TECHNICAL SPECIFICATIONS

FOR
GOODYEAR PUMP STATION MODIFICATIONS

Project No. 25-11-708

October 2025

SECTION 1
GENERAL REQUIREMENTS

1.01 Location: The work described in these Specifications is located in the City of Valdosta, Lowndes County, Georgia.

1.02 Work to be Done: The work to be done consists of the furnishing of all materials, labor and equipment for the complete construction of Goodyear Pump Station Modifications for the City of Valdosta dated August 2025 consisting of:

> Relocate the existing Goodyear raw sewage pump station, construct wetwell, pad, site improvements, pumps, generator and automatic transfer switch electrical including panel, VFD and electrical systems, paint, piping and fencing, complete with appurtenances

1.03 Schedule of Work: The Contractor shall schedule the work to minimize interruptions or shutdowns of the existing sewerage system and to not have any sewage overflow during the work without prior approval of both the Owner and Engineer.

The Contractor shall notify the Engineer and the Owner before starting any new phase of construction to verify that no interruption of service will be encountered.

The Contractor can plan on shutting the pump station down completely for a period of 30 days. The Owner has the option of installing a portable generator during this period per the unit price in the Proposal.

1.04 Drawings: The Drawings entitled "**GOODYEAR PUMP STATION MODIFICATIONS AUGUST 2025**" form a part of the Construction Agreement.

1.05 Specifications: The Specifications form a part of the Construction Agreement, and include this Section and Sections 2 through 13 as identified below:

Section Number	Title of Section
2	Control of Materials
3	Soil Erosion, Sediment Control
4	Concrete
5	Reinforcing Streel, Structural Steel and Miscellaneous Metal
6	Site Preparation, Excavation, Backfilling, Grading and Fencing
7	Building and Building Service Equipment
8	Pipe, Fittings, Valves and Drains
9	Mechanical Equipment
10	Instrumentation, Controls and Mechanical
11	Electrical – Basic Materials and Methods
12	Generator
13	Painting

1.06 Protecting Existing Utilities and Structures: Prior to any excavation, the Contractor shall call the Utilities Protection Inc. "Call Before You Dig" number (811). Any damage done to existing utility lines, drains, power and telephone cable, poles, and structures of every nature, not indicated to be replaced and/or abandoned shall be repaired or replaced by the Contractor at his own expense. The approximate position of certain known underground lines and structures are shown on the Drawings according to the best available information. Existing small lines are not shown. The Contractor shall locate, excavate and expose all existing underground lines in advance of trenching and other construction operations. Where connections are to be made at underground structures and pipe lines, elevations and locations shall be verified prior to construction of the pertinent work. Where underground utilities or obstructions are encountered which conflict with the new work, the location and/or alignment of the new or existing lines may be changed to avoid interference upon written approval of the Engineer.

1.07 Subsurface Investigations: A subsurface investigation has been made on the work and is attached as an appendix. The prospective bidder must form his own opinion of the character of the subsurface materials to be encountered in excavating for and the construction of the various facilities.

1.08 Easements: The Owner has not obtained easements for all work on private property. The Contractor will be provided copies of all easement agreements when obtained by the Owner. The Contractor shall review any special conditions of any easement agreement and notify the Engineer of any condition which cannot be met under the Plans and Specifications without an increase in contract price. The Contractor may be required to work only in areas where easements have been obtained.

1.09 Work Hours and Time Restrictions:

A. Work shall be executed Monday through Saturday during normal work hours (8:00 a.m. to 6:00 p.m., 9:00 a.m. to 4:00 p.m. on Saturday) unless otherwise approved by the City of Valdosta.

B. Requests for work outside of normal working hours must be received in writing from the City a minimum of 48 hours in advance of performing the work.

C. An inspection fee equal to the employee's time and benefits will be assessed if the Contractor elects to work outside of normal working hours or on Saturday or Sunday.

D. All trenches must be covered at night, either by backfilling or by using trench plates.

1.10 Site Safety:

A. Contractor shall be responsible for site safety. Contractor shall identify a site safety officer who shall be responsible for conducting daily safety meetings and ensuring a safe work environment.

B. All work shall be conducted in accordance with OSHA standards. In accordance with Safety Resolution 2005-12, a "Stop Work" order if an unsafe condition exists.

C. All equipment and tools used in the construction of water distribution and/or sanitary sewerage systems shall be in good working order.

D. Contractor shall provide, erect and maintain all necessary barricades, signs, lights, and danger signals necessary for the protection of the work and the safety of the public. Contractor shall provide a sufficient number of flagmen whenever it is deemed necessary.

E. All work shall be planned and performed by the Contractor in such a manner as to minimize interference with vehicular and pedestrian traffic. Whenever work will cause disruption to the normal flow of traffic or pose a potential hazard, the Contractor shall be responsible for implementing safety measures and traffic control procedures in accordance with the "Manual on Uniform Traffic Control Devices," latest edition, published by the U.S. Department of Transportation, Federal highway Administration. Contractor shall obtain approval from the City of Valdosta and/or Georgia DOT prior to working in any public right-of-way.

1.11 Working Drawings: The Contractor's attention is directed to the requirements of the "Instructions to Bidders and Special Provisions" with reference to working drawings. The Contractor shall submit a digital copy of the drawings and details, covering Reinforcing Steel, Structural Steel, Miscellaneous Metals, Piping and such other items of work as may be necessary for successful completion of the work of the Project, to the Engineer for review. After review, the Engineer will return the digital copy to the Contractor. The Contractor will forward three hard copies, exactly as marked in the returned digital copy, to the Engineer.

A. The Contractor shall check all working drawings for accuracy of dimensions and details and for conformation with the Drawings and Specifications before submitting working drawings to the Engineer for approval. The Contractor shall indicate that working drawings have been checked by him by affixing an appropriate stamp or notation on the face of each of the working drawings.

B. Responsibility for Accuracy: Approval by the Engineer of the Contractor's working drawings shall not relieve the Contractor of the responsibility for accuracy of dimensions and details. The Contractor shall be responsible for agreement and conformity of working drawings with the Drawings and Specifications.

1.12 Shop Drawings: The Contractor shall submit shop drawings and details covering the required items of work and such other items which may be necessary for the successful completion of this Contract to the Engineer for checking and approval before any fabrication, erection or installation shall commence. An approved set of shop drawings with stamp of approval shall be kept on the job at all times.

The Contractor shall notify the Engineer in writing about any information in the shop drawings which deviates from the Contract Documents.

Shop drawings, product data and engineering calculations covering all equipment, material, fabrications and similar items shall be submitted to the Engineer for review. Submittals shall verify compliance with the contract documents with any deviations noted by the Contractor.

Shop drawings, product data and engineering calculations covering all equipment, material, fabrications and similar items shall be submitted to the Engineer for review. Submittals shall verify compliance with the contract documents with any deviations noted by the Contractor. The Contractor shall submit a digital copy of drawings and details to adequately describe the function, performance characteristics, dimensions, arrangement, support, anchorage and other similar information to allow for installation, operation and maintenance. After review, the Engineer will return the digital copy to the Contractor. The Contractor will forward three hard copies, exactly as marked in the returned digital copy, to the Engineer.

