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CLEAR CREEK WELCOME CENTER
WEST TERRE HAUTE, INDIANA / INDOT

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PROJECT MANUAL
For construction of:

Clear Creek Welcome Center
West Terre Haute, Indiana

Public Works Project
84003001-22-058-C1

For

Department of Transportation

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SECTION 012200
MEASUREMENT AND PAYMENT / UNIT PRICES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Administrative and procedural requirements for measurement and payment for only the items pertaining to the sewer lines and lift stations in Drawing Set # 6. Provide lump sum or unit prices on the bid form provided in the front-end documents. These unit prices and totals shall be included in the base bid submitted.

B. Related sections include the following:

1. Section 01210 – Allowances, where applicable, for procedures for using unit prices to adjust quantity allowances.

1.2 DEFINITIONS

A. Lump Sum (LS): The total amount for a defined component, system, or structure of the Project, complete. Lump sum prices may be further allocated based on an approved Schedule of Values.

B. Each (EA): A Unit Price Pay Item for each of several similar or identical defined components or structures of the Project, complete.

C. Pay Item: A specifically described unit of work for which a price is provided in the contract.

D. INDOT SS: Indiana Department of Transportation Standard Specifications.

1.3 SUBMITTALS

A. Action Submittals

1. Submit three (3) signed original copies of Contractor's Application for Payment on forms provided.

B. Informational Submittals

1. Labor Standards Documentation

a. Certified Payroll for period of pay request.
b. Other documentation required by the Labor Standards provisions.

2. Stored Materials

   a. Bill of Sale, Invoice, or other documentation warranting the Owner has received the materials and equipment free and clear of all Liens.
   b. If stored off Project site:
      1) Evidence of receipt of materials and equipment by Contractor and that product is suitably stored.
      2) Evidence that the materials and equipment are covered by appropriate property insurance.

1.4 USE CHARGES

A. General: Cost or use charges for temporary facilities shall be included in the Contract Price. Allow other entities to use temporary services and facilities without cost, including, but not limited to, Owner's construction forces, Engineer, occupants of Project, testing agencies, and authorities having jurisdiction.

B. Sewer Service: Pay sewer service use charges for sewer usage by all entities for construction operations where not available from Owner’s existing sewer system.

1. For plant and water storage tankage filling, testing, and startup, sewer service use charges from Owner’s existing sewer system shall be waived for volumes equal to one and one-half of the tank volume. Additional volumes shall be paid at Owner’s standard charges.

C. Water Service: Pay water service use charges for water used by all entities for construction operations where not available from Owner’s existing water system.

1. For plant and water storage tankage filling, testing, and startup, water service use charges from Owner’s existing water system shall be waived for volumes equal to one and one-half of the tank volume. Additional volumes shall be paid at Owner’s standard charges.

D. Electric Power Service: Pay electric power service use charges for electricity used by all entities for construction operations where not available from Owner’s existing electric system.

E. Owner’s Sewer Service: Sewer service from Owner's existing sewer system, where available, shall be provided to Contractor for use without payment of use charges.

F. Owner’s Water Service: Water from Owner's existing water system, where available, shall be provided to Contractor for use without metering and without payment of use charges.

G. Owner’s Electric Power Service: Electric power from Owner's existing system, where available, shall be provided to Contractor for use without metering and without payment of use charges.

1.5 PROCEDURES

A. Pay Items include all necessary material, plus cost for delivery, installation, insurance, overhead, and profit.

B. Pay Items include all Work necessary or incidental to the satisfactory completion and commissioning of the facility or structure, including as applicable but not limited to:

1. Management and supervision of the Work.
2. Construction engineering.
3. Clearing and grubbing.
4. Site preparation.
5. Sediment and erosion control.
6. Dust control.
7. Weather protection.
8. Temporary fencing, signage, supports, working platforms, and barricades.
9. Temporary shoring and structure support.
10. Excavation, including rock excavation, unless specifically classified by a pay item.
11. Excavation and trench protection.
12. Dewatering, unless specifically classified by a pay item.
13. Bedding and foundation or trench bottom support.
14. Backfill, unless specifically classified by a pay item.
15. Unauthorized excavation, as well as remedial work directed by Engineer.
16. Utility services and connections.
17. Deposits and delivery, fuel, setup, and similar charges.
18. Site utilities, including application and connection fees, unless specifically classified as a pay item.
19. Site and surface restoration, unless specifically classified by a pay item.
20. Testing and commissioning.
21. Demonstration and training.

22. All other Work not otherwise included as a Pay Item incidental or necessary to the completion of the Work.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 LIST OF PAY ITEMS

A. Pay Item No. 1 – Mobilization/Demobilization

1. Pay Item Type: Lump Sum.

2. Description: Payment for:

   a. Purchase of required insurance and bonds.
   b. Plan of work and other preliminary project coordination.
   c. Coordination with suppliers and subcontractors.
   d. Coordination with property owners for temporary use of property.
   e. Identification of fill material and disposal sites.
   f. Preliminary construction engineering prior to moving onto project site.
   g. Pre-construction and post-construction audio-video surveys.
   h. Movement of workers and equipment to and from the Site.

3. Unit of Measurement: No measurement.

4. Payment: Mobilization/Demobilization shall not exceed five percent (5%) of the Base Bid.

   a. Bonds and mobilization shall be paid in the amount of sixty percent (60%) of the Pay Item amount with the first Pay Estimate.
   b. Demobilization shall be paid in the amount of forty percent (40%) of the Pay Item amount with the Pay Estimate at Substantial Completion.

B. Pay Item No. 2 - Maintenance of Traffic

1. Pay Item Type: Lump Sum.

2. Description: Maintenance of Traffic during execution of the Work.

3. Unit of Measurement: No measurement.

4. Payment: Payment will be made based on the proportion of time the Maintenance of Traffic is provided in relation to the scheduled time adjusted by the progress of the work necessitating Maintenance of Traffic, and as revised by any change orders.

C. Pay Item No. 3 - Erosion Control

1. Pay Item Type: Lump Sum.

2. Description: All erosion control measures described on the plans and required by authorities having jurisdiction.

3. Unit of Measurement: No measurement.

4. Payment: Payment will be made based on the proportion of time the Erosion Control is provided in relation to the scheduled time adjusted by the progress of the work necessitating Erosion Control, and as revised by any change orders.

D. Pay Item No. 4 – Structure Backfill

1. Pay Item Type: Unit Price.

2. Description: Installation of structure backfill in lieu of soil in utility trenches, classified by:

   a. Utility type.
   b. Pipe size and depth increment, where indicated.

   Pay item does not include structure backfill over water mains, water services, sewer laterals, sewer force mains, low pressure sewers, or other pay items in which structure backfill is included in the pay item description.

E. Pay Item No. 5 - Boring with Casing Pipe

1. Pay Item Type: Unit Price.

2. Description: Installation of boring casing pipe with carrier pipe, classified by:

   a. Nominal casing pipe size.

3. Unit of Measurement: Lineal foot, measured along the centerline of the pipe from end of casing pipe to end of casing pipe. Price includes installation of carrier pipe, casing spacers, and tracer wire.

4. Payment: Upon successful completion of casing pipe installation.

F. Pay Item No. 11 - Gravity Sanitary Sewers

1. Pay Item Type: Unit Price.

2. Description: Installation of gravity sanitary sewers, classified by:

   a. Nominal pipe size.
   b. Average segment depth increment.

3. Unit of Measurement: Lineal foot, measured:

   a. For length, by measurement along the centerline of the pipe from center to center of manholes adjoining each run.

b. For average depth, by measuring the difference between the sewer pipe invert and finish grade at top of casting at manholes on each end of the pipe run and calculating the average.
c. Excluding gravity sanitary sewers measured as Gravity Sewer Stream Crossings.

4. Payment:

a. Gravity Sanitary Sewers shall be paid in the amount of eighty percent (80%) of the unit price amount upon completion of gravity sanitary sewer and backfill installation.
b. Gravity Sanitary Sewers shall be paid in the amount of twenty percent (20%) of the unit price amount upon completion of gravity sanitary sewer testing.

G. Pay Item No. 12 - Gravity Sanitary Sewer Manholes

1. Pay Item Type: Unit Price, each.

2. Description: Installation of gravity sanitary sewer manholes, classified by:

a. Manhole nominal diameter.
b. Manhole depth increment.

3. Unit of Measurement: Individual manholes, with depth measured from the sewer invert to the top of casting.

4. Payment:

a. Gravity Sanitary Sewer Manholes shall be paid in the amount of eighty percent (80%) of the unit price amount upon completion of Gravity Sanitary Sewer Manhole and backfill installation.
b. Gravity Sanitary Sewer Manholes shall be paid in the amount of twenty percent (20%) of the unit price amount upon completion of Gravity Sanitary Sewer Manhole testing.

H. Pay Item No. 13 - Lift Stations

1. Pay Item Type: Lump Sum.

2. Description: Payment for the Work related to the Rest Area and Intermediate Lift Stations, including all site improvements. The electrical for the intermediate lift station shall be included in this pay item.

3. Unit of Measurement: Individual lift station sites.

4. Payment: Lump sum payment for this pay item shall be made in approximate proportion to the percent of Work completed at each lift station site.

I. Pay Item No. 14 - Sewer Force Mains

1. Pay Item Type: Unit Price.

2. Description: Installation of force mains, including tracer wire, fittings, locate wire boxes, other incidental items, structure backfill and surface restoration, including bases, pavement repairs, sidewalk repairs, curb repairs, and lawns and grasses, classified by:

   a. Nominal pipe size.

3. Unit of Measurement: Lineal foot, measured along the centerline of the pipe from center to center of fittings.

4. Payment:

   a. Sewer Force Mains shall be paid in the amount of eighty percent (80%) of the unit price amount upon completion of Sewer Force Main and backfill installation.
   b. Sewer Force Mains shall be paid in the amount of twenty percent (20%) of the unit price amount upon completion of Sewer Force Main testing.

J. Pay Item No. 15 - Sewer Force Main Connections

1. Pay Item Type: Unit Price, each.

2. Description: Connection of force mains to existing manholes, including fittings, coring, receiving manhole coating, and internal manhole drop, where specified, classified by:

   a. Connection type.
   b. Nominal pipe size.

3. Unit of Measurement: Individual connection.

4. Payment: Upon completion of installation and successful testing of force main.

K. Pay Item No. 16 - Force Main Air Release Valves

1. Pay Item Type: Unit Price, each.

2. Description: Installation of air release valves on force mains, classified by valve type and size, including connecting tees, vaults, lids, isolation valves, fittings, and appurtenances.

3. Unit of Measurement: Individual air release valves. Dual-body combination air release valves are considered a single valve.

4. Payment: Upon completion of installation and successful testing and air release valve and structure.

L. Pay Item No. 17 – Sewer Force Main Meters

1. Pay Item Type: Unit Price, each.

2. Description: Installation of meters, including meter boxes, fittings and valves, where applicable, classified by:

a. Meter sizes.

3. Unit of Measurement: Individual meters.

4. Payment: Upon completion of meter installation.

M. Pay Item No. 18 – Sewer Force Main Cleanouts

1. Pay Item Type: Unit Price, each.

2. Description: Installation of cleanouts on force mains.

3. Unit of Measurement: Individual cleanouts.

4. Payment: Upon completion of installation and successful testing of cleanout structure.

N. Pay Item No. 19 - Lawns and Grasses

1. Pay Item Type: Unit Price.

2. Description: Establishment of lawns and grasses at completion of work in an area, categorized by method of establishment.

   Pay item does not include lawns and grasses over water services, sewer laterals, sewer force mains, low pressure sewers, or other pay items in which lawns and grasses are included in the pay item description.

3. Unit of Measurement: Square yards.

4. Payment: Upon acceptable establishment of vegetation.

3.2 OTHER MATTERS

A. Unauthorized excavation, as well as remedial work directed by Engineer, shall be without additional compensation.

B. Where rock excavation is not specifically included as a pay item, all excavation shall be unclassified.

C. Where rock excavation is a pay item, excavation shall be classified. Rock excavation shall include the removal and satisfactory off-site disposal of rock materials. The Contract Sum will be adjusted for rock excavation according to unit prices included in the Contract Documents. Changes in the Contract time may be authorized for rock excavation.

D. Where underground storage tanks or hazardous environmental conditions are shown or indicated to be removed, the removal and disposal of materials or contents, removal of tanks, assessments, and tank closures shall be without additional compensation where not specifically included as a pay item.

E. INDOT SS: Where INDOT SS are referenced, the intent of the reference is not to incorporate or apply INDOT SS measurement requirements or pay items into these Contract Documents.

F. Overdue or Non-Compliant Submittals

1. Owner will retain 25 percent of the amount due on any pay application during each period in which Contractor fails to submit any of the required submittals or fails to comply with the submittal requirements, as determined by the Engineer.

    a. On subsequent pay applications in which the submittal non-conformance continues, the percentage the Owner will retain will be increased for each pay application by the rate of 25 percent per pay application.

2. Retainage for this non-conformance will be released during payment for the next pay application following the date the submittal information is brought back into compliance.

3. Retainage due to this non-conformance shall be in addition to all other retainages.

END OF SECTION 012200

SECTION 022300
SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Protecting existing trees, shrubs, groundcovers, plants, and grass to remain.
2. Removing existing trees, shrubs, groundcovers, plants, and grass.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Complete removal of above- and below-grade site improvements.
6. Disconnecting, capping or sealing, and abandoning site utilities in place.

B. Related Sections include the following:

1. Section 023000 – Earthwork for soil materials, excavating, backfilling, and site grading.
2. Section 029200 – Lawns and Grasses for finish grading, preparing and placing planting soil mixes and establishment of turf.

1.2 DEFINITIONS

A. Tree Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and defined by the drip line of individual trees or the perimeter drip line of groups of trees, unless otherwise indicated.

1.3 MATERIAL OWNERSHIP

A. Except for stripped topsoil or other materials indicated to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.4 PROJECT CONDITIONS

1. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Satisfactory Soils: AASHTO M 145 Soil Classification Groups A-1, A-2-4, A-2-5, and A-3, or a combination of these groups; free of rock or gravel larger than 2 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

B. Unsatisfactory Soils: Soil Classification Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7 according to AASHTO M 145, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

C. Provide "B" borrow soil materials in compliance with INDOT SS when sufficient satisfactory soil materials are not available from excavations.

2.2 TOPSOIL

A. Soils defined as Special Topsoil for Roadside Development in accordance with INDOT SS 914.01.

PART 3 - EXECUTION

3.1 PREPARATION

A. Locate and clearly flag trees and vegetation to remain or to be relocated.

3.2 TREE PROTECTION

A. Erect and maintain temporary fencing around tree protection zones before starting site clearing. Remove fence when construction is complete.

1. Do not store construction materials, debris, or excavated material within fenced area.

2. Do not permit vehicles, equipment, or foot traffic within fenced area.

3. Maintain fenced area free of weeds and trash.

4. Maintain lawns within fenced area.

B. Do not excavate within tree protection zones, unless otherwise indicated.

C. Where excavation is required within tree protection zones, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.

1. Cover exposed roots with burlap and water regularly.

2. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.

3. Cut roots above proposed grade where grade is being lowered.

4. Coat cut faces of roots more than 1-1/2 inches (38 mm) in diameter with an emulsified asphalt or other approved coating formulated for use on damaged plant tissues.

5. Backfill with topsoil as soon as possible.

D. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by Engineer.

1. Employ a certified arborist, a registered consulting arborist, or a registered consulting forester to submit details of proposed repairs and to repair damage to trees and shrubs.

2. Replace trees that cannot be repaired and restored to full-growth status, as determined by Engineer.

3.3 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction.

1. Do not damage or remove trees, shrubs, and other vegetation indicated to remain or to be relocated.

2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.

3. Grind stumps and remove roots, obstructions, and debris extending to below the proposed excavation depth.

4. Use only hand methods for grubbing within tree protection zone.

5. Remove and dispose of off-site.

B. Fill depressions caused by clearing and grubbing operations with soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.4 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and nonsoil materials from topsoil, including trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Limit height of topsoil stockpiles to seventy-two inches (72”).

2. Do not stockpile topsoil within tree protection zones.

3. Dispose of excess topsoil as specified for waste material disposal.

3.5 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.

2. Paint cut ends of steel reinforcement in concrete to remain to prevent corrosion.

3.6 DISPOSAL

A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

END OF SECTION 022300

SECTION 022400
DEWATERING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes construction dewatering where necessary:

1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site and surrounding area.

2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

B. Related Sections include the following:

1. Section 015000 – Temporary Facilities and Controls for temporary utilities and support facilities.

2. Section 022600 – Excavation Support and Protection for protection of excavations.

3. Section 023000 – Earthwork for excavating, backfilling, site grading and for site utilities.

1.2 PERFORMANCE REQUIREMENTS

A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to prevent ground-water flow into excavations and permit construction to proceed on dry, stable subgrades.

1. Maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, that excavation does not flood, and that damage to subgrades and permanent structures is prevented.

2. Prevent surface water from entering excavations by grading, dikes, or other means.

3. Accomplish dewatering without damaging existing buildings or structures adjacent to excavation.

4. Remove dewatering system when no longer needed.

1.3 SUBMITTALS

A. Informational Submittals

1. Show arrangement, locations, and details of wells and well points; locations of headers and discharge lines; and means of discharge and disposal of water.
    a. Include layouts of piezometers and flow-measuring devices for monitoring performance of dewatering system.
    b. Include a written report outlining control procedures to be adopted if dewatering problems arise.
2. Permits required for dewatering system.

B. Project Record Documents

1. Record drawings at Project closeout identifying and locating capped utilities and other subsurface structural, electrical, or mechanical conditions performed during dewatering.
    a. Note locations and capping depth of wells and well points.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements

1. Obtain permits required for installation, operation, and removal of dewatering system and disposal of water.
2. Comply with water disposal requirements of authorities having jurisdiction.

1.5 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Engineer or Owner and then only after arranging to provide temporary utility services according to utility owner's direction

B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner and Engineer will not be responsible for interpretations or conclusions drawn from this data.

1. Make additional test borings and conduct other exploratory operations necessary for dewatering.

C. Survey adjacent structures and improvements, employing a qualified professional engineer or land surveyor, establishing exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

D. During dewatering, regularly resurvey benchmarks , maintaining an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Engineer if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.

1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site and surrounding area.

2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without written permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

3.2 INSTALLATION

A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material of appropriate gradation, valves, appurtenances, water disposal, and surface-water controls.

B. Before excavating below ground-water level, place system into operation to lower water to specified levels. Operate system continuously until pipes, drains,

sewers, and structures have been constructed and fill materials have been placed, or until dewatering is no longer required.

C. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.

1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.

D. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.

1. Maintain piezometric water level a minimum of 24 inches below surface of excavation.

E. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water in a manner that avoids inconvenience to others. Provide sumps, sedimentation tanks, flow-control devices, and temporary sediment and erosion control as required by authorities having jurisdiction.

F. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to Owner.

1. Remove dewatering system from Project site on completion of dewatering.

2. Comply with applicable regulations on the closure of dewatering wells. Where regulations do not apply, plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches below overlying construction.

G. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

END OF SECTION 022400

SECTION 022600
EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes temporary excavation support and protection systems.

B. Related Sections include the following:

1. Section 015000 – Temporary Facilities and Controls for temporary utilities and support facilities.

2. Section 022400 – Dewatering for dewatering excavations.

3. Section 023000 – Earthwork for excavating and backfilling and for existing utilities.

1.2 PERFORMANCE REQUIREMENTS

A. Furnish, install, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting soil and hydrostatic pressure and superimposed and construction loads.

1. Prevent surface water from entering excavations by grading, dikes, or other means.

2. Install excavation support and protection systems without damaging existing buildings, pavements, and other improvements adjacent to excavation.

1.3 SUBMITTALS

A. Informational Submittals

1. Photographs or videotape, sufficiently detailed, of existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by the absence of, the installation of, or the performance of excavation support and protection systems.

1.4 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Engineer and then only after arranging to provide temporary utility services according to utility owner's requirements.

B. Project-Site Information: A geotechnical report may have been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner and Engineer will not be responsible for interpretations or conclusions drawn from this data.

1. Make additional test borings and conduct other exploratory operations necessary for excavation support and protection.

C. During installation of excavation support and protection systems, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations and positions for comparison with original elevations and positions.

1. Survey accuracy shall be no less than 1:4,000 horizontal and 0.01 feet vertical.

2. Promptly notify Engineer if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.

1. Shore, support, and protect utilities encountered according to utility owner's directions.

B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, utilities, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having

jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

2. Do not use movable or temporary excavation support and protection systems below the final backfill elevation of utilities.

3. Utility excavation support and protection systems below the final backfill elevation shall be permanent.

   a. Leave in place to the top of the initial backfill zone. Cut as required above this elevation.
   b. Use only metal products or timber products treated against biological and water degradation.
      1) Timber treatment shall be compatible with plastic pipe material.

C. Locate excavation support and protection systems clear of permanent construction so that other Work is not impeded.

D. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.

E. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

3.2 SOLDIER BEAMS AND LAGGING

A. Install steel soldier beams before starting excavation. Space soldier beams at regular intervals not to exceed allowable flexural strength of wood lagging. Accurately align exposed faces of flanges.

B. Install wood lagging within flanges of soldier beams as excavation proceeds. Trim excavation as required to install lagging. Fill voids behind lagging with soil, and compact.

C. Install wales horizontally at centers indicated and secure to soldier beams.

3.3 SHEET PILING

A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock to form a continuous barrier. Accurately align exposed faces of sheet piling. Cut tops of sheet piling to uniform elevation at top of excavation.

3.4 TIEBACKS

A. Tiebacks: Drill for, install, grout, and tension tiebacks into position according to manufacturer's recommendations. Test load-carrying capacity of each tieback and replace and retest deficient tiebacks.

1. Test loading shall be observed by a qualified professional engineer responsible for design of excavation support and protection system.

2. Maintain tiebacks in place until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.5 BRACING

A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.

1. Do not place bracing where it will be cast into or included in permanent concrete work, unless otherwise approved by Engineer.

2. Install internal bracing, if required, to prevent spreading or distortion of braced frames.

3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.6 REMOVAL AND REPAIRS

A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.

1. Remove excavation support and protection systems to a minimum depth of 48 inches below overlying construction and abandon remainder where required by jurisdictional authority.

B. Repair or replace, as approved by Engineer, adjacent work damaged or displaced by removing excavation support and protection systems.

END OF SECTION 022600

SECTION 023000
EARTHWORK

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Preparing subgrades for surface restoration, embankments, slabs-on-grade, walks, drives, and pavements.

2. Excavating and backfilling for buildings and structures.

3. Drainage course for slabs-on-grade.

4. Subbase for asphalt and concrete pavements.

5. Subbase for gravel roads, drives, and parking lots.

6. Subsurface drainage backfill for walls and trenches.

7. Excavating and backfilling for utility trenches, including structure backfill.

B. Related sections include the following:

1. Section 022300 – Site Clearing for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.

2. Section 025100 – Water Distribution for installing water distribution systems in excavations.

1.2 DEFINITIONS

A. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as authorized by Work Change Directive or Change Order.

B. Backfill: Material used to fill an excavation.

C. Borrow Soil: Soil imported from off-site for use as fill or backfill.

D. Drainage Course: Course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

E. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

F. Fill: Soil materials used to raise existing grades.

G. Final Backfill: Backfill placed over initial backfill to fill a trench.

H. Flexible Pipe: Pipe manufactured of polyvinylchloride, polyethylene, high-density polyethylene, or other plastic materials as determined by Engineer.

I. INDOT SS: Indiana Department of Transportation Standard Specifications, and applicable supplements, current at the time of the bid.

J. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.

K. Pipe Bedding: Aggregate material placed over the excavated subgrade in a trench before laying pipe.

L. Rigid Pipe: Pipe manufactured of ductile iron, cast iron, concrete, steel or other metals, and as determined by Engineer.

M. Rock: Rock shall consist of igneous, metamorphic, and sedimentary rock which cannot be excavated without blasting; the use of a power shovel of not less than 1 cu yd capacity, properly used, having adequate power and in satisfactory running condition; or the use of other equivalent powered equipment. Rock excavation shall also include all boulders or other detached stones each having a volume of 1/2 cu yd or more.

N. Structures: Buildings, footings, foundations, retaining walls, slabs, manholes, vaults, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

O. Subbase Course: Course placed between the subgrade and base course for hot-mix asphalt pavement, or course placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

P. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.

Q. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without an authorization by Work Change Directive or Change Order.

R. Utilities: Underground pipes, conduits, ducts, and cables, as well as underground services within buildings and structures and overhead utility supports.

1.3 SUBMITTALS

A. Action Submittals

1. Product Data, including the following:

   a. Each type of plastic warning tape.
   b. Geotextile.
   c. Controlled low-strength material, including design mixture.
   d. Geofoam.

2. Material Test Reports

   a. Sieve analysis in accordance with AASHTO T 27 and materials certifications in accordance with INDOT SS of each aggregate proposed for fill or backfill.
   b. Classification according to ASTM D2487 of each borrow soil material proposed for fill and backfill.
   c. Laboratory compaction curve according to ASTM D1557 for each on-site and borrow soil material proposed for fill and backfill.

3. Samples

   a. 8-by-10-inch sample of geotextile.
   b. 1 lb to 2 lb sample of aggregates in clear plastic zip-lock bag.

B. Informational Submittals

1. Qualification Data

   a. Geotechnical Testing Agency.

2. Product and Material Certificates

3. Schedule of Tests and Inspections

4. Field Test Reports

C. Project Record Documents

1. Field test reports

2. Record Drawings

1.4 QUALITY ASSURANCE

A. Qualifications

1. Geotechnical Testing Agency Qualifications: An independent testing agency qualified according to ASTM E329 to conduct soil materials and rock-definition testing, as documented according to ASTM D3740 and ASTM E548.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Satisfactory Soils: AASHTO M 145 Soil Classification Groups A-1, A-2-4, A-2-5, and A-3, or a combination of these groups; free of rock or gravel larger than 2 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

1. Provide B borrow soil materials in compliance with INDOT SS when sufficient satisfactory soil materials are not available from excavations.

B. Unsatisfactory Soils: Soil Classification Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7 according to AASHTO M 145, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

C. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 OTHER BACKFILL AND FILL MATERIALS

A. Class I, Class II, and Class III Materials: Materials classified according to ASTM D2321.

B. Structure Backfill: Structure backfill material as defined in Section 904.05 of the INDOT SS or No. 53 coarse aggregate as defined in Section 904.03 of the INDOT SS.

C. Flowable Backfill: Flowable backfill in accordance with Section 213 of the INDOT SS.

D. Subbase Material: Material meeting the requirements of Section 302.02 of the INDOT SS or INDOT #2 aggregate.

E. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

F. Drainage Course: Narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

G. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 4 sieve.

H. Sand: ASTM C33; fine aggregate, natural, or manufactured sand.

2.3 FILL FOR OVEREXCAVATION

A. Fill for overexcavation, whether inadvertent or to obtain a stable bottom soil condition, shall be INDOT No. 8 or INDOT No. 9 crushed stone or fracture-faced aggregate, No. 2 stone, or Class B concrete at Engineer's direction.

2.4 GEOTEXTILES

A. Geotextiles shall be in compliance with Section 918 of the INDOT SS.

2.5 WARNING TAPE

A. Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep.

