab PT series
 - b) MTL Surge Technologies MA15 series
- 2. Instrument, data and signal line protectors (traditional I/O) – panel mounted:
 - a. Surge protection minimum requirements: Withstand a 10 kA test current of a 8/20 μ s waveform in accordance with IEEE C62.41.1 Category C Area.

- b. DIN rail mounting on 35 millimeters rail (except field mounted SPDs).
- c. SPDs consisting of 2 parts:
 - 1) A base terminal block.
 - 2) A plug protection module:
 - a) Replacing a plug shall not require the removal of any wires nor interrupt the signal.
 - b) Base and plug coded to accept only the correct voltage plug.
- d. SPD Manufacturer: One of the following or equal:
 - 1) Phoenix Contact Plugtrab Series.
 - 2) Bournes Series 1800.
- 3. Instrument, data and signal line protectors (traditional I/O)– field mounted:
 - a. Surge protection minimum requirements: Withstand a minimum 10 kA test current of a 8/20 μ s waveform in accordance with IEEE C62.41.1 Category C Area.
 - b. Manufacturer: One of the following or equal:
 - 1) Plugtrab PT Series
 - 2) MTL TP48 Series.

2.6 SIGNAL ISOLATORS AND CONVERTERS

- A. Furnish signal isolators that provide complete isolation of input, output, and power input:
 - 1. Minimum isolation level: 1.5 kilovolts AC/50 hertz for at least 1 minute.
 - 2. Independently adjustable span and zero.
 - 3. Accuracy including linearity and hysteresis within 0.1 percent max at 25 degrees Celsius.
 - 4. Operating temperature: 0 degrees Celsius to 55 degrees Celsius.
 - 5. Supply power: 9 to 30 VDC.
 - 6. Output capable of driving loads up to 500 ohms

7. Field selectable for current or voltage input and current or voltage output
 - a. 4-20 mA input – 1 to 5 VDC out
 - b. 1 to 5 VDC input - 4-20 mA out
 - c. 0 – 10 VDC input – 0-20 mA out
 - d. 0-20 mA input – 0-10 VDC out
 8. Ambient temperature range: -20 degrees Celsius to +65 degrees Celsius.
- B. Manufacturer: One of the following or equal:
1. Phoenix Contact MCR Series.
 2. Acromag 1500, 600T, 800T, Flat Pack or ACR Series.
 3. Action Instruments Q500 Series or Ultra SlimPakII.
 4. AGM electronics Model TA-4000.

PART 3 EXECUTION

3.1 INSTALLATION

- A. REQUIREMENTS: Section 40 61 13 and Install in accordance with manufacturer's instructions for the specified functional requirements.
- B. Barriers shall be installed, calibrated and tested on site in accordance with the requirements of Section 40 61 21 and 40 61 26 and in accordance with the manufacturer's recommendations.
- C. Install Barriers, Isolators and surge suppressors per manufacturer's instructions.

3.2 TESTING

- A. REQUIREMENTS: Section 40 61 21
- B. Ensure proper installation per manufacturers recommendations
- C. In addition, the devices shall be operationally tested in conjunction with the functional acceptance test of the complete system of Instrumentation and Controls for the completed well system.

END OF SECTION

SECTION 40 78 59

POWER SUPPLIES

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Scope.
 - 2. Reference Standards.
 - 3. Quality Assurance.
 - 4. Submittals.
 - 5. Performance Requirements.
 - 6. Products Requirements.
 - 7. Installation.
 - 8. Testing.

1.2 SCOPE

- A. This section specifies requirements for Panel mounted 120 Vac input, 120 Vac and 24 Vdc outputs are specified herein or shown on the drawings.
- B. Comply with the specified products in Sections 40 67 16, 40 67 19, 40 78 00 and 40 67 63. Panels that do not comply with the specified products and specified logic method, hardwired or PLC logic, shall not be accepted. Cost to retrofit the panel as specified shall be borne by the panel supplier. Corrections or modifications to UL 508A Industrial Control Panels shall be transported to the panel supplier's facility for corrections, testing, relabeling and inspection.
- C. Field modifications require a UL inspector site inspection for approval of panel corrections and to re-label the panel after the field modifications are completed.
- D. Refer to Local Control Panels - Section 26 27 16 that specifies requirements for manufacturer, vendor, and Contractor provided panels that include motor controllers, combination motor starters, control devices, and logic devices as shown on the electrical drawings. These requirements apply to this section as well.
- E. Submittal drawing requirements specified in Section 40 61 13.
- F. The manufacturer shall warranty the above specified equipment for twelve months from equipment start-up or eighteen months from date of shipment, whichever occurs first, to be free from defects in design workmanship or materials

1.3 REFERENCE STANDARDS:

- A. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.
- B. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

Reference	Title
NEMA 250	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 94	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 508A	Industrial Control Panels
UL 698A	Industrial Control Panels Relating to Hazardous (Classified) Locations

1.4 QUALITY ASSURANCE

- A. REQUIREMENTS: Section 40 61 13 Process Control System General Provisions

1.5 SUBMITTALS

- A. Comply with applicable Submittal requirements specified in: Section 01 33 00.
- B. Submittal items required include:
 - 1. Connection Diagrams.
 - 2. Power supply calculations.
 - 3. Product Data: For each type of device and system:
 - 4. Include product data sheets and equipment brochures showing standard products and specified accessories.
 - 5. Mark data sheets to clearly show exact product and options being provided.
 - 6. Manufacturer's installation instructions.
 - 7. Operation and Maintenance Manual

1.6 PERFORMANCE REQUIREMENTS

- A. REQUIREMENTS: Section 40 67 63.
- B. OPERATING CONDITIONS: Section 40 67 63.

PART 2 PRODUCTS

2.1 DIRECT-CURRENT POWER SUPPLIES

- A. Convert 120 VAC to 24 volt DC or other DC voltages required or as required for the application.
- B. Sized to provide 40 percent excess rated capacity.
- C. Sized as shown on the drawings as a minimum. Provide calculations to show anticipated load does not exceed 70% of power supply rating.
- D. UL 508C listed to allow full rated output without de-rating.
- E. FEATURES:
 - 1. Convection-cooled linear type or switching type.
 - 2. Line regulation: 0.4 percent for line variations from 105 to 132 volts.
 - 3. Load regulation: 0.4 percent for load variations from 0 to full load.
 - 4. Output regulation: Within 0.05 percent for a 10 percent line change or a 50 percent load change:
 - 5. Ripple and noise: Not exceed 100 mV peak-to-peak.
 - 6. Hold-up time at maximum load: Not less than 16 milliseconds.
 - 7. Continuous duty from 0 to 50 degrees C at rated load.
 - 8. Provide a minimum of 1 set of dry contacts configured to change state on failure for monitoring and signaling purposes.
 - 9. Output electronically current limited.
 - 10. Over-voltage crowbar shutdown.
 - 11. Output voltage:
 - a. Rated 24 - 28 Vdc.
 - b. Adjustable plus or minus 5 percent.

c. Set to provide 24.0 volts.

F. MANUFACTURERS:

1. Sola
2. Allen Bradley
3. PULS
4. Phoenix Contact
5. As shown on the drawings
6. Approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

- A. REQUIREMENTS: Section 40 61 13 and Install in accordance with manufacturer's instructions for the specified functional requirements.
- B. Install all components in accordance with manufactures specifications and instructions.

3.2 TESTING

- A. Power Supplies shall be tested in accordance with the requirements of Section 40 61 21 and in accordance with the manufacturer's recommendations.
- B. In addition, the units shall be operationally tested in conjunction with the functional acceptance test of the complete system of Instrumentation and Controls for the completed system.

END OF SECTION

SECTION 40 80 01 – PROCESS PIPING TESTING

PART 1 GENERAL

1.1 SUMMARY

- A. Hydrostatic test for pressure and gravity piping, and pneumatic test for pressure and gravity piping.
- B. Systems to be tested, type of test to be performed, and test pressure shall be as specified in other sections of Specifications and Pipe Schedule.

1.2 SUBMITTALS

- A. Testing Plan:
 - 1. To be submitted for review and approval of the Engineer a minimum one week prior to testing.
 - 2. At a minimum, the plan shall include the following:
 - a. Testing date and schedule.
 - b. Piping systems and section(s) to be tested.
 - c. Test type.
 - d. Method of isolation.
 - e. Calculation of maximum allowable leakage for piping section(s) to be tested.
 - f. Proposed testing equipment to be used.
- B. Certifications of Calibration: Testing equipment.

1.3 CLOSEOUT SUBMITTALS

- A. Certified Testing Report.
 - 1. Type of test performed.
 - 2. Date and time test performed.
 - 3. Pipeline testing location.
 - 4. Name of person(s) performing test.
 - 5. Testing results, including testing pressure and measured leakage.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 PREPARATION

- A. Notify Engineer in writing 5 days in advance of testing. Perform testing in presence of Engineer.
- B. Pressure Piping:
 - 1. Install temporary thrust blocking or other restraint as necessary to protect adjacent piping or equipment and make taps in piping prior to testing.
 - 2. Wait 5 days minimum after concrete thrust blocking is installed to perform pressure tests. If high-early strength cement is used for thrust blocking, wait may be reduced to 2 days.
 - 3. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.
- C. Test section may be filled with water and allowed to stand under low pressure prior to testing.
- D. Gravity Piping:
 - 1. Perform testing after service connections, manholes, and backfilling have been completed between stations to be tested.
 - 2. Determine groundwater level at time of testing by exploratory holes or other method acceptable to Engineer

3.2 HYDROSTATIC TEST FOR PRESSURE PIPING

- A. Fluid: Clean water of such quality to prevent corrosion of materials in piping system.
- B. Exposed Piping:
 - 1. Perform testing on installed piping prior to application of insulation.
 - 2. Maximum Filling Velocity: 0.25 foot per second, applied over full area of pipe.
 - 3. Vent piping during filling. Open vents at high points of piping system or loosen flanges, using at least four bolts, or use equipment vents to purge air pockets.
 - 4. Maintain hydrostatic test pressure continuously for 30 minutes, minimum, and for such additional time as necessary to conduct examinations for leakage.
 - 5. Examine joints and connections for leakage.

6. Correct visible leakage and retest as specified.
- C. Buried Piping:
1. Test after backfilling has been completed.
 2. Expel air from piping system during filling.
 3. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.
 4. Maintain hydrostatic test pressure continuously for 2 hours minimum, reopening isolation valve only as necessary to restore test pressure.
 5. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.
 6. Maximum Allowable Leakage:
$$L = \frac{NDP^{1/2}}{7,400}$$
Where:
 - L = Leakage, gallons per hour
 - N = Number of joints under test
 - D = Nominal diameter of piping, in.
 - P = Average pressure during test, pounds per square inch
 7. Correct leakage greater than allowable, and retest as specified.

3.3 PNEUMATIC TEST FOR PRESSURE PIPING

- A. Do not perform on:
1. Polyvinyl chloride (PVC) or chlorinated polyvinyl chloride (CPVC) pipe.
 2. Piping larger than 18 inches.
 3. Buried and other non-exposed piping.
- B. Fluid: Oil-free, dry air.
- C. Procedure:
1. Apply preliminary pneumatic test pressure of 25 PSI gauge (psig) maximum to piping system prior to final leak testing, to locate visible leaks. Apply soap bubble mixture to joints and connections; examine for leakage.
 2. Correct visible leaks and repeat preliminary test until visible leaks are corrected.

3. Gradually increase pressure in system to half of specified test pressure. Thereafter, increase pressure in steps of approximately one-tenth of specified test pressure until required test pressure is reached.
 4. Maintain pneumatic test pressure continuously for minimum of 10 minutes and for such additional time as necessary to conduct soap bubble examination for leakage.
 5. Correct visible leakage and retest as specified.
- D. Allowable Leakage: Piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of leakage.
- E. After testing and final cleaning, purge with nitrogen those lines that will carry flammable gases to assure no explosive mixtures will be present in system during filling process.

3.4 HYDROSTATIC TEST FOR GRAVITY PIPING

- A. Testing Equipment Accuracy: Plus or minus 1/2-gallon water leakage under specified conditions.
- B. Maximum Allowable Leakage: 0.16 gallons per hour per inch diameter per 10 feet. Include service connection footage in test section, subjected to minimum head specified.
- C. Exfiltration Test:
1. Hydrostatic Head:
 - a. At least 6 feet above maximum estimated groundwater level in section being tested.
 - b. No less than 6 feet above inside top of highest section of pipe in test section, including service connections.
 2. Length of Pipe Tested: Limit length such that pressure on invert of lower end of section does not exceed 30 feet of water column.
- D. Infiltration Test:
1. Groundwater Level: At least 6 feet above inside top of highest section of pipe in test section, including service connections.
- E. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered defective even if pipe previously passed a pressure test.
- F. Defective Piping Sections: Replace and retest as specified.

3.5 PNEUMATIC TEST FOR GRAVITY PIPING

A. Equipment:

1. Calibrate gauges at start of each testing day. Engineer will witness calibration.
2. Install gauges, air piping manifolds, and valves at ground surface.
3. Provide pressure release device, such as rupture disc or pressure relief valve, to relieve pressure at 6 pounds per square inch (psi) or less.
4. Restrain plugs used to close sewer lines to prevent blowoff.