1.13 As-Built Drawing: As the work progresses, the Contractor shall regularly record on one set of Drawings all changes and deviations from the Contract Drawings and record the exact final locations of any deviation and original work. Upon completion, the Contractor shall have these drawings and records certified as to their completeness and correctness by the Resident Inspector and deliver them to the Engineer for incorporation in the tracings. Final as-built alignment, invert elevations and locations are to be supplied by the Contractor.

A. As-built drawings shall be as per City requirements as specified by Section C-6.

1.14 Operation and Maintenance Manuals: If applicable and before the work is 50% complete, the Contractor shall submit three printed copies and one digital pdf file of operation and maintenance manuals for equipment as specified. The digital file shall be provided on a single drive or disk.

Each component shall be labeled per the specification section referenced, for example:

"8.22 Aluminum Gates.pdf" or "11.13 Raw Water Pumps.pdf"

1.15 Material Requirements:

A. General:

1. All materials and equipment provided for the project shall be new and shall be in accordance with these Specifications.

2. Contractor shall be responsible for the delivery, handling, storage and protection of all materials and equipment used on the project.

3. All materials and equipment shall be boxed, crated or otherwise protected during transportation, handling and storage.

B. Delivery:

1. Contractor shall coordinate the delivery of all materials and equipment.

2. Contractor shall provide all equipment and tools required for unloading and moving materials and equipment.

C. Handling:

1. Materials and equipment shall be handled in accordance with the manufacturer's instructions.

2. Any materials or equipment that are dropped, dumped, improperly handled, or otherwise damaged during construction shall be subject to rejection by the Owner without further justification.

3. Contractor shall provide all equipment and tools required for moving materials and equipment to, from, and around the project site.

D. Storage and Protection:

1. Materials and equipment shall be stored in accordance with the manufacturer's instructions.

2. Contractor shall be responsible for the storage and protection of all materials and equipment.

3. Pipe may be stored along the route; however, pipe shall not be strung out for more than 1,000' beyond the point that the pipe is being installed.

4. Contractor shall be responsible for making the necessary arrangements for obtaining all storage locations/sites required to properly store and protect materials and equipment.

5. Materials and equipment shall be protected from exposure to the elements and shall be kept dry at all times. The materials and equipment shall be stored above ground level and shall be adequately supported using wood blocking, wood pallets, or other approved support material.

6. Pumps, motors, valves, electrical and instrumentation equipment, and other mechanical equipment shall be stored in a weather-tight enclosure which is maintained at a minimum air temperature of 60° F.

1.16 Clean-up: Upon completion of the work, all excess material and rubbish shall be removed from the job site and disposed of as directed by the Engineer. The surrounding construction area shall be left in essentially as good a condition as existed prior to construction. All unsuitable excavated material must be properly disposed of in a manner acceptable to the Engineer and in a manner that will not adversely impact the environment.

1.17 Payment: No separate payment will be made for the work of this Section. The cost of the work and all cost incidentals thereto shall be included in the price bid for the item to which the work pertains.

SECTION 2
CONTROL OF MATERIALS

2.01 Source of Supply and Quality of Materials: The source of supply for all materials and equipment shall be submitted to the Engineer for approval before orders are placed. Suppliers of reinforcing steel, fabricated metal work, and metal castings may be required to submit guarantees of conformity with Drawings and Specifications. Representative preliminary samples of the character and quantity prescribed shall be submitted by the Contractor or producer for examination and tested in accord with the methods referred to under the samples and testing materials section of these Specifications. Only materials conforming to the requirements of the Specifications and approved by the Engineer shall be used in the work. All materials proposed to be used may be inspected or tested at any time during their preparation and use. If, after trial, it is found that sources of supply which have been approved do not furnish a uniform product, or if the product from any source proves unacceptable at any time, the Contractor shall furnish materials from other approved sources. No material, which after approval has in any way become unfit for use, shall be used in the work.

2.02 Samples and Testing of Materials: Unless otherwise specified, standard tests of materials shall be made in accord with the Specifications and tests of the American Society for Testing Materials, by a commercial testing laboratory approved by the Engineer. Reports of the tests shall promptly be furnished to the Engineer. Tests shall be arranged by the Contractor. The cost of all tests will be paid for by the Contractor unless otherwise specified.

2.03 Schedule of Materials and Standard Tests: The following schedule of materials and the standard test to which each is to be subjected is given for the Contractor's guidance.

A. Cement (any quantity): Certificate of mill test to be furnished by producers of laboratory tests made as per ASTM C-1

B. Fly Ash: Independent laboratory test as per ASTM C 618

C. Sand (any quanitity for use in cement concrete): Tests to indicate conformity with ASTM C-33

D. Stone and Gravel (any quantity for use in cement): Coarse Aggregate, similar to sand

E. Concrete: Cylinder compression tests of concrete placed in the work from 4 cylinders made for each day's placing of each class of concrete of each 50 cubic yards or fraction thereof. One cylinder shall be broken at 7 days, 2 cylinders shall be broken at 28 days, and one cylinder shall be held in reserve.

F. Brick (1 to 5,000): Visual inspection for shape, color soundness, freedom from cracks, balls of clay, and particles of lime

G. Concrete Masonry Units: Visual inspection for shape, soundness and freedom from cracks and fractures. Laboratory tests are required on at least 5 units as per ASTM C-140.

H. Structural Tile: Visual inspection for shape, soundness, color, texture and crazing. Laboratory tests are required on at least 5 units as per ASTM C-126.

I. Building Stone:

1. 1 to 5 Tons: Visual inspection for shape and color

2. For Each Additional 5 Tons or Part Thereof: Visual inspection for shape and color and test for compression as per ASTM C-97 and C-170

J. Cast Iron Pipe and Ductile Cast Iron Pipe:

1. Field Inspection: Visual inspection for dimensions, coating, cement lining, holes, hammer test, weights

2. Laboratory Tests: Certified test reports by foundry

K. Steel Pipe: ASTM A-134 and A-139

L. Polyvinyl Chloride Pipe:

1. Visual Inspection: To ensure that pipe is homogenous throughout, free from cracks, nicks, gouges, severe scratches, voids, inclusions and other defects, reasonably uniform in color density and other physical properties. Quality Control Certification Seal and markings to include manufacturer's name or trademark, nominal pipe size and size base, PVC Cell Classification or Material Code, Dimension Ratio or Standard Dimension Ratio Number, product type, pressure class or pressure rating standard specification designation, production records code.

2. Laboratory Tests: In amounts and character as per ASTM D-3034 for sewer pipe and AWWA C 900 for water pipe

M. Structural Steel:

1. Any Quantity: Field inspection for rust, shape, and dimensions

2. 25 to 200 Tons: Independent shop inspection and certified copies of mill tests

3. For Structures and Buildings: See ASTM A-36

N. Concrete Reinforcement Steel:

1. Up to 50,000 Pounds: Field inspection for rust, shape and dimensions

2. 50,000 Pounds and Up: Independent laboratory inspection as follows:

a. Billet Steel - ASTM A-615

b. Roll Steel - ASTM A-616

c. Cold-Drawn Steel Wire - ASTM A-82

d. Wire Fabric - ASTM A-185

O. Cast Iron Castings:

1. Field Inspection: For dimensions, coatings, holes, hammer test

2. Laboratory Tests: Certified test reports by foundry

2.04 Payment: No separate payment will be made for work under this Section of the Specifications. The cost of such work and all cost incidentals thereto shall be included in the price bid for the item to which the work pertains.