B. Warning tape will be colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

2.6 SOIL TREATMENT MATERIALS

A. Soil treatment materials to achieve necessary compaction shall comply with Section 913 of the INDOT SS.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protection

1. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

2. Prior to excavation work, pothole or otherwise physically confirm location and depth of existing utilities to be exposed by excavation.

   a. Notify Engineer immediately of any potential conflicts with existing utilities.

3. Hand-dig at all locations within two (2) feet of utilities.

4. Provide protective insulating materials to protect subgrades and foundation soils against freezing temperatures or frost.

3.2 EXPLOSIVES

A. Do not use explosives.

3.3 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions.

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

2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:

   a. 24 inches outside of concrete forms other than at footings.
   b. 12 inches outside of concrete forms at footings.
   c. 6 inches outside of minimum required dimensions of concrete cast against grade.
   d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
   e. 6 inches beneath bottom of concrete slabs on grade.
   f. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

B. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by Engineer.

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

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

2. Rock excavation includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction without exceeding the following dimensions:

    a. 24 inches outside of concrete forms other than at footings.
    b. 12 inches outside of concrete forms at footings.
    c. 6 inches outside of minimum required dimensions of concrete cast against grade.
    d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
    e. 6 inches beneath bottom of concrete slabs on grade.
    f. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

3.4 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

2. Pile Foundations: Stop excavations 6 to 12 inches above bottom of pile cap before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile caps.

3. Excavation for Manholes, Vaults, Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

3.5 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.6 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Trench curves for flexible pipe shall not be less than the minimum radius of curvature recommended by pipe manufacturer.

B. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated.

1. Clearance: Pipe diameter plus 12 inches minimum to 24 inches maximum.

C. Trench Bottoms: Excavate trench bottoms to provide uniform bearing and support of bedding course, pipes and conduits. Remove projecting stones and sharp objects along trench subgrade. Where not otherwise indicated:

1. For pipes and conduit less than 6 inches in nominal diameter and flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.

2. For pipes and conduit 6 inches or larger in nominal diameter, excavate trenches 6 inches deeper than elevation required to allow for bedding course.

D. Overexcavation: Fill overexcavations to the indicated lines and grades

3.7 SUBGRADE INSPECTION

A. Notify Engineer when excavations for structures, utilities, and pavements have reached required subgrade.

B. If unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed. Notify Engineer immediately if unsatisfactory subgrade soil is encountered during utility trench excavation.

C. Proof-roll subgrade below utility structures larger than thirty feet (30’) in any horizontal dimension and building slabs with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.

2. Proof-roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.

3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Engineer, and replace with compacted backfill or fill as directed.

D. Authorized additional excavation and replacement material will be paid for according to Contract provisions.

E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Engineer, without additional compensation.

3.8 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Engineer.

1. Fill unauthorized excavations under other construction or utility pipe as directed by Engineer.

3.9 STORAGE OF SOIL MATERIALS

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

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

3.10 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.

2. Surveying locations of underground utilities for Record Documents.

3. Testing and inspecting underground utilities where indicated prior to backfill.

4. Removing concrete formwork.

5. Removing trash and debris.

6. Removing temporary shoring and bracing, and sheeting.

7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice. Use topsoil removed during site clearing as final layer of backfill, except under structures, pavements, or aggregate surfaces.

3.11 UTILITY TRENCH BEDDING AND BACKFILL

A. Overexcavation

1. Place material in overexcavation on soils free of mud, frost, snow, or ice to indicated lines and grades. Notify Engineer upon restoration of trench bottom and obtain acceptance before proceeding with pipe installation.

B. Pipe Bedding

1. Place pipe bedding where indicated in utility trenches on firm subgrades free of standing water, mud, frost, snow, or ice.

2. Place and compact pipe bedding on trench bottoms and where indicated. Shape pipe bedding to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Initial Backfill

1. Place and compact initial backfill to a height of 12 inches over the utility pipe or conduit.

   a. Carefully hand place and compact initial backfill in lifts no greater than six (6) inches in depth under pipe haunches to springline. Compact each lift evenly up on both sides and along the full length of utility piping or conduit by shovel slicing, hand tamping, and walking the backfill in.
   b. Place and compact remaining initial backfill in lifts to avoid damage or displacement of piping or conduit.

2. Flowable Backfill: Where indicated, place initial backfill of flowable backfill to a height of 12 inches over the utility pipe or conduit.

D. Final Backfill

1. Place and compact final backfill to final subgrade elevation.

2. Place backfill so that it flows into the trench without freefalling.

3. Backfilling with satisfactory soil
    a. Mechanically tamp each lift until no further settlement is obtained before placement of the next lift.
    b. Heavy equipment shall not be used until there is a cover of not less than three (3) feet over the pipes.
    c. Leave trench surface in slightly rounded condition.
    d. Maintain slightly rounded condition until surface restoration activities are initiated, but not less than thirty (30) days.
4. Backfilling with structure backfill
    a. Each lift shall be thoroughly compacted before placement of the next lift by mechanical tamping.
5. Unstable trench walls
    a. Upon written request and with Engineer's prior approval where trench walls become unstable during compaction, Contractor may push final backfill from the back of the trench into the trench the full depth, not to exceed twenty (20) lineal feet horizontally along the trench bottom, and compact using the vibratory compactor in two (2) foot diagonal lifts.
6. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.
7. Do not jet backfill.

E. Special Conditions
1. For trenches excavated under footings, unless otherwise required by Specifications or code, place utilities in schedule 40 PVC casing pipe and fill to 18 inches either side of footings with Class B concrete to elevation of bottom of footings.
2. Backfill voids with satisfactory soil while installing and removing shoring and bracing.

3.12 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in lifts to required elevations as follows:
1. Under grass and planted areas, use satisfactory soil material.
2. Under walks and pavements, use satisfactory soil material.
3. Under steps and ramps, use engineered fill.

4. Under building slabs, use engineered fill.

5. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.13 SOIL MOISTURE CONTROL

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

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.

2. Remove and replace, or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.14 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in lifts not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D1557:

1. Under structures, building slabs, and steps, scarify and recompact top 12 inches of existing subgrade and each lift of backfill or fill soil material at 95 percent.

2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each lift of backfill or fill soil material at 92 percent.

3. Under lawn or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each lift of backfill or fill soil material at 85 percent.

4. For utility trenches with structure backfill, compact each lift of initial and final backfill material at 95 percent.

D. Compact each lift of subbase in accordance with Section 302.06 of the INDOT SS.

E. Compact each lift of base in accordance with Section 301.06 of the INDOT SS.

3.15 GRADING

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

1. Provide a smooth transition between adjacent existing grades and new grades.

2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

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

1. Lawn or Unpaved Areas: Plus or minus 1 inch.

2. Walks: Plus or minus 1 inch.

3. Pavements: Plus or minus 1/2 inch.

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

3.16 SUBSURFACE DRAINAGE

A. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches of filter material, placed in compacted lifts 6 inches thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches.

1. Compact each filter material lift with a minimum of two passes of a plate-type vibratory compactor.

B. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final subgrade, in compacted lifts 6 inches thick. Overlay drainage backfill with 1 layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches.

1. Compact each filter material lift with a minimum of two passes of a plate-type vibratory compactor.

2. Place and compact impervious fill over drainage backfill in 6-inch-thick compacted lifts to final subgrade.

3.17 DRAINAGE COURSE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:

1. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.

2. Place drainage course 6 inches or less in compacted thickness in a single lift.

3. Place drainage course that exceeds 6 inches in compacted thickness in lifts of equal thickness, with no compacted lift more than 6 inches thick or less than 3 inches thick.

4. Compact each lift of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D698.

3.18 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.

B. Allow testing agency to inspect and test subgrades and each fill or backfill lift. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.

C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Engineer.

D. Testing agency will test compaction of soils in place according to ASTM D1556, ASTM D2167, ASTM D6938, and ASTM D2937, as applicable. Tests will be performed at the following locations and frequencies:

1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill lift, at least 1 test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than 3 tests.

2. Foundation Wall Backfill: At each compacted backfill lift, at least 1 test for each 100 feet or less of wall length, but no fewer than 2 tests.

3. Trench Structure Backfill

   a. For final backfill, conduct one test per lift for the shorter of each manhole run or 400 feet of trench length.

   b. Demonstration for Reduced Testing

      1) Demonstrate procedure for proper mechanical compaction with test strip.

      2) Test strip shall be two street crossings or a continuous length of pipe not less than 200 feet in length.

      3) Separate demonstration shall be required for gravity sanitary sewerage.

      4) Test compaction with field density tests at each final backfill lift.

         a) Street crossings shall be tested at two locations equidistant from each other and the edges of the structure backfill.

         b) Continuous lengths shall be tested at three lengths equidistant from each other and the edge of the test strip.

         c) Demonstration shall be achieved when all initial tests achieve minimum compaction requirements. Additional compaction between tests is not an acceptable demonstration.

      5) Upon successful demonstration, the demonstrated method, including equipment, material source, and procedure, shall be used for the duration of the Project.

      6) Testing frequency may be reduced to one test per manhole run or 400 feet.

      7) Changes to the approved method will require a new demonstration or full testing requirements.

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

3.19 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Engineer; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.20 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

B. Disposal: Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Engineer.

1. Remove waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION 023000

SECTION 024100
HORIZONTAL DIRECTIONAL DRILLING PIPING INSTALLATION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes requirements for installation of piping systems using the horizontal directional drilling method.

B. Related sections include the following:

1. Section 023000 – Earthwork for excavating, trenching, and backfilling at locations of pipe exposure.

2. Section 025100 – Water Distribution for pipe and fittings requirements for water distribution systems and for installation of valves, air release valves, hydrants, services, and other appurtenances on water pipes installed by the HDD method.

3. Section 025300 – Gravity Sanitary Sewerage for pipe and fittings requirements for gravity sewer laterals and for connections of laterals to sewer mains.

4. Section 025450 – Sewer Force Mains for pipe and fittings requirements for force mains and for installation of valves, air release valves, and other appurtenances on force mains installed by the HDD method.

5. Section 029200 – Lawns and Grasses for restoring areas disturbed by horizontal directional drilling operations.

1.2 DEFINITIONS

A. BPS: Bond Procedure Specification

B. HDD: Horizontal Directional Drilling.

1.3 SUBMITTALS

A. Action Submittals

1. Product Data

a. Drilling fluid and admixture specifications, MSDS sheets and manufacturer’s literature.

2. Shop Drawings

a. Dimensioned layouts of pipe to scale, including plan and profile, showing finished grade, deflection and radiuses of the pilot bore and all existing utilities with minimum vertical and horizontal clearances. The proposed clearances shall exceed the guidance system accuracy tolerance by a minimum of 100% for flexible pipe and 150% for DI pipe.
b. Locations of proposed pits and equipment set-ups.

3. Samples

B. Informational Submittals

1. Qualification Data

a. Provide within 10 days after Notice of Award:
1) Name, address, phone number of any subcontractor proposed for the HDD installation work.
2) Five references, including a name and telephone number, to contact and verify similar projects.
3) List of completed projects.
b. Names and resumes of all supervisory field personnel to be present during all HDD installation work.

2. Installer Certificates

a. Qualification records certifying that bonders and bonding operators employed to complete fusion bonding are qualified in the BPS when installing flexible pipe.

3. Field Test Reports

a. Calibration records for guidance equipment.

4. Manufacturers' Instructions

a. Bond Procedure Specification per ANSI (ASME B31.3, Chapter VII, paragraph A-328) when installing flexible pipe. BPS shall include cutting and facing requirements.

C. Project Record Documents

1. Record Drawings

2. Drilling Logs

1.4 QUALITY ASSURANCE

A. Qualifications

1. Contractor Experience

a. Contractor or subcontractor shall have the following minimum requirements in horizontal directional drilling:

1) Five (5) utility horizontal directional drilling projects of a similar nature and scope.
2) Successful completion of at least 50,000 linear feet of directional drilling. Conventional open cut trenching shall not be considered as applicable experience.
3) Experience with horizontal directional drilling specifically using ductile iron pipe is not necessary.

2. Supervisory personnel shall be adequately trained and shall have at least four (4) years experience in directional drilling.

3. Fusion Bonders and bonding operators shall be qualified in the use of the BPS as required by ANSI/ASME B31.3, Chapter VII, paragraph A-328.

PART 2 - PRODUCTS

2.1 DRILLING FLUID

A. Drilling fluid shall be composed of clean water and appropriate additives such as bentonite clay and polymer admixtures specifically blended for use in drilling.

B. Water shall be from a clean source with a pH of 8.5 – 10 and/or as per mixing requirements of the additive manufacturer. Water of a lower pH or with excessive calcium shall be treated with the appropriate amount of sodium carbonate or equal.

C. The drilling fluid shall have a minimum viscosity based on soil type as measured by a March funnel as follows:

1. Rocky Clay – 60 seconds

2. Hard Clay – 40 seconds

3. Soft Clay – 45 seconds

4. Sandy Clay – 90 seconds

5. Stable Sand – 80 seconds

6. Loose Sand – 110 seconds

7. Wet Sand – 110 seconds

D. No hazardous additives may be used. Drilling fluid shall be totally inert and contain no risk to the environment.

E. Drilling fluid shall be maintained at a viscosity sufficient to suspend cuttings and maintain the integrity of bore wall.

2.2 LOCATOR WIRE

A. Locator wire shall be 21% conductivity annealed copper-clad high carbon steel high strength tracer wire.

B. Insulation: High Density Polyethylene (HDPE) complying with ASTM-D1248, 30 volt rating.

C. Composite conductivity: 21% IACS (International Annealed Copper Standard).

D. Physical Characteristics:

1. AWG: 10
2. Dia. (in): 0.1019
3. Weight (lbs/1000 ft): 32.5
4. Insulation Thickness (In): 0.030
5. Breaking Load (lbs): 590

E. Connectors: Manufacturer's packaged kit consisting of insulating, spring-type connector or crimped joint and epoxy resin moisture seal; suitable for direct burial.

2.3 LOCATOR WIRE BOXES

A. Locator Wire Boxes, General

1. Tubular construction (cylindrical) with removable round lid.
2. Support flange at the base of the lower tube bell at least one-half inch wide.
    a. If box is designed for use with an integral valve support, flange may be omitted.
3. Telescoping design with upper and lower tubes overlapping three inches when the box is extended to its maximum overall length.
4. Magnetized to amplify the tracer signal.

B. Materials

1. Tube material shall be of high grade ABS, or equivalent rigid plastic that meets or exceeds ASTM D1788, Type 1 requirements.
2. Lid material shall be of cast iron or ductile iron. Tensile strength or ductility of such material shall be equal or superior to hi-tensile cast iron ASTM A126-B requirements.

3. A magnet shall be securely attached at the top of the upper tube of the box for locating purposes. Material used to retain magnet in place shall remain effective at minus 15 degrees Fahrenheit. Magnets in the lid are not acceptable.

C. Box Lids

1. Color coded per APWA standards.
   a. Blue for water.
   b. Green for sewage.
2. Cast iron construction.
3. Allow connection of the tracer signal without removal of the lid through an external brass connection lug.
4. Lock with a tamper-resistant pentagon locking nut.
5. Internal corrosion-resistant brass wire lug for locator wire connection and a wax pad to block out moisture at the wire connection.

D. Locator Wire Box Types and Applications

1. Designed for application.
2. Lite Duty Boxes: yards and ditches.
3. Roadway Boxes: Where box will be subjected to traffic.
4. Concrete/Driveway Boxes: Sidewalks and Driveways.

PART 3 - EXECUTION

3.1 EQUIPMENT

A. Directional drilling equipment shall consist of:

1. A directional drilling rig of sufficient capacity to perform the bore and pull back the pipe.
2. A drilling fluid mixing & delivery system of sufficient capacity to successfully complete the drilling and pulling.
3. A guidance system to accurately guide boring operations.

B. Drilling Rig-General

1. The directional drilling machine shall consist of a hydraulically powered system to rotate, push and pull hollow drill pipe into the ground at a

variable angle while delivering a pressurized fluid mixture to a guidable drill (bore) head.

2. The machine shall be anchored to the ground to withstand the pulling, pushing and rotating pressure required to complete the crossing.

3. The hydraulic power system shall be self-contained with sufficient pressure and volume to power drilling operations. Hydraulic system shall be free of leaks.

4. Rig shall have a system to monitor and record maximum pull-back pressure during pull-back operations.

5. A magnetic or walk-over guidance system shall be able to control the depth and direction of the pipe and must be accurate to within 6 inches.

C. Drill Head: The drill head shall be steerable by changing it's rotation and shall provide the necessary cutting surfaces and drilling fluid jets for effective use in the soils being bored.

D. Drilling Fluid Motors (if required): Drilling fluid motors shall be of adequate power to turn the required drilling tools.

E. Drill Pipe: Drill pipe shall be constructed of high quality 4130 seamless tubing, grade D or better, with threaded box and pins. Tool joints should be hardened to 32-36 RC.

F. Guidance System

1. Electronic walk-over guidance system, magnetic guidance system probe, or proven gyroscopic probe and interface.

2. Provide a continuous and accurate determination of the location of the drilling head during the drilling operation, including all depths up to fifty feet and in any soil condition, including hard rock.

3. Enable the driller to guide the drill head providing immediate information on the tool face, azimuth (horizontal direction), and inclination (vertical direction).

4. Accurate and calibrated to manufacturer’s specifications for the vertical depth of the bore hole at sensing position at depths up to fifty feet and accurate to at least 2-feet horizontally.

5. The operator shall be aware of any magnetic anomalies and shall consider such influences in the operation of the guidance system.

G. Pipe Rollers

1. Pipe rollers, if required, shall be of sufficient size to fully support the weight of the pipe while being hydro-tested and during pull-back operations. Sufficient number of rollers shall used to prevent excess sagging of pipe.

H. Pipe Rammers and Other Devices For Horizontal Thrust

1. Hydraulic or pneumatic pipe rammers, or other devices or utility placement systems for providing horizontal thrust other than those defined in the preceding sections shall not be used unless approved by the Engineer prior to commencement of the Work. Consideration for approval will be made on an individual basis for each specified location. The proposed device or system will be evaluated prior to approval or rejection on its potential ability to complete the utility placement satisfactorily without undue stoppage and to maintain line and grade within the tolerances prescribed by the particular conditions of the project.

I. Other Equipment

1. A self-contained, closed, drilling fluid mixing system shall be of sufficient size to mix and deliver drilling fluid. Mixing system shall be able to molecularly shear individual bentonite particles from the dry powder to avoid clumping and ensure thorough mixing. The drilling fluid reservoir tank shall be sized for adequate storage of the drilling fluid, but no less than 1,000 gallons. Mixing system shall continually agitate the drilling fluid during drilling operations.

2. The drilling fluid pumping system shall have a minimum capacity to supply fluid in accordance with the drilling equipment pull-back rating at a constant required pressure of no less than 1,200 psi. The delivery system shall have filters in-line to prevent solids from being pumped into the drill pipe. Connections between the pump and drill pipe shall be relatively leak-free.

3. Drilling rig shall be fitted with a permanent alarm system capable of detecting an electrical current. This system will have an audible alarm to warn the operator when the drill head nears electrified cables but is still within a safe operating distance.

4. Pipe bonding equipment specified in the BPS shall be in proper operating condition. Equipment heater performance shall be tested and certified prior to use for fusion bonding.

3.2 DIRECTIONAL DRILLING PROCEDURE

A. Notice: Notify Engineer 48 hours before initiation of drilling operations.

B. Site Preparation

1. Grade or fill work site to provide a level working area. No alterations beyond what is required for operations are to be made. Confine all activities to designated work areas.

C. Drill Path Survey and Layout

1. Accurately survey entire drill path with entry and exit stakes placed in the appropriate locations within the areas indicated on approved dimensioned layout submittal.

2. If using a magnetic guidance system, survey drill path for any surface geomagnetic variations or anomalies.

3. Contact all property owners regarding the location of all existing service lines, water wells, septic tanks, etc.

4. Contact all utilities for the determination of the location of all existing underground lines, cables, pipes, valves, vaults, etc.

5. Excavate and confirm location and elevation of existing utilities in or near path of work.

6. Maintain a continuous positive grade of the pipe to the air relief valve locations and a continuous negative grade of the pipe from the air relief valve locations with only one low point between air relief valve locations. Avoid high spots in the lines between the air relief valve locations.

7. Maintain a continuous positive grade of the pipe from the one low point between air relief valve location and discharge point or point of connection with another pipe.

8. Where conflicts occur with existing utility lines, the pipe layout may be shifted to avoid interference with the existing utility lines. All changes in location are limited to existing easements and rights-of-way. Note on layout plan all proposed changes in pipe location.

9. Drilling depths below eight feet (8’) shall not be allowed without permission from the Engineer.

10. Prepare dimensioned, scaled plan for submittal to Engineer.

D. Environmental Protection

1. Place silt fence between all drilling operations and any drainage, wetland, waterway or other area designated for such protection by contract documents, state, federal and local regulations. Additional environmental protection necessary to contain any hydraulic or drilling fluid spills shall

be put in place, including berms, liners, turbidity curtains and other measures. Adhere to all applicable environmental regulations.

2. Used drilling fluid and drilling fluid spilled during drilling operations shall be contained and properly disposed of. A spill sock, hay bales, or sand bags, shall be maintained around drill rigs, drilling fluid mixing system, entry and exit pits and drilling fluid recycling system (if used) to prevent spills into the surrounding environment. Provide pumps or vacuum truck(s) to remove excess drilling fluid from containment areas to storage facilities.

3. The spoils shall be promptly recovered by use of a vehicle-mounted vacuum system. Spoils are not to be discharged into sewers or storm drains. Dispose of all spoil and excess excavated material in accordance with all regulations.

E. Pilot Hole

1. Pilot hole shall be drilled on bore path with no deviations greater than 5% of depth over a length of 100'. In the event the pilot deviates from bore path more than 5% of depth in any 100', Contractor will notify Engineer. Unless directed otherwise, Contractor shall pull-back and re-drill from the location along bore path before the deviation.

2. In the event that a drilling fluid fracture, inadvertent returns, or returns loss occurs during pilot hole drilling operations, contractor shall cease drilling, wait at least 30 minutes, inject a quantity of drilling fluid with a viscosity exceeding 120 seconds as measured by a March funnel and then wait another 30 minutes. If drilling fluid fracture or returns loss continues, contractor will cease operations and notify Engineer. Engineer and contractor will discuss additional options and work will then proceed accordingly.

F. Reaming

1. Upon successful completion of pilot hole, Contractor will ream bore hole to a minimum of 25% greater and a maximum of 50% greater than outside diameter of pipe or bell using the appropriate tools. Contractor will not attempt to ream at one time more than the drilling equipment and drilling fluid system are designed to safely handle.

2. The type of hole opener or back reamer shall be at Contractor’s discretion based on the types of subsurface soil conditions encountered.

3. The drilling fluid shall remain in the tunnel to increase the stability of the tunnel and to provide a lubricant to reduce directional drag when the pipe is pulled.

G. Setup

1. Pipe will be placed on pipe rollers before pulling into bore hole. Rollers shall be spaced close enough to prevent excessive sagging of pipe.

2. Contractor may pre-test pipe prior to pulling. However, pre-testing will not substitute for the acceptance testing otherwise required.

3. The interior of every pipe, fitting and valve shall be cleaned of all debris, dirt and other foreign material before being bonded and shall be kept clean until accepted in the completed work. Where possible, all pipes shall be flushed upon full system completion.

4. Install polyethylene encasement on DI pipe during pipe setup or when pulling pipe according to installation Method "A" in accordance with AWWA C105 for installations below the water table.

H. Tracer Wire

1. Provide two tracer wires on the crown of all pipe and tubing.

2. The wires shall be installed along the pipe and securely fastened by two full wraps of duct tape at no more than 20 ft. intervals.

3. Terminate tracer wires above ground at each at-grade or above ground structure and at intervals of no more than 400 feet.

   a. Bring tracer wires to the surface through a locator wire box where no structures exist.
   b. Do not terminate tracer wires within limits of waterway from top-of-bank to top-of-bank.

4. Individually test each strand of tracer wire after installation. At least one tracer wire shall provide continuous transmission of tracing signal along the full length of pipe.

I. Pull-back

1. After successfully reaming bore hole to the required diameter, Contractor will pull the pipe through the bore hole. In front of the pipe will be a swivel.

2. Pipe will be elevated to the approximate angle of entry and supported with a sideboom and roller arm to allow a straight, smooth pull.

3. Once pullback operations have commenced, operations must continue without interruption until pipe is completely pulled into the bore hole. During pull-back operations contractor will not apply more than the maximum safe pipe pull pressure at any time.

4. In the event that pipe becomes stuck, Contractor will cease pulling operations to allow any potential hydro-lock to subside and will commence pulling operations. If pipe remains stuck, Contractor will notify Engineer. Engineer and Contractor will discuss options and then Work will proceed accordingly.

J. Valves, Fittings, and Appurtenances

1. Excavate and install services, pipe connections, hydrants, fittings, valves and other appurtenances where indicated in accordance with applicable specifications.

K. Recordkeeping

1. As the pilot hole is being drilled, measure the location and depth of the pilot hole. Record readings after advancement of each successive drill pipe (no more than 10').
   a. Plot on a scaled drawing of 1" = 2', both vertical and horizontal.
   b. Tabulate and record these coordinates on the record drawings daily.
   c. Access to all recorded readings and plan and profile information shall be made available to Engineer at any time.
2. Do not allow the deflection radius of the drill pipe to exceed the deflection limits of the carrier pipe as specified by the pipe manufacturer.
3. Maintain a daily project log of drilling operations and a guidance system log.

END OF SECTION 024100

SECTION 025300
GRAVITY SANITARY SEWERAGE

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes gravity-flow, nonpressure sanitary sewerage, including the following components:

1. Sewer mains.
2. Sewer laterals.
3. Manholes.

B. Related Sections include the following:

1. Section 022400 – Dewatering for trench dewatering requirements.
2. Section 022600 – Excavation Support and Protection.
3. Section 023000 – Earthwork for excavating, trenching, bedding and backfill, and pipe identification material.
4. Section 024000 – Boring and Jacking Piping Installation for installation of gravity sanitary sewerage by the boring and jacking technique.
5. Section 024100 – Horizontal Directional Drilling Piping Installation for installation of sewer laterals by the horizontal directional drilling method.

C. Related regulations include the following:

1. 327 IAC 3-6-9 for separation requirements with water mains and wells.

1.2 ACRONYMS

A. AWWA: American Water Works Association.

B. HDD: Horizontal directional drilling.

C. INDOT SS: Indiana Department of Transportation Standard Specifications.

D. PVC: Polyvinyl chloride plastic.

E. DI: Ductile iron.

F. HDPE: High Density Polyethylene

G. MJ: Mechanical joint.

H. SS: Stainless steel.

1.3 QUALIFICATIONS

A. Manholes

1. Concrete Testing Agency

a. Not less than three years experience in performing concrete tests of type specified in this Section.
b. Capable of performing testing in accordance with ASTM E329.

1.4 SYSTEM REQUIREMENTS

A. Design Requirements

1. Deferred Design Responsibility: Provide the services of a registered professional engineer to design flat top slabs for manholes:

a. to be accepted on the basis of rational design per ASTM C478.
b. located in the right-of-way or otherwise meeting the requirements of AASHTO.

1.5 SUBMITTALS

A. Action Submittals

1. Product Data

a. Pipe, joints, and fittings.
b. Locator wire and warning tape.
c. Manhole castings.
d. Manhole products, including but not limited to boots and gaskets, sealants, joint sealing products, and infiltration control products.