B. Procedure:

1. Require that no person enter manhole where pipe is under pressure.
2. Slowly introduce air into pipe section until internal air pressure reaches 4 psi greater than average back pressure of groundwater submerging pipe.
3. Allow 2 minutes minimum for air temperature to stabilize.

C. Allowable Leakage: Test section will be considered defective when time required for pressure to decrease from 3.5 psi to 2.5 psi greater than average back pressure of groundwater submerging pipe is less than that computed using values from 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	1,114	0.10
6	0.40	424	2:50	743	0.23
8	0.71	318	3:47	557	0.41
10	1.11	255	4:43	446	0.63
12	1.60	212	5:40	371	0.91
15	2.50	170	7:05	297	1.42
18	3.62	141	8:30	248	2.06
21	4.92	121	9:55	212	2.81
24	6.42	106	11:20	187	3.67
<p>Example: 15-inch diameter pipe: 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.</p>					

D. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered defective even if pipe previously passed a pressure test.

E. Defective Piping Sections: Replace and retest as specified.

3.6 FIELD QUALITY CONTROL

A. Test Report Documentation:

1. Test date
2. Description and identification of piping tested
3. Test fluid
4. Test pressure
5. Remarks, including:
 - a. Leaks (type, location)
 - b. Repair/replacement performed to remedy excessive leakage
6. Signed by Contractor and Engineer to represent that test has been satisfactorily completed.

END OF SECTION

SECTION 41 22 13 – GANTRY AND DAVIT CRANES

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: General Contractor to furnish and install complete hoist and trolley systems of the type indicated:
 - 1. Free standing Davit Crane.
- B. Work included in this Section:
 - 1. Davit cranes and all appurtenances described within this Specification are to be furnished and installed by the Contractor. See Paragraph 3.3 for davit cranes requiring equipment manufacturer's coordination.

1.2 REFERENCES

- A. National Electrical Manufacturers Association (NEMA).
- B. Hoist Manufacturers Institute (HMI).
- C. American National Standards Institute (ANSI).
- D. Crane Manufacturers Association of America (CMAA).

1.3 SUBMITTALS

- A. Submit in accordance with Section 01 33 00.
- B. Shop Drawings:
 - 1. Submit shop drawings for favorable review of the hoist systems. Include sufficient data to show that equipment conforms to Specification requirements. The shop drawing shall indicate the lowering and lifting limits of the hoist.
- C. Manuals: Furnish manufacturer's installation, lubrication, operation and maintenance manuals, bulletins, and spare parts list.
- D. Affidavits:
 - 1. Prior to installation, furnish the results of the manufacturer's shop load test. The results of this test shall be certified by a corporate officer of the manufacturer.
 - 2. After installation, furnish a certification by a representative of the manufacturer who is knowledgeable and experienced with the subject equipment that the hoists and trolleys have been properly installed, adjusted and tested and are ready for full

time operation. This certification shall also include the items specified in Paragraph 3.2, Testing, hereinafter.

1.4 QUALITY ASSURANCE

- A. All equipment furnished under this section shall: (1) be of a manufacturer who has been regularly engaged in the design and manufacture of the equipment for a period of at least 5 years; and (2) be demonstrated to the satisfaction of the Engineer that the quality is equal to equipment made by those manufacturers specifically named herein.
- B. After manufacture, perform a certified shop load test on these units. Conduct the shop test of the assembled trolley and hoist with a minimum load of 100 percent, the rated load capacity.
- C. Field test all equipment to demonstrate compliance with OSHA standards.

1.5 WARRANTY

- A. The Manufacturer of the equipment shall warrant for one- (1) year from date of startup, not to exceed 18 months from date of shipment, that all equipment provided by the Manufacturer will be free from defects in material and workmanship. In the event a component fails to perform as specified or is proven defective in service during the warranty period, the Manufacturer shall repair or replace, at his discretion, such defective part.

PART 2 EQUIPMENT

2.1 MANUFACTURERS

- A. Free Standing Davit Crane: Thern Co. with capacity as indicated in Paragraph 3.3 complete with Worm Gear Hand Winch, Adjustable Boom, Mast and Boom Rotate, Mast Locks, and Flush Mount Style Base or Wall Mount Style Base, or Equal.

2.2 PORTABLE DAVIT CRANE

- A. Crane: See Paragraph 3.3 for schedule of cranes, capacities and scope of supply. Cranes associated with the mixed liquor return pumps shall be provided under this Specification scope of supply. Crane shall be portable in pieces capable of being lifted and moved with one (1) person.
- B. Winch: Machine cut worm gear operating
- C. Mast and Boom: Provide adjustable boom with range. Provide ratchet style screw-jack for varying height of boom. Mast and boom shall rotate 360 degrees and shall have adequate vertical lift so that the pump or mixer may be lifted over the

process/membrane basin walls and placed on the walkway. Provide mast locks for rotating base. Mast locks must be locked and released without the use of tools.

- D. Hoist Lift Height: The distance from the lowest submersible pump or mixer served by the cranes, to the maximum lifting elevation of the crane mast, minimum 30 feet.
- E. Rope: Provide Wire Rope Assembly, SS wire rope with SS eye hook and swaged ball fitting, properly sized for the rated capacity and required lift height, unless otherwise noted on the Schedule.
- F. Grip Eye: Provide one (1) painted steel grip eye for lifting pump chains for each crane.
- G. Factory standard powder-coating. Comply with specification section 09 90 00.
- H. Base: Provide Flush Mount Style Base with cap as shown in the drawings and shown in the schedule in 3.03.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install hoists and trolleys as shown on Drawings and in accordance with approved submittals and manufacturer's recommendations.

3.2 TESTING

- A. After field installation, adjust stop and limit switches and test the assembled unit over its full range of travel. Test all cranes at 125 percent of the rated load. Perform all tests to comply with OSHA requirements and furnish certificates of compliance.

3.3 SCHEDULES

- A. Davit Crane Schedule

Number	Location	Working load (lbs)	Model	Furnished by
2	Aeration Basin Walkways	850	Thern 5PA5	Contractor

- B. Davit Crane Base Schedule

Number	Location	Type (wall mounted/flush mounted)	Furnished by
4	Aeration Basin Walkways	Flush mounted with cap	Contractor

END OF SECTION

SECTION 43 11 11 - SINGLE STAGE CENTRIFUGAL TURBO BLOWERS AND APPURTENANCES

PART 1 PART 1 - GENERAL

1.1 DESCRIPTION:

- A. Provide and test single stage centrifugal turbo blowers, motors, variable frequency motor controllers, inlet filter, inlet silencer, outlet flexible joint, outlet silencers, back flow barrier, manual isolation valve, blow-off valve, and silencers, acoustical enclosures, controls, motor cooling air outlet silencer, magnetic bearings, and appurtenances as indicated and specified.
- B. Each single-stage radial centrifugal turbocompressor is to be designed to provide oil-free air to the aeration system.
- C. The turbocompressor and control cabinet shall be mounted on a common base plate.
- D. A UL listed VFD shall vary the turbocompressor speed to provide continuous flow control and power optimization according to the changes in the process airflow, pressure change,s and ambient conditions (68 degrees Fahrenheit at 32% humidity) automatically without operator interface when the controls are in the auto or remote modes.
- E. The speed of the blowers shall be varied using either the local Control Panel Touchscreen or a Master Control Panel to assure the turbocompressor(s) are operating at maximum efficiency.
- F. Accessories shall be as shown on the contract drawings and described in this specification.

1.2 REFERENCES:

- A. American Bearings Manufacturers Association (ABMA).
- B. American Gearing Manufacturers Association (AGMA).
- C. American Iron and Steel Institute (AISI).
- D. American National Standards Institute (ANSI):
 - 1. S1.11: Standard Octave-Band and Fractional-Octave-Band and Digital Filters.
 - 2. S2.19: Mechanical Vibration - Balance Quality Requirements of Rigid Rotors, Part 1: Determination of Possible Unbalance, Including Marine Applications
- E. ASME PTC 10 – 1974, reaffirmed 1986 Compressors and Exhausters

- F. American Society for Testing and Materials (ASTM):
 - 1. A36: Standard Specification for Carbon Structural Steel
- G. American Welding Society (AWS)
 - 1. D1.1: Structural Welding Code.
- H. International Organization for Standardization (ISO):
 - 1. 5389: Turbocompressors Performance Test Code
 - 2. 9001: Quality Management Systems Requirements
- I. National Electrical Manufacturers Association (NEMA):
 - 1. MG1: Motors and Generators.
- J. OSHA

1.3 SUBMITTALS:

- A. Submit the following shop drawings in accordance with Section 01 33 00.
- B. Data regarding blower, motor, variable frequency motor controllers, filters, silencer, valves, controls and acoustical enclosure characteristics and performance:
 - 1. Prior to fabrication and testing, provide guaranteed performance curves based on actual shop tests of mechanically duplicate blowers, showing they meet indicated and specified requirements for capacity, pressure rise, total power draw (wire to air), temperature rise and efficiency.
 - 2. Total Power Draw in kW must include all motor, thermal, mechanical and electrical losses of the blower, motor, variable frequency motor controllers, cooling, harmonic filters as well as losses of all auxiliary equipment and components.
 - 3. For units of same size and type, provide curves for a single unit only.
 - a. Results of shop performance tests as specified.
 - b. Submit curves for guaranteed performance, and shop performance tests on 8-1/2-inch by 11-inch sheets, one curve per sheet.
 - c. Electrical schematics and Control Panel wiring diagrams.
 - d. Wiring diagrams of field connections with identification of terminations between local panel, junction boxes, equipment items, instrument devices, and the like.

- e. Catalog cuts of all components including valves, tubing, switches, lights, etc.
- f. O&M instructions and parts list
- g. Equipment Data and Specifications
- h. Certified setting plans, with tolerances, for anchor bolts with weights and heaviest piece to be lifted.
- i. Materials of Construction
- j. Specifications for all components
- k. Compressor guaranteed performance curves based on actual shop tests of mechanically duplicate including performance curves of air flow rate in scfm versus horsepower and air flow rate in scfm versus rpm curves for each compressor at specified minimum and maximum temperatures, including efficiency and polytropic head from surge point to 100 percent of rated capacity.
- l. Motor manufacturer and performance data and characteristics unless the blower motor is an integral part of the blower system.
- m. Controls Descriptions
- n. Variable Frequency Motor Controller manufacturer and data
- o. PLC manufacturer and data
- p. Harmonic Analyses Report: Provide harmonic analysis report. Report to be reviewed by Engineer prior to release of drives for fabrication.
- q. Submit voltage THD frequency scan of each type of variable frequency motor controller supplied for use in field testing.
- r. Factory performance test facilities and test procedures, set up, equipment to be used and testing tolerances to be followed.
- s. Provide description of equipment (compressor, motor and variable frequency motor controller) and provisions to deal with frequent power outages
- t. Shop drawing data for accessory items.
- u. Certified setting plans, with tolerances, for base pads.
- v. Manufacturer's literature as needed to supplement certified data.

- w. Operating and maintenance instructions and parts lists.
- x. Listing of reference installations as specified with contact names and telephone numbers.
- y. Certified results of blower pressure testing.
- z. Certified results of dynamic balancing.
- aa. List of recommended spare parts other than those specified.
- bb. Shop and field inspection reports.
- cc. Bearing Life: Certified by the blower manufacturer. Include design data.
- dd. Blower shop test results.
- ee. Motor shop test results.
- ff. Qualifications of field service technician.
- gg. Recommendations for short and long-term storage.
- hh. Field testing procedures, set up, equipment to be used and testing tolerances to be followed.
- ii. Special tools.
- jj. Number of service person-days provided and per diem field service rate.
- kk. Recommended location of inlet and discharge pressure and temperature instrumentation.
- ll. Blow-off valve assembly and details.
- mm. Manufacturer's product data, specifications and color charts for shop painting.
- nn. Provide a listing of the materials recommended for each service specified and indicated. Provide documentation showing compatibility with process fluid and service specified and indicated.
- oo. The latest ISO 9001 series certification.
- pp. Provide a scaled drawing for each blower service showing the blower, drive and enclosure, hoists and bridge cranes including equipment weights, lifting attachments, slings and clearances for equipment removal and maintenance.

qq. Material Certification:

rr. Provide certification from the equipment manufacturer that the materials of construction specified are recommended and suitable for the service conditions specified and indicated. Provide proposed materials at no additional cost to the Owner.

ss. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.

C. A copy of the contract mechanical process, structural, electrical and instrumentation drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with "No changes required" or provide a statement that no changes are required.

1. Failure to include all drawings or a statement applicable to the equipment specified in this section will result in submittal return without review until a complete package is submitted.

D. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked and indexed to indicate requested deviations and clarifications from the specified requirements.

1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.

2. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specifications and justifications are submitted in a complete package.

1.4 SPARE PARTS:

A. Provide spare parts that are identical to and interchangeable with similar parts installed.

1. For each blower:

a. Two sets of filters.

2. Blowers of the same size and performance.

- a. One set of all special tools required.

1.5 QUALITY ASSURANCE:

- A. Blowers shall be the product of one manufacturer.
- B. Blowers shall be manufacturer's standard cataloged product and modified to provide compliance with the drawings, specifications and the service conditions specified and indicated.
- C. Welding: In accordance with latest applicable American Welding Society Code D1.1 or equivalent.
- D. Shop tests as specified.
- E. Services of Manufacturer's Representative as stated in Section 01 75 16 and as specified herein.
- F. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified:
 - 1. Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.
 - 2. Installation: Inspect grouting, location of anchor bolts; setting, leveling, alignment, field erection; coordination of piping, electrical and miscellaneous utility connection:
 - a. 1 person-day.
 - 3. Functional Testing: Calibrate, check alignment and perform a functional test. Tests to include all items specified.
 - a. 1 person-day.
 - 4. Performance Testing: Field performance test equipment specified.
 - a. 1 person-day.
 - 5. Vendor Training: Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classroom sessions.
 - a. 1 person-day.