SECTION 3
SOIL EROSION AND SEDIMENT CONTROL

3.01 Soil Erosion and Sediment Control Program: Siltation and soil erosion shall be prevented by the installation of erosion control measures and practices prior to or concurrent with land-disturbing activities. The Contractor shall utilize silt fence, hay bales, mulch, grass, slope drains and other erosion control devices or machines as necessary. All soil erosion and sedimentation control measures must be installed prior to initiation of construction activity. Siltation and erosion control shall be in compliance with the "Georgia Erosion and Sedimentation Act of 1975" as amended to date and these Specifications. Erosion, sedimentation and pollution control may include temporary construction work outside the right of way where necessary as a result of construction operations, such as haul roads and equipment storage sites. Any violations of the Act shall be subject to those penalties and fines as defined by the Act.

3.02 24-Hour Contact:

3.03 Erosion Control Program: Vegetation and mulch will be applied to applicable areas **immediately** after grading is completed. Best Management Practices (BMPs) will be employed to prevent erosion in areas of bare soils and concentrated water flows. Diversions and dikes will be installed to divert sediment-laden runoff into the sediment barriers and to protect cut and fill slopes from erosive water flows.

3.04 Standards and Specifications: All designs will conform to and all work will be performed in accordance with the standards and specifications of the publication entitled "Manual For Erosion and Sediment Control in Georgia" and in compliance with the "Georgia Erosion and Sedimentation Act of 1975" as amended to date. All materials shall be first-class quality to withstand a 25-year storm event.

3.05 Limit of Progress: The Engineer will limit the area of excavation commensurate with the Contractor's capability and progress in keeping the finish grading, mulching, seeding and other such pollution control measures current in accordance with an accepted schedule. Should seasonal limitations make such coordination unrealistic, special erosion control measures shall be taken immediately to the extent feasible and justified. Excavation shall not exceed 100' in advance of pipe laying.

3.06 Construction in Rivers, Streams and Impoundments: Unless otherwise approved in writing by the Engineer, construction operations in rivers, streams and impoundments shall be restricted to those areas which must be entered for the construction of temporary or permanent structures. As soon as conditions permit, rivers, streams and impoundments shall be promptly cleared of all false work, piling which are to be removed, debris, and other obstructions placed therein or caused by the construction operations. Frequent fording of live streams with construction equipment will not be permitted; therefore, temporary bridges or other structures shall be used wherever an appreciable number of stream crossings are necessary. Unless otherwise approved in writing by the Engineer, mechanized equipment shall not be operated in live streams except as may be required to construct channel changes and temporary or permanent structures, and to remove temporary structures.

3.07 Temporary Erosion Control: Temporary erosion control shall consist of planting temporary grass of a quick growing species such as millet, rye grass or cereal grasses suitable to the area. The Contractor shall use all means necessary to control dust on and near the work site and all offsite barrow areas. The Contractor should thoroughly moisten all surfaces as required to prevent dust from being a nuisance to the public, neighbors and concurrent performance of work on the site. Where the location of temporary erosion control structures is not indicated on the Drawings, the following guidelines shall be used: Install sedimentation structures at the toe of all disturbed earth slopes, around all drainage structure inlets, across constructed drainage ways at approximately 150' centers and at the tops of slopes and terraced slopes as indicated on the details. Siltation fences or hay bales only shall be used across constructed drainage ways. Hay bales only shall be used at drainage structure inlets. Perimeter barriers may be any of the types detailed. All areas left disturbed for a period greater than 14 days shall be stabilized with temporary seeding or straw mulch.

3.08 Silt Fence: Where shown on the Drawings and as directed by the Engineer, the Contractor shall furnish, install, maintain and remove water permeable self-supporting silt fencing to remove sediment laden runoff.

A. Fabric: Silt fencing shall be composed of strong rot-proof synthetic fibers formed into a fabric of either the woven or non-woven type. Either type of fabric shall be free of defects or flaws, coatings which may change its properties after installation, resist exposure to sunlight or heat and have finished edges to prevent fraying. Type fences shall be woven type.

In lieu of silt fence described above, the Contractor may use haybales. Haybales shall be placed as shown on the Drawings and secured with 2"× 4" wood post or No. 4 steel rebar.

1. Type “NS” Fence: Posts shall be a minimum of 4' long and either hardwood or steel may be used. If hardwood is used, the size may be 1.5" × 1.5" with a cross-section of 2.25-square inch. Steel posts shall be “U”, “T” or “C” shaped with a minimum weight of 1.15-pounds per foot with props for fastening the fence. Maximum post spacing shall be 6'. Type “NS” sediment barriers shall have a P-factor no greater than 0.045.

2. Type “S” Fence: Posts shall be a minimum of 4' long and either hardwood or steel may be used. If hardwood is used, the size may be 1.5" × 1.5" with a cross-section of 2.25-square inch. Steel posts shall be “U”, “T”, or “C” shaped with a minimum weight of 1.15-pounds per foot with props for fastening the fence. Maximum post spacing shall be 4'. Type “S” sediment barriers shall have a P-factor no greater than 0.030.

B. Posts and Woven Wire Supports: Post installation shall start at the center of the low point (if applicable) with remaining posts spaced a maximum of 6' apart from Type “NS” fence and 4' apart for Type “S” fence. Post shall be driven in a minimum of 18". Fabric shall be secured to post with nails, staples, wire or string. Toe of fabric shall be buried 6" in the soil with 2" turned back upstream. If fence is erected in sections, a minimum of 18" overlap will be required.

C. Payment: Payment for silt fence will be in accordance with the unit price bid in the proposal as installed and/or other locations as directed by the Engineer. In the event repairing fence or removing silt deposit is required, the work shall be performed at no additional cost.

3.09 Check Dam: Stone or Haybale check dams may be installed as shown. For stone check dams, the drainage area shall not exceed 2 acres. For hay bales, the drainage area shall not exceed 1 acre. The center of the check dam must be at least 9" lower than the ends and 2' tall maximum with 2:1 side slopes. A geotextile should be used as a separator between the stone and the soil base. Stone check dams should be graded sizes 2" to 10". Hay bales should be staked with 2 × 2 wood post or No. 4 steel rebar and embedded a minimum of 4".

Payment for check dams will be in accordance with the unit price bid in the proposal as installed and / or other locations as directed by the Engineer. In the event repairing of the check dam or removing silt deposit is required, the work shall be performed at no additional cost.

3.10 Riprap: The Contractor shall furnish and place riprap as required and where shown. Riprap shall consist of stone or bagged sand-cement to a thickness of approximately 12". Stone shall be hard quarry or fieldstone of such quality that it will not disintegrate on exposure to water or weathering. Stone shall range in weight from a minimum of 25-pounds to a maximum of 150-pounds with at least 75% of the pieces weighing more than 50-pounds. Bagged sand-cement riprap shall consist of one part cement and five parts of sand in clean cloth bags approximately one cubic foot in size. Sand and cement shall be as specified for concrete work herein.

Riprap will be paid for based on the number of square yards measured in place to the thickness specified in the proposal at locations shown on the Drawings or other locations as directed by the Engineer.