2. Shop Drawings

a. Precast manhole structures.

B. Informational Submittals

1. Coordination Drawings

a. Show clearances from water and storm sewer system piping and structures.
1) Indicate interface and spatial relationship between manholes, piping, and proximate structures.
2) Draw profiles at horizontal scale of not less than 1 inch equals 50 feet and vertical scale of not less than 1 inch equals 5 feet. Indicate manholes and piping.

b. Show types, sizes, materials, and elevations of other utilities crossing system piping.

2. Design calculations and detail drawings.
   a. Manhole flat top slabs (if designed on the basis of rational design per ASTM C478, located within a right-of-way, or otherwise subject to AASHTO design standards).
3. Factory Test Reports
   a. Manhole flat top slabs (if accepted on the basis of proof-of-design test).
4. Product Certificates.
5. Material Certificates.
6. Schedule of Tests and Inspections.
7. Field Test Reports.
8. Design Data
   a. Precast manhole concrete design.
9. Manufacturers' Instructions.
   a. Pipe installation.
   b. Manhole boot installation.
   c. Products used with manholes.
10. Product Warranties.

C. Project Record Documents
1. Product Data.
2. Field Test Reports.
3. Record Drawings, including:
   a. Vertical Information
      1) Invert elevation(s) of all pipes connecting to manholes.
      2) Casting elevations.
      3) Top (if below pipe) or bottom (if above pipe) elevation of all utilities encountered (including utility size, material, and type descriptions).
         a) Include utility relocations or changes required for the Work.
   b. Horizontal Information
      1) Northing and easting of all manholes and other structures (centered on casting or hatch).
      2) Distance of all lateral connections from downstream manhole.
      3) Northing and easting of all lateral terminations.
   c. Calculated Information
      1) Sewer segment length.
      2) Sewer segment grade.

d. General
    1) Vertical and horizontal information shall be based on control provided for the project.
    2) Accuracy shall match that in the annotation in Drawings.

D. Monolithic (Cast-in-place) Manholes

1. Action Submittals

a. Plans and details of proposed manhole construction with dimensions.
b. Design concrete mix.
c. Steel reinforcement.
d. Pipe penetration and manhole boot details.

1.6 QUALITY ASSURANCE

A. Pipe and fitting manufacturer's quality control system shall be ISO 9001 registered.

B. Manholes

1. Allowable Tolerances

a. Length and width of precast units measured at face adjacent to mold shall be the following:
    1) Units 10 ft or under: ± 1/8".
    2) Units 10 to 20 ft: + 1/8", - 3/16".
    3) Units over 20 ft: + 1/8", - 1/4".
b. Thickness of units shall be + 1/4", - 1/8".
c. Units shall not be out of square more than 1/8" per 6 ft or 1/4" total.

C. Regulatory Requirements

1. Comply with requirements of utility company providing wastewater service.

2. Comply with standards of authorities having jurisdiction for sewer-service piping, including materials, installation, and testing.

3. Comply with requirements of IDEM and EPA regarding wastewater facilities and service.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manhole components, pipe, gaskets, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle pipe and manholes according to manufacturer's written rigging instructions.

D. Do not skid or roll products on or against other products. Use padded sling, hooks and pipe tongs in such a manner to prevent damage to products.

E. Do not stack ductile iron pipe higher than the limits shown in ANSI/AWWA C600. Stacking of pipe shall meet the requirements of the pipe manufacturer. Do not stack fittings.

F. Do not allow gaskets to come in contact with petroleum products.

PART 2 - PRODUCTS

2.1 GENERAL

A. All pipe and fitting sizes and references to pipe diameters are intended to be nominal.

B. Special Applications and Limitations

1. PVC and HDPE sewer pipe can be used in buried locations only.
2. Horizontal Directional Drilling of Laterals
    a. HDPE Sewer Lateral Pipe.
3. Boring and Jacking Pipe Installations
    a. Water Quality Pipe.
4. Pipe Bursting
    a. HDPE Gravity Sewer Pipe.

2.2 GRAVITY SEWER PIPE

A. General

1. Pipe and fittings shall have an integral bell without solvent cement joints and shall have smooth inner walls.
2. PVC pipe and fittings shall be colored green for identification as sewer pipe.
3. No saddles or clamps will be allowed.

B. Smooth Exterior Wall Pipe and Fittings

1. Pipe 15” or less shall meet ASTM D3034. The pipe shall have a minimum cell classification of 12454-B per ASTM D1784.
    a. Pipe installed at 16’ depth or less shall be SDR-35.
    b. Pipe installed at depths greater than 16’ shall be SDR-26.
2. Pipe in sizes larger than 15” through 48” shall meet ASTM F679. The pipe shall have a minimum cell classification of 12454-C per ASTM D1784.

a. Pipe installed at 16’ depth or less shall be PS46.
b. Pipe installed at depths greater than 16’ shall be PS115.

3. Minimum tensile strength of 34.50 Mpa per ASTM D1784.

4. Minimum pipe stiffness of 46 psi for SDR-35 and 115 psi for SDR-26 when measured at 5% vertical ring deflection tested per ASTM D2412.

C. Joints

1. Joints shall be flexible gasket compression-type conforming to ASTM F477.

2. Joint performance shall be in accordance with ASTM D3212 under both pressure and 22” Hg vacuum.

3. Joints and couplings connecting to different pipe or fitting types shall be in accordance with both manufacturers’ recommendations.

D. Fittings

1. Fittings shall conform to ASTM D3034.
   a. Fittings installed at 16’ depth or less shall be SDR-35.
   b. Fittings installed at depths greater than 16’ shall be SDR-26.
2. PVC plastic shall have a cell classification of 12454-B as defined in ASTM D1784.

2.3 WATER QUALITY PIPE

A. General

1. Pipe and fittings shall have an integral bell without solvent cement joints.

2. No saddles or clamps will be allowed.

B. PVC Pipe

1. General
   a. Pipe and fittings shall be colored green for identification as sewer pipe.
   b. Plastic shall have a cell classification of 12454-B as defined in ASTM D1784.
2. SDR Series Pipe and Fittings
   a. SDR Series Water Quality Pipe shall conform to ASTM D2241, SDR-21, or SDR-17.
   b. Fittings for SDR Series Water Quality Pipe shall meet the same standards applicable to the pipe.
3. AWWA Series Pipe
   a. AWWA Series Water Quality Pipe:

1) Pipe sizes through 12” shall conform to AWWA C-900, DR 18.
2) Pipe sizes greater than 12” shall conform to AWWA C-905, DR 32.5.

C. DI Pipe

1. Pipe shall conform to AWWA C151.

2. Pressure Class in conformance with AWWA C150:

a. Pipe sizes through 12” shall be 350 psi pressure class.
b. Pipe sizes greater than 12” shall be 250 psi pressure class.

3. Joints

a. Buried Service
1) Mechanical joints shall be in accordance with AWWA C110 and AWWA C111.
2) Push-on type joint shall conform to AWWA C111.
3) Gaskets meeting AWWA C111.
b. Exposed Service: Flanged in conformance with ANSI B16.1, Class 125.

4. Coatings

a. Interior cement mortar lining and bituminous seal coat shall meet the requirements of AWWA C104.
b. Outside coating shall meet the requirements of AWWA C151.
c. Interior and exterior coatings shall be provided for all pipe, fittings, and adapters.

5. Encasement

a. Polyethylene encasement shall conform to AWWA C105.
1) Color: Green

D. Fittings for AWWA Series Pipe and DI Pipe

1. Fittings for AWWA Series Pipe and DI Pipe shall be DI meeting the requirements of AWWA C110.

E. Joints

1. Joints shall be flexible gasket compression-type conforming to ASTM F477.

2. Joint performance shall be in accordance with ASTM D3139 under both pressure and 22” Hg vacuum.

3. Joints connecting to different pipe or fitting types shall be in accordance with manufacturer’s recommendations.

4. No solvent cement joints shall be allowed.

2.4 HDPE PIPE

A. General

1. Pipe

   a. HDPE pipe (PE 3408) shall meet the requirements of ASTM D3350 and ASTM F714. Cell classifications shall be 345444C.
   b. Pipe shall be IPS OD for pipe sizes three inches or less.
   c. Pipe shall be DI OD for pipe sizes larger than three inches.
   d. Pipe shall be green-striped or have a green color.

2. Joints: Fusion butt-welded.

3. Fittings

   a. Manufactured in accordance with the same standards, design pressure classes, dimensions, and temperature ranges specified as for HDPE pipe.
   b. Manufactured by the same manufacturer as the pipe, using identical materials.
   c. Do not use tapping sleeves for connections.
   d. Fittings shall not be field fabricated.

B. HDPE Sewer Lateral Pipe

1. Pressure Class: 130 psi

2. Standard Dimension Ratio (SDR): DR 13.5.

C. HDPE Gravity Sewer Pipe

1. Depth of Cover 0 - 16.0 feet: Minimum SDR-17

2. Depth of Cover >16.0 feet: Minimum SDR-13.5

D. Service Saddles

1. Service saddles shall be designed for use specifically with HDPE pipe. Saddles shall meet applicable requirements of AWWA C800 and AWWA Manual M23 Design and Installation of PVC Pipe.

2. Saddles shall utilize wide double stainless steel straps or be of full-circumference stainless steel sleeve design. Strap saddles shall have a ductile iron body coated with a fusion epoxy or nylon coating.

3. Gasket shall be a broad pressure activated design bonded into a cavity in the saddle body or have spring-tensioning to accommodate pipe thermal expansion.

4. Straps, bolts, nuts and washers shall be 18-8 Type 304 stainless steel with all welds passivated for corrosion resistance.

2.5 PRE-CAST MANHOLES

A. Manhole Sections, General

1. Precast manhole sections shall be manufactured in accordance with ASTM C478. Concrete shall be minimum 28-day compressive strength of 4000 psi.

2. Thickness and Design

   a. Manhole sections less than 6 feet (6') in diameter shall have a minimum wall thickness of 5 inches.
   b. Continuous steel hoop reinforcement shall not be used except with Engineer's prior approval.
   c. Flat slab tops shall be designed according to:
      1) ASTM C478 if located outside of the right-of-way.
      2) AASHTO if located within the right-of-way.
   d. Where depth exceeds twelve feet (12'), provide two cages of reinforcement per ASTM C76 for Class III reinforced concrete pipe of same diameter.

3. Hoisting lugs or hooks shall be cast in place for handling and setting. No through-the-wall lift holes are allowed.

4. Openings of proper sizes and suitable design shall be cast in place or factory cored for receiving the sewer and/or drop pipes and connections.

5. Manhole diameter indicated is minimum. Provide larger diameter manholes where a minimum distance between penetrations cannot meet the following requirements:

   a. Twelve inches (12") for non-cored openings.
   b. Eight inches (8") for factory-cored openings.

6. Provide supplemental reinforcing to the primary reinforcing cage at all penetrations twelve inches (12") or larger in diameter.

7. Precast concrete items shall not exhibit cracks, voids, or other visible imperfections; evidence of imperfect proportioning, mixing, or molding; or visible reinforcing steel.

8. All precast manhole items, including adjusting rings, used on any particular manhole, shall be provided by the same manufacturer.

B. Manhole Joints

1. Precast Manhole Sections

   a. Joints shall be tongue and groove with rubber gaskets conforming to ASTM C443.
   b. Supplementary joint sealer shall conform to Federal Specification SS-S-210.
   c. Exterior joint collars shall conform to ASTM C877, Type II.

2. Adjusting Rings and Casting Frame: Butyl mastic or trowelable joint sealer, provided in extrudable 1/2 inch preformed cords, conforming to Federal Specification SS-S-210.

C. Base Sections

1. Base sections for forty-eight inch (48") and sixty inch (60") diameter manholes shall be constructed with the base and first riser section as one complete integral precast unit. Base sections for larger diameter manholes shall use a gasketed joint between the base section and first riser.

2. Base sections shall be a minimum of eight (8) inches thick and reinforced with two layers of steel.

3. Benches.

   a. Benches may be precast or cast-in-place into base section.
   b. Use 3,500 psi minimum 28 day compressive strength concrete for cast-in-place benches.
   c. Brushed finish to prevent slipping.
   d. Slope toward the channel not less than one (1) inch per foot.

4. Flow Channels.

   a. Channels shall be smooth, continuous, "U"-shaped in cross section, with constant width and invert grade from inlet to discharge.
   b. Changes of flow direction shall be made with a smooth curve with the maximum possible radius.
   c. For cast-in-place flow channels, provide a minimum of three inches (3") from the top of the base slab to the invert out so the finished sewer channel can be properly installed and shaped.

5. Bedding

   a. Manhole base bedding shall be No. 8 crushed stone or No. 8 fracture-faced aggregate.
   b. Over-excavation, whether inadvertent or to obtain a stable soil condition, shall be filled with No. 8 crushed stone, No. 8 fracture-faced aggregate, No. 2 stone, or concrete as directed by Engineer.

D. Pipe Connections: Pipe Connectors shall comply with ASTM C923.

1. Rubber sleeve with stainless steel banding installed in factory. Stainless steel elements of the connector shall be totally non-magnetic Series 305 SS.

2. Rubber compression gasket cast into section.

E. Cone Sections

1. Eccentric cone type.

2. Provide uniform circumference internally on top four inches (4”) to allow use of internal chimney seal.

F. Flat Tops

1. Precast flat tops shall be not less than eight (8”) inches thick and reinforced with two layers of steel.

G. Outside Drops

1. General: Outside drops can be:
   a. Precast with manhole sections.
   b. Field constructed with Engineer’s prior approval.
2. Precast Outside Drops: Comply with requirements for manhole sections and joints.
3. Field Constructed Outside Drops
   a. Comply with sewer pipe requirements for drop pipe.
   b. Use only rubber compression gasket cast in place for pipe connections.
   c. Encasement concrete: minimum 28-day compressive strength of 4,000 psi.

H. Manhole Steps

1. Injection molded copolymer polypropylene around one-half inch ½” ASTM A-615 Grade 60 steel bar.
2. Impact strength shall be >800 pounds with no deflection.
3. Meet or exceed ASTM C478, AASHTO M-199 and OSHA specifications.
4. Specifically designed for use in sanitary sewer manholes.
5. Steps shall be installed at the precast concrete factory.
   a. Steps shall be driven into specially sized holes cast or drilled into the manhole section per manufacturer’s direction.
   b. Cast holes shall be formed in the manhole section using an insert plug which is removed upon curing.
   c. Seal or grout must be provided if the step holes protrude completely through the manhole wall.
   d. Steps shall not be placed directly above the manhole flow channel. Steps should be located above the largest bench area in the manhole base.
6. Step spacing shall meet regulatory requirements. If no regulatory spacing requirement exists, steps shall begin 24” below lid with 12" minimum and 16" maximum spacing. Steps shall be equally spaced, the entire depth of the manhole.

I. Adjusting Rings

1. Adjusting rings shall be precast concrete conforming to ASTM C478.

2. Nominal thickness shall be between four (4”) inches and twelve (12”) inches. Adjusting rings less than four inches (4”) shall not be used.

3. Maximum of 3 rings.

J. Castings

1. General

a. Castings shall be manufactured in accordance with ASTM A48 – Class 35B and have a minimum tensile strength of 35,000 psi.
b. Castings shall be of uniform quality free from blowholes, porosity, hard spots, shrinkage, distortion or other defects.
c. Casting shall be manufactured true to pattern. Component parts shall exhibit a good fit and be interchangeable. Horizontal bearing surfaces shall be machined and not experience rocking or rattling under traffic or other loads.
d. Castings shall be well cleaned by shot blasting or other methods.
e. Each lid shall have “Sanitary Sewer” in two inch cast letters unless indicated otherwise in the Drawings.

2. Standard frames and lids.

a. R1772 by Neenah Foundry Co. with Type C heavy duty solid lid.
b. 1875-3 by East Jordan Iron Works, or equal.

3. Bolt-down gasketed frames and lids.

a. R1916-F by Neenah Foundry Co.,
b. 1045 HD by East Jordan Iron Works, or equal.

K. External Joint Wrap

1. External joint wrap shall comply with ASTM C-877.

L. External Chimney Seal

1. External chimney seal shall be a single continuous rubber band meeting the material requirements of ASTM C923.

2. Seal shall have adequate width to extend as one piece from cone section to casting frame.

3. Attachment shall be with a minimum of two 16 gauge type 304 stainless steel bands with type 304 SS accessories.

M. External Chimney Backplaster

1. External chimney backplaster shall be trowelable grade butyl rubber

2. Wrap shall meet ASTM E-1745.

N. Internal Chimney Seal

1. General: Internal Manhole Chimney Seals shall consist of a flexible internal rubber sleeve, interlocking extensions, and stainless steel compression bands conforming to ASTM C923.

2. Seal: The seal shall remain flexible throughout a 25-year design life, allowing repeated vertical movement of the frame of not less than two (2) inches and repeated horizontal movement of the frame of not less than one-half (½) inch.

3. Sleeve

    a. The sleeve portion of the seal shall be a minimum double pleated with a minimum unexpanded vertical height of 8, 10, or 13 inches, respectively.
    b. The sleeve and extension shall have a minimum thickness of three-sixteenths (3/16) inches and shall be made from a high quality rubber compound conforming to the applicable requirements of ASTM C923, with a minimum 1500 psi tensile strength, a maximum 18% compression set, and a hardness (durometer) of 48 ± 5.

4. The area of the seal that compresses against the manhole frame/casting and the chimney/cone shall provide a watertight seal.

5. Hardware

    a. The bands shall be fabricated from 16 gauge stainless steel with no welded attachments and shall have a minimum adjustment range of two (2) diameter inches.
    b. Screws, bolts, or nuts used to lock the band in place shall be stainless steel.

6. The internal seals shall be as manufactured by Cretex Specialty Products, NPC Specialty Products, or an approved equal.

O. Manhole Encapsulation System

1. Manhole encapsulation system shall be a heat-shrinkable, wraparound sleeve that creates a barrier to water infiltration.

2. Material: Irradiated and cross-linked polyethylene impermeable backing, coated with protective heat-activated adhesive.

3. Bonding: Bond to primed concrete, metal, and fiberglass surfaces.

4. Compatibility: Compatible with concrete, steel, iron, and fiberglass.

5. Closure: Separate closure seal to secure sleeve in place during installation and seal overlap area.

6. Functional Performance of Heat-Shrinkable Sleeves:

    a. Peel Strength, ASTM D 1000: 8.6 pli.
    b. Lap Shear, ASTM D 1002: 1.5 psi.
    c. Water Absorption, ASTM D 570: 0.05 % maximum.
    d. Low Temperature Flexibility, ASTM D 2671: -40 degrees F.

7. Physical Properties of Heat-Shrinkable Sleeves:
    a. System Type: High shrink.
    b. Supplied Thickness: 101 mils.
    c. Fully Recovered Thickness: 125 mils.
    d. Shrink Factor: 40%, minimum.
8. Sleeve Adhesive:
    a. Softening Point, ASTM E 28: 212 degrees F.
9. Sleeve Backing:
    a. Tensile Strength, ASTM D 638: 2900 psi.
    b. Elongation, ASTM D 638: 600%
    c. Hardness, ASTM D 2240, Shore D: 46.
    d. Abrasion Resistance, ASTM D 1044: 35 mg.
10. Primer:: Product of Manhole Encapsulation System manufacturer designed for use in the application.
    a. Use: Primes steel, concrete, and fiberglass surfaces for installation of sleeve.
    b. Compatibility: Compatible with common substrates and sleeve adhesive.

P. Inflow Dish
1. Inflow dish shall be made of ultra high density polyethylene copolymer material that meets ASTM D1248, Class A, Category 5, Type 111.
    a. Dish shall have a minimum impact brittleness temperature of –180 degrees F.
    b. Thickness shall be uniform one-eighth inch or greater.
    c. Material shall be corrosion proof from all gases associated with wastewater collection systems.
2. Lift strap shall be a woven polypropylene web attached to the bowl of the dish by a wide head stainless steel rivet and a stainless steel three-quarter (3/4) inch backup washer. All cut edges shall be seared to prevent raveling.
3. Ventilation shall be provided by a vent hole and/or a valve located on the side of the bowl.
4. The hole or valve shall allow a maximum release of five (5) gallons of water per twenty-four (24) hours
    a. Valve shall not be affected by debris that might collect in the bottom of the dish.
    b. Sewer gas shall be vented at one (1) psi or less.
5. Gasket shall be made of closed cell neoprene attached by a pressure sensitive adhesive to the weight bearing surface of the dish.
6. Dish measurement shall be as required by the product manufacturer for the frame and casting.

2.6 MONOLITHIC (CAST-IN-PLACE) MANHOLES

A. Monolithic manholes may be approved on a case-by-case basis.

2.7 CONNECTIONS TO EXISTING MANHOLES

A. Manhole wall penetration seals shall be rubber sleeves complying with ASTM C923.

B. Internal Drops

1. Solvent-welded Schedule 40 or SDR 21 PVC pipe and fittings for gravity sewers.

2. Force main pipe materials with restrained joints or flange joints for force mains.

3. Use 304 SS braces and anchor fixtures.

C. Structural Repair Grout

1. Structural repair grout material shall be designed to fill large voids in manhole walls and to repair or reconstruct inverts where no hydrostatic pressure exists. Material shall consist of rapid setting cements, aggregates, and various accelerating agents. Material shall not contain chlorides, gypsum, or metallic particles.

2. Structural repair grout shall be Strong-Seal QSR by Strong-Seal Systems Corporation, Sauereisen SewerGard Trowelable No. 210 by Sauereisen Corporation, or equal.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to estimate wastewater flows, size pipe and calculate friction loss, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved by Engineer.

B. Utilize ductile iron sewer mains and fittings within pumping and treatment facilities.

C. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer. Comply with ASTM D3212 for joint tightness.

D. Install manholes for changes in pipe direction or pipe grade.

E. Lateral Connections.

1. Material and construction requirements for mainline sewers shall apply to sewer laterals.

2. Use fittings for lateral connections to new sewers.

3. Use saddle taps only to connect laterals to existing sewers and only with Engineer's prior written approval.

F. Install proper size couplings according to manufacturer's instructions where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

G. Install gravity-sewer piping according to the following:

1. Meet or exceed minimum slope required by regulatory authorities.

2. Install ductile-iron gravity sewer piping according to AWWA C600 and ASTM A746.

3. Install ductile-iron and special fittings according to AWWA C600 and AWWA M41.

4. Install PVC sewer piping according to ASTM D2321, ASTM F1668, AWWA M23, and the Uni-Bell PVC Pipe Association's Handbook of PVC Pipe.

5. The practice of blocking pipe up to grade with select locations of bedding material, then bedding under is prohibited. The entire length of the bed section is to be at proper grade before installing pipe.

6. Provide a waterproof bulkhead in the new gravity sewer pipe at the point of connection to the existing sewer system from the time of the connection until the new sewers have been completed and cleaned of all debris as approved by the utility owner. Capture all debris captured from the bulkhead removal at the first downstream manhole.

7. Use a laser beam for horizontal and vertical control of the sewer, unless alternative method of control is submitted to and accepted by Engineer prior to work.

   a. Set up laser unit so that the alignment of the beam is through the centerline of the pipe or outside the pipe directly above and parallel to the centerline of the pipe. Confirm elevation at regular intervals along pipe segment using survey equipment.
   b. If set up on the centerline:
      1) Provide a blower for continuous air circulation within the pipe.
      2) Establish a target on line and grade to provide a method of checking the setting of the laser beam as construction progresses.
   c. If set up above the pipe:

1) Provide means to ensure the grade pole is plumb when checking pipe grade.
2) Set grade pole on the invert of the pipe when checking alignment and grade.

H. Install piping encasement over DI pipe and fittings according to ASTM A674 or AWWA C105.

I. Clear interior of piping and manholes of dirt, water, and superfluous material as work progresses. Place plug in end of incomplete piping at end of day and when work stops.

J. Field Cut Pipe

1. Per manufacturer's recommendations except when joining pipes.

2. Reestablish homing marks, insuring for proper seating depths.

3. Bevel end by grinding or filing as close to the original taper provided by the manufacturer as possible.

3.2 PIPE JOINT CONSTRUCTION

A. Join PVC sewer piping according to ASTM D2321 and ASTM D3034 for elastomeric-seal joints or ASTM D3034 for elastomeric-gasket joints.

B. Join PVC profile gravity sewer piping according to ASTM D2321 for elastomeric-seal joints or ASTM F794 for gasketed joints.

C. Join DI gravity sewer piping according to AWWA C600 for push-on joints.

D. Join DI fittings and special fittings according to AWWA C600 or AWWA M41.

E. Join flanged joints of DI pipe and fittings according to AWWA C115.

F. Join dissimilar pipe materials with nonpressure-type, flexible couplings according to both pipe manufacturer's directions.

3.3 MANHOLE INSTALLATION

A. General: Manholes shall be installed straight and plumb. Completed manholes shall be rigid, true to dimensions, and watertight.

B. Bottom of excavation shall be flat, level and dry, with stable soils, prior to manhole installation. Place and level stone base prior to manhole installation. Fill overexcavation with indicated aggregate or concrete material prior to bedding.

C. Install and compact pipe bedding from bottom of manhole to level of entry pipe prior to making pipe connection to manhole. Do not use concrete at piping connections with new manholes.

D. Place backfill evenly around manhole to prevent lateral movement.

E. Install manhole sections so that steps are in vertical line below casting lid and above largest bench.

F. Manhole Frames Above Grade or in Floodway: Where manhole covers are more than 3 inches above finished grade, within a legal drain or FEMA designated floodway, or where shown on the plans, manhole frames and lids shall be bolt-down type and frames shall be bolted through the anchor base flange to the cone section with four 3/8" stainless steel anchor bolts, washers, and concrete anchors.

G. Adjusting Rings: Install adjusting rings according to manufacturer's recommendations and the following procedure:

1. Clean the concrete cone or top slab to assure a flat seating surface free of debris.

2. Install adjusting rings of thickness necessary to come within 1/4" of grade with the cover frame in place, considering the space between the adjusting rings created by the compressed joint sealer.

3. Apply two strips of joint sealant to each joint from the top of the cone or slab to the casting frame. Install joint sealant around the entire circumference, overlapping the ends.

4. Install adjusting rings centered over eccentric cone top, straight and plumb. Reset when knocked offline.

5. Set the casting frame in place, centered on the top adjusting ring.

H. Chimney Seals

1. Chimney Seals shall be installed according to manufacturer's directions.

I. Manhole Encapsulation System

1. Surface Preparation

   a. Prepare surfaces in accordance with manufacturer's instructions.
   b. Ensure surfaces are clean, dry, and free of frost, surface rust, foreign objects, sharp edges, and projections that could damage manhole encapsulation system.

2. Installation

   a. Install manhole encapsulation system in accordance with manufacturer's instructions.

1) Install 12 inch wide or 18 inch wide encapsulation from frame to eccentric cone section.
2) Install 12 inch wide encapsulation on all barrel joints.

3. Field Quality Control

a. Sleeve Inspection: Visually inspect installed sleeve to ensure:
1) Sleeve is in full contact with substrate, including cone section and manhole frame.
2) No cracks or holes in polyethylene backing.
3) No voids exist below sleeve.
4) Adhesive has flowed beyond sleeve edges.

b. Site Adhesion Testing: Peel tests.
1) Frequency of Test: 1 in every 100 sleeves.
2) Surface Temperature at Time of Test: 77 ±10 degrees F.
3) Peel Rate: 4 inches /minute.
4) Perform testing using hand peel gauge on 1 inch wide strip.
5) Cut strip and induce initial failure by undercutting and peeling back strip until 2 inch flap is created.
6) Attach clamp to strip and hand peel gauge to clamp and peel back at a 90 degree angle to surface at specified peel rate.
7) Passing Minimum Peel Strength: 8.6 pli with cohesive failure of adhesive.