6. Credit to the Owner, all unused service person-days specified above, at the manufacturer's published field service rate.
 7. Any additional time required of the factory trained service technician to assist in placing the equipment in operation, or testing or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the Owner.
- G. If equipment proposed is heavier, longer, wider or taller, different rotation, or discharge arrangement than specified and indicated; provide all structural, architectural, mechanical, electrical and plumbing revisions at no additional cost to the Owner.
1. If equipment is heavier than specified, the Contractor shall provide all hoisting equipment sized to maintain the minimum safety factor between the specified maximum equipment weight and the lifting capacity of the hoisting equipment indicated and specified.

1.6 DELIVERY, STORAGE AND HANDLING:

- A. Comply with the requirements specified in Section 01 66 00.
- B. Storage and Protection:
 1. Protect the turbocompressor system components and accessories at the project site and during installation prior to project completion per manufacturer's instructions.
 2. If the compressor is to be stored prior to installation, the following conditions must be observed.
 - a. Ambient temperature: -10 C - + 60 C (+14 F to +140 F)
 - b. For a maximum 72 Hour storage, ambient temperature: -40 C - + 60 C (-40 F to +140 F)
 3. Store the battery pack of the magnetic bearing controller in a fully charged condition and in a cool but frost-free room.
 4. Maximum relative humidity < 95 %, non-condensing, non-corrosive, no dripping water.
 5. Maximum storage time is 6 months, If longer contact Sulzer.
 - a. When the magnetic bearing controller (MBC) is stored for a period longer than six months, the power supply must be connected to re-fresh the capacitors. A

480V/3/60 (or voltage specific to blower) power source (provided by the end-user) must be connected to the MBC for two hours every sixth month of storage to ensure the capacitors are kept in good condition.

1.7 WARRANTY

- A. Provide manufacturers' standard warranty. The warranty period shall be for 24 months after shipment.

1.8 MAINTENANCE

A. Special Tools:

1. If needed, provide one set of special tools required for complete assembly or disassembly of the turbocompressor system and accessories.
2. Special tools shall be defined as any tool not typically necessary for general plant maintenance.

B. Spare Parts:

1. Each turbocompressor shall be furnished with the following spare parts labeled and packed for warehouse storage as recommended by the turbocompressor supplier and / or specified in Section 01 31 13. Spare parts shall be as follows.
 - a. One complete set of main process air filters (If Supplied by Sulzer).
 - b. One complete set of cooling air filters.

PART 2 MATERIALS

2.1 SYSTEM DESCRIPTION:

- A. Blower capacities and operating data are indicated in the Blower and Compressor Schedule.
- B. Equipment Limitations:
 1. Blowers: Provide two (2) Sulzer Blowers, Model Number HST-30-46-1-U350-48
- C. Coordinate blower assembly package dimensions and weights with hoists and bridge cranes as specified in Sections 41 22 13 respectively and as shown.

2.2 MANUFACTURERS:

- A. Single Stage Centrifugal Turbo Blowers

2.3 SEISMIC DESIGN REQUIREMENTS:

- A. Conform to the requirements indicated on the structural drawings and in Section 01 41 20 – Seismic Requirements for Non-Structural Components.
- B. The Contractor shall conform to the seismic design requirements for this project and for the work of this specification section.
- C. Provide all equipment bases, anchorage, supports and foundations designed in accordance with the seismic requirements indicated and specified.
- D. Additionally, provide with the Certificate of Unit Responsibility, certification for all equipment signed by a registered structural engineer stating that computations were performed and that all components have been sized for the seismic forces specified and indicated.

2.4 SERVICE CONDITIONS:

- A. Refer to fine bubble diffuser specification for minimum and maximum month air flow capacities.
- B. Capacity Air Flows per blower:
 - 1. System Operating Capacity, scfm:
 - a. Start-Up Conditions: 6,900 SCFM
 - b. Design Loading Conditions: 7,600 SCFM at full load
 - c. Minimum System Operating Capacity: 4,295 SCFM
- C. Blower Design Differential Pressure: 8.4 PSIG
- D. Design Conditions:
 - 1. Gas: Air
 - 2. Site Altitude above MSL, feet: **373**
 - 3. Site Barometric Pressure, PSIA: **14.50**
 - 4. Blower Inlet Pressure, PSIA: **14.50**
 - 5. Maximum Process Air Inlet Temperature, degrees F: **100**
 - 6. Minimum Process Air Inlet Temperature, degrees F: **0**
 - 7. Relative Humidity, percent: **20 to 80%**

8. Inlet Pressure losses, PSIA: **0.1**

E. Guaranteed Performance:

Test Condition	Blower Inlet Temp. (°C)	Blower Inlet RH (%)	Airflow (scfm)	Annual Operating Time (A) (hrs/year)	Fraction of Total Usage (%)
Minimum	6.3	83	4,295	1,460	16.67
Average	12.5	69	6,900	5,840	66.67
Maximum	18.8	55	14,667	1,460	16.67

2.5 BLOWERS:

- A. Provide direct driven single stage centrifugal blowers without gear boxes and lubricants, blowers using gear boxes and requiring lubricants are not acceptable.
- B. Provide compressors with a design life of 20 years before major refurbishing is required.
- C. Air cooling of the motor and control cabinet components is acceptable. Systems that use water cooling are not acceptable.
- D. Rotor critical speed must be a minimum of 20 percent above the operating design speed.
- E. Provide compressors equipped for piped inlet as indicated.
- F. Provide motors with no physical connection between stator and shaft while power is applied to the compressor.
- G. Bearing: Magnetic type
- H. Cooling: Air or closed loop heat exchanger system
- I. Turndown: 45 percent of maximum
- J. No special foundations required
- K. Blower components must be UL certified.
- L. Blower Configuration: Horizontal or vertical as indicated in the Blower and Compressor Schedule

2.6 MATERIALS:

- A. Impeller: Forged and machined aluminum alloy or Type 316 stainless steel, cast impellers are not acceptable
- B. Casing: Aluminum alloy, A1Si7Mg-T6 or ASTM A36 steel

- C. Baseplate and Frame: ASTM A36 steel, epoxy painted
- D. Face and drill flanges of suction and discharge connections in accordance with 150-lb. ANSI Standard or provide adaptor pieces.

2.7 MOTORS:

- A. Horsepower rating of motors: Not less than maximum brake horsepower requirements under any condition of operation specified and without operating in the motor service factor.
- B. Permanent magnet synchronous type
- C. 460 Volt, 3-ph, 60 Hertz, +/- 10 percent
- D. Service factor: 1.15
- E. Provide stator temperature monitoring.
- F. Provide high temperature shutoff
- G. Insulation: Class H.
- H. Duty: Continuous
- I. Inverter duty

2.8 VARIABLE FREQUENCY MOTOR CONTROLLERS:

- A. Provide each blower system with a variable frequency motor controller that controls the blowers startup/shutdown sequence, maintains the speed setpoint, engages safety shutdowns and surge control
- B. UL Certified
- C. Variable frequency motor controller manufacturer must have a manufacturing operation in North America for manufacturing, technical services, support and provision for replacement parts.
- D. Provide variable frequency motor controller variable frequency motor controller with a three phase pulse width modulated (PWM) rectifier section.
- E. The variable frequency motor controller shall employ a full wave rectifier to prevent input line notching, a DC bus choke, DC bus capacitors and Insulated Gate Bipolar Transistors (IGBT) as the output switching device to convert nominal 480 volts, 3-ph, 60 Hertz, 3 wire input power into adjustable-frequency 3 wire system at 0 to 480 volts, 3-ph, 0 to 60 Hertz output power.

- F. Provide output speed control of required motor under variable torque load or constant torque as required by the driven equipment.
- G. Provide AC line reactor and DC choke to reduce input harmonic content, and provide protection from power line transients.
- H. Harmonic Control in Electrical Power Systems shall be a requirement of this project. Harmonic filters (passive or active), phase multiplication devices, or any other components required to mitigate harmonic voltage THD to 5 percent and current THD to 8 percent maximum levels shall be an integral part of the variable frequency motor controller system. Compliance measurement shall be based on THD at the variable frequency motor controller circuit breaker terminals or actual THD measurement at the variable frequency motor controller circuit breaker terminals during full load variable frequency motor controller operation. Designs which employ shunt tuned filters must be designed to prevent the importation of outside harmonics which could cause system resonance or filter failure. Calculations supporting the design, including a system harmonic flow analysis, must be provided as part of the submittal process for shunt tuned filters. Any filter designs which cause voltage rise at the variable frequency motor controller terminals must include documentation in compliance with the total system voltage variation of plus or minus 10 percent. Documentation of Power Quality compliance shall be part of the commissioning required by the variable frequency motor controller supplier. Actual job site measurement testing shall be conducted at full load and documented in the operation and maintenance manuals. Harmonic measuring equipment utilized for certification shall carry a current NITS calibration certificate.
- I. Characteristics:
 - 1. Steady state speed error: < 1 percent.
 - 2. Output amps: 110 percent of rated, continuous.
 - 3. Low torque ripple
 - 4. High immunity to resonance vibrations
 - 5. Starting torque: > 200 percent, depending on compressor and drive sizing.
 - 6. Control unit is physically completely separated from the power module and mounted on a separate control compartment at an easily accessible height.
- J. Motor control circuits shall be wired in accordance with the requirements specified herein or indicated on the Drawings. Where not indicated, the control circuits shall be standard two-wire "start-stop" and the Contractor shall furnish wiring accordingly. Controls shall be designed to allow for automatic re-start when power is returned after a system outage, unless otherwise directed.

- K. All components of the drive shall be designed and sized for the abnormal condition of continuous operation of the driven equipment specified herein at loads up to 15 percent above rated full load.
- L. RMS harmonic output of the drive not to provide more than 5 percent increase in motor heating over similar operation of the motor with zero harmonics in the current.

2.9 ACCESSORIES:

- A. Expansion Joints: Provide an expansion joint in the inlet and outlet piping, bolt on metal bellows type all Type 316 stainless steel.
 - 1. Material: Type 316L stainless steel
- B. Enclosure:
 - 1. Free field sound pressure level without accessories not to exceed 85 dbA at any point 3 feet (1 meter) from the compressor assembly when operating at specified air flow rates and differential pressure.
- C. Blow Off Valves: Provide an integrally mounted electrically controlled or electro-pneumatically controlled blow-off valve for each blower sized to handle the flow and pressures seen during start up and shut down.
 - 1. Blower manufacturer to provide all components such as a small high pressure compressor.
 - 2. Contractor to provide piping, valves and tubing as indicated.
- D. Air Pressure Gauges or other measurement device: Provide pressure monitoring in the inlet and outlet piping for each compressor.
- E. Provide temperature sensors in the inlet piping and a temperature sensor on the motor for each compressor.

2.10 INLET FILTER:

- A. Filter silencers shall be side outlet, single stage, cartridge style w/ integrated weather hood, suitable for indoor or outdoor service.
- B. Filter silencers shall include 316L stainless steel discharge air knife configured for a common header blower arrangement; freeze discouragement discharge air knife shall include automated controls w/ NEMA-4 enclosure & stainless-steel fittings. Controls shall be Endustra Series DK.

- C. Filter silencer outlet shall include 125# ANSI flange pattern connection sized to fit directly to the blower inlet piping without requirement for reducers or transitions.
- D. Filter silencer housing metal parts shall be mild steel, abrasive blasted to SP#10 near white, primed with zinc-filled epoxy powder coat, and top-coated with exterior-grade polyester powder coat finish, interior and exterior (no liquid or oil-based paint), minimum dry film thickness (DFT) 5-7 MIL
- E. Filter silencer shall include stainless steel attachments for support/leveling legs; support/leveling legs shall be stainless steel
- F. Total initial combined clean differential pressure across filter silencer initial + filter elements at 120% of rated flow shall not exceed 2" WG
- G. Initial clean differential pressure across filter elements only at 120% of rated flow shall not exceed 0.5" WG.
- H. Face velocity at specification rated SCFM shall be less than 50 f/m
- I. Final filter differential pressure shall be rated not less than 12" WG
- J. Filter elements shall be a cartridge-style, single stage, Endustra Tri-Vent® Series
- K. Filter element service/changes shall not require tools
- L. Filter element maximum clean weight shall not exceed 25# (each)
- M. Filter element medium shall be Enduralast® Hi-Flow Synthetic, 98% efficient @ 10 micron (nominal)
- N. Filter silencers shall be Endustra Tri-Vent® Series TKZ w/ Series DK Freeze Discouragement Air Knife & Automated Controls

2.11 CONTROLS:

- A. Provide compressors with the ability to be controlled by an existing SCADA system.
- B. Provide diagnostics and troubleshooting.
- C. Provide built in automatic surge protection.
- D. Provide built-in flow measurement, speed measurement, vibration measurement, temperature and pressure sensors with associated data display and adjustment capability.