3.11 Grassing of Disturbed Areas: The Contractor shall furnish and install all materials and provide all labor for grassing and sedimentation control as indicated on the Drawings and/or Specifications.

A. Preparation: The Contractor shall grass all areas that were disturbed by clearing or construction operations. Grassing shall be by conventional seeding or hydroseeding. Before seeding commences, the Contractor shall spread the stored stock piled top soil over the entire area, working the better top soil into the more rocky areas. The entire area shall be smoothed with a drag and all clods broken up. All deleterious material, large stones, roots, limbs and other debris shall be removed to leave a smooth area that would be suitable for mowing. Grassing (by seeding) shall be completed as soon as practical after finish grading is completed in order to minimize erosion from rainfall and runoff. Any erosion occurring in grassed areas shall be immediately repaired.

B. Grass Seed: Grass seed selection shall be in accordance with the "Manual for Erosion and Sediment Control in Georgia" as amended to date. Otherwise, the type of grass seed applied shall be determined by site and soil compatibility and Owner discretion.

C. Temporary and Permanent Seeding: Temporary seeding is required on any areas exposed longer than 14 days. Permanent seeding shall be done only if it can be completed between March 1st and April 15th or August 15th and November 15th. Use temporary seeding during remaining periods. The Contractor shall provide for later permanent seeding by obtaining a signed proposal to the Owner from an approved local landscaper for the work specified. The Owner shall deduct the amount of the proposal from the final payment. The work of spreading and compacting topsoil shall be performed by the Contractor, as specified, prior to planting rye grass. Replacing or repairing of eroded topsoil shall be done as necessary by the local landscaper at time of later grassing, and this work shall be included in his proposal.

D. Hydro-seeding: Mix the seed (inoculated if needed), fertilizer and wood cellulose or wood pulp fiber mulch with water and apply in slurry uniformly over the area to be treated. Apply within one hour after the mixture is made.

E. Grassing Along Highway Right of Way: Grassing along highway right of way shall be in accordance with Department of Transportation, State of Georgia, Standard Specifications, Construction of Roads and Bridges, 1993 Edition, Section 700.

F. Grassing through Established Pastures and Lawns: Grassing through established pastures and lawns shall be by seeding with the same type of grass as was disturbed or, if acceptable to the Owner, seeding may be as recommended by the local Soil Conservation Agent.

G. Grassing of Other Areas: Grassing of other areas shall be by planting grass of a quick growing species that will also give a permanent cover. Permanent seeding shall be a mixture of Bermuda and centipede.

H. Planting: Preparation of soil along highway right of way shall be as set out in highway specifications. The Contractor shall use recognized equipment and materials in preparation of the soils. Before planting, a fertilizer of 6-12-12 composition or approved equal shall be evenly applied at the rate of 1,500-pounds per acre and disced or harrowed into the dampened soil.

I. Maintenance: Temporary grass may be intermixed with permanent grass. However, the Contractor shall cut and maintain the temporary grass such that the permanent grass will become established and not be choked out. The Contractor will be required to maintain the grass on the site until the job is accepted.

J. Payment: Grassing will be paid for on a lump sum basis and shall include all areas where the existing grass has been disturbed or destroyed by the Contractor's operation. Areas to be grassed shall be designated by the Engineer. Final acceptance and payment of grassing is defined as a full cover, over the seeded area of live and growing grass, when at least 98% of the total area has no bare spots exceeding 1-square foot, and the ground surface is fully stabilized against erosion. The cost of such work and all cost incidentals thereto shall be included in the unit prices bid for the item to which the work pertains.

3.12 Seed, Fertilizer, Mulch: Seed, fertilizer, mulch and periodic watering shall be applied in adequate quantities to assure a satisfactory ground cover over the entire disturbed area of construction operations. Water thoroughly as soon as completed and at least twice daily, or more often if necessary to provide continuous growth without setback until all growth from seed is thoroughly established.

The mulching material will consist of dry straw or hay of good quality, free of seeds of competing plants, and at the rate of two or two and a half tons per acre, respectively. Straw or hay mulch will be applied uniformly over the disturbed areas to achieve 75% coverage. It must be spread within 24-hours after seeding is done. The spreading must be done by blower-type or other mulch-spreading equipment or by hand and anchored by pressing the mulch into the soil. Anchoring must be done immediately after the mulch is spread. A disk harrow with the disk set straight or a special "packer disk" may be used. The disk may be smooth or aerated and should be 20" or more in diameter and 8" to 12" apart. The edges of the disk should be dull enough not to cut the mulch but sharp enough to press into the soil leaving much of it in an erect position.

No separate payment will be made for the above work. The cost of such work, and all cost incidentals thereto, shall be included in the unit prices bid for the item to which the work pertains.

3.13 Slope Stabilization: Sedimentation shall be controlled by the use of hay mulch on all slopes. On slopes greater than 3:1, the Contractor shall install blankets. Prior to placing the blanket, the grassing shall have been completed and the area left in a smooth, uniform condition, free from stones, lumps, roots, and other material which would prevent from making snug contact with the underlying soil.

A. Fiberglass Blanket: The fiberglass blanket shall be machine produced consisting of uniform layer of continuous, randomly-oriented glass fiber strands. The blanket shall be at least 48" wide and weighing a minimum of 0.2-pounds per square yard when used on slopes and 0.4 pounds per square yard when in waterways.

1. Securing and Stapling: All staples shall be driven flush with the ground. Staples for securing the blanket shall be made from cold drawn wire no less than 6" lengths of 14-gauge, to form a "U" of 1" in width. Longer staples may be required for loose soil.

Each strip of the blanket shall be held firmly in place by means of 3 rows of staples; 1 row along each edge and 1 row along the middle. The staples shall be spaced no more than 3' apart in each row with the staples in the middle row spaced alternately with those at the edges. The edge staples shall be placed in the 2" overlap. At the end of each blanket, staples shall be placed in a row with spacing of approximately 12".

An anchor slot or trench, 9" in depth, shall be dug across the upgrade end of the site. The first 12" of the blanket shall be placed in the trench and the backfill tamped solidly in place. Adjacent strip ends shall overlap 2" and adjoining ends shall overlap 6" with the upstream section on top.

B. Organic Fiber Blanket:

1. Straw Blanket: The straw blanket shall be a machine-produced blanket of clean, weed-free straw from agricultural crops with consistent thickness and the straw evenly distributed over the entire area of the blanket.

   a. Slopes: The top of each blanket shall be covered with a photodegradable plastic mesh having a maximum mesh size of 5/16" × 5/16" which is sewn to the straw using biodegradable thread. The blanket shall be at least 48" wide with a minimum thickness of ⅜" and a minimum dry weight of 0.5-pounds per square yard.

   b. Waterways: The blanket shall be the same as for slopes except having the photodegradable plastic mesh on the top and bottom.

2. Excelsior Blanket: A machine produced mat of curled wood excelsior of which 80% has 6" or longer fiber length with consistent thickness and the fiber evenly distributed over the entire area of the blanket. The blanket shall be smolder resistant. The top of the blanket shall be clearly labeled.

   a. Slopes: The top of each blanket shall be covered with a photodegradable plastic mesh having a maximum mesh size of 1½"× 3". The blanket shall be at least 48" wide with a minimum thickness of ¼" and a minimum dry weight of 0.8-pounds per square yard.

   b. Waterways: The blanket shall be the same as for slopes except having the photodegradable plastic mesh on the top and bottom.