4. Backfilling and Protection

a. Allow sleeve to cool before backfilling manhole. Water quenching is permissible to expedite backfilling.
b. Prevent damage to sleeve by backfilling with select backfill or material with no sharp stones or large particles, or protect sleeve with extruded polyethylene mesh or other suitable protective shield.

J. Manhole Backplaster

1. Apply backplaster evenly at a minimum thickness of ¼ inch from the frame to two inches below the last adjusting ring.

2. Install wrap over backplaster, covering the backplaster completely.

K. Inflow Dish

1. The manhole frame shall be cleaned of all dirt and debris before placing the inflow dish on the rim.

2. Inflow dish shall be fully seated around the manhole frame rim to prevent water from infiltrating between the cover and the manhole frame rim.

L. Manhole Coating When Receiving Force Main Discharge

1. Coat inside to prevent deterioration from sewer gases.

2. Clean casting and concrete surface to remove dirt, loose concrete and cement laitance with blast or power tool cleaning per SSPC-SP11 Specifications.

3. Apply one coat of Tnemec 46H-413 Hi Build Tneme-Tar to interior concrete surfaces and all casting surfaces to 16 mils to 20 mils thickness.

M. In general, top of casting elevations given are approximate. Unless a top of casting elevation is specifically indicated to differ from this requirement, field adjust all castings to the following elevations:

1. Set tops of frames and covers +0 inches to -1/4 inch (0” $\leq \geq$ -1/4”) with finished surface for manholes that occur in travelling or paved surfaces.

2. Set tops of frames and covers 3 inches (3”) above finished surface elsewhere.

3.4 CONCRETE PLACEMENT

A. Place concrete external to manhole according to ACI 318/318R.

B. Place cast-in-place concrete for monolithic manholes and cast-in-place bases in pre-cast manholes according to ACI 350/350R.

3.5 CLOSING ABANDONED SANITARY SEWERAGE SYSTEMS

A. General: Where new sewers replace existing sewers, abandon existing sewers only after completion of construction, testing, and acceptance of new sewers. Connect existing customers to new sewers prior to abandonment.

B. Abandoned Piping

1. Abandonment by Removal
   a. Remove and dispose of all piping to be abandoned.
   b. Fill excavation with final backfill in accordance with utility trench requirements.
2. Abandonment by Capping
   a. Clean pipe to be abandoned using high pressure jetting and, if required, heavy cleaning.
   b. Close open ends of underground piping to be abandoned with plastic plugs, concrete, or other acceptable methods suitable for size and type of material being closed.
   c. Do not use wood plugs.
3. Abandonment by Filling
   a. Clean pipe to be abandoned using high pressure jetting and, if required, heavy cleaning.

b. Flowable backfill is to be pumped into the sewer pipe from one manhole to the next.
c. Abandoned pipes are to be filled with flowable backfill until it is visually apparent on the opposite end that all space within the pipe has been filled.

C. Abandoned Manholes

1. Abandonment by Filling

a. Break two holes in side of manhole barrel at bench elevation of the structure.
b. Remove top of manhole down to at least 36 inches (36”) below final grade.
c. Fill manhole to within 12 inches (12”) of top of remaining manhole structure with stone, rubble, or gravel.
d. Fill top 12 inches of manhole with concrete.
e. Fill excavation with final backfill in accordance with utility trench requirements.

2. Abandonment by Removal

a. Excavate and remove manhole.
b. Fill excavation with final backfill in accordance with utility trench requirements.

3.6 CONNECTIONS TO EXISTING MANHOLES

A. Make connections from sewers to existing manholes by coring a circular opening into existing manhole of the size required for the flexible connector. Saw cutting and hammer taps are prohibited except with Engineer’s prior approval. Install flexible connector into manhole, and pipe through connector, according to connector manufacturer’s instructions.

B. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall, unless otherwise indicated.

C. Prevent concrete or debris from entering existing piping and manholes while making connections. Remove debris or other extraneous material that may accumulate.

D. Chip out new channel as required. Provide smooth transition into existing channel and bench. Use structural repair grout to form new channel and bench.

E. Where manhole conditions prohibit coring and with Engineer’s prior approval, a hole 3 inches larger in diameter than the pipe may be cut or chipped out of the manhole and structural repair grout packed around entering connection.

3.7 FIELD QUALITY CONTROL

A. Testing, General

1. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
    a. Inspect and test completed piping systems.
    b. Schedule inspections and tests with Owner and Engineer with at least 48 hours' advance notice.
    c. Submit separate report for each test.
2. Failures of inspections or tests indicate defects that must be repaired or replaced.
3. Replace failed work using new materials, and repeat testing until test results are within allowances specified.

B. Visual Inspection: Inspect interior of main line piping by lamping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (24") of backfill is in place, and again at preparation of initial punch list.

C. Cleaning
1. Conduct standard cleaning prior to acceptance testing.

D. Mandrel Deflection Test
1. Applicability: Conduct deflection tests on PVC or other flexible pipe sewers 48-inches and less in diameter using a mandrel.
2. Mandrel Characteristics
    a. Mandrel manufactured for the purpose of determining flexible pipe deflection shall have a diameter of at least 95% of the base pipe ID indicated in the applicable pipe standard.
    b. Minimum mandrel length shall be as follows:
        1) Eight inches (8") long for 8-inch diameter pipe.
        2) Ten inches (10") long for 10-inch diameter pipe.
        3) Ten inches (10") long for 12-inch diameter pipe.
        4) Twelve inches (12") long for 15-inch diameter pipe.
        5) As approved by Engineer for pipe larger than 15-inch.
    c. Mandrel shall be made of steel or aluminum and have nine (9) or more arms.
    d. Provide proving ring clearly marked with diameter and ASTM standard.
3. Procedure
    a. Conduct test a minimum of 30 days after the backfill has been placed to final grade.
    b. Pull the mandrel through all main line sewers.
    c. The pipe shall pass the deflection test if one person can pull the mandrel through the pipe by hand.
4. Any pipe that does not pass the deflection test shall be replaced by the Contractor and retested.

E. In-Situ Deflection Test

1. Applicability: Conduct in-situ deflection tests on PVC or other flexible pipe sewers larger than 48-inches in diameter.

2. Equipment

   a. Provide a rigid small-diameter rod of a length equal to the manufactured inside diameter of the pipe less the acceptable deflection limits of the pipe.
      1) Acceptable deflection shall be the lesser of the manufacturers' published deflection standards, the applicable regulatory standards, or the applicable certification agency standards.
   b. Device shall include a level capable of determining level and plumb conditions.

3. Procedure

   a. Conduct test a minimum of 30 days after the backfill has been placed to final grade.
   b. With Engineer present, conduct in-situ deflection test using the following procedure.
      1) Spot checks shall occur at the following locations.
         a) One location in each section of pipe.
         b) At locations indicated by Engineer.
      2) Circumferentially mark an equal distance at the following locations measured from the spigot end of the pipe.
         a) At the springline of the pipe on both sides.
         b) At the crown of the pipe.
         c) At the bottom center of the pipe.
      3) Place the rod at the locations of the marks at the top and bottom of the pipe and at the spring line of the pipe using the level to confirm level or plumb, as applicable.

4. Any pipe that will not allow the rod-type device to be placed level or plumb at the marks in the pipe shall be replaced by the Contractor and retested.

F. Closed-Circuit Television Inspection

1. Visually inspect mainline sewers by closed circuit television to identify visual defects in the pipe. Run water through sewer prior to televising to aide in identification of grade reversals.

2. Submit video inspection record to Engineer within seven (7) days of inspection.

3. Repeat closed-circuit television inspection after repair of defects.

G. Low Pressure Air Test

1. Applicability: All main line sewers twenty four inches (24") and smaller, including attached laterals, shall be subjected to an air test.

2. Test shall comply with ASTM F1417.

3. Procedure.

a. Waiting Period: The air test may be done after final backfill is placed in the trench.

b. Equipment: At a minimum, the following shall be provided:

1) Mechanical or pneumatic plugs.

2) Air control panel.

3) Shut-off valve, pressure regulative valve, pressure relief valve, and input pressure gauge. The pressure regulator or relief valve shall be set no higher than 9 psig to avoid over pressurization;

4) Continuous monitoring pressure gauge having a range of 0 to at least 10 psi. The gauge shall be no less than four (4) inches in diameter with minimum divisions of 0.10 psi and an accuracy of ± 0.04 psi;

5) To reduce the potential for sewer line over-pressurization, two (2) separate hoses shall be used to:

a) Connect the control panel to the sealed line for introducing low pressure air; and

b) Constantly monitor air pressure buildup in the line.

6) If pneumatic plugs are utilized, a separate hose shall be required for inflation.

c. Testing Procedures: The procedures for the low pressure air test are as follows:

1) Plug Installation: After a manhole to manhole segment of pipe has been backfilled to final grade and all laterals and appurtenances installed, securely place and brace suitable test plugs in the ends of the sewer segment and in all lateral stubs included in the test. All plugs shall be securely restrained and braced prior to and during the test.

2) Line Pressurization: Add air slowly to the test section until the pressure inside the pipe reaches 4.0 psig plus the necessary adjustment for groundwater (Initial Pressure). The air pressure adjustment for groundwater is:

a) 2.0 psig unless groundwater monitoring wells have been installed.

b) If groundwater wells or manhole groundwater monitoring taps have been installed, the adjustment shall be determined by the following:

$$\text{Adjustment} = \text{Depth of Groundwater} \times 0.43$$

where:

Adjustment = Adjustment added to the starting pressure of the low-pressure air test, psig. The maximum adjustment shall be 2.0 psig.

Depth of Groundwater = As measured above the top of pipe, feet.

0.43 = Conversion factor

If more than one well was installed, take the average depth of the nearest downstream and nearest upstream monitoring locations.

3) Do not exceed 6.0 psig at any time during the low-pressure air test.
4) Pressure Stabilization: After the initial pressure is reached, the air supply shall be throttled to maintain that initial pressure for at least two (2) minutes. This time permits the temperature of the entering air to equalize with the temperature of the pipe wall.
5) Testing
    a) When temperatures have equalized and the pressure stabilized at the initial pressure, the air hose from the control panel to the air supply shall be shut off or disconnected.
    b) The continuous monitoring pressure gauge shall then be observed while the pressure is decreased to no less than 0.5 psig below the initial pressure. At this reading, or any convenient observed pressure reading between the initial pressure and 0.5 psig below the initial pressure, timing shall begin.
    c) A timed pressure drop of 0.5 psig shall be used. The allowable time shall be predetermined using Table 02530-1.

TABLE 02530-1
SPECIFICATION TIME REQUIRED FOR A 0.5 PSIG PRESSURE DROP
FOR SIZE AND LENGTH OF PIPE INDICATED

Pipe Dia. (in)	Min. Time (min:sec)	Length for Min. Time (ft)	Time for Longer Length (sec)	Specification Time for Length (L) Shown (min:sec)							
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft
4	1:53	597	0.190L	1:53	1:53	1:53	1:53	1:53	1:53	1:53	1:53
6	2:50	398	0.472L	2:50	2:50	2:50	2:50	2:50	2:50	2:51	3:12
8	3:47	298	0.760L	3:47	3:47	3:47	3:47	3:48	4:26	5:04	5:42
10	4:43	239	1.187L	4:43	4:43	4:43	4:57	5:56	6:55	7:54	8:54
12	5:40	199	1.709L	5:40	5:40	5:42	7:08	8:33	9:58	11:24	12:50
15	7:05	159	2.671L	7:05	7:05	8:54	11:08	13:21	15:35	17:48	20:02
18	8:30	133	3.846L	8:30	9:37	12:49	16:01	19:14	22:26	25:38	28:51
21	9:55	114	5.235L	9:55	13:05	17:27	21:49	26:11	30:32	34:54	39:16
24	11:20	99	6.837L	11:24	17:57	22:48	28:30	34:11	39:53	45:35	51:17
27	12:45	88	8.653L	14:25	21:38	28:51	36:04	43:16	50:30	57:42	64:54
30	14:10	80	10.683L	17:48	26:43	35:37	44:31	53:25	62:19	71:13	80:07
33	15:35	72	12.926L	21:33	32:19	43:56	53:52	64:38	75:24	86:10	96:57
36	17:00	66	15.384L	25:39	38:28	51:17	64:06	76:55	89:44	102:34	115:23

6) No time adjustment will be made for lateral lengths.
7) Determination of Line Acceptance: If the time shown for the designated pipe size and length elapses before the 0.5 psig pressure drop, the section of pipe being tested shall have passed the test. The test may be discontinued once the prescribed time has elapsed even though the pressure drop has not occurred.
8) Determination of Line Failure: If the pressure drops 0.5 psig or more before the appropriate time has elapsed, the air loss rate shall be considered excessive and the section of pipe being tested shall have failed the test.
9) Uncover, replace, or repair and completely retest any section of sewer or laterals not passing the test. The method of repair shall be subject to acceptance by Engineer. Grouting is not an acceptable method of repair.

H. Joint Test

1. Applicability: All main line sewers larger than twenty four inches (24") shall be subjected to a joint test using air or water under low pressure. All joints shall be tested.

2. Testing: Testing procedures shall be per ASTM C1103 and as follows:

a. Waiting Period: The joint test may be done at any time after final backfill is placed.
b. Equipment: Equipment used shall be made specifically for joint testing of pipelines.
c. Joint Test Apparatus Installation
1) Clean the joint and interior joint surfaces.
2) Move the joint test apparatus into the sewer line to the joint to be tested and position it over the joint. Make sure the end element sealing tubes straddle both sides of the joint and the hoses are attached. For the water test, the bleed-off petcock must be located at top dead center.
3) Inflate end element sealing tubes with air in accordance with equipment and manufacturer's instructions.
d. Joint Air Test
1) Pressurize the void volume with air to 3.5 psig plus the necessary adjustment for groundwater (Initial Pressure). The air pressure adjustment for groundwater is:
a) 2.0 psig unless groundwater monitoring wells have been installed.
b) If groundwater wells have been installed, the air pressure adjustment for groundwater will be done in the same manner as for a low pressure air test.
2) Allow the air pressure and temperature to stabilize before shutting off the air supply. Start the timing of the test.
3) Measure the pressure drop after five (5) seconds.

4) After the joint test is completed, exhaust void volume, then exhaust end element tubes prior to removal of the testing apparatus.

e. Joint Water Test
   1) Introduce water into the void volume until water flows evenly from open petcock. Close the petcock and pressurize with water to 3.5 psi plus the necessary adjustment for groundwater (Initial Pressure). The water pressure adjustment for groundwater is:
      a) 2.0 psig unless groundwater monitoring wells have been installed.
      b) If groundwater wells have been installed, the water pressure adjustment for groundwater will be done in the same manner as for a low pressure air test.
   2) Shut off the water supply and start test timing.
   3) Measure the pressure drop after five (5) seconds.
   4) After the joint test is completed, exhaust end element tubes which will automatically release the water from the void volume, prior to removal of the testing apparatus.

f. Determination of Line Acceptance: If the pressure holds or drops less than one (1) psig for the five (5) second test time, the joint shall have passed the test.

g. Determination of Line Failure: If the pressure drops one (1) psig or more during the five (5) second test time, the joint shall have failed the test.

h. If the joint fails, repair and retest as necessary. The method of repair shall be subject to acceptance by Engineer. Grouting is not an acceptable method of repair.

I. Water Infiltration Test

1. Applicability: If water is observed in the sewer at any time during the construction or acceptance process, conduct a weir test to determine if the 100 gal/in/mi/day maximum allowable infiltration rate in any two adjacent manholes or the entire system is being exceeded.

2. Procedure: A snap-in weir of appropriate size, with a calibrated weir overflow, shall be inserted in the pipe. The weir shall be maintained in the pipe as directed by Engineer.

3. Determination of Line Acceptance: If the flow over the weir is not observed to exceed the infiltration allowance of 100 gal/in/mi/day at any time, the sewer segment(s) being tested shall have passed the test.

4. Determination of Line Failure: If at any time the flow over the weir is observed to exceed the infiltration allowance of 100 gal/in/mi/day, the segment shall have failed the test.

5. Repair all visible leaks, even if the allowable infiltration requirements are met. The method of repair shall be subject to acceptance by Engineer. Grouting of the joint or crack to repair the leakage shall not be permitted.

6. If the defective portion of the sanitary sewer cannot be located, remove and reconstruct as much of the work as necessary to obtain a system that passes infiltration requirements.

J. Vacuum Test

1. Applicability: All manholes shall be subjected to a vacuum test. The vacuum test shall include the sewer-to-manhole connection boot and all joints between the casting and the bottom of the base. Internal chimney seals shall be tested separately.

2. General: Testing shall be done per ASTM C1244.

3. Waiting Period: If possible, each manhole shall be tested immediately after assembly and prior to backfilling. If the test is done after backfilling, the Contractor shall be responsible for re-excavation to locate and correct any leaks that have been identified. The vacuum test shall be done BEFORE the internal chimney seal, if any, is installed and tested.

4. Equipment: Equipment used shall be made specifically for vacuum testing of manholes.

5. Testing Procedures

a. Plug Installation: All pipes entering the manhole shall be temporarily plugged, taking care to securely brace the pipes and plugs to prevent them from being drawn into the manhole.
b. Test Head Installation: The test head shall be placed at the top of the manhole casting in accordance with the manufacturer's recommendations.
c. Air Evacuation: A vacuum of ten (10) inches of mercury shall be drawn on the manhole, the valve on the vacuum line of the test head closed, and the vacuum pump shut off.
d. Timing Pressure Rise: The time for the vacuum reading to drop from ten (10) inches to nine (9) inches of mercury shall be measured. The allowable time shall be determined by using the following Table 02530-2:

a)

TABLE 02530-2
MINIMUM TIME REQUIRED FOR A PRESSURE RISE OF 1 INCH Hg
FOR MANHOLES OF VARIOUS DEPTHS AND DIAMETERS

Manhole Depth to (ft.)	Diameter (in)		
	48	60	72
	Time (sec)		
8	20	26	33
10	25	33	41
12	30	39	49
14	35	46	57
16	40	52	65

18	45	59	73
20	50	65	81
22	55	72	89
24	59	78	97
26	64	85	105
28	69	91	113
30	74	98	121
Add for each addn'l 2'	5	7	8

b)

6. Determination of Manhole Acceptance: If the time shown for the designated manhole depth and diameter elapses before the vacuum reading drops one (1) inch, the manhole shall have passed the test.

7. Determination of Manhole Failure: If the vacuum reading drops more than one (1) inch before the appropriate time has elapsed, the manhole shall have failed the test.

8. Uncover, replace, or repair manhole. Retest until successful test is accomplished.

K. Internal Chimney Seal Leakage Test

1. Applicability: All internal chimney seals, where required, shall be tested using a leakage test.

2. Procedure: The leakage test shall be conducted as follows:

   a. Waiting Period: The leakage test shall be done after the manhole has passed the vacuum test.
   b. Testing Procedures: Install the chimney seal and only the bottom expansion band per manufacturer's recommendation. Fully tighten the bottom band. Do not install the top expansion band.
   c. Pulling the top of the seal away from the manhole frame, pour one (1) gallon of water behind the seal.
   d. Observe the bottom seal for a minimum of one (1) minute for leakage.
   e. Drain the water by folding the top of the chimney seal down.
   f. If the chimney seal passes the test, install the top expansion band per manufacturer's recommendation.

3. Determination of Chimney Seal Acceptance: If the bottom expansion band holds water without visible leaking, the chimney seal will have passed the test.

4. Determination of Chimney Seal Failure: If the bottom expansion band has any leakage during the test time, the chimney seal will have failed the test.

5. Replace or reposition the bottom expansion band and retest until a successful test is accomplished.

END OF SECTION 025300

SECTION 025450
SEWER FORCE MAINS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Sewer force main installed by the open trench method.

2. Products for sewer force mains installed by horizontal directional drilling, boring and jacking, or pipe bursting methods.

3. Valves, including air valves.

B. Related sections include the following:

1. Section 022400 – Dewatering for trench dewatering requirements.

2. Section 022600 – Excavation Support and Protection for excavation support and protection requirements.

3. Section 023000 – Earthwork for excavating, trenching, bedding and backfill, and pipe identification material.

4. Section 024000 – Boring and Jacking Piping Installation for installation of sewer force mains by the boring and jacking technique.

5. Section 024100 – Horizontal Directional Drilling Piping Installation for installation of sewer force mains by the horizontal directional drilling method.

C. Related regulations include the following:

1. 327 IAC 3-6-9 for separation requirements with water mains and wells.

1.2 ACRONYMS

A. HDD: Horizontal Directional Drilling.

B. HDPE: High-density polyethylene plastic.

C. PVC: Polyvinyl chloride plastic.

D. DI: Ductile Iron.

E. CI: Cast-Iron.

1.3 DEFINITIONS

A. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.

B. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.

1.4 SUBMITTALS

A. Action Submittals

1. Product Data: For each type of product indicated.

2. Shop Drawings

   a. Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.
   b. Dimension and detail pipe and fitting layouts for all exposed pipe and all pipe 24” or larger.
   c. Exposed piping and fitting supports.

3. Samples

   a. Pipe bedding.

B. Informational Submittals

1. Coordination Drawings

   a. Show types, sizes, materials, and elevations of other utilities crossing system piping.
   b. Detail support systems for existing utilities.
   c. Detail temporary or permanent existing utility relocations.

2. Calculations

   a. Thrust and longitudinal tensile stress calculations due to thermal expansion and contraction for HDPE pipe restraint for pipe-to-structure connections and connections to pipes of different materials.

3. Manufacturer Certificates

4. Product and Material Certificates

   a. Piping.
   b. Valves.
   c. Fittings.

5. Schedule of Tests and Inspections

6. Field Test Reports

   a. Pressure and leakage tests.

7. Manufacturers' Instructions
    a. Pipe installation.
    b. Valve installation.
8. Product Warranties

C. Project Record Documents
1. Product Data
    a. Valves of all types.
2. Field test reports
3. Manufacturer's operations and maintenance literature
    a. Air valves.
4. Record Drawings

1.5 QUALITY ASSURANCE

A. Qualifications
1. Pipe, fitting, and valve manufacturer's quality control system shall be ISO 9001 registered or provide the services of an Independent Inspection Agency. Piping materials shall bear label, stamp, or other markings of specified testing agency.
2. Concrete Valve Vaults
    a. Concrete Testing Agency
        1) Not less than three years experience in performing concrete tests of type specified in this Section.
        2) Capable of performing testing in accordance with ASTM E329.
    b. Allowable Tolerances
        1) Length and width of precast units measured at face adjacent to mold shall be the following:
            a) Units 10 ft or under: ± 1/8".
            b) Units 10 to 20 ft: + 1/8", - 3/16".
            c) Units over 20 ft: + 1/8", - 1/4".
        2) Thickness of units shall be + 1/4", - 1/8".
        3) Units shall not be out of square more than 1/8" per 6 ft or 1/4" total.

B. Regulatory Requirements
1. Comply with requirements of utility company providing wastewater service.

2. Comply with standards of authorities having jurisdiction for sewer-service piping, including materials, installation, and testing.

3. Comply with requirements of IDEM and EPA regarding wastewater facilities and service.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manhole components, pipe, gaskets, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle pipe and manholes according to manufacturer's written rigging instructions.

D. Do not skid or roll products on or against other products. Use padded sling, hooks and pipe tongs in such a manner to prevent damage to products.

E. Do not stack ductile iron pipe higher than the limits shown in ANSI/AWWA C600. Stacking of pipe shall meet the requirements of the pipe manufacturer. Do not stack fittings.

F. Do not allow gaskets to come in contact with petroleum products.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Sewer Service: Do not interrupt sewer service from facilities occupied by Owner or others or sewer flow through the sewer system unless permitted under the following conditions and then only after arranging to provide temporary sewer service according to requirements indicated:

1. Notify Engineer and Owner no fewer than two (2) days in advance of proposed interruption of service.

2. Do not proceed with interruption of sewer service without Owner's written permission.

3. Comply with requirements of utility owner in providing temporary sewer service.

PART 2 - PRODUCTS

2.1 GENERAL

A. All pipe and fitting sizes and all references to pipe diameter on the Drawings or in the Specifications are intended to be nominal.

B. Special Applications and Limitations

1. PVC and HDPE sewer force main pipe will only be used in buried locations.

2. Horizontal Directional Drilling

   a. PVC Sewer Force Mains – IPS or DI OD with indicated joints.
   b. DI Sewer Force Mains with indicated joints.
   c. HDPE Sewer Force Mains.

3. Boring and Jacking Pipe Installations

   a. PVC Sewer Force Mains – DI OD.
   b. DI Sewer Force Mains.
   c. HDPE Sewer Force Mains.

4. Pipe Bursting

   a. HDPE Sewer Force Mains.

2.2 SEWER FORCE MAINS

A. PVC Sewer Force Mains

1. General

   a. Pipe and fittings shall be colored green for identification as sewage pipe.
      1) Restrained joint PVC IPS OD sewer force mains for horizontal directional drilling applications may be yellow in color.
   b. Plastic shall meet ASTM D1784.
   c. PVC Sewer Force Mains shall be used only in buried service.

2. PVC Sewer Force Mains – IPS OD

   a. Pipe sizes shall be from three inch (3”) through twelve inch (12”) conforming to ASTM D2241, SDR-21 or SDR-17.

3. PVC Sewer Force Mains – DI OD

   a. Pipe sizes four inch (4”) through twelve inch (12”) shall conform to AWWA C-900, DR 18 or DR 14.
   b. Pipe sizes greater than twelve inch (12”) shall conform to AWWA C-905, DR 21 or DR 18.

4. Pipe Joints

a. Buried Service-Open Trench or Boring and Jacking Installation
    1) Joints shall be push-on flexible gasket compression-type conforming to ASTM F477.
    2) Joint performance shall be in accordance with ASTM D3139 under both pressure and 22" Hg vacuum.
    3) Joints connecting to different pipe or fitting types shall be in accordance with manufacturer's recommendations.
    4) Manufactured restrained joints under conditions indicated by manufacturer.
    5) Field-adaptable restraint shall have a working pressure equal to at least the pipe's working pressure rating and shall be Megalug Series as manufactured by EBAA Iron, or Uni-Flange Series by Ford Meter Box Company (16" or less), or equal under conditions indicated by manufacturer.
    6) No solvent cement joints shall be allowed.
b. Buried Service-HDD Installation
    1) Restrained boltless flexible type conforming to ASTM F477 with performance in accordance with ASTM D3139.
    2) Do not use joints with bulky glands or flanges that may prevent the smooth flow of the drilling fluid over the joint.
    3) Do not use joints that restrain movement by means of teeth, elements in or around the gaskets, or other similar friction or pipe-gripping methods.
    4) Joints shall be UL and FM approved for continuous use at rated pressure in HDD applications.
    5) Joints shall be specified by pipe manufacturer for use in HDD applications.

5. Fittings and Fitting Joints: DI meeting the requirements of AWWA C110, standard pattern or AWWA C153, compact pattern.
    a. Mechanical joints in accordance with AWWA C110 and AWWA C111.
    b. Push-on type joint conforming to AWWA C111.
    c. Manufactured restrained joints under conditions indicated by manufacturer.
    d. Field-adaptable restraint shall have a working pressure equal to at least the pipe's working pressure rating and shall be Megalug Series as manufactured by EBAA Iron, or Uni-Flange Series by Ford Meter Box Company (16" or less), or equal under conditions indicated by manufacturer.