- E. Provide Ethernet connectivity to existing facility Control Logix PLC network. All blower status information and control capability shall be accessible via this Ethernet connection.
- F. Provide the hardwired interconnections with the existing PLC control system in accordance with the contract drawings including but not limited to the P&IDs and the PLC I/O drawings.

2.12 SHOP PAINTING:

- A. Primer and Finish Paint: Shop apply to all exterior ferrous surfaces, high solids epoxy in accordance with Section 09 90 00.
- B. Ferrous surfaces which are not to be painted shall be given a shop applied coat of grease or rust resistant coating.
- C. Provide additional shop paint coating for touch-up to all surfaces after installation and testing is completed and equipment accepted.

2.13 SHOP TESTING:

- A. Comply with the requirements specified in Section 01 75 16 and as specified herein.
- B. Provide motor shop testing in accordance with Section 26 08 00.
- C. Blower Tests:
 - 1. Test blowers under a hydrostatic head of at least 20.
 - 2. Provide witness performance tests as specified herein for all blowers in accordance with ISO 5389.
 - 3. Provide 30 days notice prior to start of testing.
 - 4. Testing must be done at the compressor manufacturer's fabrication facility.
- D. Blower Tests:
 - 1. Provide a mechanical test of each unit prior to performance testing.
 - a. Test duration: Minimum 1 hour after stabilization of temperature.
 - b. Record: Duration, temperature, speed and noise.
- E. Test Points:
 - 1. Maximum Blower Air Flow Rate
 - 2. Minimum Blower Air Flow Rate

3. 45 percent of Maximum Air Flow Rate
 4. Evaluation Points in accordance with Engineer.
- F. Mechanical operation of all equipment: Provide tests complying with all requirements of the Contract Documents. Vibration amplitudes not to exceed 0.15 inches/second peak to peak.
- G. Failure to comply with any one of the required performance parameters as specified and indicated will be grounds for rejection of the compressor system.
- H. Test tolerance as follows:
1. Power: + 0 percent
 2. Flow: +/- 0 percent
 3. Discharge Pressure: +/- 0 percent
- I. Provide a copy of the test procedures form of the tests to be conducted, layout, and other relevant data 30 days prior to testing, allowing the witness Engineer's sufficient time to review and study the test program.
- J. All test equipment must be calibrated within 12 months of the factory testing and stability and calibration in accordance with ISO 9001.
- K. Test all blowers, appurtenances, harmonic filter and Main Control Unit as a system testing all stop, start, operating conditions, safety alarms and shutdowns.
- L. Upon completion of testing: If required, provide blower internals with a rust preventative coating for safety of internal components during shipment and storage at the jobsite.
- M. Provide witnessed factory operating and testing of the completed compressor assembly, including the compressor, controls and instrumentation along with simulated start of the compressor and motor.
1. Provide testing of all start and stop sequences and all safety and alarm systems with the skid mounted local control panel. Connect the electric inlet blow-off valve during these tests to prove proper control and sequencing.
- N. Provide a minimum of 30 days written notice to the Engineer prior to shop testing.
- O. In the event that specified tests indicate that compressor, motor, variable frequency motor controller drive or controls will not meet specifications, Engineer has the right to require additional complete witnessed tests for all compressors, motors, variable frequency drives and controls at no additional cost to the Owner.
- P. Repeat tests until specified results are obtained.

- Q. Correct or replace promptly all defects or defective equipment revealed by or noted during tests at no additional cost to the Owner.
- R. When witness performance testing is specified, provide roundtrip airfare, all transportation and lodging for witness testing for two (2) people. If air travel is more than 6 hours provide business class airfare.

PART 3 EXECUTION

3.1 INSTALLATION:

- A. Install items in accordance with shop drawings with no exceptions, manufacturer's printed instructions and as indicated.

3.2 FIELD TESTING:

- A. Comply with the requirements specified in Section 01 75 16 and as specified herein.
- B. Test piping connections to prove the blower nozzles are installed with the pipe in a free supported state and without need to apply vertical or horizontal pressure to align piping with blower nozzles. This must be performed and the piping acceptable prior to any field performance testing.
- C. Field testing will not be conducted without an accepted procedure, calibration certificates for all testing equipment, gauges and flow meters and a completed and signed pretesting check list. Testing shall comply with ISO 5389:1992 Turbocompressors, VDI 2045:1993 Acceptance and Performance Tests on Turbo Compressors and Displacement Compressors, and ASME PTC 10-1974 / Reaffirmed 1986 Compressors and Exhausters.
- D. After installation of equipment, and after inspection, operation, testing and adjustment have been completed by the manufacturer's field service technician, conduct running test for each blower in presence of the **Engineer** to determine its ability to operate and deliver its rated capacity under specified conditions.
 - 1. During tests, observe and record pressure, capacity, kW, noise and vibration and motor inputs. Manufacturer's field service representative shall measure and report overall electric power, pressure ratio of the compressor, and capacity of the compressor.
 - a. Test Duration: Determined by the **Engineer**, but not less than four hours of continuous operation at each condition specified and indicated
 - 2. Run each blower for minimum one hour prior to taking temperature readings of the blowers and motors.

3. Immediately correct or replace all defects or defective equipment revealed by or noted during tests at no additional cost to the Owner.
4. Repeat tests until specified results are obtained.
5. Contractor to provide all labor, piping, testing equipment, equipment, flow meters and test gauges for conducting tests.
 - a. Contractor shall provide calibrated test gauges for all permanently installed gauges and portable calibrated flow meters for all blower systems even in those cases where permanent flow meters are installed.
 - b. All calibrations must be within 30 days of the field testing.
- E. The testing will not be started and will not be accepted until the calibrated testing equipment stated above is operational and all certifications have been submitted.
- F. Make all adjustments necessary to place equipment in specified working order at time of above tests.
- G. Remove all replace equipment at no additional cost to the Owner with equipment that will meet all requirements specified and indicated if unable to demonstrate to the satisfaction of the **Engineer** that equipment will perform the service specified, indicated and as submitted and accepted.

3.3 FIELD TOUCH-UP PAINTING:

- A. After installation and testing by the Engineer, apply touch-up paint to all scratched, abraided and damaged shop painted surfaces. Coating type and color shall match shop painting.

3.4 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 46 05 13 – GENERAL REQUIREMENTS FOR EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

- A. SCOPE: This section specifies general requirements applicable to all equipment. Ensure all equipment meets the requirements of this Section and the requirements of each individual equipment specification.

1.2 QUALITY ASSURANCE

- A. REFERENCE STANDARDS:

1. This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In the event of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.
 - a. ABMA Std 9 Load Ratings and Fatigue Life for Ball Bearings
 - b. ABMA Std 11 Load Ratings and Fatigue Life for Roller Bearings
 - c. ANSI B1.1 Unified Inch Screw Threads (UN and UNR Thread Form)
 - d. ANSI B1.20.1 Pipe Threads, General Purpose (Inch)
 - e. ANSI B16.1 Gray Iron Pipe Flanges and Flanged Fittings
 - f. ANSI B18.2.1 Square and Hex Bolts and Screws (Inch Series)
 - g. ANSI B18.2.2 Square and Hex Bolts (Inch Series)
 - h. ANSI S2.19 Mechanical Vibration – Balance Quality Requirements of Rigid Rotors, Part 1
2. Unless otherwise specified, references to documents shall mean the documents in effect on the effective date of the Agreement. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

B. UNIT RESPONSIBILITY:

1. Where specified in the individual equipment specification, ensure equipment assemblies made up of two or more components are provided as a working unit by the unit responsibility manufacturer. The unit responsibility manufacturer shall select, design, and provide all components such that equipment specified in the individual equipment specification, and all equipment specified elsewhere but referenced in the individual equipment specification, is compatible and operates reliably to achieve the specified performance requirements. The unit responsibility manufacturer shall be the driven equipment manufacturer. Agents, representatives, or entities not a direct division of the driven equipment manufacturing corporation will not be accepted as a substitute for the driven equipment manufacturer meeting this requirement.
2. Ensure all equipment assemblies are products for which unit responsibility has been accepted by the unit responsibility manufacturer(s). Unit responsibility for related components does not require or obligate the unit responsibility manufacturer to warranty the workmanship or quality of components not manufactured by them.

C. BALANCE:

1. For machines 1.0 HP and greater, all rotating elements in motors, pumps, blowers and centrifugal compressors shall be fully assembled, including coupling hubs, before being statically and dynamically balanced. All rotating elements shall be balanced to the following criteria:

$$U_{per} = 6.015 \frac{GW}{N}$$

Where:

- U_{per}* = permissible imbalance, ounce-inches, maximum
G = Balance quality grade, millimeters per second
W = Weight of the balanced assembly, pounds mass
N = Maximum operational speed, rpm

2. Where specified, balancing reports, demonstrating compliance with this requirement, shall be submitted as product data. Equipment balance quality grade shall be G 2.5 (G = 2.5 mm/sec) or better in accordance with ANSI S2.19.

1.3 SEISMIC AND ANCHOR BOLT REQUIREMENTS

- A. Anchor and brace equipment to resist seismic loads specified in Section 01 41 20. Seismic design and engineering calculations in accordance with Section 01 41 20.

PART 2 PRODUCTS

2.1 FLANGES AND PIPE THREADS

- A. Flanges on equipment and appurtenances provided under this section shall conform in dimension and drilling to ANSI 816.5 Class 150, except where noted. Pipe threads shall conform in dimension and limits of size to ANSI B1 .1, coarse thread series, Class 2 fit.
- B. Threaded flanges shall have a standard taper pipe thread conforming to ANSI B1 .20.1. Unless otherwise specified in the individual equipment specification, provide flat faced flanges.
- C. Flange assembly bolts shall be heavy pattern, hexagonal head, carbon steel machine bolts with heavy pattern, hot pressed, hexagonal nuts conforming to ANSI 818.2.1 and 818.2.2. Threads shall be Unified Screw Threads, Standard Coarse Thread Series, Class 2A and 28, ANSI 81 .1.

2.2 BEARINGS

- A. Unless otherwise specified in the individual equipment specification, equipment bearings shall be oil or grease lubricated, ball or roller type, designed to withstand the stresses of the service specified. Each bearing shall be rated in accordance with the latest revisions of ABMA Methods of Evaluating Load Ratings of Ball and Roller Bearings. Equipment bearings shall have a minimum L-1.0 rating life of 50,000 hours. The rating life shall be determined using the maximum equipment operating speed.
- B. Grease lubricated bearings, except those specified to be factory sealed and lubricated, shall be fitted with easily accessible grease supply, flush, drain and relief fittings. Extension tubes shall be used when necessary. Grease supply fittings shall be standard hydraulic alemite type.
- C. Oil lubricated bearings shall be equipped with either a pressure lubricating system or a separate oil reservoir type system. Each oil lubrication system shall be of sufficient size to safely absorb the heat energy normally generated in the bearing under a maximum ambient temperature of 60 degrees Celsius and shall be equipped with a filler pipe and an external level indicator gage.
- D. For bearings accessible to touch, located within 7 feet measured vertically from floor or working level, or within 15 inches measured horizontally from stairways, ramps, fixed ladders or other access structures: incorporate either bearing housings with

sufficient cooling to maintain surface temperature at or below 65 degrees Celsius for continuous operation at bearing rated load and a 50 degrees Celsius ambient temperature, or provide appropriate shielding to prevent inadvertent human contact.

2.3 V-BELT ASSEMBLIES

- A. Unless otherwise specified in the individual equipment specification, V-belt assemblies shall be Dodge Dyna-V belts with matching Dyna-V sheaves and Dodge Taper-lock bushings, Wood's Ultra V-belts with matching Ultra-V sheaves and Wood's Sure-Grip bushings, or Approved Equal.
- B. Sheaves and bushings shall be statically balanced. Additionally, sheaves and bushings which operate at a peripheral speed of more than 5500 feet per minute shall be dynamically balanced. Mount sheaves separately on their bushings by means of three pull-up grub or cap tightening screws. Key seat bushings to the drive shaft.
- C. Select belts for not less than 150 percent of rated driver horsepower. Where two sheaves sizes are specified, shall be capable of operating with either set of sheaves. Provide antistatic belts where explosion proof equipment is specified. Multiple belts shall be in matched sets.

2.4 COUPLINGS

- A. Unless otherwise specified in the individual equipment specification, equipment with a driver greater than 1/2 horsepower, where the input shaft of a driven unit is directly connected to the output shaft of the driver, shall have its two shafts connected by a flexible coupling which accommodates angular misalignment, parallel misalignment and end float, and which cushions shock loads and dampens torsional vibrations. The flexible member shall consist of a tire with synthetic tension members bonded together in rubber. Attach flexible member to flanges by means of clamping rings and cap screws; the flanges shall be attached to the stub shaft by means of taper lock bushings which shall give the equivalent of a shrunk-on fit. There shall be no metal-to-metal contact between the driver and the driven unit. Each coupling shall be sized and provided as recommended by the coupling manufacturer for the specific application, considering horsepower, speed of rotation, and type of service.
- B. Where torque or horsepower ratings exceed the above coupling's capacity, Falk Steel Flex, Thomas-Rex, or Approved Equal couplings are acceptable provided they are sized in accordance with the equipment manufacturer's recommendation, and sizing data are submitted; install in accordance with the coupling manufacturer's recommendation.