3. Securing and Stapling: Staples shall be driven vertically into the ground to anchor the plastic mesh. Staples shall be spaced approximately 2-yards apart on each side of the blanket and one row in the center alternately spaced between each side staple. Where blankets are laid side to side, the staples shall be placed with half of the staple anchoring mesh from each blanket. At the beginning of a blanket, staples shall be placed in a row with spacing of approximately 12".

   In waterways, there shall be no longitudinal seams unless overlapped at least 6" with the upgrade section on top. The first 12" of the first row of blankets shall be placed in a 6" deep anchor slot stapled in the bottom, and the slot shall be backfilled and solidly tamped.

C. Payment: Slope stabilization will be paid for on a square yard basis as installed and approved by the Engineer. The cost of such work, and all cost incidentals thereto, shall be included in the unit prices bid for the item to which the work pertains. Laps will not be measured but considered as incidental to the work.

3.14 Final Stabilization: When monitoring is required, stabilized means at least 70% of the soil surface is uniformly covered in permanent vegetation unlike the NPDES Storm Water Discharges Associated with Construction Activities, General Permit (GAR 100001, 100002, 100003), which includes installation of equivalent permanent

stabilization measures (such as the use of riprap, gabions, permanent mulches or geotextiles). Permanent vegetation consists of planted trees, shrubs, perennial vines; a crop of perennial vegetation appropriate for the season and region; or a crop of annual vegetation and a seeding of target crop perennials appropriate for the region such that within the growing season a 70% coverage by the perennial crop is achieved. For linear construction projects on agricultural or silvicultural lands, stabilized means stabilizing it for its agricultural or silvicultural use.

Final acceptance of grassing for payment is defined as a full cover, over the seeded area of live and growing grass, when at least 98% of the total areas has no bare spots exceeding 1-square foot, and the ground surface is fully stabilized against erosion.

3.15 Maintenance Program: Best management practices will be inspected daily. Any damages will be repaired by the end of the day. Cleanout of sediment control structures will be accomplished in accordance with the publication entitled "*Manual for Erosion and Sediment Control in Georgia*," latest edition and sediment disposal accomplished by spreading on the site. Sediment basins and barriers will remain in place until disturbed areas are stabilized. The sediment control barriers will then be removed and the areas by these structures grassed.

No separate payment will be paid for the above work, except silt fence, unless the work performed was in accordance with "Grassing of Disturbed Areas" paragraph, then payment would be made on a linear foot basis as specified. Otherwise, the cost of the above work and all cost incidental thereto shall be included in the unit prices bid for the item to which the work pertains. In case of failure on the part of the Contractor to adequately control erosion, pollution, and / or siltation, the Owner reserves the right to employ outside assistance or to use his own forces to provide the necessary corrective measures. Such incurred direct costs plus Project Engineering costs will be charged to the Contractor and appropriate deductions made from the Contractor's monthly progress estimate.

SECTION 4
CONCRETE

4.01 General: The work described by this Section consists of furnishing all materials and equipment and performing all labor for the complete construction of all concrete work, including all work and appurtenances thereto, as shown or specified or both. Work shall include the installation of all sleeves, inserts, piping, hangers, anchors, frames and other items to be built into the concrete work, and all other work and appurtenances specified or required or both for proper execution of the work. All products to be built into concrete work shall be correctly positioned in the formwork. Positioning must be inspected and approved by the Engineer before concrete is placed.

4.02 Applicable Specifications and Quality Assurance: Concrete work shall conform to all requirements of ACI-318 *Building Code Requirements for Structural Concrete,* ACI-350 *Code Requirements for Environmental Engineering Concrete Structures* and ACI301 *Specifications for Structural Concrete.*

4.03 Concrete: Concrete shall be composed of cement, Class F fly ash (if required), admixtures (if required), fine aggregate, coarse aggregate and water proportioned and mixed to produce a plastic workable mix in accordance with the requirements of this Section and shall be suitable for the specific conditions of placement. Concrete shall be classified as 'A,' 'B' or 'C,' shall have normal setting characteristics (unless high early strength cement is specified); shall be used in the locations identified below and shall have 28-day compressive strengths not less than those listed below, except that concrete containing high early strength cement shall have 7-day compressive strengths not less than those listed below.

A. Class 'A' concrete shall have a compressive strength of not less than 4,000-psi, and shall be used for reinforced concrete work and for unreinforced footings not thicker than 8".

B. Class 'B' concrete shall have a compressive strength of not less than 2,500-psi, and shall be used for blocking gravity type walls and for unreinforced footings and slabs thicker than 8".

C. Class 'C' concrete shall have a compressive strength of not less than 1,500 psi and shall be used for concrete sub foundations, pipe envelopes and concrete backfill where required.

4.04 Materials:

A. Admixture: Admixture may be added to Class 'A-1,' Class 'A-2' and Class 'B' concrete if its addition is approved by the Engineer. If approved, it shall be added in accordance with the admixture manufacturer's printed instructions. A standard dispenser shall be used to introduce the admixture into the mix, and the services of the admixture manufacturer's representative to install and establish the operation of the dispenser shall be furnished by the Contractor.

B. Fine Aggregate: Fine aggregate shall be natural sand having fineness modulus of no less than 2.30 and no more than 3.00. Variation in fineness modulus shall be limited to +0.20 from the average of all tests.

Aggregate shall satisfy the requirements of ASTM C33, amended to date, except that gradation shall be as follows:

Sieve Size	***Percent Passing, by Weight***
No. 4, Sieve	95 – 100
No. 8, Sieve	80 – 90
No. 16, Sieve	50 – 85
No. 30, Sieve	25 – 60
No. 50, Sieve	10 – 30
No. 100, Sieve	2 – 10

C. Coarse Aggregate: Coarse aggregate shall be washed gravel or crushed stone consisting of hard, strong, durable and uncoated particles and shall contain neither vegetable matter nor soft, friable, thin and elongated particles in quantities considered deleterious by the Engineer. Coarse aggregates shall satisfy the requirements of ASTM C33, as amended to date, except that gradations shall be as follows:

Sieve Size	***Percent Passing, by Weight***
1-½" Sieve	100
1" Sieve	95 – 100
½" Sieve	25 – 60
No. 4, Sieve	0 – 10
No. 16, Sieve	0 – 5

D. Cement: The cement for concrete Class 'A,' Class 'B,' or Class 'C' shall be Portland Cement. Bland fineness shall be less than 2,000. Cement types shall be furnished in accordance with the following:

1. Portland Cement shall conform to ASTM D150 Type II.
2. High Early Portland Cement shall conform to ASTM C150 Type III.
3. If Type II cement is not commercially available, subject to prior approval by the Engineer the Contractor may use an approved mix of Type I cement with fly ash. Fly ash, if used, shall satisfy the requirements of ASTM C618, except that loss-on-ignition shall not be more than 6%.
4. Cement shall be ACI 318-11 exposure categories F, S, P and C, and exposure category classes F2, S3, P1 and C1. Additional requirements

include a maximum W/C ratio of 0.45, minimum compressive strength of 4,500 psi and total air content of 6%.