B. DI Sewer Force Mains
    1. Pipe shall conform to AWWA C151.
    2. Pressure class in conformance with AWWA C150:

a. Pipe sizes through twelve inches (12") shall be 350 psi pressure class.
b. Pipe sizes greater than twelve inches (12").
    1) 250 psi pressure class for buried service with MJ or push-on joints.
    2) 350 psi pressure class for exposed service and for flanged or restrained joints.

3. Pipe and Fitting Joints
    a. Buried Service-Open Trench or Boring and Jacking Installation
        1) Mechanical joints in accordance with AWWA C110 and AWWA C111.
        2) Push-on type joint conforming to AWWA C111.
        3) Gaskets meeting AWWA C111.
        4) Manufactured restrained joints under conditions indicated by manufacturer.
        5) Field-adaptable restraint shall have a working pressure equal to at least the pipe's working pressure rating and shall be Megalug Series as manufactured by EBAA Iron, or Uni-Flange Series by Ford Meter Box Company (16" or less), or equal under conditions indicated by manufacturer.
    b. Buried Service-HDD Installation
        1) Pipe Joints
            a) Restrained boltless flexible type.
            b) Do not use joints with bulky glands or flanges that may prevent the smooth flow of the drilling fluid over the joint.
            c) Pipe joints shall be specified by pipe manufacturer for use in horizontal directional drilling applications.
        2) Fitting Joints
            a) Fitting joints shall be field-adaptable restraints, shall have a working pressure equal to at least the pipe's working pressure rating, and shall be Megalug Series as manufactured by EBAA Iron, Uni-Flange Series by Ford Meter Box Company (16" or less), or equal under conditions indicated by manufacturer.
    c. Exposed Service
        1) Threaded flanges, gaskets, and flange fittings in conformance with AWWA C115.
        2) ASME B16.5, Class 150, DI or ASME 16.1, Class 125, CI for other flanges, gaskets, and flange fittings.
        3) Flange Backup Rings
            a) Flange backup rings shall be of the type and pressure rating as the pipe.
            b) Ductile iron backup rings shall be of the convolutant type, fabricated from ductile iron per ASTM A536, grade range 60/40/18 to 65/45/12. Ductile iron flange

backup ring bolting dimension shall conform to ASME B16.5 Class 150.

c) Backup rings shall be finished and cast with flash removed from all edges and bolt holes to the specified dimensions. Finish shall be epoxy coated with bitumastic 300M high build coal tar epoxy in accordance manufacturer's recommendations or as noted on the plans.

4. Coatings

   a. Interior seal-coated cement mortar lining shall meet the requirements of AWWA C104.
   b. Exterior coating shall meet the requirements of AWWA C151.
   c. Interior and exterior coatings shall be provided for all pipe and fittings
   d. Exterior coatings shall be provided for all adapters.

5. Encasement

   a. Buried Service: Polyethylene encasement shall conform to AWWA C105.
      1) Color: Green.
   b. Exposed Service: None.

6. Fittings

   a. DI meeting the requirements of AWWA C110, standard pattern or AWWA C153, compact pattern.
   b. Special fittings not included in applicable AWWA specifications shall be reviewed on a case-by-case basis.
      1) Manufacturer shall legibly mark specials in accordance with the laying schedule and marking diagram.

C. HDPE Sewer Force Mains

1. Pipe

   a. HDPE pipe (PE 3408) shall meet the requirements of ASTM D3350 and ASTM F714. Cell classification shall be 345444C.
   b. Pipe four inches (4") or greater in diameter shall be DI or IPS OD pipe size. Pipe smaller than four inches (4") in diameter shall be IPS.
   c. Pressure Class: Class 160
   d. Standard Dimension Ratio (SDR): SDR 11.
   e. HDPE Sewer Force mains shall be used only in buried service.
   f. Pipe shall be green-striped or be green in color.

2. Joints: Fusion butt-welded.

3. Fittings

a. Manufactured in accordance with the same standards, design pressure classes, dimensions, and temperature ranges specified as for HDPE pipe.
b. Manufactured by the same manufacturer as the pipe, using identical materials.
c. Do not use tapping sleeves for main-to-main connections.
d. Fittings shall not be field fabricated.
e. Stiffeners shall be provided by fitting manufacturer and acceptable to pipe manufacturer.

2.3 LOCATOR WIRE

A. Locator wire for open trench installations shall be annealed copper-clad high carbon steel high strength tracer wire.

B. Insulation: High Density Polyethylene (HDPE) complying with ASTM-D1248, 30 volt rating.

C. Composite conductivity: 21% IACS (International Annealed Copper Standard).

D. Physical Characteristics:

1. AWG: 10

2. Dia. (in): 0.1019

3. Weight (lbs/1000 ft): 32.5

4. Insulation Thickness (In): 0.030

5. Breaking Load (lbs): 590

E. Connectors: Manufacturer's packaged kit consisting of insulating, spring-type connector or crimped joint and epoxy resin moisture seal; suitable for direct burial.

2.4 LOCATOR WIRE BOXES

A. Locator Wire Boxes, General

1. Tubular construction (cylindrical) with removable round lid.

2. Support flange at the base of the lower tube bell at least one-half inch wide.

a. If box is designed for use with an integral valve support, flange may be omitted.

3. Telescoping design with upper and lower tubes overlapping three inches when the box is extended to its maximum overall length.

4. Magnetized to amplify the tracer signal.

B. Materials

1. Tube material shall be of high grade ABS, or equivalent rigid plastic that meets or exceeds ASTM D1788, Type 1 requirements.

2. Lid material shall be of cast iron or ductile iron. Tensile strength or ductility of such material shall be equal or superior to hi-tensile cast iron ASTM A126-B requirements.

3. A magnet shall be securely attached at the top of the upper tube of the box for locating purposes. Material used to retain magnet in place shall remain effective at minus 15 degrees Fahrenheit. Magnets in the lid are not acceptable.

C. Box Lids

1. Color coded per APWA standards, green for sewage.

2. Cast iron construction.

3. Allow connection of the tracer signal without removal of the lid through an external brass connection lug.

4. Lock with a tamper-resistant pentagon locking nut.

5. Internal corrosion-resistant brass wire lug for locator wire connection and a wax pad to block out moisture at the wire connection.

D. Locator Wire Box Types and Applications

1. Designed for application.

2. Lite Duty Boxes: yards and ditches.

3. Roadway Boxes: Where box will be subjected to traffic.

4. Concrete/Driveway Boxes: Sidewalks and Driveways.

2.5 PLUG VALVES

A. Description: Resilient-seated eccentric.

1. Standard: MSS SP-108.

2. Connections, as applicable:

a. Mechanical-joints: conform to AWWA C111.
b. Flanges: conform to ANSI B16.1, Class 125 or ANSI B16.5, Class 150.

3. Body: Cast iron or ductile iron.

4. Pressure Rating

a. 3" – 12" Valves: 175-psig minimum.
b. 14" – 72" Valves: 150 psig minimum.

5. Seat Material: As recommended by manufacturer for sewage service.

2.6 AIR VALVES

A. Air Release Valves

1. Connections

a. Valves shall have full size NPT inlets equal to nominal valve size. Body inlet connection shall be hexagonal for a wrench connection.
b. All valves shall have 3 additional NPT connections for connection of backwash accessories, gauges, testing, and draining.
c. Valves shall be connected to force main with single or double-strap tapping sleeve designed for use with potable water connections for same type of pipe.
d. Valves will be connected to tapping sleeve with brass nipples and full flow ball-type shut-off valve of same size as valve inlet.

2. Body and Seat

a. Valve body and bonnet shall be fabricated of cast iron equal to ASTM A126 Class B or A48 Class 35.
b. Bolted cover with alloy screws and gasket shall be provided for valve maintenance.
c. Valve seat shall provide drop tight shut-off to the full pressure rating.

3. Backwash accessories, including bronze full-flow shut-off valve, quick-connect couplings, and flexible extension hose, shall be provided by manufacturer.

4. Valve shall have a stainless steel extended leverage mechanism with sufficient mechanical advantage so that the valve can fully open under full operating pressure.

5. Guide shaft and float shall be fabricated of series 300 stainless steel. Bronze or plastic materials shall not be acceptable for internal trim.

6. Operating float shall be provided with deflector skirt or concave bottom.

7. Valve shall be rated for a maximum working pressure of at least 150 psi.

8. Valve exterior shall be coated with a universal alkyd primer.

9. Valve outlet shall include a gooseneck of galvanized steel nipples and fittings with a stainless steel screen held with a hose clamp.

10. Overall height shall not exceed 23 ½".

11. Wastewater air release valves shall be Model 400 SARV manufactured by APCO Valve & Primer Corporation or equal.

B. Combination Air Valves

1. Connections

   a. Valves shall have full size NPT inlets and outlets equal to nominal valve size. Body inlet connection shall be hexagonal for a wrench connection.
   b. All valves shall have 3 additional NPT connections for connection of backwash accessories, gauges, testing, and draining.
   c. Valves shall be connected to force main with single or double-strap tapping sleeve designed for use with potable water connections for same type of pipe.
   d. Valves will be connected to tapping sleeve with brass nipples and full flow ball-type shut-off valve of same size as valve inlet.

2. Body and Seat

   a. Valve body and bonnet shall be fabricated of cast iron equal to ASTM A126 Class B or A48 Class 35.
   b. Bolted cover with alloy screws and gasket shall be provided for valve maintenance.
   c. Valve body shall be sized to provide adequate a full flow through area equal or greater than the valve size.
   d. Valve seat shall provide drop tight shut-off to the full pressure rating.

3. Backwash accessories, including bronze full-flow shut-off valve, quick-connect couplings, and flexible extension hose, shall be provided by manufacturer.

4. Valve shall have extended leverage mechanism with sufficient mechanical advantage so that valve can fully open under full operating pressure.

5. Guide shaft and float shall be fabricated of series 300 stainless steel. Bronze or plastic materials shall not be acceptable for internal trim.

6. Operating float shall be provided with a deflector skirt or a concave bottom.

7. Valve shall be rated for a maximum working pressure of at least 150 psi.

8. Valve exterior shall be coated with a universal alkyd primer.

9. Valve outlet shall include a gooseneck of galvanized steel nipples and fittings with a stainless steel screen held with a hose clamp.

10. Wastewater combination valves shall be Model No. 801BW, 801SBW, or 802BW as manufactured by VAL-MATIC, Series 440 SCAV manufactured by APCO Valve and Primer, or equal.

C. Air Valve Vaults

1. Description: Precast, reinforced-concrete vault, designed for A-16 load designation according to ASTM C857 and made according to ASTM C858.

2. ASTM A48 Class No. 35A minimum tensile strength, gray-iron traffic frame and cover.

2.7 TAPPING AND LINE STOP SLEEVES

A. PVC and Ductile Iron Force Main Sleeves.

1. Sleeves for branches to 12” in size:

a. Fabricated from 304 stainless steel or its equivalent.
b. Provide a 360 degree seal around the pipe.
c. ANSI/NSF Standard 61 Certified.
d. Body construction:
   1) Outlet Half (load bearing half)
      a) Outlet sizes 2" - 8” 12 gauge Stainless Steel
      b) Outlet sizes >8” 10 gauge Stainless Steel
   2) Back Half (conforming half) 14 gauge Stainless Steel
e. Length:
   1)

Outlet Size	Length
2”-6”	15"
8”	21"
10”	27"
12”	30"

f. Outlet construction: Schedule 10 SS pipe
g. Sized to accept full size cutter with an AWWA C207 Class D, ANSI 150 lb. drilling flange, corrosion resistant coating and recessed for tapping valve MSS-SP60.
h. Bolting lugs
   1) Pass-through bolt design to avoid alignment problems and allow tightening from either side of the pipe.
   2) Triangular design with a maximum 3" bolt center spacing.
   3) Not be integrally welded to the sleeve.
i. Bolts, nuts and washers shall be 304 stainless steel. The bolts shall be track head type with permanently lubricated heavy hex nuts and stainless washers.

j. The full circumferential gasket shall be molded of synthetic rubber compounded for use with water and sewage. The gasket shall have a gridded surface, be a full 1/4" thick with 304 stainless steel bridge plates molded flush into the gasket and have a raised hydromechanical outlet seal to seal against line surges and water hammer.

k. The sleeves shall be rated at 150 PSI hydrostatic with a test pressure of 200 PSI on pipe with a full circumferential break.

2. Sleeves for branches larger than 12” in size

a. Fabricated A36 steel, 18-8 stainless steel, or its equivalent.

b. Bolts and nuts shall be high strength, low alloy steel, ASTM A242 or AWWA C111.

c. Gasket shall be SBR ASTM D2000 BA508, 180 degrees F. max. operating temp.

d. Flange shall be AWWA C207 Class D ANSI 150# drilling, recessed to accept standard tapping valve.

e. Finish

1) A36 Steel: Fusion bonded epoxy.

2) Stainless Steel: Fully passivated to ASTM A380.

f. Rated for a pressure at least equal to 150% of actual operating pressure.

3. Completion Plugs and Covers

a. Completion Plug: DI per ASTM A536.

b. Cover Plate: A36 Steel: Fusion bonded epoxy.

c. O-Rings and Gaskets: Molded of synthetic rubber compounded for use with water and sewage.

4. Line Stop Expandable Stoppers

a. Recommended by manufacturer for use with type and material of pipe.

b. Rated at or above operating pressure in main.

B. HDPE Tapping Saddles

a. Saddles shall be designed for use specifically with HDPE pipe and have a pressure rating at least equal to the pipe. Saddles shall meet applicable requirements of AWWA C800 and AWWA Manual M23 Design and Installation of PVC Pipe.

b. Saddles shall utilize wide double stainless steel straps or be of full-circumference stainless steel sleeve design. Strap saddles shall have a ductile iron body coated with a fusion epoxy coating.

c. Gasket shall be a broad pressure activated design bonded into a cavity in the saddle body or have spring-tensioning to accommodate pipe thermal expansion.

d. Straps, bolts, nuts and washers shall be 18-8 stainless steel with all welds passivated for corrosion resistance.

2.8 TAPPING VALVES

A. Description

1. Resilient seated type, cast iron body.

2. Epoxy coated to AWWA C550.

3. Comply with AWWA C509 or AWWA C515 and be designed for use specifically as tapping valves.

B. Rating

1. Rated at zero leakage at 250 psi water working pressure and have a 400 psi hydrostatic test for structural soundness.

2. Testing shall be conducted in accordance with AWWA C509 or AWWA C515, as applicable.

C. End Configurations

1. Tapping sleeve side: ANSI B16.1 flanged end with centering ring.

2. Outlet side: Mechanical joint with accessories per AWWA C111.

2.9 VALVE ACCESSORIES AND SPECIALTIES

A. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "SEWAGE" and bottom section with base that fits over valve and with a barrel approximately 5 inches in diameter.

1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.

B. Operators, unless indicated otherwise:

1. Buried Service: 2” AWWA Operating Nut.

2. Exposed Service to 6’-6” above finished floor: Lever.

3. Exposed Service above 6’-6” above finished floor: As directed by Engineer.

C. Stems: Non-rising unless indicated otherwise.

2.10 MISCELLANEOUS PIPE FITTINGS

A. Ductile-Iron Rigid Expansion Joints

1. Three-piece, ductile-iron assembly consisting of telescoping sleeve with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections

2. Complying with AWWA C110 or AWWA C153.

3. Select and assemble components for expansion necessary.

4. Include AWWA C111 ductile-iron glands, rubber gaskets, and steel bolts.

5. Pressure rating 250 psig minimum.

B. Ductile-Iron Flexible Expansion Joints:

1. Compound, ductile-iron fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153.

2. Include two gasketed ball-joint sections and one or more gasketed sleeve sections.

3. Assemble components for offset and expansion indicated.

4. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

5. Pressure Rating: 250 psig minimum.

C. Longitudinal Restraint Fittings

1. Applicability: HDPE pipe 6-inches (6”) and larger in size.

2. Longitudinal restraint shall be flexible HDPE saddles designed for attachment to HDPE pipe using the electrofusion method.

   a. Manufactured of pre-blended virgin resin with a PPI listing of PE3408 and in compliance with ASTM D1248 and ASTM D3350.
   b. Minimum axial resistance rating of 7,000 lb-ft per saddle.

2.11 PIPING SPECIALTIES

A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

B. Tubular-Sleeve Pipe Couplings:

1. Description: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and with ends of same sizes as piping to be joined.

   a. Standard: AWWA C219.

b. Center-Sleeve Material: Ductile iron.
c. Joint: Mechanical joint.
d. Gasket Material: Natural or synthetic rubber.
e. Pressure Rating: 200 psig minimum.
f. Metal Component Finish: Corrosion-resistant coating or material.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Sewer Force Main Connection: Connect sewer force mains according to requirements of sewer utility company and of size and in location indicated.
   1. HDPE Pipe Connections
      a. Provide longitudinal restraint designed to withstand thermal expansion and contraction of pipe at all connections to structures and pipe of different materials.
      b. Use stiffeners approved by pipe manufacturer for particular application at all mechanical connections except flange adapters.
         1) Install flange adapters according to pipe and adapter manufacturer's recommendations.

B. Install ductile-iron pipe and fittings according to AWWA C600 and AWWA M41.
   1. Install PE corrosion-protection encasement according to ASTM A674 or AWWA C105.

C. Install PE pipe and fittings according to the following:
   1. ASTM D2774 and ASTM F645.
   2. Handbook of Polyethylene Pipe.
   3. AWWA M55 - PE Pipe—Design and Installation.

D. Install PVC pipe and fittings according to ASTM F645 and AWWA M23.

E. Bury piping with depth of cover indicated on Drawings, if not indicated, bury according to applicable regulations.

3.2 JOINT CONSTRUCTION

A. Make pipe joints according to the following:
   1. Ductile-Iron Piping Gasketed Joints: AWWA C600 and AWWA M41.

2. PE Piping: ASTM D2774 and ASTM F645.

3. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D2774 or ASTM D3139 and pipe manufacturer's instructions.

4. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure.

3.3 ANCHORAGE INSTALLATION

A. Anchorage, General

1. Install underground piping with restrained joints at horizontal and vertical changes in direction.

2. Install anchorages for tees, plugs and caps, bends, crosses, and valves.

3. Anchorages and restrained-joint types that may be used include the following:

   a. PVC Pipe
      1) Field-adaptable restraint systems.
   b. DI Pipe
      1) Locking mechanical joints.
      2) Bolted flanged joints.
      3) Field-adaptable restraint systems.
   c. HDPE
      1) Heat-fused joints.

B. Include anchorages for the following piping systems:

1. Gasketed-Joint, Ductile-Iron Sewer Force Main Piping: Per AWWA C600.

2. Gasketed-Joint, PVC Sewer Force Main Piping: Per AWWA M23.

C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.4 VALVE INSTALLATION

A. Plug Valves: Comply with AWWA C600 and AWWA M44. Install each plug valve with stem pointing up. Install valve box in all buried applications.

3.5 AIR VALVE INSTALLATION

A. Install in a vertical position with the inlet facing downwards.

B. Install at all high points substantially where indicated on the Drawings but with exact location determined at time of construction.

C. Maintain a continuous positive grade of the pipe to the air valve location and a continuous negative grade of the pipe away from the air valve to avoid high spots in the lines between the valves.

1. Piping shall be installed to a grade necessitating only the number of valves indicated on the Drawings without prior written approval of Engineer.

D. No air valves and vaults shall be placed in areas subject to vehicular traffic without prior written approval of Engineer.

E. Depth of force main shall be adjusted downwards as necessary to provide adequate clearance between top of valve vault with top of valve and fittings.

3.6 CONCRETE VAULT INSTALLATION

A. Install precast concrete vaults according to ASTM C891.

B. Elevation of valve vault and grading around the vault shall provide for positive run-off away from vault.

3.7 LOCATOR WIRE

A. Provide one locator wire on the crown of all plastic pipe and tubing.

B. The wires shall be installed along the pipe and securely fastened by duct tape at no more than 20 ft. intervals.

C. Terminate tracer wires above ground at each at-grade or above ground structure and at intervals of no more than 400 feet.

1. Bring tracer wires to the surface through a locator wire box where no structures exist.

D. Individually test each strand of tracer wire after installation. Provide continuous transmission of signal along the full length of pipe. Replace faulty wiring.

3.8 PAINTING

A. Paint all exposed piping and valves.

3.9 FIELD QUALITY CONTROL

A. Hydrostatic Tests, General

1. Provide all equipment for test and conduct tests in presence of Engineer.

2. Test all new sewer force mains, valves, and air valves.

   a. Test pressure shall be at least 1.5 times the working pressure at the point of testing, minimum 50 psig whichever is greater.
   b. Test each valved section separately.
   c. Install necessary test ports and blow-offs using service saddles and corporation stops.
   d. Prior to tests, slowly fill pipe with water, then flush to expel air.

3. Fill pipeline with water and apply test pressure 24 hours before testing.

4. Conduct hydrostatic tests for two hours to six hours.

5. Follow AWWA C600 (DI pipe) and C605 (PVC pipe) in addition to the following for all pressure testing.

6. Do not exceed pipe and/or thrust resistant design pressures during test.

7. Do not vary pressure by more than +/- 5 psi for the duration of the test.

B. Pressure Test

1. Apply pressure with a hydrostatic test pump designed specifically for the purpose. Pump system shall include accurate pressure gauge measuring outlet pressure.

2. Examine exposed pipe, fittings, valves, and joints during the test. Correct visible leaks or defects discovered during the pressure test. Repeat the test until no defects are identified.

3. At the conclusion of the pressure test, cap the corporation stop outlets.

C. Leakage Test

1. After completion of the pressure test, conduct a leakage test to determine the quantity of water lost by leakage under the specified test pressure. Leakage shall be defined as the quantity of water that must be supplied into the newly laid pipe or any valved section thereof to maintain pressure within 5 psi of the specified test pressure after the pipe has been filled with water and the air has been expelled.

2. Leakage shall not be measured by a drop in pressure in a test section over a period of time.

3. No ductile iron pipe installation will be accepted if the leakage is greater than that determined by the following formula:

L = SD *P/133,200

Where:

L = allowable leakage, in gallons per hour

S = length of pipe tested, in feet

D = nominal diameter of the pipe, in inches

P = average test pressure during the leakage test, in pounds per square inch (gauge)

a. No PVC pipe installation will be accepted if the leakage is greater than that determined by the following formula:

L = ND *P/7,400

Where:

L = allowable leakage, in gallons per hour

N = number of joints in length tested

D = nominal diameter of the pipe, in inches

P = average test pressure during the leakage test, in pounds per square inch (gauge)

4. Acceptance

a. Acceptance shall be determined based on allowable leakage. If any test discloses leakage greater than that specified, the Contractor shall at his own expense, locate and make approved repairs as necessary until the leakage is within the specified allowance.

b. All visible leaks are to be repaired regardless of the amount of leakage. All flanged pipe shall be "bottle-tight".

c. If the section under test contains various diameters, allowable leakage will be the sum of the computed leakage for each size.

D. Locator Wire Test

1. Individually test each strand of locator wire after installation. At least one locator wire shall provide continuous transmission of tracing signal along the full length of pipe.

E. Prepare reports of testing activities.

END OF SECTION 025450

SECTION 027000
BASES AND PAVEMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes installation or repair of the following:

1. Granular, asphalt, or concrete bases.
2. Asphalt, concrete or aggregate driveways, roadways, and parking lots.
3. Concrete curbs and gutters.
4. Asphalt or concrete walkways.
5. Aggregate shoulders for asphalt and concrete pavements.
6. Pavement markings.
7. Wheel Stops.
8. Metal Bollards.

B. Related sections include the following:

1. Section 022300 – Site Clearing for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
2. Section 023000 – Earthwork for preparation of aggregate subbase and base, and aggregate pavement shoulders.

1.2 REFERENCES

A. INDOT SS: Indiana Department of Transportation (INDOT) Standard Specifications, and applicable supplements, current at the time of the bid.

B. Approved or Prequalified: On the list of materials, equipment, and sources maintained by INDOT in accordance with INDOT SS Section 106 or otherwise certified by INDOT at the time of the bid.

1.3 DEFINITIONS

A. Base: Aggregate material placed between the subbase course and hot-mix asphalt or concrete paving, or used as a driving surface.

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

C. Paving Terminology: Refer to INDOT SS for definitions of terms.

1.4 SUBMITTALS

A. Action Submittals

1. Product Data, including the following:
    a. Asphalt Job Mix Formula: For each asphalt job mix proposed for the Work in accordance with INDOT SS.
    b. Concrete Design Mixtures: For each concrete pavement mixture. Include alternate mixture designs when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
    c. Each joint-sealant product.
2. Shop Drawings
    a. Indicate pavement markings, lane separations, and defined parking spaces. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.
3. Samples
    a. For each paving fabric, 8 inches by 10 inches.

B. Informational Submittals

1. Qualification Data
    a. For manufacturers of Approved or Prequalified materials by INDOT SS.
2. Material Certificates
    a. Where Approved or Prequalified: For each paving material, from manufacturer.
    b. Where not Approved or Prequalified: For each paving material, signed by manufacturers certifying that each of the following materials complies with requirements:
        1) Asphalt materials.
        2) Cementitious materials.
        3) Steel reinforcement and reinforcement accessories.
        4) Fiber reinforcement.
        5) Admixtures.

6) Curing compounds.
7) Applied finish materials.
8) Bonding agent or epoxy adhesive.
9) Joint fillers.

c. For each type of joint sealant and accessory, signed by product manufacturer.

3. Material Test Reports

a. For each paving material, from manufacturer, in accordance with INDOT SS.

b. Compatibility and Adhesion Test Reports: From joint sealant manufacturer, indicating the following:
1) Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
2) Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

c. Product Test Reports: For joint sealants, based on evaluation of comprehensive tests performed by a qualified testing agency.

4. Schedule of Tests and Inspections

5. Field Test Reports

C. Project Record Documents

1. Field test reports

2. Record Drawings

1.5 QUALITY ASSURANCE

A. Qualifications

1. Testing Agency Qualifications

a. INDOT-approved testing laboratory for asphalt or concrete, for testing indicated.

b. Qualified for asphalt testing according to ASTM D3666 for testing indicated.

c. Qualified for concrete testing according to ASTM C1077 and ASTM E329 for testing indicated, as documented according to ASTM E548.

2. Material Manufacturer Qualifications

a. Products complying with INDOT SS: Manufacturer certified by INDOT for specified Approved or Prequalified products.

b. Products not requiring INDOT SS compliance
1) Manufacturer of ready-mixed concrete products who complies with ASTM C94 requirements for production facilities and equipment.

3. Joint Sealant Qualifications

a. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

B. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of agency owning or controlling right-of-way or property for paving work.

1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.6 DELIVERIES, STORAGE, AND HANDLING

A. Deliver joint sealant materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multicomponent materials

1.7 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required by regulatory agencies and for other construction activities.

B. Asphalt Materials: Do not apply asphalt materials if application surface is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:

1. Tack Coat: Minimum surface temperature of 60 deg F.

2. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.

3. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.

C. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer.

D. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for oil-based materials, 55 deg F for water-based materials, and not exceeding 95 deg F.