2.5 SHAFT CONNECTIONS

- A. Prior to assembly, keys, keyways, collets, retaining bolts, couplings, and other shaft attachment assemblies used to attach impellers, fan blades, sheaves, couplings, or other rotating elements to drive shafts and driver shafts with an anti-seize compound as recommended by the equipment manufacturer.
- B. Provide anti-seize or anti-galling compound with a molybdenum disulfide and graphite combination in aluminum complex base grease; conform with MIL-PRF-907E. Candidate products include Jet Lube 550 by Jet Lube, Inc., E-Z Break by LA-CO, or Approved Equal.

2.6 GUARDS

- A. Exposed moving parts shall be provided with guards which meet all applicable OSHA requirements. Guards shall be fabricated of 14-gage steel, 1/2-13-15 expanded metal screen to provide visual inspection of moving parts without removal of the guard. Guards shall be galvanized after fabrication and shall be designed to be readily removable to facilitate maintenance of moving parts. Reinforced holes shall be provided. Lube fittings shall be extended through guards.

2.7 GAGE TAPS, TEST PLUGS AND GAGES

- A. Provide gage taps on the suction and discharge of pumps, blowers, and compressors.

2.8 NAMEPLATES

- A. Provide nameplates on each item of equipment or instrumentation for which an equipment number or instrument tag number is listed and shall contain the specified equipment name or abbreviation and equipment number. Equipment nameplates shall be engraved or stamped stainless steel and fastened to the equipment in an accessible and visible location with stainless steel screws or drive pins.

2.9 LUBRICANTS

- A. For each mechanical equipment component, provide a supply of the required lubricant adequate to last through Commissioning. Lubricants shall be as recommended by the equipment manufacturer and be products of the Owner's current lubricant supplier. Consolidate various lubricants, with the equipment manufacturers' approval, into the fewest number of different types. Provide a consolidated list showing the lubricants required for each mechanical equipment component; estimated lubricant quantities needed for a full year's operation, assuming continuous operation.

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 46 41 50 – HYPERBOLIC MIXERS

PART 1 GENERAL

1.1 SUMMARY

- A. Work Included: Furnish, install and place into satisfactory operation hyperbolic mixers for the Pasco Clean Water Preservation Project Phase 1 complete with all accessories and appurtenances as shown on the Drawings and specified herein, and as needed for a complete installation.
- B. General:
 - 1. Mixers shall be of the non-clogging, vertical shaft, hyperboloid-body type.
 - 2. The mixer and its appurtenances shall be specifically designed for continuous duty operation in a submerged application in a biological reactor. The mixers shall not overload the motors at any point within the operating limits recommended by the mixer manufacturer.
 - 3. The mixer shall be designed with no submerged bearings and with a dry installed motor. The entire weight of the mixers shall be supported by new steel bridges/walkways.

1.2 SUBMITTALS TO THE ENGINEER

- A. Submit shop drawings, manufacturer's literature, maintenance data and operating instructions and warranty data in accordance with the General Conditions of the Contract and Section 01 33 00.
- B. Attention is directed to the fact that the Drawings are based on the Invent Hyperclassic hyperbolic mixers. If the equipment accepted requires an arrangement differing from the indicated on the Drawings, the Contractor shall prepare and submit for review detailed mechanical drawings showing all necessary changes. Such changes shall be at no additional cost to the Owner.
- C. Submit general arrangement and assembly drawings indicating:
 - 1. construction details and dimensional drawings;
 - 2. structural requirements which include support base and anchor bolt requirements;
 - 3. operating weight distribution;
 - 4. installation requirements requiring coordination with the Contractor.

- D. Submit electrical load calculations, rated power, rated input power and shaft power, recommended position and depth of the mixers in the tank, minimum distances from tanks walls and bottom requirements.
- E. Bearing life calculations.
- F. Standard Manufacturers shop test results.
- G. Operations and Maintenance Manuals as required in Section 01 78 23.

1.3 QUALITY ASSURANCE

- A. All equipment in this Section shall be furnished by or through a single supplier. The Contractor shall be responsible for the coordination and proper operation of the entire system. Equipment shall be fabricated, assembled, erected and placed in proper operating condition in full conformity with the Drawings, Specifications, instructions and recommendations of the equipment manufacturer.
- B. Qualifications of Manufacturer: The manufacturers shall be experienced in the design and construction of equipment for this purpose, and shall have furnished such equipment and can prove that it has performed successfully for a period of not less than five (5) years.
- C. Project Design:
 - 1. The project design is based on Invent Environmental Technologies, Inc. of Cedar Grove, NJ as listed in this Section.
- D. Acceptable Manufacturers:
 - 1. Invent Environmental Technologies, Inc.

1.4 WARRANTY

- A. The equipment shall be warranted for one (1) year from the date of Substantial Completion.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. The mixers shall be capable of completely mixing each selector zone as required to meet the requirements of the performance test outlined below. Each test will be conducted in the presence of the Engineer and the Owner. The performance requirements presented below define the minimum mixing capacity of each mixer. If

additional mixing capacity is required to meet the performance test requirements, the Contractor shall provide the necessary equipment at no additional cost to the Owner.

- B. Mixers installed in Anoxic Selector Zones shall be designed to meet the following conditions:

No. of mixers	12
Mixer configuration	Hyperbolic
Mixer Body	8 sections, with 8 integral transport ribs
Liquid being mixed	Mixed liquor
Percent solids	0.1 to 0.5 percent
Sludge Volume Index	Minimal 80 l/kg
Maximum mixer body speed	RPM
Zone Size :	
Depth	18.25 feet
Length	20 feet
Width	16 feet
Motor Horsepower:	1 Hp
Motor Type:	Squirrel Cage, Induction type
Nominal Motor Speed:	Coordinate with Mixer RPM Requirements
Motor Efficiency:	IE3 / NEMA MG1 Premium Efficiency
Design:	Design B
Duty:	Continuous, designed for a minimum of ten starts per hour.
Insulation:	Class F
Voltage:	460V, 3 Ph., 60 Hz.
Service Factor:	1.15 (The motor service factor shall not be used in sizing the motors)

2.2 MATERIALS

A. General

1. Each mixer assembly shall consist of a dry installed heavy-duty speed reducer with hollow shaft, electric motor, space heaters inside motor housing, baseplate, composite FRP shaft, and composite hyperbolic mixer body.
2. The bottom of the hyperbolic mixing body should not exceed 12" above the basin floor, or installed diffusers.
3. Mixers shall be capable of handling biological activated sludge with a solids concentration from 0.1 to 0.5 percent solids with a SVI of minimal 80 l/kg., and shall

be designed to prevent settlement in the tanks and to re-suspend biological material on the tank bottom.

4. The mixer should be designed as a vertical shaft mixer, with a dry installed motor. During operation the mixer should not generate any upward forces on the bridge construction.
 5. The mixer should have a steady stationary flow pointed downward parallel to the mixer shaft. The highest speeds and turbulent fluctuations should be produced in the bottom area. On the water surface, no or little surface turbulence should appear.
- B. Gear Drive
1. The gear drive assembly for each mixer shall consist of parallel-shaft helical gear box and motor as designed by SEW Eurodrive or approved equal.
 2. The gear drive assembly shall have a high-quality corrosion protection coating, robust weather protective hood, and thermostat switches/PTC thermistor for thermal protection of the motor.
 3. The gear box housing shall be cast iron covered with an epoxy coating, having a thickness of at least 6.0 mil. The gear box shall be connected to the mounting base using a flange connection with 316 additional stainless steel nuts and bolts.
 4. The gear box speed shall not exceed 18.3 rpm. The calculated lifetime L10 of the bearings shall exceed 100,000 hours.
 5. The drive motors shall be a squirrel cage induction motor, 460 V, 3 phase, 60 Hz, 1,800 RPM, Class F insulation.
 6. The motors shall be equipped with a weather protection hood.
 7. The motors shall be equipped with integral thermal overloads mounted in the motor windings.
 8. The hollow shaft shall be covered and sealed with a special hollow shaft cap.
- C. Mounting Base
1. The mounting base of each mixer shall consist of a gear base plate mounted in rubber buffers connected permanently to the bridge/supports by bolted connection. The plate shall be able to be leveled using the threaded bolts, which can be adjusted in height.

2. The rubber buffers shall absorb start-up torque, prevent any transfer of vibrations to the bridge and constitute the galvanic separation of the mixer from its surroundings.
3. The mounting base shall be a fastening set for the concrete bridge/walkway with threaded rods and chemical anchors which are permanently anchored to the concrete.

D. Shaft

1. The drive shaft of the mixer shall be made from FRP.
2. At the top end of the mixer shaft, there shall be a tappet for the connection to the gear hollow shaft.
3. At the lower end there, shall be 16 counter-sunk laminated stainless steel insert nuts for the connection to the mixer body itself.
4. All bolted connections shall utilize 316 stainless steel hardware.

E. Hyperboloid Mixer Body

1. Each hyperboloid mixer body shall be manufactured of composite material and be a streamlined stress-free body. The mixer body is composed of 8 identical parts that will fit together in the basin.
2. The transport ribs which accelerate the flow are integrated into the mixer body.
3. The hyperboloid mixer shall have counter-sunk laminated stainless steel insert nuts.
4. No mixer body designs with welded ribs or fins are acceptable.

F. Spare Parts

1. One set of rubber buffers per installed mixer type.
2. One shaft holder for each shaft diameter supplied.
3. All lubricating oils required for the first year of operation shall be provided. The products supplied shall be factory prefilled, in accordance with manufacturer's recommendations.
4. Spare parts shall be identical to and interchangeable with similar parts installed.

PART 3 EXECUTION

3.1 FACTORY TESTS

- A. The hyperbolic mixer manufacturer shall perform the following inspections and tests on each unit before shipment:
 - 1. Hyperbolic mixer body diameter, motor rating, and electrical connections shall be checked for compliance with contract requirements.
- B. Certified copies of all test procedures and results shall be provided to the Engineer prior to shipment.

3.2 INSTALLATION

- A. In accordance with manufacturer's specifications.

3.3 START-UP AND TESTING

- A. In accordance with Specification Section 01 75 16.
- B. Performance Test:
 - 1. Prior to start of the performance tests, fill the zones to the maximum water elevation with test water (plant effluent).
 - 2. Run the mixer for one hour. Demonstrate each mixer:
 - a. Is free of overheating of any parts.
 - b. Is free of all objectionable vibration, in accordance with manufacturer's recommendations.
 - c. Is free of overloading of any parts.
 - 3. Via the Control Station(s), verify mixer functions.
 - 4. Record amperage draw.
 - 5. Continue operating the mixer for 24 hours without overheating, excessive vibration or overloading.
- C. Suspended Solids Testing

Conduct a suspended solids concentration test as follows:

1. The mixer manufacturer shall prove guaranteed performance and the quality of the mixer by performing a suspended solids concentration test demonstrating that each mixer achieves uniformity of the suspended solids within each zone.
2. Conduct suspended solids concentration test at mixed liquor suspended solids concentrations of 5000 mg/L +/-10 % in all zones with an SVI greater than or equal to 80 ml/g as that specified.
3. For a mixer selected by the Engineer, demonstrate that a uniform concentration of the mixed liquor suspended solids is achieved at the end of a 30 minute test period with the mixer running and no incoming or return flows with uniformity defined as plus or minus ten percent of the average deviation of suspended solids concentration for all samples taken.
4. Take six samples at locations as selected by the Engineer with sample locations equally spaced horizontally and vertically within each zone.
5. The maximum depth at which any sample is taken shall be a minimum of 12-inches above the basin floor.
6. Collect samples a minimum of 12-inches from any wall.
7. Provide all samples tested at an independent laboratory accepted by the Engineer and paid for by the Contractor.
8. Immediately correct or replace all defects or defective equipment revealed by or noted during tests at no additional cost to the Owner.
9. Repeat tests until specified results are obtained.
10. Contractor to provide all water labor, piping, testing equipment, equipment, flow meters and test gauges for conducting tests.
11. Make all adjustments necessary to place equipment in specified working order at time of above tests.

END OF SECTION

SECTION 46 51 21 - COARSE BUBBLE DIFFUSERS

PART 1 GENERAL

1.1 DESCRIPTION:

- A. This section includes requirements for design, manufacture, installation, and start-up of coarse bubble diffusers including primary effluent box aeration components as shown on the drawings and specified in this section.

1.2 SUBMITTALS:

- A. Shop Drawings: Submit the following in accordance with Section 01 33 00
 1. Certified shop and erection drawings.
 2. Shop drawing data for accessory items.
 3. Templates or certified setting plans, with tolerances, for anchor bolts.
 4. Manufacturer's literature as needed to supplement certified data.
 5. Operating and maintenances instructions and spare parts lists.
 6. Listing of reference installations as specified with contact names and telephone numbers.
 7. Qualifications of field service engineer.
 8. Shop and field inspections reports.
 9. Recommended spare parts other than those specified.
 10. Recommendations for short- and long-term storage.
 11. Special tools.
 12. Shop and field-testing procedures and equipment to be used.
 13. Provide a listing of the materials recommended for each service specified and indicated.

1.3 SPARE PARTS:

- A. Provide spare parts that are identical to and interchangeable with parts installed.

1.4 QUALITY ASSURANCE:

- A. Diffusers to be manufacturer's standard cataloged product and modified to provide compliance with the specification and the service conditions specified and indicated.

1.5 DELIVERY, STORAGE AND HANDLING:

- A. Provide in accordance with Section 01 66 00 and as specified.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION:

- A. Coarse bubble diffuser system having no moving parts
- B. Minimum aeration system configuration requirements are indicated on the drawings and specified herein for coarse bubble diffusers.
- C. Shall be clog resistant and designed for harsh environments.