5. Other provisions of these Specifications, except for cement, shall be applicable to such concrete.

E. Fly Ash: Fly ash shall be Class F and conform with the requirements of ASTM C618, as amended to date, except that the loss-on-ignition shall not be more than 6%.

F. Admixtures:

1. Concrete directly exposed to the elements and to cycles of freezing and thawing shall contain 4% (+/-1%) entrained air.

2. Retarder shall be used when ambient air temperature of 75° F or higher is reached or expected during the day. Retarding admixtures shall conform to ASTM C-494.

3. Type-F high-range water-reducing admixture may be added to Type A concrete for placement and consolidation. Type-F water-reducing admixture shall conform with ASTM C-494. The admixture shall be able to be "re-dosed" at the site if required, but only if the elapsed time from the time it was batched and the time the concrete is placed is less than 90-minutes. Concrete not placed at or sooner than 90-minutes from the time it was batched shall be returned to the ready mix plant.

G. Water: Water shall be fresh, clean and free from injurious amount of oil and acidic, alkaline and organic materials.

H. Forms: Forms shall be of plywood or of tongue-and-groove lumber and shall be of grade and type which will provide the concrete finish required. Forms constructed of tongue-and-groove lumber shall be lined when used to form exposed-to-view surfaces; form lining, where used, shall be tempered fiberboard not thinner than ⅛". Metal forms and other types of manufactured forms shall not be used unless their use has been approved by the Engineer. Form oil shall be non-staining mineral oil. Form ties shall be of the cone nut threaded rod or standard snap-tie type and designed so that when removed, no metal will be left closer than 1" from the finished concrete surface. The cavities left in faces of concrete work by removal of form ties shall be pointed-up with non-shrink mortar. Form ties shall have a working strength of not less than 3,000 pounds when fully assembled and must be approved by the Engineer.

I. Grout: Grout shall be composed of 1 part Portland Cement to 1 part sand to 2 parts of aggregate no larger than ⅜" and to those parts of water which will produce a grout having a consistency approved by the Engineer.

J. Floor Hardener: Floor hardener shall be a silicious aggregate: Master Builders "Mastercron Aggregate," Devoe Paint Division of Cleanese Coatings Company "Hurundum," or equal.

K. Water Stops: Water stops shall be of those configurations and types shown on the Drawings.

L. Nonshrink Cement Based Grout: The work covered in this Specification consists of furnishing all manufactured nonshrink cement-based grout where called for on the Drawings. Nonshrink grout shall contain only premeasured, prepackaged materials supplied by the manufacturer. Water to be used for mixing Portland Cement manufactured grout shall be potable.

1. Requirements for Nonshrink Cement-Based Grout: Manufacturer must submit certified information verifying:

a. Plastic Volume Change: The grout shall show no shrinkage (0.0%) and a maximum of 4.0% expansion at any time before initial set when testing according to ASTM C827.

b. Hardened Volume Change: The grout shall show no shrinkage (0.0%) and a maximum of 0.2% expansion on the hardened state.

c. Compressive Strength: All nonshrink cement-based grout shall show a minimum 28 day compressive strength of 5,000 psi at standard laboratory temperatures when tested according to ASTM C109.

d. Placeability: All nonshrink cement-based grouts shall be capable of a flowable consistency (124 – 145 flow) when tested according to ASTM C109. Standard nonshrink cement-based grout shall have a minimum initial set time of 60 minutes when tested according to ASTM C191.

e. Soundness: The grout shall contain no metallic substances, aluminum powder or other materials known to compromise long-term durability.

f. Technical Service: Technical service shall be made available by the manufacturer upon request of the Contractor for purposes of advising on proper procedures dealing with grout installation.

2. Expansion Joint Filler: Expansion joint filler and sealer shall be as shown in the Drawings.

M. Sand-Cement Repair Mortar: Mortar used for filling voids in concrete surfaces shall consist of not more than one part Portland cement to two and one-half parts sand by damp, loose volume.

N. Smooth Steel Rods for Expansion Joints: ASTM A 36, smooth, round dowels shall be sawed to the length indicated; shearing of dowels will not be allowed. Dowels shall be of size, length and spacing indicated on the drawings.

O. Supports for Reinforcing Bars: Bar supports including bolsters, chairs, spacers and other devices for slabs and mats cast on earth shall be of the height necessary to position the reinforcing bars as indicated on the drawings and shall have sand plates or other similar devices to prevent the supports from sinking into the earth

grade. Materials for the manufacture of bar supports may consist of steel wire, plastic or precast concrete. Bar supports for elevated slabs and mats shall have plastic coated legs. Concrete bricks may be used to support reinforcing bars for slabs and footings for non liquid-containment structures cast on grade. Compressive strength of bricks shall not be less than 4,000 psi.

P. Fiber Reinforcement: High zirconia (minimum 16%) alkali-resistant glass fibers specifically designed for use with Portland cement and conforming to ASTM C1666/C1666M and Appendix F, ½"length typical shall be provided.

4.05 Storage:

A. Cement and fly ash shall be stored immediately upon receipt at the jobsite in a thoroughly dry, weather tight and properly ventilated building having adequate provisions for preventing cement from absorbing moisture. Storage shall permit ease of access for inspection and permit definite identification of each shipment.

B. Fine and coarse aggregate shall be stored separately in a manner which will avoid the inclusion of foreign material. Stockpiles of coarse aggregate shall be built in horizontal layers in a manner which will minimize or eliminate segregation.

4.06 Sampling and Testing: Sampling and testing of aggregate, cement, and concrete cylinders shall be as specified in the "Control of Materials" section, and shall be made by an independent laboratory approved by the Engineer. Costs of all concrete testing shall be paid by the Owner. The Owner shall have access to all places where concrete materials and concrete are manufactured, stored, proportioned, mixed, placed and tested. *Modification 8.2, Standard Minimum Specification for Ready Mix Concrete* shall apply.

A. Aggregate: The Contractor shall select the source of the concrete aggregates which he proposes to use in the work. The Contractor shall furnish suitable samples of those aggregates to the testing laboratory for testing and preparation of design mix not more than 60 days and no less than 30 days in advance of the time of proposed use.

B. Cement: Cement which has been stored for more than 4 months after being tested shall be re-tested before use.

C. Required Concrete Tests: Four (4) cylinders from the same batch of concrete shall be made for each day's placing of each class of concrete of each 50 cubic yards or fraction thereof. Each cylinder shall comprise a test under the definition of this Specification, with 1 cylinder being broken at the age of 7 days, 2 cylinders broken at the age of 28 days and 1 cylinder held in reserve.

D. Owner's Duties in Inspection: All sampling, molding, transportation, storing, curing, preparation for breaking and testing of cylinders shall be the responsibility of the Owner and shall be performed by qualified personnel observing all requirements of ASTM C31 and ASTM C39. The Owner shall make and record slump test in connection with each sampling of concrete. The Owner shall determine the air content of the concrete delivered to the jobsite. The Owner representative shall visit the batching plant, observe and report on the compliance of procedures used therein with all provisions of this Specification and of

applicable ASTM and ACI Standards, observe job conditions in the handling and placing of concrete and report any items of noncompliance with these Specifications to the Engineer.