1.8 WARRANTIES

A. Special Warranties

1. Provide maintenance bond, in form acceptable to Owner, or fund escrow, acceptable to Owner, for maintenance of temporary surface and installation of

pavements not complete due to seasonal limitations at the time of Final Completion.

PART 2 - PRODUCTS

2.1 AGGREGATE BASE AND SURFACE MATERIALS

A. Aggregate subbase, base, and surface material shall comply with Section 301.02 of the INDOT SS.

2.2 GEOTEXTILE FABRICS

A. Geotextile fabric shall comply with Section 918.02 (Geotextile Fabric for Use Under Rip Rap) of the INDOT SS.

2.3 ASPHALT PAVEMENTS

A. Asphalt Materials, General: Asphalt materials, including aggregate, binders, and emulsions shall comply with Section 400 (Asphalt Pavement) and Section 902 (Asphalt Materials) of the INDOT SS.

B. Asphalt job mix formula for roadways, drives and sidewalks shall be previously approved for INDOT roadway projects of similar nature.

2.4 CONCRETE PAVEMENTS

A. Concrete for Driveways and Sidewalks:

1. Use Class A concrete, 3,500 psi compressive strength for driveways per ACI 318.

2. Use Class B concrete, 3,000 psi compressive strength for sidewalks per ACI 318.

B. Concrete for Roadways, Curbs, and Gutters: Concrete shall be 3,500 psi compressive strength meeting the requirements of Section 500 (Concrete Pavement) and Section 901 (PCC Materials) of the INDOT SS.

C. Curing Materials and Admixtures shall comply with Section 912 of the INDOT SS.

2.5 JOINT FILLERS

A. Joint fillers shall comply with Section 906.01 of the INDOT SS.

2.6 JOINT SEALING MATERIALS

A. Joint sealing materials shall comply with Section 906.02 of the INDOT SS.

2.7 SEAL COAT

A. Seal coat shall be TYPE II Application, RS-2, AE-90, AE-90S, or HFRS-2 as defined in INDOT Section 902.01(b).

2.8 PAVEMENT MARKING PAINT

A. Pavement marking paint shall comply with Section 909.05 (White and Yellow Traffic Paint) of the INDOT SS.

2.9 PAVEMENT MARKERS

A. Pavement markers and adhesives shall be Approved or Prequalified.

2.10 EPOXY PENETRATING SEALERS

A. Epoxy penetrating sealers shall comply with Section 909.09 (Epoxy Penetrating Sealers) of the INDOT SS.

2.11 PROPRIETARY PCC SEALERS

A. Proprietary PCC sealers shall be Approved or Prequalified.

2.12 REINFORCEMENT

A. Reinforcing steel bars, dowels, and welded wire fabric shall comply with Section 910.01 of the INDOT SS.

1. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete, and as follows:

    a. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
    b. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

2.13 SIGNAGE AND ILLUMINATION

A. Signage and illumination, including posts, breakaway systems, overhead support systems, color, size, location and other material features shall comply with all applicable regulatory requirements.

2.14 HERBICIDES

A. Commercial chemical for weed control, registered by the EPA. Provide in granular, liquid, or wettable powder form.

2.15 ASPHALT SEALER

A. Asphalt pavement sealer shall be black and comply with ASTM-D3320.

2.16 GUARDRAILS AND RAILING

A. Guardrails, railing, and supports shall comply with applicable INDOT SS.

2.17 CONCRETE WHEEL STOPS

A. General

1. Size: 4-1/2 inches high by 9 inches wide by 72 inches long.
2. Provide chamfered corners and drainage slots or notches on underside and holes for anchoring to substrate.
3. Dowels: Galvanized steel, 3/4-inch diameter, 10-inch minimum length.
4. Precast, air-entrained concrete, 2500-psi minimum compressive strength.

2.18 METAL BOLLARDS

A. Fabricate metal bollards from Schedule 40 steel pipe.

1. Cap bollards with 1/4-inch-thick steel plate welded to the pipe where not being filled with concrete.
2. Where bollards are indicated to receive controls for door operators, provide necessary cutouts for controls and holes for wire.
3. Where bollards are indicated to receive light fixtures, provide necessary cutouts for fixtures and holes for wire.

B. Fabricate bollards with 3/8-inch-thick steel baseplates for bolting to concrete slab where not embedded. Drill baseplates at all four corners for 3/4-inch anchor bolts.

1. Where bollards are to be anchored to sloping concrete slabs, angle baseplates for plumb alignment of bollards.

C. Fabricate internal sleeves for removable bollards from Schedule 40 steel pipe or 1/4-inch wall-thickness steel tubing with an OD approximately 1/16 inch less than ID of bollards. Match drill sleeve and bollard for 3/4 inch steel machine bolt.

D. Prime bollards for field painting.

2.19 BOLLARD SHIELDS

A. Plastic tube shield with dome top, nominal thickness 0.125 inch.

1. Shield pipe diameter: Manufacturer's recommendation for bollard size.

2. Sleeve height: 52 inches or as indicated.

3. Sleeve Color: OSHA yellow.

4. Surface of sleeve to be smooth with round top, no ribbed or two piece systems accepted.

B. Material: Low density polyethylene thermoplastic (LDPE) tubes having ultra-violet resistance and anti static properties.

PART 3 - EXECUTION

3.1 PAVEMENTS, GENERAL

A. Examination

1. Verify that subgrade is dry and in suitable condition to begin paving.

2. Proceed with paving only after unsatisfactory conditions have been corrected.

3. Verify that utilities, traffic loop detectors, and other items requiring a cut and installation beneath the pavement surface have been completed.

4. Proof-roll prepared subbase below roadways on which pavements are to be placed with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding.

a. For utility line pavement repairs, completely proof-roll in one direction.
b. For new roadways or roadway replacements, proof-roll in one direction and repeat in perpendicular direction.

c. Limit vehicle speed to 3 mph.
d. Proof-roll with a loaded 10-wheel tandem-axle dump truck weighing not less than 15 tons.
e. Soft spots and areas of pumping or rutting exceeding depth of 1/2 inch require correction.

5. Proceed with pavement operations only after nonconforming conditions have been corrected and surface is ready to receive pavement.

6. Remove loose material from compacted subbase surface immediately before placing pavement.

7. Provide protective insulating materials to protect subgrades against freezing temperatures or frost. Remove snow, ice, or frost from subbase surface and reinforcement before placing pavement. Do not place pavement on frozen surfaces.

8. Do not place pavement around manholes or other structures until they are at required finish elevation and alignment.

B. Cold Milling

1. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.
   a. Mill to depth indicated or required.
   b. Mill to a uniform finished surface free of excessive gouges, grooves, and ridges.
   c. Control rate of milling to prevent tearing of existing asphalt course.
   d. Repair or replace curbs, manholes, and other construction damaged during cold milling.
   e. Excavate and trim unbound-aggregate base course, if encountered, and keep material separate from milled hot-mix asphalt.
   f. Transport milled hot-mix asphalt to asphalt recycling facility.
   g. Keep milled pavement surface free of loose material and dust.

3.2 PAVEMENT REPAIR, GENERAL

A. Repair drives, parking lots, and other private pavements to a condition equal to or better than existed prior to the Work.

B. Repair sidewalks to a condition equal to or better than existed prior to the Work, subject to the approval of authorities having jurisdiction.

1. Minimum four inches (4”) thick Class B concrete, set on a 4" compacted sand or aggregate base. Concrete shall be float finished with a tooled joint every 4 feet and an expansion joint every 48 feet. Unless shown otherwise, wire mesh shall be used and shall be 6 x 6 x W 2.9/2.9 gauge W.W. mesh.

C. Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

D. Curb and Gutters

1. Meet requirements of authorities having jurisdiction. At a minimum:

a. Repair curbs and gutters to original profile and finish. Match elevations.
b. Provide minimum six inches (6”) base under curb and gutter.
c. Saw cut edges.
d. Material and construction shall comply with curb replacement requirements of Section 605 of the INDOT SS.

3.3 AGGREGATE SUBBASE, BASE, AND SHOULDERS

A. Place aggregate subbase and base courses on prepared subgrades free of mud, frost, snow, or ice.

B. Place aggregate subbase in compliance with Sections 302.03 through 302.07 of the INDOT SS.

C. Place base in compliance with Sections 301.03 through 301.08 of the INDOT SS.

D. Pavement Shoulders: Place shoulders along edges of subbase and base course to prevent lateral movement of pavement. Construct shoulders, at least 12 inches wide, of satisfactory soil materials and compact simultaneously with each subbase and base lift to not less than 95 percent of maximum dry unit weight according to ASTM D1557.

3.4 GEOTEXTILE FABRIC

A. Install geotextile fabric in accordance with manufacturer’s recommendations and Section 616.11 (Installation of Geotextile Under Riprap) of the INDOT SS.

3.5 SIDEWALK BASE

A. Provide four inches (4”) level, compacted sand base under concrete sidewalks.

3.6 AGGREGATE DRIVING SURFACES

A. Subgrade Treatment: Complete a Type II subgrade treatment in accordance with INDOT Section 207.

B. Place, level, and compact aggregate surface material in accordance with Section 303 of the INDOT SS.

C. Apply a Type 5 seal coat in accordance with INDOT Section 404 where indicated on the Drawings.

3.7 ASPHALT PAVING

A. Asphalt Pavement Repairs, Additional

1. Subbases on Soils: Place eight inches (8") of compacted aggregate base in the repair, unless otherwise indicated.

2. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseat concrete pieces firmly.

    a. Pump hot undersealing asphalt under rocking slab until slab is stabilized or, if necessary, crack slab into pieces and roll to reseat pieces firmly.
    b. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Recompact existing unbound-aggregate base course to form new subgrade.

3. Tack Coat: Coat vertical surfaces abutting HMAC patches. Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.15 gal./sq. yd.

    a. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
    b. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

4. Leveling Course: Where depressions deeper than 1 inch in exist in pavements, install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions.

    a. Install leveling wedges in compacted lifts not exceeding 3 inches thick.

5. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch.

    a. Clean cracks and joints in existing hot-mix asphalt pavement.
    b. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.
    c. Use hot-applied joint sealant to seal cracks and joints more than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.

6. Patching: Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

    a. Base Mix: 275 lb./syd. of HMA Type B, Intermediate in accordance with INDOT SS.

b. Surface Layer: 165 lb./syd. of HMA, Type B, Surface in accordance with INDOT SS.
c. All paving shall be done in accordance with Section 305 of the INDOT SS.

B. Surface Preparation

1. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

2. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

a. Mix herbicide with prime coat if formulated by manufacturer for that purpose.

3. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd..

a. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
b. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

C. HMA Placement

1. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

a. Place hot-mix asphalt base course in number of lifts and thicknesses indicated by INDOT SS.
b. Place hot-mix asphalt surface course in single lift.
c. HMA temperature shall meet or exceed requirements in Section 400 of INDOT SS.
d. Apply surface course and compact with roller in accordance with Section 400 of INDOT SS.

2. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

a. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.

3. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface. Match grade of existing pavement at transitions.

D. Joints

1. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.
    a. Clean contact surfaces and apply tack coat to joints.
    b. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
    c. Offset transverse joints, in successive courses, a minimum of 24 inches.
    d. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time.
    e. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
    f. Compact asphalt at joints to a density within 2 percent of specified course density.

E. Compaction
1. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.
    a. Complete compaction before mix temperature cools to 185 deg F.
2. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.
3. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
    a. Average Density: greater than or equal to 93.0 percent.
4. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
5. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.
6. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.
7. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
8. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

F. Installation Tolerances

1. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:
    a. Base Course: Plus or minus 1/2 inch.
    b. Surface Course: Plus 1/4 inch, no minus.
2. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:
    a. Base Course: 1/4 inch.
    b. Surface Course: 1/8 inch.
    c. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

G. Field Quality Control
1. Testing Agency: Engage an INDOT certified testing agency to perform tests and inspections.
2. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D3549.
3. Surface Smoothness: Finished surface of each pavement course will be tested for compliance with smoothness tolerances.
4. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D979 or AASHTO T 168.
    a. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D2041, and compacted according to job-mix specifications.
    b. In-place density of compacted pavement will be determined by testing core samples according to ASTM D1188 or ASTM D2726.
    c. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than 3 cores taken. Sample at locations indicated by Engineer.
    d. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D2950 and correlated with ASTM D1188 or ASTM D2726.
5. Replace and compact hot-mix asphalt where core tests were taken.
6. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

H. Asphalt Sealer
1. Apply two (2) coats of asphalt sealer 30 days after asphalt laying and all field quality control is complete.

2. Apply first coat in lengthwise fashion to pavement surface.

3. Apply second coat in cross wise fashion (90 degrees to direction of first coat).

4. Apply sealer at uniform rate recommended by manufacturer.

3.8 CONCRETE PAVING

A. Edge Forms And Screed Construction

1. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

2. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

B. Steel Reinforcement

1. General: Comply with INDOT SS and CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

2. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

3. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

4. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

5. Zinc-Coated Reinforcement: Use galvanized steel wire ties to fasten zinc-coated reinforcement. Repair cut and damaged zinc coatings with zinc repair material.

6. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D3963.

7. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch overlap of adjacent mats.

C. Joints

1. General: Form construction, isolation, and contraction joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.

    a. When joining existing pavement, place transverse joints to align with previously placed joints, unless otherwise indicated.

2. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour unless pavement terminates at isolation joints.

    a. Continue steel reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of pavement strips, unless otherwise indicated.
    b. Provide tie bars at sides of pavement strips where indicated.
    c. Butt Joints: Use bonding agent or epoxy bonding adhesive in compliance with INDOT SS at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
    d. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
    e. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.

3. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.

    a. Locate expansion joints in accordance with INDOT SS, unless otherwise indicated.
    b. Extend joint fillers full width and depth of joint.
    c. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
    d. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
    e. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
    f. Protect top edge of joint filler during concrete placement with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

4. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, matching jointing of existing adjacent concrete pavement where applicable, as follows:

    a. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 3/8-inch radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover marks on concrete surfaces.

b. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.

c. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

5. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to a 3/8-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.

D. Concrete Placement

1. Inspection: Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast in. Notify other trades to permit installation of their work.

2. Moisten subbase to provide a uniform dampened condition at time concrete is placed.

3. Comply with INDOT SS and ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

4. Do not add water to fresh concrete after testing.

5. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

6. Consolidate concrete according to INDOT SS by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

a. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.

7. Screed pavement surfaces with a straightedge and strike off.

8. Commence initial floating using bull floats or darbies to impart an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

9. Curbs and Gutters

a. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing as specified for formed concrete.

b. When automatic machine placement is used for curb and gutter placement, submit revised mix design and laboratory test results that meet or exceed requirements. If results are not approved, remove and replace with formed concrete.

10. Slip-Form Pavers: When automatic machine placement is used for pavement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce pavement to required thickness, lines, grades, finish, and jointing as required for formed pavement.

    a. Compact subbase and prepare subgrade of sufficient width to prevent displacement of paver machine during operations.

11. When adjoining pavement lanes are placed in separate pours, do not operate equipment on concrete until pavement has attained 85 percent of its 28-day compressive strength.

12. Cold-Weather Placement: Comply with INDOT SS and ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

    a. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
    b. Do not use frozen materials or materials containing ice or snow.
    c. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mix designs.

13. Hot-Weather Placement: Comply with INDOT SS and ACI 301 and as follows when hot-weather conditions exist:

    a. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
    b. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
    c. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

E. Float Finishing

1. General: Do not add water to concrete surfaces during finishing operations.

2. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand floating if area is small or

inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

a. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.
b. Medium-to-Fine-Textured Broom Finish: Draw a soft bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.
c. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

F. Concrete Protection And Curing

1. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

2. Comply with INDOT SS and ACI 306.1 for cold-weather protection.

3. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

4. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

5. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:

a. Moist Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
1) Water.
2) Continuous water-fog spray.
3) Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
b. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
c. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

G. Installation Tolerances

1. Comply with tolerances of INDOT SS, ACI 117 and as follows:
    a. Elevation: 1/4 inch.
    b. Thickness: Plus 3/8 inch, minus 1/4 inch.
    c. Surface: Gap below 10-foot long, unleveled straightedge not to exceed 1/4 inch.
    d. Lateral Alignment and Spacing of Tie Bars and Dowels: 1 inch.
    e. Vertical Alignment of Tie Bars and Dowels: 1/4 inch.
    f. Alignment of Tie-Bar End Relative to Line Perpendicular to Pavement Edge: 1/2 inch.
    g. Alignment of Dowel-Bar End Relative to Line Perpendicular to Pavement Edge: Length of dowel 1/4 inch per 12 inches.
    h. Joint Spacing: 3 inches.
    i. Contraction Joint Depth: Plus 1/4 inch, no minus.
    j. Joint Width: Plus 1/8 inch, no minus.

H. Field Quality Control
1. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

2. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C172 shall be performed according to the following requirements:
    a. Testing Frequency: Obtain at least 1 composite sample for each 100 cu. yd. or fraction thereof of each concrete mix placed each day.
        1) When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
    b. Slump: ASTM C143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.
    c. Air Content: ASTM C231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
    d. Concrete Temperature: ASTM C1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
    e. Compression Test Specimens: ASTM C31; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
    f. Compressive-Strength Tests: ASTM C39; test 1 specimen at 7 days and 2 specimens at 28 days.
        1) A compressive-strength test shall be the average compressive strength from 2 specimens obtained from same composite sample and tested at 28 days.

3. Strength of each concrete mix will be satisfactory if average of any 3 consecutive compressive-strength tests equals or exceeds specified compressive strength and

no compressive-strength test value falls below specified compressive strength by more than 500 psi.

4. Test results shall be reported in writing to Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

5. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but will not be used as sole basis for approval or rejection of concrete.

6. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Engineer.

7. Remove and replace concrete pavement where test results indicate that it does not comply with specified requirements.

8. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements

I. Repairs And Protection

1. Remove and replace concrete pavement that is broken, damaged, or defective or that does not comply with requirements in this Section.

2. Drill test cores, where directed by Engineer, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with portland cement concrete bonded to pavement with epoxy adhesive.

3. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.

4. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

3.9 PAVEMENT MARKING

A. Allow paving to age for 30 days before starting permanent pavement marking.

B. Sweep and clean surface to eliminate loose material and dust.

C. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

D. Install pavement markings in accordance with Section 808 of the INDOT SS.

3.10 WHEEL STOPS

A. Install wheel stops in bed of adhesive as recommended by manufacturer.

B. Securely attach wheel stops to pavement with not less than two galvanized-steel dowels embedded at one-quarter to one-third points. Securely install dowels into pavement and bond to wheel stop. Recess head of dowel beneath top of wheel stop.

END OF SECTION 027000

SECTION 029200
LAWNS AND GRASSES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Seeding.
2. Hydroseeding.
3. Sodding.
4. Plugging.

B. Related sections include the following:

1. Section 022300 – Site Clearing for topsoil stripping and stockpiling.
2. Section 023000 – Earthwork for excavation, filling and backfilling, and rough grading.

1.2 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

C. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

D. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

E. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

F. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.

G. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

H. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.3 SUBMITTALS

A. Action Submittals

1. Product Data

a. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to this Project.

B. Informational Submittals

1. Product and Material Certificates

a. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

1) Certification of each seed mixture for turfgrass sod and plugs. Include identification of source and name and telephone number of supplier.

b. For soil amendments and fertilizers, from manufacturer.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws, as applicable.

B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod in time for planting within 24 hours of harvesting. Protect sod from breakage and drying.

C. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.

2. Accompany each delivery of bulk fertilizers, lime, and soil amendments with appropriate certificates.

1.5 PROJECT CONDITIONS

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of planting completion.

1. Spring Planting: March 1 through May 15.

2. Fall Planting: August 15 through October 15.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

1.6 WARRANTIES

A. Special Warranties

1. Provide maintenance bond, in form acceptable to Owner, or fund escrow, acceptable to Owner, for maintenance of temporary surface and installation of pavements not complete due to seasonal limitations at the time of Final Completion.

PART 2 - PRODUCTS

2.1 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Species: Seed species shall comply with Section 621.06 of the INDOT SS.

1. Sun: Type R seed mixture, applied at a rate of 170 lb/acre.

2. Shade: Type U seed mixture, applied at a rate of 150 lb/acre.

2.2 TURFGRASS SOD

A. Turfgrass Sod: Number 1 Quality/Premium, including limitations on thatch, weeds, diseases, nematodes, and insects, complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted.

B. Turfgrass Species: Kentucky Bluegrass.

2.3 PLUGS

A. Plugs: Turfgrass sod, Number 1 Quality/Premium, including limitations on thatch, weeds, diseases, nematodes, and insects, complying with "Specifications for Turfgrass Sod Materials" in TPI's "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture, cut into square or round plugs, strongly rooted, and capable of vigorous growth and development when planted; of the following turfgrass species and plug size:

B. Turfgrass Species: Kentucky Bluegrass.

C. Plug Size: 2 inches.

2.4 LIME

A. ASTM C602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:

1. Class: T, with a minimum of 99 percent passing through No. 8 sieve and a minimum of 75 percent passing through No. 60 sieve.

2. Class: O, with a minimum of 95 percent passing through No. 8 sieve and a minimum of 55 percent passing through No. 60 sieve.

3. Provide lime in form of ground dolomitic limestone, calcitic limestone, or mollusk shells.

2.5 FERTILIZERS

A. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

B. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.

2.6 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of agricultural crops.

B. Sphagnum Peat Mulch: Partially decomposed sphagnum peat moss, finely divided or of granular texture, and with a pH range of 3.4 to 4.8.

C. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content of 2 to 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

1. Organic Matter Content: 50 to 60 percent of dry weight.

2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

D. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.

E. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

F. Asphalt Emulsion: ASTM D977, Grade SS-1; nontoxic and free of plant-growth or germination inhibitors.

2.7 EROSION CONTROL MATERIALS

A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches long.

B. Erosion-Control Fiber Mesh: Biodegradable burlap or spun-coir mesh, a minimum of 0.92 lb/sq. yd. with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches long.

C. Erosion-Control Mats: Cellular, non-biodegradable slope-stabilization mats designed to isolate and contain small areas of soil over steeply sloped surface, of

3-inch minimum nominal mat thickness. Include manufacturer's recommended anchorage system for slope conditions.

2.8 HERBICIDES AND PESTICIDES

A. Herbicides and pesticides, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted herbicides or pesticides unless authorized in writing by authorities having jurisdiction.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.

2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.

3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.

4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Engineer and replace with new planting soil.

3.2 PREPARATION, GENERAL

A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

1. Where hydroseeding or hydromulching, protect adjacent and adjoining areas from overspray.

2. Protect grade stakes set by others until directed to remove them.

3.3 TURF AREA PREPARATION

A. Limit turf subgrade preparation to areas to be planted.

B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 4 inches. Remove stones larger than two inches (2") in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Apply superphosphate fertilizer directly to subgrade before loosening.

2. Apply soil amendments and fertilizer on surface, and thoroughly blend planting soil.

a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
b. Mix lime with dry soil before mixing fertilizer.
c. Reduce elevation of planting soil to allow for soil thickness of sod.

C. Unchanged Subgrades: If turf is to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:

1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.

2. Loosen surface soil to a depth of at least four inches (4"). Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 4 inches of soil. Till soil to a homogeneous mixture of fine texture.

3. Remove stones larger than 2 inches (2") in any dimension and sticks, roots, trash, and other extraneous matter.

4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.

D. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.

E. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

F. Before planting, restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 SEEDING

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.

1. Do not use wet seed or seed that is moldy or otherwise damaged.

2. Do not seed against existing trees.

B. Sow seed at rate indicated.

C. Rake or mechanically mix seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.

D. Protect seeded areas in ditch flowlines and with slopes exceeding 1:4 with erosion-control blankets and 1:6 with erosion-control fiber mesh installed and stapled according to manufacturer's written instructions.

E. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket over seeded areas. Spread by hand, blower, or other suitable equipment. Anchor straw in one of the following methods:

1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.

2. Bond straw mulch by spraying with asphalt emulsion at a rate of 10 to 13 gal./1000 sq. ft.. Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.

F. Protect seeded areas from hot, dry weather or drying winds by applying compost mulch within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch, and roll surface smooth.

3.5 HYDROSEEDING

A. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.

1. Mix slurry with nonasphaltic tackifier, asphalt-emulsion, or iber-mulch manufacturer's recommended tackifier where hydromulching slopes greater than 1:4.

2. Apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than 1500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate.

3.6 SODDING

A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.

B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.

1. Lay sod across angle of slopes exceeding 1:3.

2. Anchor sod on slopes exceeding 1:6 with wood pegs spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.

C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

3.7 PLUGGING

A. Plant plugs in holes or furrows, spaced 12 inches apart in both directions. On slopes, contour furrows to near level.

3.8 TURF MAINTENANCE

A. Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.

2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.

3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist.

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.

C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:

1. Mow to a height of 1-1/2 to 2 inches.

3.9 HERBICIDE AND PESTICIDE APPLICATION

A. Apply herbicides, pesticides and other chemical products and biological control agents in accordance with requirements of authorities having jurisdiction and manufacturer's written recommendations as needed to establish satisfactory turf. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

3.10 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Engineer:

1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 12 inches by 12 inches.

2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.

3. Satisfactory Plugged Turf: At end of maintenance period, the required number of plugs has been established as well-rooted, viable patches of grass, and areas between plugs are free of weeds and other undesirable vegetation.

B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

3.11 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

C. Remove nondegradable erosion-control measures after grass establishment period.

END OF SECTION 029200

SECTION 072210
HATCHES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Hatches.

1.2 REFERENCES

A. ASTM A36 - Standard Specification for Structural Steel.

B. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

C. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

D. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

E. ASTM A780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.

F. ASTM A786 - Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.

G. ASTM A793 - Standard Specification for Rolled Floor Plate, Stainless Steel.

H. ASTM A1008 - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.

I. NAAMM's "Metal Finishes Manual for Architectural and Metal Products"

1.3 SYSTEM REQUIREMENTS

A. Design Requirements

1. Hatches shall have clear openings of the sizes indicated.

2. Hatches shall have the number of leafs and opening direction as indicated.

a. Where opening direction is not indicated, provide as directed by Engineer.

1.4 SUBMITTALS

A. Action Submittals

1. Product Data: Provide manufacturer's product data for all materials in this specification.
    a. Traffic rated hatches shall be certified to meet AASHTO H-20 wheel loading.
    b. Railing systems shall be certified to withstand minimum 200 pound test load.
2. Shop Drawings: Show profiles, embedment details, attachment details, accessories, location, and dimensions.
3. Samples: Manufacturer to provide upon request; sized to represent material adequately.

B. Informational Submittals

1. Manufacturer's Installation Instructions
2. Product Warranties

C. Project Record Document

1. Product Data
2. Shop Drawings
3. Product Warranties
4. Manufacturer's operations and maintenance literature

1.5 DELIVERY, STORAGE, AND HANDLING

A. Storage and Protection. Store materials in a dry, protected, well-vented area off the ground.

PART 2 - PRODUCTS

2.1 STEEL MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A36.

1. ASTM A123 for galvanizing steel and iron products.

2. ASTM A153 for galvanizing steel and iron hardware.

B. Rolled-Steel Floor Plate and Diamond Tread Plate: ASTM A786, rolled from plate complying with ASTM A36 or ASTM A283, Grade C or D.

1. ASTM A123 for galvanizing steel and iron products.

2. ASTM A153 for galvanizing steel and iron hardware.

C. Steel Sheet: Electrolytic zinc-coated, ASTM A591 with cold-rolled steel sheet substrate complying with ASTM A1008, Commercial Steel (CS), exposed.