2.2 ACCEPTABLE MANUFACTURERS:

- A. EDI MaxAir SS Diffuser
- B. SSI Wide Band Diffuser

2.3 SERVICE CONDITIONS:

- A. Service Conditions: Primary Effluent.
- B. Provide diffuser elements to operate at the maximum pressure indicated when new. Maximum pressure is defined as the pressure measured from a point inside the upper drop pipe to atmosphere corrected to standard conditions.

2.4 PERFORMANCE REQUIREMENTS:

- A. Mixing: Uniform throughout. Provide sufficient number of diffusers to meet mixing demand of 30 SCFM per 1000 cubic feet.

2.5 GENERAL:

- A. Materials: Diffuser assembly consisting of stainless steel diffuser element, connection to diffuser manifold, supports and appurtenances.
- B. Diffuser shall have no moving parts or maintenance items below water surface.

2.6 DIFFUSER ASSEMBLIES:

- A. Provide diffuser assemblies that consist of a coarse air diffuser and fastening device.
- B. Provide diffusers free of voids, tears, bubbles, creases, or other structural defects.

2.7 SUPPORTS:

- A. Provide supports as specified, indicated, and required to secure coarse air system in place as recommended by manufacturer.

2.8 PRODUCT TESTING AND QUALITY CONTROL:

- A. Test all diffusers in clean water, running the system with 6 inches of water over the diffusers to monitor the air distribution. Check for blocked diffusers or any other problem with the air distribution.

PART 3 EXECUTION

3.1 INSTALLATION:

- A. Install items in accordance with manufacturer's printed instructions and as indicated and specified.
- B. Follow equipment manufacturer's recommendations for sequencing of equipment installation:
 - 1. Layout and install supports in accordance with manufacturer's instructions and anchor setting plan.
- C. Clean air header pipe, mains, submains, distribution headers, blowers, filters, and drop legs prior to installing diffuser elements:
 - 1. Install diffusers and their fastening devices.
 - 2. Protect diffusers from unpressurized submergence in wastewater.

3.2 FIELD PERFORMANCE TESTING AND INSPECTION:

- A. Mounting tests:
 - 1. Test support and tie-down provisions of stainless steel diffuser piping to ensure a margin of safety of 10 against calculated buoyant forces.
- B. Inspection of Piping: Inspect piping for proper joints, supports and tie-downs, end plugs and drain relief valves.
- C. Leakage Tests:

1. Introduce clear water into the basin after cleaning and completion of installation.
2. Admit compressed air to the system when diffusers covered by about 2 inches of water.
3. Inspect all piping for leakage and make necessary repairs.
4. Demonstrate a watertight system to the satisfaction of **Engineer**.

3.3 CONTRACT CLOSEOUT:

- A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 46 51 31 - FLEXIBLE MEMBRANE TUBE FINE BUBBLE DIFFUSERS

PART 1 GENERAL

1.1 DESCRIPTION:

- A. This section includes requirements for design, manufacture, installation, and start-up of flexible tubular fine bubble diffusers including in-basin aeration components as shown on the drawings and specified in this section.
- B. Provide and test entire aeration and piping systems including air mains, drop legs, manifolds, distribution headers, fine bubble air diffuser assemblies, expansion joints, support components.
- C. The aeration system manufacturer shall hold all responsibility for the complete aeration system supply and installation of in-basin piping, diffuser assemblies and support components.
- D. The Contractor shall hire a qualified sub-contractor with specific installation experience of aeration systems, or subcontract directly with the aeration system manufacturer for installation, testing, and start-up of the diffusers.

1.2 REFERENCES:

- A. American Society for Testing and Materials (ASTM):
 - 1. A240/A240M: Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - 2. A530: Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe.
 - 3. A554: Specification for Welded Stainless Steel Mechanical Tubing.
 - 4. D573: Standard Test Method for Rubber Deterioration in an Air Oven
 - 5. D2564: Solvent Cements for Poly Vinyl Chloride (PVC) Plastic Piping Systems
 - 6. D2855: Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
 - 7. D2241: Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings

8. D3915: Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds for Plastic Pipe and Fittings Used in Pressure Applications
- B. American Iron and Steel Institute (AISI):
 1. Specification for Type 316L.
- C. ASCE Oxygen Transfer Standards.
- D. Mil. Std. 105-D.

1.3 SUBMITTALS:

- A. Shop Drawings: Submit the following in accordance with Section 01 33 00
 1. Certified shop and erection drawings.
 2. Data, regarding diffuser characteristics and performance, to include complete headloss calculation for the aeration equipment from the manufacturer's point of responsibility and certified oxygen transfer performance curves.
 3. Shop drawing data for accessory items.
 4. Templates or certified setting plans, with tolerances, for anchor bolts.
 5. Manufacturer's literature as needed to supplement certified data.
 6. Operating and maintenances instructions and spare parts lists.
 7. Listing of reference installations as specified with contact names and telephone numbers.
 8. Qualifications of field service engineer.
 9. Shop and field inspections reports.
 10. Recommended spare parts other than those specified.
 11. Recommendations for short- and long-term storage.
 12. Special tools.
 13. Shop and field-testing procedures and equipment to be used.
 14. Number of service man days provided and per diem field service rate.

15. Provide a listing of the materials recommended for each service specified and indicated.
- B. A copy of the contract mechanical process, electrical and instrumentation drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes for the equipment proposed for this specification section. If no changes are required, mark all drawings with "No Changes Required" or provide a statement that no changes are required.
 1. Failure to include all drawings or a statement applicable to the equipment specified in this section will result in submittal return without review until a complete package is submitted.
- C. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations and clarifications from the specified requirements.
 1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.
 2. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specifications and justifications are submitted in a complete package.

1.4 SPARE PARTS:

- A. Provide spare parts that are identical to and interchangeable with parts installed.
- B. Furnish and deliver the following spare parts:
 1. Quantity of complete diffuser assemblies amounting to 5 percent of the total installed.
 2. One (1) pressure gauge (0-10 psi) mounted on a female end quick disconnect for use with the pressure monitoring system.
 3. One (1) hand type air pump with female quick disconnect suitable for clearing pressure monitoring lines.

1.5 QUALITY ASSURANCE:

- A. Diffusers, aeration system piping and appurtenances to be the product of one manufacturer.

- B. Diffusers to be manufacturer's standard cataloged product and modified to provide compliance with the specification and the service conditions specified and indicated.
- C. Welding: In accordance with American Welding Society Code or equivalent.
- D. Provide services of factory-trained service technician, specifically trained on type of equipment specified:
 - 1. Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.
 - 2. Functional Testing: Calibrate, check alignment and perform a functional test with water. Tests to include all items specified.
 - a. 2 person-days.
 - 3. Field Performance Testing: Field performance test equipment specified.
 - a. 2 person-days.
 - 4. Vendor Training: Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classrooms sessions.
 - a. 1 person-day.
 - 5. Credit to the Owner, all unused service person-days specified above, at the manufacturer's published field service rate.
 - 6. Any additional time required of the factory trained service engineer to assist in placing the equipment in operation or testing, or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the Owner.
- E. Manufacturer of diffusers must have at least five (5) operating installations with systems of the size specified and in the same service as specified operating for not less than five (5) years.

1.6 DELIVERY, STORAGE AND HANDLING:

- A. Provide in accordance with Section 01 66 00 and as specified.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION:

- A. Tapered fine bubble membrane type diffuser system.
- B. Process operating mode:
 - 1. Modified Ludzack-Ettinger Process
- C. Minimum aeration system configuration requirements are indicated on the drawings and specified herein for fine bubble tube diffusers.

2.2 ACCEPTABLE MANUFACTURERS:

- A. EDI
- B. SSI

2.3 SEISMIC DESIGN REQUIREMENTS:

- A. Conform to the requirements indicated on the structural drawings and as specified in Section 01 41 20 – Seismic Requirements for Non-Structural Components.
- B. It shall be the responsibility of manufacturer and supplier along with the Contractor to conform to the seismic design requirements for this project and for the work of this specification section.
- C. Provide all equipment bases, anchorage, supports and foundations designed in accordance with the seismic requirements indicated and specified.
- D. Additionally, provide with the Certificate of Unit Responsibility, certification for all equipment signed by a registered structural engineer stating that computations were performed and that all components have been sized for the seismic forces specified and indicated.

2.4 SERVICE CONDITIONS:

- A. Provide drop leg pipe, manifold, distribution headers, diffuser elements, and airflow control orifice to operate at the maximum pressure indicated when new. Maximum pressure is defined as the pressure measured from a point inside the upper drop pipe to atmosphere corrected to standard conditions.
- B. Provide sufficient number of diffusers to meet SOTR demands listed in Paragraph C. Installation shall include an additional number of diffuser blanks equal to 10 percent of the total number of diffusers installed in each zone.

- C. Provide the following tube diffuser grids for Aeration Zones 1 through 3 in Aeration Basins 1 through 4.
1. No. of Reactors: 4 basins x 3 zones: 12 total reactors, each 48 ft long x 20 ft wide
 2. Standard Oxygen Transfer Rate (SOTR), Standard Oxygen Transfer Efficiency (SOTE), airflow, number of diffusers, and system configuration shown are based on the following:

TABLE 46 51 31-01 Maximum Month Summer Day at 26°C							
	SOTR (lbs/day)	Diffuser Submergence (ft)	Dissolved Oxygen Conc. (PPM)	Max Airflow/Diff user (SCFM)	Min SOTE (%)	Airflow (SCFM)	Minimum Membrane Effective Area
Zone 1	575	16.25	2.0	7.0 to 15.8	32	1,597	450 to 640
Zone 2	402	16.25	2.0	6.5 to 14.1	32	1,189	355 to 430
Zone 3	298	16.25	2.0	5.7 to 11.7	32	889	200 to 300
Total per Basin	1,275	---	---	---	---	3,675	---
Bains in Service	4	---	---	---	---	4	---
Total	5,102	---	---	---	---	14,700	---

TABLE 46 51 3144 42 13 03-02 Peak Summer Hour at 26°C					
	SOTR (lbs/d)	Diffuser Submergence (ft)	Dissolved Oxygen Conc. (PPM)	Airflow (SCFM)	Minimum Membrane Effective Area (sf)
Zone 1	380	16.25	0.5	1,051	450 to 640
Zone 2	281	16.25	0.5	795	355 to 430
Zone 3	187	16.25	0.5	568	200 to 300
Total per Basin	848	---	---	2,414	---
Bains in Service	4	---	---	4	---
Total	3,392	---	---	9,656	---

TABLE 46 51 31-03-03 Minimum Winter Conditions 13°C					
	SOTR (lbs/d)	Diffuser Submergence (ft)	Dissolved Oxygen Conc. (PPM)	Airflow (SCFM)	Minimum Membrane Effective Area (sf)
Zone 1	274	16.81	2.0	694	450 to 640
Zone 2	112	16.81	0.5	281	355 to 430
Zone 3	99	16.81	0.5	277	200 to 300
Total per Basin	485	---	---	1,252	---
Bains in Service	4	---	---	4	---
Total	1,940	---	---	5,008	---

2.5 GENERAL:

A. Materials:

1. Type 316L Stainless steel drop pipes to limit indicated.
2. PVC or stainless steel manifold and distribution headers pipes.
3. Diffuser assembly consisting of membrane diffuser element and connection to diffuser manifold.
4. Flexible HDPE drainline, sump and airlift purge system.
5. Expansion joints and fixed joints.
6. Bolts, nuts and gaskets for flanged joints.
7. Type 316 Stainless steel supports and anchor bolts.
8. DWP monitoring system.

- B. The quantities and arrangement of air diffusers indicated is based on 3-inch diameter membrane tube type diffuser system. Use of other sizes, diameters, and/or other types of diffusers requiring different quantities and arrangements to meet specified performance, are not acceptable.

2.6 STAINLESS STEEL MATERIALS AND FABRICATION:

- A. Fabricate all welded parts and assemblies from sheets and plates of Type 316L stainless steel with a 2D finish conforming to AISI 316L and ASTM A240-78a.
- B. Fabricate nonwelded parts and pieces from sheets and plates of Type 316 stainless steel conforming to AISI 316 and ASTM A240-78a.
- C. Fabricate stainless steel piping in accordance with ASTM A778 and stainless steel fittings in accordance with ASTM A774.
- D. Provide upper drop legs of the diameter shown on the Drawings with dimensional tolerances conforming to ASTM A554 and ASTM A530 with a minimum nominal wall thickness of 0.109-inch.
- E. Welding:
 - 1. Do all welding in the factory using shielded arc, inert gas, MIG or TIG method.
 - 2. Add filler wire to all welds to provide for a cross section and weld metal thickness equal to or greater than the parent metal.
 - 3. Fully penetrate butt welds to the interior surface and provide gas shielding to interior and exterior of joint.
 - 4. Interior weld beads shall be smooth, evenly distributed with an interior projection not exceeding 1/16-inch beyond the ID of the air header or fittings.
 - 5. Continuously weld both sides of face rings and flanges.
 - 6. Field welding will NOT be permitted.
- F. Corrosion protection and finishing:
 - 1. Passivate all welded stainless steel fabrications by using the following procedure:
 - a. Wire brush all outside weld areas to remove weld splatter. Brushes shall be of stainless steel and used only on stainless steel.
 - b. Remove all carbon deposits, greases, and oils by pickling and neutralization to aid the regeneration of a uniform corrosion resistant, chromium oxide film.