E. Contractor's Duties in Inspection: The Contractor shall deliver to the laboratory and Owner all materials to be used in tests required by these Specifications. The Contractor shall supply test cylinders, wheelbarrows, shovels, mixing boards, shaded work space for molding cylinders and similar equipment required by the Owner's representative for molding test cylinders. Contractor shall provide stable, insulated storage boxes equipped with thermostatically controlled heat for storage of cylinders for the first 24 hours after molding in accordance with ASTM C31. He shall keep slump cone available for use on the job at all times.

F. Evaluation of Tests: Evaluation of test results shall be in accordance with ACI 214-65. Concrete shall be deemed satisfactory if the average of all 28 day tests representing one design strength is equal to or greater than the design strength and if the following additional conditions are met for 28 day tests.

1. No one test shall be less than 85% of the design strength.
2. The average of any two consecutive tests shall not be less than 92.5% of the design strength.
3. The average of any three consecutive tests shall be equal to or greater than the design strength.

G. Not more than one test in 25 consecutive tests shall fall below the design strength.

H. Faulty Concrete: Failure to measure up to any of the specified conditions constitutes faulty concrete. Unless otherwise directed by the Engineer, faulty concrete shall be removed and replaced with concrete as specified at no expense to the Owner.

I. Additional Tests: Any additional tests must be approved by the Engineer prior to testing at no expense to the Owner. Load test, if permitted by the Engineer, shall be conducted in accordance with the loading criteria as required by the design of the structure as determined by the Engineer.

J. Slump Tests: Slump tests of each concrete placement shall be made in the field with an accurately made sheet iron test cone and shall be made by the Contractor in accordance with the procedure described in ASTM C-143. The slump of concrete to be placed in piers and wall shall not be less than 4", nor greater than 7". The slump for concrete to be placed in slabs on earth shall not be less than 1", nor greater than 4".

K. Leakage Tests: All water holding structures shall have a leakage test performed prior to acceptance. The test shall be performed in accordance with ACI 350.1-01. The testing shall conform to the following:

1. Fill structure to be tested to the normal operating liquid level. Filling rate shall not exceed 4' of water per hour and shall be at continuous uniform rate with continuous monitoring.

2. The exterior surface of the tank shall be monitored for flowing leaks. Repair any flowing leaks which occur before continuing filling.

3. The water shall be kept at the test level for at least 3 days prior to the actual test.

4. Measure the vertical distance to the water surface from a fixed point on the tank above the water surface. Record measurements at 24-hour intervals. The test shall be performed for a minimum of 3 days

5. A drop of the water surface exceeding 1/10 of 1% of the normal volume of contained liquid will be considered failing.

6. The structure will have also been considered to have failed the test if flowing or seeping water is observed, or if moisture can be transferred to a dry hand from the exterior surface.

7. Independently measure change in water volume due to evaporation and precipitation using a 24" deep white, watertight container not less than 10 square feet of surface area. Position the container to experience environmental conditions similar to the structure being tested. The volume change of the structure shall be corrected based on the water volume change in the sample container.

8. Failing tanks which exhibit no visible signs of leaking or seepage may be permitted to be immediately retested.

9. Failing tanks will be drained, repaired and retested until the tank has met the test requirements.

10. Methods for repairing concrete should be submitted as shop drawings for review by the Engineer.

11. Repairs and retesting of tanks shall be accomplished at no additional cost to the Owner

4.07 Design Mix: Design mix for each classification of concrete to be used in the work shall be prepared and tested by the laboratory. The design mix shall be prepared, proportioned and mixed using samples of the cement, fly ash (if required), admixture (if required) and the aggregates to be used in the work. Not fewer than 4 cylinders shall be made from the design mix for each classification of concrete: 2 shall be tested at 7 days, and 2 shall be tested at 28 days. Cylinders shall be made and tested in accordance with ASTM C-31 and C-39. If an existing design mix that was recently prepared using the same source of proposed materials is demonstrated to conform to this Specification, the Engineer may approve its use in the work.

4.08 Proportioning and Mixing: Proportioning and mixing shall be accomplished either at the jobsite or at a central mix plant. If proportioning and mixing is accomplished at the jobsite, the Contractor shall provide the equipment necessary to positively determine and control the actual amounts of ingredients entering the mix. If proportioning and mixing is accomplished at a central mix plant, the Contractor shall, through the testing laboratory, furnish a laboratory representative who shall control the proportioning and

mixing of Class 'A-1' or Class 'A-2' concrete except as may be otherwise approved by the Engineer.

A. Proportioning of materials shall be accomplished in a manner which will produce a workable mixture having a slump within the required limits and having minimum water content.

1. The exact proportion of materials to be used in concrete shall be identical to that established by the design mix except that the proportions of materials shall be changed whenever, in the opinion of the Engineer, a change is necessary to obtain the required strength and the desired density for uniformity and workability. In structures intended to be watertight, good workability will be considered to be primary importance. The equipment necessary to positively determine and control the amounts of materials entering the concrete shall be furnished by the Contractor.

   All materials shall be measured by weight, except for water, which may be measured by volume. One bag of Portland Cement shall be considered to weigh 94 pounds.

2. Cement and Fly Ash Content:

   a. Each cubic yard of concrete containing Type I or Type III cement shall contain not less than the following quantities of cement and fly ash.

      - Class 'A-1' or Class 'A-2': 470 pounds (5 bags) of cement and 100 pounds of Class F fly ash.
      - Class 'B': 376 pounds (4 bags) of cement and 100 pounds of Class F fly ash.
      - Class 'C': 376 pounds (4 bags) of cement; no fly ash required.

   b. Each cubic yard of concrete containing Type II cement shall contain not less than the following quantities of cement:

      - Class 'A-1' or Class 'A-2': 564 pounds (6 bags)
      - Class 'B': 470 pounds (5 bags)
      - Class 'C': 376 pounds (4 bags)

3. In calculating the total water content of mixes, the amount water borne on the surfaces of the aggregates shall in all cases be the least amount necessary to produce a plastic mix having the required strength and the desired density, uniformity, workability and characteristics, yet being within the limits of slump.

4. The total volume of aggregates to be used in each cubic yard of concrete and proportion of fine aggregate to coarse aggregate shall be that amount necessary to produce a dense mixture having the required workability.

B. Jobsite Mixing: Mixing, if accomplished at the jobsite, shall be accomplished with a batch mixer of approved design and of a type which will insure a uniform distribution of the ingredients. The entire contents of the drum shall be

discharged before recharging. The volume of each batch shall not exceed the rated capacity of the mixer. The Contractor shall during the mixing and placing of concrete have no fewer than 2 mixers on the jobsite to maintain continuity of the placing in the event of mechanical failure of 1 of the mixers. The mixing of each batch shall continue not less than 1-½ minutes after all ingredients have been placed in the mixer. During mixing the mixer shall rotate at peripheral speed of no fewer than 200' per minute.

C. Central Plant Mixing: Mixing, if accomplished at a central mix plant, shall be accomplished by a plant which has had its layout, equipment and trucks approved by the Engineer. Concrete shall be mixed and transported to the jobsite in accordance with the requirements of ASTM C94. Loading tickets for Class 'A-1' or Class 'A-2' concrete shall be initialed by the laboratory representative and shall bear the time of loading. Tickets shall be handed to the inspector when the trucks arrive at the jobsite and before the load is discharged.