D. Metallic-Coated Steel Sheet: ASTM A653, Commercial Steel (CS) with A60 (ZF180) zinc-iron-alloy (galvannealed) coating or G60 (Z180) mill-phosphatized zinc coating; stretcher-leveled standard of flatness; with minimum thickness indicated representing specified thickness according to ASTM A924.

E. Steel Finishes: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation for Steel Sheet: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, or other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."

2. Surface Preparation for Metallic-Coated Steel Sheet: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas, and apply galvanizing repair paint specified below to comply with ASTM A780.

   a. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.

3. Factory-Primed Finish: Apply shop primer immediately after cleaning and pretreating.

4. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat. Comply with paint manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils.

5. Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard thermosetting polyester or acrylic urethane

powder coating with cured-film thickness not less than 1.5 mils. Prepare, treat, and coat metal to comply with resin manufacturer's written instructions.

2.2 STAINLESS STEEL MATERIALS

A. Rolled and Diamond Tread Stainless-Steel Floor Plate: ASTM A793, Type 304 unless otherwise indicated.

1. Finish: Manufacturer's standard.

B. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A666, Type 304 unless otherwise indicated. Remove tool and die marks and stretch lines or blend into finish.

1. Finish: Manufacturer's standard.

C. Stainless Steel Angles: ASTM A276, Type 304.

D. Compression Springs: ASTM A313, Type 316.

E. Stainless Steel Fasteners: Type 316 stainless steel.

1. Bolts: ASTM F593.

2. Nuts: ASTM F594.

2.3 ALUMINUM

A. Aluminum Extrusions: ASTM B221, Alloy 6063-T6.

1. Mill finish, AA-M10 (Mechanical Finish: as fabricated, unspecified).

B. Aluminum Diamond Tread Plate: ASTM B632, 1/4-inch 6061-T6 with mill finish.

C. Aluminum-Alloy Rolled Tread Plate: ASTM B632, Alloy 6061-T6.

1. Mill finish, AA-M10 (Mechanical Finish: as fabricated, unspecified).

D. Aluminum Sheet: ASTM B209, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than strength and durability properties of Alloy 5005-H15; with minimum sheet thickness indicated representing specified thickness according to ANSI H35.2.

1. Mill Finish: AA-M10 (Mechanical Finish: as fabricated, unspecified).

2. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.

3. Baked-Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Apply baked enamel complying with paint manufacturer's written specifications for cleaning, conversion coating, and painting.

2.4 HATCHES, GENERAL

A. Cover Leaf: 1/4 inch aluminum diamond plate.

B. Channel Frame: 1/4 inch aluminum with continuous anchor flange.

C. Frame Coating: bituminous coating where in contact with concrete.

D. Locking System
   1. Interior: Type 316 stainless steel slam lock with removable key.
   2. Exterior: Padlockable with Type 316 stainless steel slam lock with removable key.

E. Cover equipped with the following stainless steel features:
   1. Spring assists.
      a. Compression spring operators enclosed in telescopic tubes.
      b. Upper tube shall be the outer tube to prevent accumulation of moisture, grit, and debris inside the lower tube assembly.
      c. Lower tube shall interlock with a flanged support shoe welded or bolted to the frame.
   2. SS Type 316 heavy duty hinges.
   3. SS Type 316 tamper proof attaching hardware.
   4. Automatic SS Type 316 hold open arm with aluminum latch.

F. Hatches shall be cast into concrete structures.

2.5 STANDARD HATCHES

A. Load Rating: 300 psf uniform live load with a maximum allowable deflection of 1/150 of the span.

B. Built-in neoprene gasket to limit the transmission of odors. The gasket shall limit air infiltration to less than 1 cfm per lineal foot of opening perimeter with a pressure differential equal to a 1" column of water.

C. Drain: 1-1/2 inch drainage coupling located in frame.

2.6 TRAFFIC RATED HATCHES

A. Loading: Designed to withstand H-20 wheel loadings suitable for use in locations where not subjected to high density traffic.

B. Drain: 1-1/2 inch drainage coupling located in frame.

C. Cover Leaf: Reinforced with beams to meet H-20 live load requirements.

2.7 WATERTIGHT HATCHES

A. Cover Leaf: Reinforced to support 625 pounds per square foot (10 foot water column) live load capacity.

B. Special water-resistant gasket to prevent intrusion of water.

C. No drain.

2.8 ACCESSORIES

A. Grating Panels

1. Material: Grate shall be constructed of fiberglass or aluminum
   a. Hardware shall be stainless steel.
2. Loading: 300 psf live load.
3. Grating shall have a 6 inch viewing area on each lateral unhinged side for visual observation and limited maintenance.
4. Operation shall be independent of the access cover.
5. A padlock loop shall be provided for the grate.
6. Grate shall be equipped with torsion rod lift assistance and a automatic hold open arm shall be included to automatically lock the panel in the fully open (90 degrees) position.
   a. A release handle shall be provided to close the grating panel.
7. Color: High visibility; orange or yellow.

B. Nets

1. Rails: Aluminum

2. Hooks, hardware, and anchors shall be constructed of Type 316 stainless steel.

3. Netting: Heavy-duty polyester

a. Color: Orange
b. Minimum breaking strength: 5000 pounds.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that hatch installation will not disrupt other trades. Verify that the substrate is dry, clean, and free of foreign matter. Report and correct defects prior to any installation.

B. Verify that other trades with related work are complete before installing hatches.

C. Mounting surfaces shall be straight and secure; substrates shall be of proper width.

3.2 INSTALLATION

A. Installer shall check as-built conditions and verify the manufacturer’s hatch details for accuracy to fit the application prior to fabrication. Comply with manufacturer's installation instructions.

B. Accessories: Install required components per manufacturer’s standard installation instructions.

END OF SECTION 077210

SECTION 112470
FLOW METERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Magnetic Flow Meters

B. Related sections include the following:

1. Section 014000 – Quality Requirements for testing and reporting requirements.

2. Section 025100 – Water Distribution for connecting piping requirements for potable water meters.

1.2 SYSTEM REQUIREMENTS

A. Design Requirements

1. Magnetic Flow Meters

Location	Metered Fluid	Meter Size (in)	Pipe Size (in)	Flow Rate (gpm)	Full Scale (gpm)	Liner	Electrode	Transmitter	
								Location	Output
Rest Area Lift Station Discharge	Wastewater	2	4	70	70	Polyurethane, Hard Rubber	316SS	Local	4-20mA

B. Performance Requirements

1. Magnetic Flow Meters

a. Meter inaccuracy shall be no more than $\pm$0.5% of actual flow rate at all flow rates above 1 fps. Accuracy shall be verified by calibration in a flow laboratory traceable to the U.S. National Institute of Standards and Technology.

b. Flowmeter shall be suitable for operation at ambient temperatures from -40°F to 140°F.

c. Flowmeter shall be capable of operating at process temperatures from 28°F to 110°F and at pressures from full vacuum to 150 psi.

d. Flowmeter and transmitter shall be rated for accidental submergence.

1.3 SUBMITTALS

A. Action Submittals
   1. Product Data
   2. Shop Drawings

B. Informational Submittals
   1. Manufacturer Test Reports
   2. Schedule of Tests and Inspections
   3. Field Test Reports
   4. Maintenance Data
   5. Manufacturers' Instructions
   6. Manufacturers' Field Reports
   7. Product Warranties

C. Project Record Documents
   1. Product Data
   2. Shop Drawings
   3. Factory test reports
   4. Field test reports, including certificate of accuracy
   5. Manufacturer's operations and maintenance literature
   6. Record Drawings

1.4 QUALITY ASSURANCE

A. Qualifications
   1. Magnetic flowmeter manufacturer shall have meters of the DC pulse type successfully metering the same types of fluids for a minimum of five years.

1.5 WARRANTIES

A. Manufacturer's Warranty: Provide Manufacturer's Warranty.

PART 2 - PRODUCTS

2.1 MAGNETIC FLOW METERS

A. Description

1. Magnetic flowmeters shall be microprocessor-based utilizing DC bipolar pulsed coil excitation. Meters shall indicate, totalize, and transmit flow in full pipes.

B. Body

1. The housing shall be stainless steel with powder coat finish or composite elastomer.

2. The liner shall be as indicated on the product data table at the end of this specification and as recommended by manufacturer for the application.

3. Ends shall be flanged:

   a. For meters 2” to 24”, flanges shall be ANSI B16.5 Class 150 lb.
   b. For meters 28” to 48”, flanges shall be AWWA C-207, Class D.

4. The meters shall be provided with stainless steel grounding rings, probes, straps, or grounding electrodes as recommended by manufacturer for the application.

C. Electronics

1. The integrally-mounted flow sensor and local or remote transmitter shall meet IEC requirements for Class I, Division 2, Groups B, C, and D locations.

2. When remote mounted, the flowmeter transmitter shall be furnished in a NEMA-4X enclosure box and adequate cable to extend between the meter and the transmitter without splices or intermediate connectors

3. A 2-line or 3-line backlit display in the local or remote transmitter shall be provided to display flow rate and total flow.

4. Transmitter shall be capable of communicating status, flow rate, and totalized flow, where applicable, with remote flow recorders and SCADA systems.

5. Programmable low flow cutoff, empty pipe cut-off, unidirectional and bidirectional flow settings, and two flow alarms shall be provided.

6. The flowmeter shall allow selection and changes of meter settings and troubleshooting functions to be made by menu from outside the housing. It shall not be necessary to remove covers, panels or fasteners to accomplish calibration or program changes.

7. The meter software shall incorporate a password feature preventing inadvertent program changes.

8. The meter shall feature nonvolatile EPROM memory and universal electronics module compatibility between all of manufacturer's magmeters.

9. The flowmeter shall be designed to function on 120VAC 60 Hz power supply. Power consumption shall not exceed 20 watts.

10. All printed circuit boards shall be contained in a plug-in module and be interchangeable for any size provided without requiring test equipment.

11. Totalized flow and programmed configuration shall be maintained in memory for the meter's lifetime.

D. Manufacturer's Testing

1. Magnetic flow meters shall be manufacturer-tested prior to shipment for mechanical and electrical correctness.

E. Provide the following supplies:

1. Manufacturer recommended spare parts

F. The magnetic flow meters shall be:

1. Sparling TigerMAG Model 656

2. Siemens (Danfoss) Sitrans FM

3. Endress + Hauser PROline PROMAG 50, or

4. approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. If remotely mounted, install electronics at location shown on the Drawings.

B. Install in accordance with the manufacturer's written instructions. All moving parts shall be lubricated per the manufacturer's recommendations.

C. Coordinate with Owner for control of facilities during meter installation. Minimize cut-in time of meter.

D. Match existing pipe insulation around meters, if any. Leave transmitter exposed so that all readouts and control keypads are accessible.

E. Orient transmitters to allow for ease of reading and accessibility of control keypads.

F. Properly ground meter according to manufacturer's recommendations.

3.2 STARTUP

A. Manufacturer's Field Services

1. Provide Field Quality Control Testing by Factory Authorized Service Representative in accordance with manufacturer's recommendations.

3.3 DEMONSTRATION AND TRAINING

A. Provide demonstration and training for meters and recorders.

END OF SECTION 112470

SECTION 113100
SUBMERSIBLE LIFT STATION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes submersible lift station structures and equipment, including:

1. Wet wells and valve vaults.
2. Pumps.
3. Guide rails and pump removal components.
4. Site Piping and Valves.
5. Pump control system.
6. Alarm dialer.
7. Hatches.
8. Control panel.

B. Related sections include the following:

1. Section 022400 – Dewatering for dewatering requirements.
2. Section 023000 – Earthwork for excavating, trenching, bedding and backfill, and pipe identification material.
3. Section 025300 - Gravity Sanitary Sewerage for connecting gravity sewer pipes.
4. Section 025450 - Sewer Force Mains for connecting sewer force mains.
5. Section 077210 – Hatches for hatches in lift station structures.

C. Related regulations include the following:

1. 327 IAC 3-6-9 for separation requirements with water mains and wells.

1.2 ACRONYMS

A. AFBMA – Anti-Friction Bearing Manufacturers Association

B. NEC – National Electric Code

C. FM – Factory Mutual

D. ANSI - American National Standards Institute.

E. ASTM - American Society for Testing & Materials.

F. HI - Hydraulic Institute.

G. NEMA - National Electric Manufacturer's Association

H. NFPA – National Fire Protection Association

I. UL – Underwriters Laboratories

1.3 SYSTEM REQUIREMENTS

A. Design Requirements

1. Submersible pumps at the Rest Area Lift Station Site shall be capable of meeting the following design criteria:

a.	Number of Pumps:	2 Pumps
b.	Primary Design Flow:	70 GPM
c.	Primary Design Head:	127’ TDH
d.	Motor Horsepower:	7.5 HP
e.	Electrical:	480 Volt, 3 phase, 60 Hz
f.	Pumped Material:	Raw Sewage

1.4 SUBMITTALS

A. Action Submittals

1. Product List
    a. Recommended spare parts list.
2. Product Data
    a. Manufactured control system products.
    b. Pumps and motors, including:
        1) Size, type, design, and model.
        2) Performance characteristics.
        3) Materials of construction.
    c. Guide rails and pump removal system components.
    d. Alarm dialer.
    e. Valves.
    f. Hatches.
    g. Manufactured steps and ladders.
3. Shop Drawings
    a. Wet well and valve vault construction, including:

1) Dimensioned drawings of pre-cast concrete components, including details of reinforcing steel.
2) Calculations indicating compliance with standards and specifications, sealed by an engineer registered in the location of the project, where applicable.

b. Dimensioned piping, structure, and valve layouts.

c. Electrical control panels, including:
1) Power supply line drawings.
2) Manufacturer's literature on incorporated components.
3) Control schematics.
4) Control panel layout.
5) Bill of materials.

B. Informational Submittals

1. Coordination Drawings

2. Manufacturer Test Reports

a. Prior to delivery:
1) Manufacturer's factory test results on pumps.
2) UL certification for control panel.

b. Test reports of compressive strength test on pre-cast concrete components.

3. Schedule of Tests and Inspections

4. Field Test Reports

5. Manufacturers' Instructions

6. Manufacturers' Field Reports

7. Product Warranties

C. Project Record Documents

1. Product Data

2. Shop Drawings

3. Factory test reports

4. Field test reports

5. Manufacturer's operations and maintenance literature

6. Record Drawings

1.5 QUALITY ASSURANCE

A. Qualifications

1. Pumps shall be manufactured and tested in accordance with the applicable requirements of the Hydraulic Institute and ASTM/ANSI standards.

2. All pump and control equipment shall be an integral package supplied by a single pump manufacturer/representative to provide undivided responsibility.

3. Pump manufacturer shall have a local certified repair company capable of providing on-site emergency service within 24-hours of notice.

4. Pre-Cast Concrete Structures

    a. Testing Agency
        1) Not less than three years experience in performing concrete tests of type specified in this section.
        2) Capable of performing testing in accordance with ASTM E329.
    b. Allowable Tolerances
        1) Length and width of precast units measured at face adjacent to mold shall be the following:
            a) Units 10 ft or under: ± 1/8".
            b) Units 10 to 20 ft: + 1/8", - 3/16".
            c) Units over 20 ft: + 1/8", - 1/4".
        2) Thickness of units shall be + 1/4", - 1/8".
        3) Units shall not be out of square more than 1/8" per 6 ft or 1/4" total.

5. Valves

    a. Valves, gear actuators, and motor operators shall comply with AWWA standards.
        1) Where no AWWA standard exists, comply with ASTM standards.

6. Control System

    a. Panel manufacturer shall be certified by Underwriters Laboratories (UL) as being a UL 508 and UL 698A listed systems panel manufacturer certified to install a serialized label for quality control and insurance liability considerations.
    b. Use only components readily available locally or through national mail-order electrical suppliers.

B. Regulatory Requirements

1. Motors and electrical controls shall meet all applicable requirements of the National Electrical Code and state and local regulations.

2. Comply with requirements of utility company providing wastewater service.

3. Comply with standards of authorities having jurisdiction for sewer-service piping, including materials, installation, and testing.

4. Comply with requirements of IDEM and EPA regarding wastewater facilities and service.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Storage and Protection

1. Environmentally sensitive electrical equipment such as motor starters, controls, transmitters, shall be protected against injury or corrosion due to environmental conditions or physical damage by storing under roof in a structure properly heated in cool weather and ventilated in hot weather. Control humidity in the storage at no more than 50 percent relative.

2. Contractor shall not store submersible pump units in the wet well.

3. All openings shall be capped with dustproof closures and all edges sealed or taped to provide a dust-tight closure.

4. Pre-Cast Concrete Structures

   a. Protect precast concrete units from dirt and damage during transportation and handling.
   b. Do not place units in positions which will cause overstress, warp or twist.
   c. Store units off the ground.
   d. Place stored units so that identification marks are discernable.

1.7 PROJECT CONDITIONS

A. Utility owner’s requirements shall prevail where these specifications and utility owner requirements are conflicting.

B. Climatic Conditions: All components exposed to weather must be constructed of material that is resistant to corrosion and will not require surface protection throughout its expected life. In general, these materials are stainless steel, aluminum, Krydon, fiberglass reinforced polyester (FRP), and ultraviolet stabilized PVC.

C. Hazardous Locations: Pumps, electrical systems, and controls in the wet well shall meet NEC Class 1, Division 1, Group C & D requirements. Electrical systems and controls in the pump control panels shall meet NEC Class 1, Division 2, Group C & D requirements. Rail packages shall be of the non-sparking configuration.

D. Interruption of Existing Sewer Service: Do not interrupt sewer service from facilities occupied by Owner or others or sewer flow through the sewer system unless permitted under the following conditions and then only after arranging to provide temporary sewer service according to requirements indicated:

1. Notify Engineer and Owner no fewer than two (2) days in advance of proposed interruption of service.

2. Do not proceed with interruption of sewer service without Owner's written permission.

3. Comply with requirements of utility owner in providing temporary sewer service.

1.8 SCHEDULING

A. Ensure completion and acceptance of upstream and downstream facilities prior to testing and commissioning.

PART 2 - PRODUCTS

2.1 OPERATING CONDITIONS

A. Submersible Pump System
   a. Rest Area Lift Station: 70 GPM, 127’ TDH

2.2 ACCEPTABLE PUMPING SYSTEMS

A. Rest Area LS: Myers WG75HH submersible grinder pump.

2.3 PUMP REMOVAL SYSTEM

A. The guide rail system for pump removal shall be provided by the pump manufacturer for the pump model provided.

B. Base and Discharge Elbow

1. Each lift-out system shall consist of a cast or ductile iron discharge base, cast or ductile iron pump carrier and sealing plate, steel pump guide plate, and cast iron elbow. All exposed nuts, bolts, and fasteners shall be 300 series stainless steel.

2. Discharge elbow shall be of the size indicated and integral to the base assembly.

3. A sealing plate shall be threaded or bolted to the pump. A simple downward sliding motion of the pump and guide plate on the guide rails shall cause the unit to be automatically connected and sealed to the base.

C. Seal

1. The open face of the sealing plate shall have a dove-tailed groove machined into the face to hold an “O”-ring seal or bellows seal.

D. Guide Rails

1. Two rail pipes shall be used to guide the pump from the surface to the discharge base connection.

2. The guide rails shall be firmly attached to the access hatch frame.

3. The guide rails shall be 2" schedule 40 galvanized steel pipe.

4. The weight of the pump shall bear solely on the discharge base and not on the guide rails.

5. Rail systems which require the pump to be supported by legs which might interfere with the flow of solids into the pump suction will not be considered equal.

6. Systems deeper than 12 feet shall use an intermediate guide for each 12 feet of wet well depth.

E. Lifting Chain

1. An adequate length of stainless steel lifting chain shall be supplied for removing pump.

2. The chain shall be connected to the pump or discharge flange as recommended by the pump manufacturer and also connected in an easily accessible location near the access hatch above the pumps in a manner to allow easy accessibility to the chain.

3. The chain shall provide at least 4:1 safety factor in strength.

2.4 LEVEL CONTROL SENSORS

A. Submersible Pressure Transducer

1. Pumps shall be controlled by a submersible pressure transducer.

2. Isolated diaphragm sensor design specifically manufactured for use in hostile fluids and gases.

3. Silicon pressure cell sensor with integral, compliant barrier diaphragm.

4. Static accuracy of +/- 1% FSO BFSL.

5. Certified intrinsically safe for hazardous locations.

6. Datalogger compatible.

7. Fully temperature compensated.

8. Shall be MJK 3400 as manufactured by MJK Automation.

B. Float Switches

1. Backup control of pump on, off, lag and alarm levels shall be by float switches.

2. Switches shall consist of a mercury tube switch sealed in a corrosion-resistant polypropylene housing with a minimum of 18 gauge, 2 wire, SJOW/A jacketed cable.

3. Float switches shall be suspended from the bracket so that adjustment or replacement may be done without the use of any tools.

C. Cable shall be of sufficient length to reach the control panel with no splices.

D. Level controls shall be UL/CSA listed.

2.5 PUMP CONTROL PANEL

A. Exterior pump control panels shall be NEMA 4X. Interior pump control panels shall be NEMA 12. Control panels shall be sized for the application. Separate control panel shall be furnished with each pumping system.

B. Stainless steel control panels shall be type 304 stainless steel, with a minimum thickness of 14 gauge.

C. The enclosure shall be of one piece construction with smooth, rounded corners and shall be constructed to have a smooth exterior and interior. The enclosure shall be fitted with a closed cell neoprene gasketed cover. The enclosure shall be provided with back panel mounting provisions. Exterior panels shall be provided with weather hoods.

D. The cover shall be hinged with a heavy duty corrosion resistant stainless steel piano hinge. The cover shall be lockable by means of two (2) high quality combination stainless steel latches and padlock hasps.

E. All control switches, lights, and meters on exterior-mounted panels, except those specifically indicated as being external, shall be mounted within the enclosure on a hinged aluminum panel. Control switches, lights, and meters on interior-mounted panels shall be placed on the front door unless otherwise indicated.

F. The back panel shall be a minimum of .080" aluminum and held in place by four (4) #10 screws, which will mate to four (4) threaded standoffs, which are molded into the enclosure.

G. A thermostat and heater shall be provided in each exterior-mounted control panel to prevent condensation and freezing.

H. A surge suppressor shall be provided in the control panel to protect all connected electrical equipment.

I. Panel shall include override relay, terminal blocks, two (2) ground lugs, and all necessary wiring and brackets.

J. All internal wiring shall be neat and color coded. Each wire shall be a different color or stripe (except for ground), and all incoming wires shall terminate into a box clamp type terminal block (except incoming power).

K. Circuit breakers shall be provided for each pump and for the control circuit.

L. A control transformer with primary fusing shall be provided for the control circuits where 120V power supply is not available.

M. For all control panels provided 3-phase power, socket-type power phase monitor shall shut down the control circuit and protect the 3-phase equipment upon loss of phase, phase imbalance, or phase reversal.

N. A weatherproof flashing alarm light shall be mounted on the outside of exterior control panels. Alarm light shall have a red bulb within a glass or acrylic cover surrounded by a removable cast aluminum protective cage. Alarm lights for interior control panels shall be located as indicated on the Drawings.

O. A weatherproof audible alarm horn shall be mounted on the outside of exterior control panels. Alarm horns for interior control panels shall be located as indicated on the Drawings. Horn shall be rated at 103 dB minimum.

P. A 20A weatherproof 120V GFI convenience outlet shall be located on the outside of the control panel. Receptacle shall be powered from control panel.

Q. A schematic diagram (showing wire color) shall be permanently fastened to the inside of the enclosure.

R. The control panel shall be U.L. listed as an assembly and shall bear the UL label certifying that the system meets all U.L. requirements, including but not limited to UL 508 and UL 698A.

S. A mounting package shall be furnished to mount the control panel. All necessary hardware to mount the pedestal and control panel shall be stainless steel.

T. Controllers mounted on top of the wet well shall be mounted in accordance with NFPA 820 (Standard for Fire Protection in Wastewater Treatment and Collection Facilities).

U. Explosion-proof conduit sealing fittings or Intrinsically Safe Relays (ISRs) shall be used at all locations necessary to meet IEC and local requirements. Conduit seal fittings shall be ductile iron. ISRs shall be UL and FM approved and designed to interface devices in hazardous locations with equipment in non-hazardous locations. The ISR shall operate from 120VAC and accept a minimum of two (2) inputs from a hazardous area.

2.6 PUMP CONTROLS

A. The pump controls shall be mounted on an internal panel face and be capable of controlling the duplex, three-phase pumping system.

B. Pump Controls

1. HOA Switches - Each pump shall be controlled by a hand-off-auto switch (momentary in the hand position).

2. Digital Pump Controller

    a. Standard off-the-shelf 100% digital microprocessor (programmable logic controllers with custom software shall not be acceptable).
    b. Digital readout and a keypad for entering operational settings.
    c. Capable of accepting a pressure input of 0 to 35 feet, a current input of 4 to 20mA, or a voltage input of 0 to 10 volt (field selectable) that will function with any type of level transmitter.
    d. Control adjustments shall be accomplished by direct digital inputs (potentiometers or other analog adjustments shall not be acceptable).
    e. Allows for programming changes and complete level simulation from the front of the control plate without codes or special keypad sequences.
    f. LED indicators shall be lighted and identify the function to be changed as the operator steps through the programming mode.
    g. One 4 to 20 mA analog output.
    h. Digital outputs from the controller shall be normally open relay contacts rated for 120 vac.
    i. One RS485 serial port capable of operating with standard Modbus protocols.

C. Pump Control Sequence

1. Lead pump shall be started in Auto mode by the “On” level sensor.

2. Lag pump shall be started in the “Auto” mode by the “Lag” level sensor.

3. Alarm light shall be turned on by “Alarm” level sensor.

4. All pumps shall be turned off by the “Off” level sensor. Pumps may continue to be operated in “Hand” position with the level below the “Off” level sensor.

D. Control Lights and Switches

1. Control lights on the inside panel shall be provided for the following conditions:

    a. Pump run (green) for each pump.
    b. Moisture in pump (amber) for each pump.
    c. Power on (red) for control panel.

2. Switches or buttons will be provided on the inside panel for:

    a. alarm test (pushbutton).
    b. alarm reset (pushbutton).
    c. test lights (pushbutton).

3. No control lights shall be provided on the panel exterior.

E. Alarm Dialer / Remote Terminal Unit (RTU)

1. RTU shall be Mission MyDro Model 150.

2. Alarm Conditions:

    a. Low Level
    b. High Level
    c. Pump 1 Seal Fail
    d. Pump 1 Overload Trip & Over Temperature
    e. Pump 2 Seal Fail
    f. Pump 2 Overload Trip & Over Temperature
    g. Power Failure.

3. Supplier shall provide all monitoring equipment and accessories and employ full-time service and support personnel necessary to provide and support the complete system.

4. Shall be fully configurable by the Owner using simple configuration methods.

5. RTU shall be powered by 12 volts AC with built-in battery backup capable of powering the RTU for 24 hours in case of primary AC failure.

6. All terminations inside the RTU enclosure shall be low voltage AC or DC, 28 volts or less.

7. RTU shall be supplied with a U.L. recognized 120 VAC or to 12 VAC step-down transformer.

8. Provide alarm reporting via telephone service or through a protected customer website. Coordinate programming and alarm reporting with Owner.

F. Include a non-resetable hourmeter for each pump on the inside panel to register the elapsed operating time.

G. A solid state alternator relay shall be provided to automatically alternate pumps between lead and lag operation after each run.