- c. Completely immerse all stainless steel assemblies and parts after welding and brushing in a pickling solution of 6 percent nitric acid and 3 percent hydrofluoric acid at 60 degrees C for a minimum of 15 minutes. Parts shall be free of iron particles or other foreign material after this procedure.
 - d. Neutralize all stainless steel assemblies and parts previously pickled by immersion in a trisodium phosphate rinse.
- G. Provide all nuts, bolts, and washers including anchor bolts in Type 316 stainless steel.

2.7 PVC MATERIALS AND FABRICATION:

- A. Produce all PVC moldings and extrusions from PVC compound conforming to ASTM D3915, compound cell classification 124544 with a minimum tensile strength of 7,200 psi.
- B. Blend UPVC resins and limit amount of fillers to achieve a minimum "K" value of 58 for fittings and a minimum "K" value of 64 for pipe.
- C. Provide Schedule 80 lower drop legs and manifolds of the diameter shown on the Drawings. Transition from Type 316L stainless steel drop leg to Schedule 80 PVC shall be 2 feet-0 inches above centerline of manifold.
- D. Provide PVC fittings as shown on the Drawings conforming to ASTM 2241.
- E. Add up to two parts by weight of titanium dioxide per 100 parts of resin to PVC compounds be used for air lateral piping to minimize ultraviolet light degradation.
- F. Solvent Welding:
 - 1. Solvent weld all PVC joints in the factory in accordance with ASTM 2241 except edges need not be chamfered.
 - 2. Do all solvent welding with solvent cements specifically formulated for use with PVC in accordance with ASTM D2564.

2.8 AIR MANIFOLD PIPING:

- 1. Out-of-basin air piping including blower manifold, air header, and header stubs are required and are to be supplied and installed by the Contractor.
 - a. Header stubs shall extend to the inside top of the wall and terminate with a full diameter, horizontal face flange.

- b. The Contractor shall provide an isolating/balancing valve for control and distribution of air to the aeration grid and to allow isolating of the grid for inspection and maintenance on the header stub.
 - c. Isolation/balancing valve shall be positioned for accessibility from the top of the tank.
- 2. Drop pipe shall be provided with a flanged top connection and plain end.
 - a. Drop pipe shall extend from the top connection to within 2 feet of the air manifold.
 - b. Material of construction for the drop pipe shall be schedule 40, stainless steel.
 - c. Drop pipe shall connect to air manifold piping by means of a wrap-around clamp adapter.
- 3. All submerged manifolds and header components shall be Schedule 80 PVC minimum.
 - a. Use of PVC piping shall only be employed when the expected mean wall temperature is less than 140°F. If temperature exceeds this limit, alternate materials shall be used or cooling loops added until the temperature is at the appropriate level.
 - b. Use of PVC piping shall only be employed when diffuser mounting system reinforces pipe wall at each mounting location.
 - c. Use of non-reinforced diffuser connections including threaded diffuser mounts is not acceptable.
- 4. Pipe supports shall be all stainless-steel construction.
 - a. Supports shall accommodate longitudinal movement in the piping components due to the thermal expansion and contraction over a temperature range of 100°F.
 - b. Supports shall restrain the axial and rotational movement of the pipe while providing for unrestrained longitudinal movement.
 - c. Supports shall allow leveling of the air piping with 2-inch minimum vertical adjustment at each support.
 - d. Each pipe support shall be connected to basin floor by at least 2 anchor bolts.

- e. The integrated pipe support assembly shall be designed to withstand the associated uplift force of the piping and diffuser assemblies with a minimum design factor of safety equal to ten (10).
- B. Provide a stainless-steel upper drop leg section from the air main connection as shown on the Drawings:
 - 1. Provide an ANSI-150-lb drilled flanged connection at the top of the drop leg as shown.
 - 2. Provide a plain end for the lower end of the drop leg. Connect upper section of drop leg to lower PVC section with a Type 316 stainless steel band coupling.
 - 3. Support drop leg with Type 316L stainless steel type supports.
- C. Provide PVC manifold piping as indicated perpendicular to the distribution header air piping:
 - 1. Furnish manifolds of the same nominal pipe sizes as associated drop legs and as indicated on the Drawings.
 - 2. Fabricate manifolds in sections up to 20 feet in length. Join manifold sections with ANSI 150-lb (PN10) drilled flanges and gaskets, or Type 316 stainless steel band couplings.
 - 3. Support manifolds with Type 316L stainless steel supports. Maximum spacing between supports shall not exceed 8 feet. Design manifold connections and supports to resist thrust generated by expansion or contraction of the lateral piping. Provide supports as described in this specification.
 - 4. Fabricate manifold piping with 6 to 10-inch diameter fixed joint connections to each distribution header pipe:
 - a. Furnish manifolds with minimum schedule 40 PVC or schedule 5 stainless steel dimensions when stub to submain connection is reinforced with a solvent welded saddle tee.
 - b. Furnish manifolds with Schedule 80 dimensions when stub to manifolds connection is unreinforced.
 - 5. Furnish manifolds for long-term exposure to 130 degrees F. mean-wall temperatures.

- D. Provide 4", 6", 8", or 10" diameter schedule 80 PVC or schedule 5 stainless steel air distribution header piping as shown on Drawings perpendicular to the air submain:
 - 1. Fabricate distribution header piping in sections up to 23 feet in length. Join sections of lateral piping with fixed joints or expansion joints.
 - 2. Support each section of distribution header piping with a minimum of two supports having a maximum spacing of 7 feet-6 inch.
 - a. Locate distribution header piping supports at approximately 1/4 span to coincide with the zero bending moment point.
 - b. Distribution header piping supports, or guides, shall allow longitudinal movement of the lateral section to prevent stress buildup in the lateral due to thermal expansion/contraction forces. Guides that clamp or grip the lateral will be unacceptable.
 - c. Provide supports as specified in paragraph 2.08.

2.9 DIFFUSER ASSEMBLIES:

- A. Provide diffuser assemblies that consist of a nominal 3 inch dia. EPDM tube membrane diffuser, and fastening device. Provide diffusers composed of EPDM elastomer resistant to attack by common municipal wastewater. EPDM material to meet the requirements of ASTM D-573.
- B. Provide diffusers free of voids, tears, bubbles, creases, or other structural defects.
- C. Dynamic wet pressure of the diffuser element: Between 8.2 and 8.6 inches of water column when operated at 1.0 SCFM. Dynamic wet pressure is the pressure required to operate the diffuser in tap water at the specified flow rates minus any losses for submergence and flow control devices.
- D. Membrane shall be elastic and allow openings to close when the air supply is interrupted.
- E. Membrane shall contract and close around full diameter support frame.
- F. Membrane shall employ a non-perforated section that is aligned and seals against the support frame, air distribution orifices.
- G. Membrane material for the diffuser unit shall be EPDM.
 - 1. Alternate membrane materials are not acceptable.

H. Membrane shall be extruded in a single piece with perforations.

1. All manufacturer standard perforation patterns are acceptable.

2.10 SUPPORTS:

A. Provide supports as specified, indicated, and required.

1. Use of non-full diameter mechanical connections including threaded connections is not acceptable.
2. The diffuser membrane shall be held in place by two 304 stainless clamps.

B. Manifold Supports:

1. Provide manifold supports as indicated or required by the manufacturer and as specified.
2. Submain supports shall include manifold hold-down and guide straps mounted on anchor bolts attached to tank floor in accordance with equipment manufacturer's recommendations.
3. Guide straps shall be designed to resist the following uplift without exceeding specified design stress. Submain guide straps to be minimum 2-inches wide:

<u>Manifold Diameter, inch</u>	<u>Uplift force per support lbs.</u>
4, 6 and 8	325

4. Submit certification prepared by a registered or licensed professional structural engineer in the state of Washington to show compliance of support design.
5. Provide supports with a mechanism to provide for plus or minus 2 inches vertical and 1/2-inch lateral adjustment for alignment of the manifold in the field.
6. Manifold supports with a pipe centerline of 22 inches or higher shall require a diagonal stainless steel support strut for additional support rigidity.

C. Distribution Header Piping Supports:

1. Provide stainless steel distribution header piping supports as specified.
2. Fixed supports shall consist of a hold-down mechanism and self-limiting clamp device:

- a. Hold-down mechanism and clamp shall provide a 1-1/2 inch wide contoured bearing surface for the air distribution header piping and end of tubes.
 - b. Clamping device shall positively grip the air distribution header piping and tube down when tight and be self-limiting to prevent overstressing the pipe if the clamp is overtightened.
3. Intermediate guide supports shall consist of a self-limiting hold-down and sliding mechanism:
 - a. Hold-down and sliding mechanism shall provide a 1-1/2 inch wide contoured bearing surface with chamfered leading edges to maintain contour of the air distribution header piping.
 - b. Sliding mechanism shall provide minimum resistance to movement of the air distribution header under full buoyant uplift load. Mechanism shall provide 1/8 inch clearance around piping and be self-limiting if the mechanism is overtightened.
 - c. Maximum horizontal thrust of 20 lbs or less shall initiate movement of the piping relative to the mechanism under full buoyant uplift load.
4. Provide supports with a mechanism to provide for plus or minus 1-1/2-inch vertical adjustment for alignment of the air distribution header piping in the field.
5. Adjusting and aligning mechanism shall be infinitely adjustable within its limits to allow precise leveling of the air distribution header piping and diffuser assemblies to within +/- 3 mm of a common horizontal plane without removing the piping from the support.
6. Fixed and guide distribution header piping supports shall have sufficient strength to resist both axial and lateral loads of 140 lbs. applied 6 inches above the base without deflecting more than 1/2-inch.
7. Anchor supports to tank floor with one stainless steel wedge anchor bolt designed for embedment in 3,000 psi concrete:
 - a. Design wedge anchors with a pullout strength, factor of safety of 4 or more.
 - b. Static load test 1% of all anchorage assemblies as hereinafter specified.

2.11 EXPANSION JOINTS AND FIXED JOINTS:

- A. Provide a PVC expansion system to prevent thermally induced stresses due to expansion and contraction over a temperature range of 125 degrees F. All expansion joints shall be airtight and permit free and easy movement of the plain end of the pipe within the coupling barrel.
- B. Expansion joints shall consist of a barrel section solvent welded to one end of the lateral pipe, an O-ring gasket and a threaded, screw-on retainer ring. Expansion couplings shall meet the following criteria:
 - 1. Minimum stroke - 4 inches.
 - 2. Average force to operate - 50 lbs.
- C. Fixed joints shall consist of a spigot section solvent welded to one end of a distribution lateral, a threaded socket section solvent welded to the mating distribution lateral, an O-ring gasket, and a threaded screw-on retainer ring.

2.12 DRAINLINE, SUMP, AND AIRLIFT PURGE SYSTEM:

- A. Furnish a PVC drainline, sump, and airlift purge system to drain the entire submerged aeration piping system for each aeration diffuser grid.
- B. Construct each aeration grid with an integral 4-inch diameter drainline terminating at a sump. The sump bottom elevation shall be lower than the invert of the air distribution header piping and drainline:
 - 1. Connect drain sump to 3/4-inch diameter airlift eductor line extending to the drainline invert elevation. Extend airlift eductor to a point 18 inches above the basin water level and terminate with a PVC ball valve.
 - 2. Support airlift eductor with Type 316L stainless steel brackets at walkway or platform beam location.
- C. Systems using drainlines at the ends of the aeration grids shall be provided with a combination support/thrust anchor at each header-drainline connection to prevent joint blow-apart.

2.13 DIFFUSER PRESSURE MONITORING SYSTEM:

- A. Furnish monitoring equipment to measure dynamic wet pressure (DWP) and diffuser air flow of a typical diffuser in each type of diffuser aeration grid (12 per aeration tank).

- B. Furnish one portable routine maintenance pressure monitoring panel. The panel shall be housed in a fiberglass NEMA 4X enclosure, suitable for hand carrying and contain the following equipment components:
 - 1. Orifice and diffuser differential pressure gauges.
 - 2. Bubble pipe blow-down valve.
 - 3. Bubble pipe air flow rotameter.
 - 4. Quick coupling connectors.
 - 5. Polypropylene fittings.
 - 6. Polyethylene fittings.
 - 7. One set of pressure monitoring instructions complete with calibration curves.
 - 8. Mounted to the enclosure shall be a stainless steel hanger device of a design suitable to hang the enclosure on the handrail.
 - 9. The portable panel dimensions shall be a minimum 14 inches high x 10 inches wide.
- C. Monitoring system to be suitable for either gas or liquid cleaning systems

2.14 PRODUCT TESTING AND QUALITY CONTROL:

- A. Prior to initiation of production, submit a testing plan designed to insure consistently good quality and uniformity of the diffuser assemblies, including a sampling plan. After testing, all diffusers tested shall be marked with their test results.
- B. Test diffusers in a plan designed to give 95 percent confidence that the diffusers meet the quality control requirements listed below. Submit a test plan designed to meet the above requirements. The testing plan to be in accordance with Mil. Standard 105D, AQL Level 1.5, Double Normal Sampling.
- C. Test all diffusers in accordance with the sampling plan to insure uniformity. Uniformity is defined as substantially even distribution of air bubbles when the diffuser is submerged and operating at 1.0 SCFM.
- D. Test all diffusers in accordance with the sampling plan for dynamic wet pressure. Dynamic wet pressure is defined as the pressure loss across the diffuser when operated at a specific airflow minus any pressure for orifice headloss or diffuser

submergence. The dynamic wet pressure must be between 14 and 16 inches of water column when operated at 1.0 SCFM.

- E. Inspect all diffusers in accordance with the sampling plan to insure compliance with dimensional tolerances.
- F. Oxygen Transfer Test:
 - 1. Perform a shop oxygen transfer test per latest ASCE Standard "Measurement of Oxygen Transfer in Clean Water".
 - a. Perform tests at the actual water depth, submergence, diffuser density and air rate per diffuser as that proposed for the full scale tank.
 - b. Perform tests at design diffuser density specified in the manufacturer's Owner approved shop drawing submittal. The diffusers must meet the specified SOTE for maximum month conditions specified in the materials section diffuser design tables provided in this Specification.
 - 2. Clean tank in which diffusers are tested and then fill with fresh tap water. Care must be taken to avoid any contamination of test water with chemicals used for tank cleaning.
 - 3. Temperature of the fresh water, if possible, shall be 20 degrees C.
 - 4. Station sampling points at different points throughout geometry of tank to give true effective cross sample within tank. Minimum of six samples are required per test. If submerged tank is used individual sample pumps must be used for each sample. Run sample pumps continuously to insure representative samples. Take samples concurrently and of equal volumes. To facilitate above, all pumps and lengths of tubing to be identical. In tank dissolved oxygen probes can be used if desired.
 - 5. A rotameter, orifice plate or similar device is installed to measure air flows. This apparatus sized such that flows to be measured are all within range of accuracy.
 - 6. Dissolve and mix catalyst, cobalt chloride or cobalt sulfate, into tank contents. Cobalt concentration of 0.05 - 0.25 mg/l and measured prior to initial run and immediately after final run.
 - 7. While mixing, release a deoxygenating solution of sodium sulfite into tank contents of at least two different locations. Sodium sulfite reagent grade by Fisher or Mallincrodt or Santosite as manufactured by Monsanto to insure no build-up of cobalt ion concentration. Sodium sulfite added at 1.5

times stoichiometric requirements or approximately 12 mg/l sodium sulfite per mg/l of tank D.O. to provide excess for oxidation during mixing.

8. Calculations: Provide all calculations relating to field oxygen transfer efficiency. Calculations shall be based on the ASCE Non-Linear Regression Method.
9. A maximum of ten test runs made on any tank full of water.

PART 3 PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Clean air header pipe, mains, submains, distribution headers, blowers, filters, and drop legs prior to installing diffuser elements:
 1. Install tubes and their fastening devices.
 2. Protect diffuser tubes from unpressurized submergence in wastewater.

3.2 FIELD PERFORMANCE TESTING AND INSPECTION:

- A. Mounting tests:
 1. Test support and tie-down provisions of PVC diffuser piping to insure a margin of safety of 10 against calculated buoyant forces. Test support and tie-down system of PVC header piping to insure a margin of safety of 2 against calculated buoyant forces.
 2. Upon installation of supports and prior to installation of piping, test all supports of each type with no less than 10 percent of supports of each type, chosen at random to be witness tested by Engineer. Tests shall be conducted on a complete support assembly including anchor bolt, hold-down mechanism, and clamp by inserting a 6-inch diameter metal pipe specimen in the assembly attached to a lever which is placed on a fulcrum. Apply a static load to the opposite end of the lever to produce a vertical extracting force on the complete support assembly equal to 180 lb. or four times the calculated maximum buoyant force that the support assemblies will be subjected to during normal operation.
- B. Inspection of Piping: Inspect piping for proper joints, supports and tie-downs, end plugs and drain relief valves.
- C. Level Test: Flood tanks with clean water to top of dome diffusers. Check level of diffusers to verify same elevation within +1/8-inch.

D. Leakage Tests:

1. Introduce clear water into the basin after cleaning and completion of installation.
2. Admit compressed air to the system when diffusers covered by about 2 inches of water.
3. Inspect all piping for leakage and make necessary repairs.
4. Demonstrate a watertight system to the satisfaction of Engineer.

END OF SECTION

SECTION 46 53 70 - FIBERGLASS REINFORCED PLASTIC BAFFLE WALL

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

The work covered by this section shall include materials and installation for the slide guide fiberglass reinforced plastic (FRP) Baffle Wall System as shown on drawings, which includes but is not limited to:

- A. FRP baffle wall panels
- B. FRP columns
- C. FRP angles
- D. Column clip angles
- E. Fasteners and connections

1.2 QUALITY ASSURANCE

- A. Contractor shall be responsible for verifying all field dimensions for development and approval of manufacturer's drawings.
- B. Baffle system components (excluding any associated concrete items) shall be provided by a single manufacturer to insure coordination and compatibility of parts.
- C. Manufacturer of baffle wall system shall have full responsibility for products and design. Split responsibility of materials or design is not acceptable.
- D. The supplier of the baffle wall system must be the manufacturer and fabricator of the fiberglass components utilized on this pre-engineered baffle wall system. The supplier and manufacturer of the fiberglass components shall take full responsibility for the products, materials and design. In addition, a certification letter from the manufacturer identified to be the material source shall state that the manufacturer takes full responsibility for the design and use of the products specified. No split responsibility of the product manufacturing, fabrication, design or quality of the fiberglass components purchased by the contractor from a manufacturer shall be acceptable, implied or expressed, with regard to the baffle wall system provided on this project.
- E. Manufacturer of baffle wall system shall have completed within the last five years a minimum of five (5) projects of similar type as those required in this scope.
- F. Manufacturer must be ISO9001 certified, and manufacturer and fabricate all of the FRP components in its own facility.

1.3 PERFORMANCE TESTING

- A. Materials shall comply with Federal and Local laws or ordinances, applicable codes, standards, regulations, and/or regulatory agency requirements including:
 - 1. ASTM D 638, Standard Test Method for Tensile Properties of Plastics
 - 2. ASTM D 790, Standard Test Method for Flexural Properties of Plastics
 - 3. ASTM D 570, Standard Test Method for Water Absorption of Materials
 - 4. ASTM D 256, Standard Test Method for Izod Impact (Notched)

1.4 DESIGN CRITERIA

Design load, considered as uniform loading over the entire wall, should include fluid flow pressure plus any dynamic pressure associated with mechanical equipment. Actual load requirements, which vary with process, should be specified by the Design Engineer.

- A. Design Load: The load for design shall be the greater of water differential or wind load but not a combination of the two.
 - 1. Water Differential: 2 Inches H₂O. (Considered as a uniform load over the entire wall)
 - 2. Mass Differential: 0 psf (load variance from one aeration zone to another side of a wall due to operating load variances or startup/downcycle of aeration zones)
 - 3. Wind Load (if applicable): 41 Lbs./SF Uniform Load (ultimate design wind pressure determined per ASCE 7)
- B. Deflection Limits and Factors of Safety
 - 1. Baffle Panels: $L/D = 90$ (not to exceed 2.75"); Factor of Safety = 2.0
 - 2. Columns: $L/D = 108$, Factor of Safety = 2.3

1.5 SUBMITTALS

Submittals shall comply with Section 01 33 00 and shall include, but not be limited to:

- A. Drawings including layouts; connection and framing details; fastener types and spacing; product description, and installation guidelines.
- B. Material certifications.

PART 2 PRODUCTS

2.1 MANUFACTURER(S)

- A. The standard for design, characteristics, and performance shall be based on materials and components provided by:

1. Enduro Composites, Inc., (713) 358-4000, www.endurocomposites.com.

2.2 MATERIALS

FRP Baffle Panels, Columns, Angles and Slide Guide Angle End Attachments

- A. Baffle panels, FRP columns, FRP angles, and associated components shall be ANSI/NSF Standard 61 certified.

1. Certification shall be by an approved, independent third party and in the Baffle Manufacturer's own name.
2. Certifications of raw materials, not in the Baffle Manufacturer's name, shall not be acceptable.
3. Each fiberglass component used in the baffle wall system, including baffle panels, channels, beams, structural framing, angles, and other components, shall have third party certification for ANSI/NSF Standard 61. Individual fiberglass baffle components shall also be rated in accordance with ANSI/NSF Standard 61 to a designated maximum surface area to volume ratio of 490 sq cm/L or more. If the ratio rating for any individual part does not meet the surface to volume ratio specified herein, Manufacturer shall also submit a stamped calculation for engineer approval to meet or exceed the specification intent.

- B. FRP structural materials shall exhibit these minimum physical properties:

Tensile Strength	48,000 psi	ASTM D 638
Flexural Strength	58,000 psi	ASTM D 790
Flexural Modulus	2,00,000 psi	ASTM D 790
Izod Impact (Notched)	25	ASTM D 256
Water Absorption	0.25% maximum	ASTM D 570

- C. FRP Baffle Panels

1. FRP baffle panels shall be a ribbed profile in 2.75" depth x 24" height coverage (full panel dimension).
2. FRP baffle panels shall be a minimum of 1/4" (.25 inch) thick.

3. Header beam is not allowed within 12-inches of the top of the FRP baffle wall.
4. FRP baffle panels shall have (top) horizontal ribs that slope downward not less than 10 degrees to minimize sediment build-up.
5. FRP baffle panels shall be designed to slide into structural guides at each panel end. Only bolting of every 5th panels is required.
6. FRP baffle panels shall comply with the structural requirements in Paragraph 1.4.
7. FRP material shall include glass fiber reinforcements 50% (minimum) of the material weight embedded within UV Stabilized Polyester Resin. Color shall be standard gray.
8. FRP material shall have a surfacing veil on both top and bottom sides.
9. Factory cut edges and drilled holes shall be sealed with ANSI/NSF approved material.

D. FRP Structural Framing / Angles

1. FRP framing shall comply with the structural requirements in in Paragraph 1.4.
2. FRP vertical columns shall be top braced to a header beam and bottom braced to the concrete floor. Cantilevered or knee brace connections are not acceptable.
3. FRP vertical columns shall have a cap fabricated from a piece of FRP flat sheet to prevent water entrapment.
4. Header beam is not allowed within 12-inches of the top of the FRP baffle wall.
5. FRP angles shall be a minimum of 3/8" (.375 inch) thickness and 90 degrees.
6. FRP Beam shall have integral slots where Baffle Panels can slide. Slots shall not be made by the use of angles bolted or glued to a FRP Beam.
7. Installing contractor shall field attach FRP angles to concrete structure.
8. FRP material shall include glass fiber reinforcements 50% (minimum) of the material weight embedded within UV Stabilized Polyester Resin. Color shall be standard gray.
9. FRP material shall have a surfacing veil on both top and bottom sides.
10. Factory cut edges and drilled holes shall be sealed with ANSI/NSF approved material.

E. Other Structural Components (if indicated on drawings)

1. Column base plates of FRP shall not be allowed.
2. Baseplates must be a full moment connection.

F. Hardware

1. Fasteners, anchorage, and other structural hardware shall be: 316 Stainless Steel to be supplied by the manufacturer.
2. All submerged anchors shall be epoxy adhesive type (size as required) rated for exterior and submerged exposure.

G. Pipe Penetrations

1. Pipe penetrations (if shown on drawings) shall be retrofitted by Contractor to penetrate tank cover at 90-degree angles.

H. Doors

1. Hinged doors (as required and detailed on the plan drawings) shall be factory fabricated by the FRP baffle system manufacturer.

PART 3 EXECUTION

3.1 MATERIAL HANDLING

- A. At the time of delivery, all materials shall be inspected for shipping damage. The freight company and the Manufacturer shall be notified immediately of any damage or quantity shortages.
- B. The Contractor shall protect FRP materials from cuts, scratches, gouges, abrasions, and impacts. When lifting crated FRP materials, spreader bars shall be used (not wire slings unless materials are fully protected). FRP components shall not be dragged across one another unless separated by a non-scratching spacer.

3.2 INSTALLATION

- A. Before placing and attaching components, the contractor must confirm the alignment and location of column base plates, surfaces, brackets, saddles, etc.. All bearing surfaces must be level, flat, clean and free of debris.
- B. Erection shall proceed according to sequence shown on the approved drawings.
- C. Contractor shall install pads, curbs or piers to modify uneven or sloped concrete surfaces to create a flat, level surface for baffle system attachment.

- D. Contractor shall field cut materials as required and shown on the Manufacturer's drawings.
- E. Contractor shall seal field cut edges with NSF approved material.
- F. Contractor shall install beams and connections as shown on the approved layout drawings. Field modifications (cuts, copes, holes, etc.) unless shown on the drawings are not allowed without the manufacturer's written approval. Shim FRP beams only with approved materials.
- G. Before placement of baffle panels, contractor shall check alignment and location of FRP framing members and existing structure.
- H. Contractor shall adjust FRP baffle panels for proper bearing and alignment.
- I. Contractor shall drill holes for fasteners through baffle panel and support beam.
- J. Contractor shall fasten baffle panels to structural supports as shown on the approved layout drawings. Unless noted otherwise, FRP baffle panels shall be attached to each support per manufacturer's recommendations with nut and bolt assemblies. Refer to manufacturer's installation instructions and drawings for proper fastener selection and procedure.
- K. Contractor shall seal field-drilled holes with NSF approved material.
- L. Contractor shall place and fasten other miscellaneous components or hardware as shown on the approved drawings.

END OF SECTION