H. Provide motor winding heat sensor circuit from each pump equipped with heat sensor. Circuit shall disconnect the starter upon high temperature signal and automatically reset when condition is corrected.

I. Provide seal failure alarm circuit from each pump equipped with seal failure sensor. Seal failure alarm shall energize panel alarm light but not disconnect the starter.

J. Time-Delay Relays: 5 HP and more

1. Relays shall be of the plug-in socket design.

2. Operate on 24 or 120VAC, as applicable for the controls design, and shall have DPDT contacts rated at 10A minimum.

3. Have a red LED for output contact status.

4. Be on-delay or off-delay as required.

5. Delay the start of the lag pump upon restoration of power after outage.

K. Nameplates and Identification

1. Provide screw-in type, engraved nameplates or laser-screened laminated mylar identification labels for all controls, disconnects, indicators, and lights on outer or inner panel doors.

2. Provide laser-screened laminated mylar identification labels for major components inside panel such as circuit breakers, motor starters, and transformers

3. Provide permanent printed labels or legible permanent marker identification for relays, fuses, phase monitors, surge arrestors, and any other minor equipment within panel.

4. All control wiring shall be numbered on each termination.

L. Surge Protection

1. Provide Category C-1 surge suppressor where the largest downstream motor is 10 horsepower or less, Category C-2 for motors to 25 HP, and C-3 for motors are larger than 25 HP.

2. Surge suppressor shall be designed for use at service entrance.

2.7 VARIABLE FREQUENCY DRIVES

A. Description: NEMA ICS 2, IGBT, PWM, VFD; listed and labeled as a complete unit and arranged to provide variable speed of a NEMA MG 1, Design B, 3-phase, standard-efficiency induction motor by adjusting output voltage and frequency.

B. Design and Rating: Match load type such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

C. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.

D. Unit Operating Requirements:

1. Input ac voltage tolerance of 380 to 500 V, plus or minus 10 percent.

2. Input frequency tolerance of 50/60 Hz, plus or minus 6 percent.

3. Capable of driving full load, under the following conditions, without derating:

a. Ambient Temperature: 0 to 40 deg C.
b. Humidity: Less than 90 percent (non-condensing).

c. Altitude: 3300 feet (1000 m).

4. Minimum Efficiency: 96 percent at 60 Hz, full load.

5. Minimum Displacement Primary-Side Power Factor: 96 percent.

6. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.

7. Starting Torque: 100 percent of rated torque or as indicated.

8. Speed Regulation: Plus or minus 1 percent.

9. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.

E. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.

2. Maximum Speed: 80 to 100 percent of maximum rpm.

3. Acceleration: 2 to a minimum of 22 seconds.

4. Deceleration: 2 to a minimum of 22 seconds.

5. Current Limit: 50 to a minimum of 110 percent of maximum rating.

F. Self-Protection and Reliability Features:

1. Input transient protection by means of surge suppressors.

2. Snubber networks to protect against malfunction due to system voltage transients.

3. Under- and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.

4. Motor Overload Relay: Adjustable and capable of NEMA 250, Class 20 performance.

5. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.

6. Instantaneous line-to-line and line-to-ground overcurrent trips.

7. Loss-of-phase protection.

8. Reverse-phase protection.

9. Short-circuit protection.

10. Motor overtemperature fault.

G. Automatic Reset and Restart: To attempt three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.

H. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.

I. Torque Boost: Automatically vary starting and continuous torque to at least 1.5 times the minimum torque to insure high-starting torque and increased torque at slow speeds.

J. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled fan-ventilated motors at slow speeds.

K. Status Lights: Door-mounted LED indicators shall indicate the following conditions:

1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.

L. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual speed control potentiometer and elapsed time meter.

M. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:

1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (VDC).

9. Set-point frequency (Hz).

10. Motor output voltage (V).

N. Control Signal Interface: Provide VFD with the following:

1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.

2. Output Signal Interface:

a. A minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:
1) Output frequency (Hz).
2) Output current (load).
3) DC-link voltage (VDC).
4) Motor torque (percent).
5) Motor speed (rpm).
6) Set-point frequency (Hz).

3. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:

a. Motor running.
b. Set-point speed reached.
c. Fault and warning indication (overtemperature or overcurrent).
d. PID high or low speed limits reached.

O. Communications: Provide an RS485 interface allowing VFD to be used with an external system within a multidrop LAN configuration. Interface shall allow all parameter settings of VFD to be programmed via BMS control. Provide capability for VFD to retain these settings within the nonvolatile memory.

P. Manual Bypass: Arrange magnetic contactor to safely transfer motor between controller output and bypass controller circuit when motor is at zero speed. Controller-off-bypass selector switch sets mode, and indicator lights give indication of mode selected. Unit shall be capable of stable operation (starting, stopping, and running), with motor completely disconnected from controller (no load).

Q. Isolating Switch: Non-load-break switch arranged to isolate VFD and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.

R. Bypass Controller: NEMA ICS 2, full-voltage, nonreversing enclosed controller with across-the-line starting capability in manual-bypass mode. Provide motor overload protection under both modes of operation with control logic that allows common start-stop capability in either mode.

S. Integral Disconnecting Means: NEMA AB 1, instantaneous-trip circuit breaker with lockable handle.

2.8 PRECAST CONCRETE WETWELL AND VALVE VAULT

A. Description and Conditions: All bases, barrels, and tops for wet wells and valve pits shall be precast reinforced concrete capable of withstanding external pressures including live surface loads, soil pressures and groundwater elevations to the finished grade in combination with internal pressures due to variable liquid elevations from empty to the top of the structure.

B. Material

1. All precast concrete structures shall be watertight and of durable materials not subject to decay or excessive corrosion.

2. Minimum compressive strength for all concrete shall be 4,000 psi at 28 days.

3. Reinforcing steel shall meet ASTM A615 with a yield strength of 60,000 psi.

4. Design of concrete structures shall meet specification ACI 350, AASHTO load factor design method including an HS20 loading, ASTM C890, ASTM C857, and ASTM C478, as applicable.

5. Manufacturing of precast reinforced sections shall conform to ASTM C478. Sections at depths greater than twelve (12) feet shall be reinforced with two cages of reinforcement as is required for Class III reinforced concrete sewer pipe of same diameter per ASTM C76.

6. Joints shall have tongue and groove O-ring seals, butyl joint sealer, and exterior joint collar meeting requirements of WM-9 and ASTM C443.

7. Handling or lifting lugs shall be provided for ease of unloading and placement.

8. Pipe connections through all precast concrete walls for all but ductile iron pipe shall be flexible connectors meeting ASTM C923.

9. Pipe connections through all precast concrete walls for ductile iron pipe shall be flexible connectors meeting ASTM C923 or modular seals designed for precast concrete structure pipe penetrations, similar to Link-Seal Model S-316.

10. External joint collar shall be Mac Wrap Exterior Joint and Sealer as manufactured by Mar-Mac Manufacturing Company or approved equal.

11. Manhole steps in valve vault shall be a polypropylene plastic encapsulating a ½" grade 60 steel reinforcing bar meeting ASTM C478, ASTM D4101 for polypropylene plastic, and ASTM A615 for reinforcing steel cast into vault sections.

2.9 SITE PIPING AND FITTINGS

A. Piping

1. Pipe shall be ductile iron conforming to AWWA C151.

2. Pressure class shall be 350 psi pressure class in conformance with AWWA C150:

B. Joints

1. Exposed Service

   a. Threaded flanges, gaskets, and flange fittings in conformance with AWWA C115.
   b. ASME B16.5, Class 150, DI or ASME 16.1, Class 125, CI for other flanges, gaskets, and flange fittings.
   c. Flange Backup Rings
      1) Flange backup rings shall be of the type and pressure rating as the pipe.
      2) Ductile iron backup rings shall be of the convolutant type, fabricated from ductile iron per ASTM A536, grade range 60/40/18 to 65/45/12. Ductile iron flange backup ring bolting dimension shall conform to ASME B16.5 Class 150.
      3) Backup rings shall be finished and cast with flash removed from all edges and bolt holes to the specified dimensions. Finish shall be epoxy coated with bitumastic 300M high build coal tar epoxy in accordance manufacturer's recommendations or as noted on the plans.

2. Buried Service

   a. Mechanical joints in accordance with AWWA C110 and AWWA C111.
   b. Push-on type joint conforming to AWWA C111.
   c. Gaskets meeting AWWA C111.
   d. Manufactured restrained joints under conditions indicated by manufacturer.
   e. Field-adaptable restraint shall have a working pressure equal to at least the pipe's working pressure rating and shall be Megalug 1100 as manufactured by EBAA Iron, Uni-Flange Series 1400 (16" or less) by Ford Meter Box Company, or equal.

C. Coatings

1. Interior seal-coated cement mortar lining shall meet the requirements of AWWA C104.

2. Exterior coating shall meet the requirements of AWWA C151.

3. Interior and exterior coatings shall be provided for all pipe and fittings

4. Exterior coatings shall be provided for all adapters.

D. Encasement

1. Buried Service: Polyethylene encasement shall conform to AWWA C105.

2. Exposed Service: None.

E. Fittings

1. DI meeting the requirements of AWWA C110, standard pattern or AWWA C153, compact pattern.

2. Specials

a. Special fittings not included in applicable AWWA specifications shall be reviewed on a case-by-case basis.
b. Manufacturer shall legibly mark specials in accordance with the laying schedule and marking diagram.

F. DI expansion couplings shall be provided in all underground piping extending between structures and at the transition to the force main.

G. Piping shall be supported independently of the pump flanges and shall not bear on the concrete structures at penetrations.

H. Quick connect coupling shall be male stainless steel cam and groove-type connector meeting MIL-C-27487 dimensions. Provide stainless steel female dust cap for connector.

2.10 PLUG VALVES

A. Plug valves shall be resilient-seated eccentric.

1. Standard: MSS SP-108.

2. Connections, as applicable:

a. Mechanical-joints: conform to AWWA C111.
b. Flanges: conform to ANSI B16.1, Class 125 or ANSI B16.5, Class 150.

3. Body: Cast iron or ductile iron.

4. Pressure Rating

a. 3” – 12” Valves: 175-psig minimum.
b. 14” – 72” Valves: 150 psig minimum.

5. Seat Material: As recommended by manufacturer for sewage service.

B. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "SEWAGE" and bottom section with base that fits over valve and with a barrel approximately 5 inches in diameter.

1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.

C. Operators, unless indicated otherwise:

1. Buried Service: 2” AWWA Operating Nut.

2. Exposed Service to 6’-6” above finished floor: Lever.

3. Exposed Service above 6’-6” above finished floor: As directed by Engineer.

D. Stems: Non-rising unless indicated otherwise.

2.11 CHECK VALVES

A. General

1. Check valves shall be swing checks of the rubber flapper type conforming to AWWA C508. Check valves shall have an external adjustable weighted lever and a flexing, sprung, internally steel reinforced flapper of Buna-N with an “O” ring seating edge and be designed for 175 PSI working pressure.

B. Cushioned Swing Check Valves

1. Application: Cushioned swing check valves shall be used in applications greater than 120’ TDH or where indicated on the Drawings.

2. Cushioned swing check valves shall have a air cushioning cylinder assembly externally attached to the side of the valve body to eliminate valve slamming.

2.12 POWER SUPPLY AND DISTRIBUTION

A. Provide underground or overhead power supply to power meter according to directions of power company.

B. Provide mounting panels for power supply and control panels as shown on Drawings.

C. Provide disconnects, grounds, conduit, fuse and breaker boxes, wiring, and other electrical power distribution components as provided in the Contract Documents and as required by electrical codes.

2.13 VENTS

A. Vents shall be made of flanged ductile iron pipe, PVC, or welded steel.

B. Provide galvanized steel insect screen and ½” x ½” protective welded wire screen wedged between flange faces, attached with stainless steel screw-type band, or welded to pipe.

2.14 ALARM DIALER

A. Panel mounted dialer, Mission MyDro Model 150.

B. Dialer to monitor: Low Level; High Level; Pump 1 Seal Fail, Overload Trip & Over Temperature; Pump 2 Seal Fail, Overload Trip & Over temperature; Power Failure.

C. Provide in pump control panel or separate NEMA 4X SS enclosure mounted adjacent to pump control panel.

D. The services of a factory trained qualified representative shall be provided to certify the completed system, make all adjustments necessary to place the system in operation and instruct the operating personnel in the proper care and operation of the equipment.

E. Provide local telephone service to dialer on Owner’s account. Coordinate with Owner.

2.15 STRAIN RELIEF GRIPS

A. All pump power and sensor cables shall be fitted with stainless steel Kellem type strain relief grips.

B. Cable restraints shall support the cables from the top of the wet well.

C. Strain relief grips shall be attached by stainless steel hooks with snap clips.

2.16 NAMEPLATES

A. Each piece of mechanical equipment shall be provided with a substantial nameplate, securely fastened in place and clearly inscribed with the manufacturer's name, year of manufacture, serial number, and principal rating data.

B. A second identical nameplate shall be provided for all submersible pumps and affixed to the interior of the control panel.

2.17 SPECIALTY TOOLS

A. Furnish with each different type, kind, or size of pumping unit, two (2) sets of any special tools, gauges, and fixtures required to adjust, operate, maintain, or repair the pump.

B. Tools shall be suitably marked high-grade items.

C. Furnish tools in neat, special steel cases fitted with locks and keys and delivered to the Engineer prior to the initial operation of equipment.

PART 3 - EXECUTION

3.1 WET WELL AND VALVE VAULT INSTALLATION

A. Granular material shall be placed and graded to be flat and level in the bottom of the excavation prior to tank installation. Material type and depth shall be according to manufacturer's instructions, but depth shall not be less than 6".

B. All joints shall be sealed watertight with butyl rubber sealant according to pre-cast concrete manufacturer's direction.

C. Install exterior collar on all wet well and valve vault joints.

D. Coat exterior surface below grade with a two part bituminous epoxy or approved equivalent. Coat interior surface where indicated on the Drawings.

1. Apply after proper concrete curing time.

2. Surface Preparation: All surfaces must be clean and structurally sound, free of dirt, grease, oil, paint, etc. Remove contamination with abrasive blasting, water blasting or wire brush. Make sure all dust is removed after abrasives. Metal should be blasted to SSPC SP-6, 2 to 4 mils profile before coating. Concrete should be blasted or acid etched before coating. Remove all acid with water before coating.

3. Mixing: Mix well according to manufacturer's directions with low speed drill and mixing paddle. Stir until uniform, smooth material is seen. Mix minimum of three (3) minutes. Scrape sides and bottom frequently. Avoid entrapping air in mixture. For best results, when spraying, strain material through a 60 mesh screen prior to spraying.

4. Application: Apply by brush or spray. If sprayed, brush into imperfections. Do not exceed manufacturer's indicated pot life. If heated and sprayed, mix only what can be applied within 30 minutes. Spraying will be done only with specialized equipment. Both components must be heated to 100°F before spraying. Plural component guns may be used where indicated by manufactuer. Higher temperatures and larger masses shorten pot life.

5. Limitations: Do not use below 40°F. Store material under dry conditions. For best results before spraying, rolling, or applying by brush, condition material to 70°F or higher.

E. Test wet well in accordance with ASTM C1244.

3.2 PUMP INSTALLATION

A. All pumps and pumping equipment shall be installed per the manufacturer's recommendations.

B. During pump installation, the open power cable ends are to be suspended above the maximum flood elevation or maximum expected water level. If not installed in this manner, Contractor may be required to replace the pump motors and cables with new units to ensure that water has not penetrated the cable and entered the motor housing.

C. Pumps will be tested after installation using clean water. Tests shall include:

1. Pumping draw-down test to confirm pump output meets or exceeds design.

2. Test controls for proper function.

3. Amp test to confirm power draw within equipment limits.

3.3 CONTROLS AND POWER DISTRIBUTION

A. Control wiring and pump power wiring shall be installed in separate conduits from the wetwell to the control panel. Seal conduits watertight on both ends.

B. Control panel shall be mounted at the location indicated on the Drawings.

3.4 VALVES

A. Locate and orient exposed valves to allow valve to be readily operated without operator binding. Operating levers or wheels on valves should be horizontal (operating stem vertical) with adequate space to fully open and fully close the valve. Check valve swing arms should be capable of freely operating without binding or touching other components.

B. Orient buried valves, valve box, actuator, and other components to allow valve to be readily operated without binding. Operating nuts should be vertical and centered in the valve box.

C. Valve boxes shall be carefully installed over each buried valve (except combination valves) and supported in a manner that will not allow surface loads to be transmitted to the valve or pipe. Care shall be taken to see that the bottom of the box is clear and free of debris, rocks, etc., which will interfere with the operation of the valve stem.

3.5 FIELD PAINTING

A. Field paint all new equipment; exposed piping, valves, and fittings; submerged and exposed structural steel; exposed electrical conduits; miscellaneous metal items including galvanized steel; and aluminum surfaces in direct contact with concrete.

B. Do not field paint stainless steel, fiberglass, aluminum, grating, or items with special coatings.

C. Shop coats of paint or other protective coatings damaged in transit or during construction shall be touched up in the field with primer coat before start of finish coats.

D. Colors of paint where not specified shall be as selected by the Owner.

3.6 FIELD QUALITY CONTROL

A. Testing, General

1. Test new wet wells, controls, pumping, and piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

2. Inspect and test completed piping systems.

3. Schedule inspections and tests with Owner and Engineer with at least 48 hours' advance notice.

4. Submit separate report for each test.

5. Any visible leaks, evidence of leaks, or malfunctioning or improperly functioning equipment or controls shall result in a failed test.

6. Failures of inspections or tests indicate defects that must be repaired or replaced.

7. Replace failed work using new materials and repeat testing until test results are within allowances specified.

B. Cleaning

1. Conduct standard cleaning prior to acceptance testing.

C. Wet Well Exfiltration Test

1. Applicability

a. All new wet wells shall be tested by a water exfiltration test.
b. Test after:
    1) Installation with all piping connections in place.
    2) Installation of all electrical conduits and other penetrations to the wet well structure.
    3) Plugging of all lift holes.

4) Installation of drop connections.
5) Backfilling to design grade.
6) Groundwater has been lowered to below the bottom of the wet well.
7) Curing of any coating or lining applied to the interior of the wet well.

c. Test before:
1) Installation of pumps, electrical power and controls wiring, and other electrical and mechanical systems.

2. Procedure

a. Seal all inlets and outlets with watertight plugs or bulkheads. The wet well vent shall be screened, capped, flanged, or otherwise blocked.
b. Fill the wet well with water until the elevation of the water is above the interface of the concrete and the hatch frame. Clearly mark the test level in the wet well.
c. Fill and maintain full of water for a period of at least 24 hours prior to the start of the test to allow for absorption of water by the concrete.
d. Prior to initiation of the test, raise the water level to the test level mark.
e. Conduct the test a minimum of 24 hours. Once the test begins, the hatch shall only be opened in the presence of Engineer.
f. At the end of the test period, refill the wet well to the test level, measuring the volume of water added.

3. Determination of Wet Well Acceptance: : If the volume of water required to refill the wet well to the initial test level is less than or equal to the following volumes, the wet well shall have passed the test.

a. The maximum leakage allowance for unlined wet wells shall be fifty-thousandths of a percent (0.050%) of the water volume per 24 hours.
b. No leakage shall be allowed for lined wet wells.

4. Determination of Wet Well Failure: If the volume of water required to refill the wet well to the initial test level is more than the acceptable volumes, the wet well shall have failed the test.

5. Correction

a. If the wet well fails this test, locate defects and notify Engineer of findings. Repair or replace defects in a manner acceptable to Engineer.

D. Pump and Controls Tests

1. Applicability

a. All new lift station pumps and controls shall be tested.
b. Test after:
1) Installation of all electrical and mechanical systems have been completely installed, with all connections in place.
2) Backfilling to design grade.
3) Completion and acceptance of force main(s) discharging from lift station.

4) Manufacturer's successful start-up of all mechanical, electrical, and controls systems.
    a) Submit manufacturer's start-up records with request for testing.

2. Procedure

    a. Provide the following pump test equipment and materials:
        1) Clean water to conduct test
        2) Amp/volt meter
        3) Stop watch
        4) Tape or level rod to measure float settings
        5) Calibrated pressure gauge to measure operating head. The gauge shall be calibrated in feet of water from 0 to 100 feet (or next higher normal gauge range if pump shut-off head is higher) in one foot increments.
        6) A connection for the pressure gauge on the tee or cross in the valve vault. Equip the gauge stem connection with a gauge cock or miniature ball valve to close the connection after testing is complete. The connection shall be left in place and shall be suitable for use as an air bleed off.
    b. Conduct the following tests or analyses in the presence of Engineer and Owner's representative:
        1) Manually check all floats' on/off operations, alarm and run lights, and alarm horns.
        2) Check the functioning and performance of control switches, alternators, and gauges.
        3) Confirm proper functioning of the SCADA or remote monitoring system.
        4) Determine pump capacity for each pump individually and all pumps operating simultaneously.
            a) Determine inflow rate (if any).
            b) Perform full-cycle pump-down test of each pump. Check amperage draw of each leg of each pump motor.
            c) Perform full-cycle pump-down test of all pumps. Check voltage at motor power cable connections.
            d) Determine each pump's capacity with force main full.
            e) Plot performance of each pump on pump curves.

3. Determination of Pumps and Controls Acceptance: If all pumps and controls function as designed and intended, the pumps and controls shall have passed the test.

4. Determination of Pumps and Controls Failure: If any pump or control shall not function as designed and intended, the pumps and controls shall have failed the test.

5. Correction

    a. If the pumps and controls fail this test, locate defects and notify Engineer of findings. Repair or replace defects in a manner acceptable to Engineer.

END OF SECTION 113100

SECTION 113250 – ODOR CONTROL SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Providing and installing a complete odor control feed system with chemical storage tank. The chemical feed system consists of two chemical feed pumps, control panel, calibration column, piping and other components enclosed in a fiberglass cabinet to feed odor control chemical (Nitra-Nox) into the wastewater system. The chemical feed system and odor control shall have the capability to feed over a 24-hour period.

1.2 SYSTEM REQUIREMENTS

A. All components of the odor control chemical feed system shall be compatible with odor control chemical (Nitra-Nox). All components also shall be compatible with the conditions of the normal operations of the wastewater system. All materials must be compatible with the following:

1. Hydrogen Sulfide (H2S)
2. Nitra-Nox (Odor Control Chemical)

1.3 SUBMITTALS

A. Action Submittals

1. Product List
2. Product Data
3. Shop Drawings

B. Informational Submittals

1. Qualification Data
2. Manufacturer Certificates
3. Manufacturers' Instructions
4. Product Warranties

1.4 QUALITY ASSURANCE

A. Qualifications

1. The supplier of the above equipment shall have a minimum of five (5) years experience in supplying odor control equipment utilizing hydrated ferric oxide (Iron Sponge) media.

2. The supplier of the above equipment shall have a minimum of five (5) odor control installations utilizing hydrated ferric oxide (Iron Sponge) media.

3. Odor control experience with any media other than Iron Sponge will not qualify a supplier under this section.

4. Systems utilizing biological reactions in their process will also not be considered.

B. Regulatory Requirements

1. Comply with all pertinent codes and regulations.

2. Where provisions of pertinent codes, regulations, referenced standards, or the requirements of this section conflict the more stringent of the codes and standards or specifications shall govern.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 CHEMICAL STORAGE TANK

A. The chemical storage tank shall be high density polyethylene (HDPE).

B. The chemical storage tank shall be compatible with Nitra-Nox (odor control chemical).

C. Chemical storage tank shall be 1100-gallon capacity.

D. Chemical storage tank shall be 51" tall and 87" in diameter.

2.2 CHEMICAL FEED SYSTEM

A. General - The chemical feed system shall be manufactured by Aulick Chemical Solutions or approved equal. The operation of the chemical feed system shall be operated from the control panel located inside of the fiberglass cabinet. All components enclosed in the stainless-steel cabinet shall be rated for outdoor weather exposure and other conditions.

B. Control panel shall be equipped with hinged door.

C. The chemical feed system shall include calibration column for calibrating the feed rate.

D. Enclosure – All components shall be enclosed in a 25 1/4” width, 27” height, and 12” depth fiberglass cabinet. The fiberglass cabinet shall be lockable. The fiberglass cabinet shall be anchored to concrete with 4 each 3/8” stainless steel anchors.

E. Components - Chemical feed system shall include; 1 Stenner Perastaltic metering pumps, control panel, and calibration column.

F. Control Panel- Control panel shall be located in a separate internal panel mounted in the fiberglass cabinet.

G. Electrical Requirement- 120 VAC/ 1PE/ 60

2.3 CHEMICAL FEED PUMPS

A. General- Chemical feed pumps shall be manufactured by Stenner Pump Co. Each pump shall be a peristaltic metering pump.

B. Performance - Each pump shall be equipped with:

1. The flow rate of each pump shall have an adjustable feed rate.

2. Calibration column shall be included for feed rate calibration.

3. 4" fiberglass cabinet cooling fan.

2.4 PIPING/PVC REQUIREMENT

A. All suction and discharge piping located inside the fiberglass cabinet shall be provided by manufacturer. All piping shall be 1⁄2 “diameter SCH 80 PVC diameter. All valves, fittings and connectors shall be 2 “SCH 80 PVC.

B. All fill line piping shall be 2” SCH 80 PVC. All fill lines, fittings, and connectors shall be SCH 80 PVC.

C. Fill line should have 2” plastic female camlock with 2” plastic male camlock cap.

D. All chemical feed seals shall be compatible with the chemicals to be used in the regular operation, maintenance, and cleaning of the feed system.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Inspection:

1. Prior to all work of this Section, carefully inspect the installed work of all other trades and verify that all such work is completed to the point where fabrication and installation of the work of this Section may properly begin.

2. Make all required measurements in the field to ensure proper and adequate fit of connecting piping.

3. Immediately notify Engineer in the event of discrepancies; do not proceed with fabrication or installation until all such discrepancies have been fully resolved in writing.

3.2 FIELD SITE/UTILITIES

A. Electrical- One 120 VAC, 60 Hz, 15 Amp single-phase electrical service shall be required.

B. Concrete Pad- 6" concrete pad is required. Refer to contract drawings for size of concrete pad for tank and fiberglass system to set on. Refer to contract drawing for location of electrical line and chemical discharge line in the concrete pad.

C. Chemical Feed System- The Fiberglass Chemical Feed System shall be bolted to the concrete with (4) 3/8 "stainless steel anchors.

3.3 INSTALLATION

A. Visual inspection of all components, equipment and chemical storage tank.

B. Complete testing on chemical feed pumps and piping/ PVC.

C. The installation of the equipment shall be in accordance with the manufacturer guidelines.

D. All personnel shall be qualified in their area of work to complete the installation.

3.4 EQUIPMENT TESTING

A. Before shipping/ delivering chemical feed system, Aulick Chemical Solutions shall perform testing.

3.5 FIELD TESTING

A. A manufacturer's representative shall be on site for field testing, training, and demonstration during start up.

3.6 WARRANTY

A. The manufacture shall guarantee that the fiberglass system & storage system will perform as described in these specifications. The manufacture shall provide full warranty in materials of workmanship for a period of 12 months from substantial completion

B. B. The manufacture shall repair or replace defective components under this warranty. In addition, the chemical storage tanks shall be warranted for a period of 3 years from start up or 44 months from the shipment, whichever comes first.

END OF SECTION 113250