4.09 Installing Smooth Dowels in Construction Joints: Smooth steel dowels shall be smooth, straight and free of any bends or tabs that would prevent the dowels from functioning. Dowels shall be clean and free of dirt, grease, rust, or mill scale. Dowels shall be installed parallel with the surface of the slab, mat or wall and shall be installed square to the face of the joint. The half of the dowel that will be in the second concrete pour shall be lightly greased.

4.10 Placing: Before concrete is placed, the depth and character of the foundations, the adequacy of forms and falsework and the placing of reinforcing steel and inserts must be inspected and approved by the Engineer. Approval, however, shall not relieve the Contractor from the responsibility to produce the required work. Handling and placing of concrete and the preparation for placing concrete shall be as follows:

A. Accumulated water and debris must be removed from excavations and from forms into which concrete is to be placed. Flow of water into those places shall be diverted into side drains or sumps and be removed without disturbing newly placed concrete. Forms, unless lined, shall be thoroughly wetted with water before concrete is placed so as to tighten the joint. Runways for buggies and wheelbarrows, if used, shall not be supported by forms. Concrete shall be conveyed in a manner which will not disturb forms.

B. Concrete shall be placed in daylight. Placing of concrete in a portion of the work shall not be started if that portion of the work cannot be completed during daylight unless otherwise specifically approved by the Engineer. That approval, however, will not be given unless an adequate lighting system is provided and lighting system is approved by the Engineer.

C. Concrete shall not be placed when the atmospheric temperature is cooler than 35°F. If, after placing concrete, the atmospheric temperature becomes cooler than 35°F, the Contractor shall enclose, heat and protect the concrete in a manner which will keep the air surrounding the fresh concrete at a temperature not cooler than 45°F for a period of 5 days after concrete is placed. In addition, all requirements specified in ACI 306.1-90 *Standard Specification for Cold Weather*

Concreting shall apply. The Contractor shall assume all risk of protecting the concrete. Unsatisfactory concrete shall be rejected.

D. When the ambient temperature is 90°F or above, special precautions shall be taken during mixing, placing and curing. In no case should the temperature of the concrete, when placed, be above 90°F. Attention shall be given to coordinating the dispatching of trucks with the rate of placement to avoid delays in delivery. When elapsed time from batching to placement is so long as to result in significant increases in mixing water demand or in slump loss, mixing in the trucks should be delayed until only sufficient time remains to accomplished mixing before the concrete is placed. On truck arrival at the jobsite, addition of water shall not be allowed other than that required to adjust the specified slump. The forms and reinforcing steel should be cooled to a temperature of not more than 90°F by spraying with fog nozzles. Admixtures for retardation shall conform to ASTM C494-17, Type B or Type D. Water curing is preferred, but prompt application of curing compound meeting ASTM C309-11 may be used. In addition, all requirements specified in ACI 305.1-06 *Specification for Hot Weather Concreting* shall apply.

E. Concrete shall be transported from the mixer to the point of deposit with a crane-handled bottom-dump concrete bucket, concrete buggies or wheelbarrows. In the event the quality of the concrete as it reaches the forms and the method and placing thereof in the opinion of the Engineer is not satisfactory, the Contractor shall change his method of operation so as to place concrete in a manner approved by the Engineer.

F. Concrete shall be placed in a manner which will prevent the segregation of aggregates and prevent displacing, reinforcing, coating and splattering the concrete reinforcing which is in place. Troughs, pipes, hoppers, chutes and canvas tremies shall be arranged and used in a manner which will insure the concrete is placed in the manner specified. The placing of concrete within formwork shall be regulated in a manner which will insure that the pressure within the formwork, caused by that placing, shall not exceed the design pressure of the formwork. Concrete shall be placed in continuous horizontal layers, the thickness of which in general shall not exceed 12". Each batch and each layer shall be placed immediately following the preceding batch and layer, so there will be no “cold joints” in the work. Care shall be used to fill each part of the forms. Concrete shall be deposited as near final position as possible. After the concrete has taken its initial set, care shall be used to avoid jarring the formwork and placing strain and vibration on the ends of projecting concrete reinforcements. If concrete must be dropped more than 5', it shall be deposited through a tremie.

1. Concrete when placed shall be compacted with mechanical internal-vibrating equipment. Compaction shall be supplemented with hand spading using a steel-splicing rod. Vibrating equipment shall not be used to transport concrete within forms. Vibrating equipment shall maintain an impulse rate of no less than 5,000 impulses per minute when submerged in concrete. No less than 1 spare vibrator shall be maintained on the jobsite as a relief. The duration of vibration shall be limited to that time

necessary to satisfactorily consolidate the concrete without causing objectionable segregation. The vibrator shall not be inserted into lower layers which have begun to set.

2. Thin-section work shall be thoroughly worked with a steel rod. Faces of thin-section work shall be shaped and mortar flushed to the surface. Small diameter holes shall be drilled in formwork beneath large wall sleeves and inserts to prevent the entrapment of air beneath those sleeves and inserts when concrete is placed.

G. Concrete shall be placed and compacted in a manner which forms a dense, compact, impervious structure having smooth faces on exposed surfaces. Concrete work found to be porous, plastered and otherwise defective in the opinion of the Engineer shall be removed and replaced in whole or in part as directed by the Engineer at no additional expense to the Owner.

4.11 Joints:

A. Construction Joints: Construction joints shall be located where shown and where directed and approved by the Engineer. Placing of concrete, once started, shall continue without interruption so that the placement will be monolithic. No less than 72 hours shall elapse between casting of adjoining units unless otherwise approved by the Engineer. The Contractor shall submit to the Engineer for approval the detailed location of construction joints not shown on the Drawings but required for the execution of the work prior to the detailing of any reinforcing steel in accordance with the General Requirements section of these Specifications.

1. Construction joints in footings and walls required for proper execution of the work but not shown shall be located where directed by the Engineer and across regions of low shearing stress so as to least impair the strength and appearance of the work. Special provisions shall be made for joining successive units as shown and as directed by the Engineer.

2. Construction joints in slabs, required for proper execution of the work but not shown, shall be located where directed by the Engineer. Special provisions, including concrete footing for construction joints in slabs on earth, shall be made for joining successive units as shown and as directed by the Engineer.

3. Keys shall be constructed in construction joints where shown and where directed by the Engineer. Keys and water stops shall be placed in those construction joints which will be subject to water pressure.

B. Expansion Joints: Expansion joints, when required, shall be as shown on the Drawings.

C. Bonding: Before placing new concrete work on and against concrete work which has recently set and that which has cured, the surfaces of recently set and cured concrete work shall be thoroughly roughened and made free from all foreign matter and laitance, the forms shall be placed and tightened, and the surfaces of the recently set and cured concrete shall be slushed with grout. New concrete shall be placed before the grout has attained its initial set. Bonding shall be

accomplished in a manner which will insure complete bonding. Grout 2" to 4" shall be applied to construction joints.

Bonding of new concrete work to existing hardened concrete shall be accomplished with a multi-component epoxy adhesive complying with ACI 503R and construction procedures complying with ACI 503.2.

4.12 Forms: Forms shall be constructed, braced and removed in accordance with the following:

A. Forms shall be built to conform to the shape, lines and dimensions of the concrete work. Forms shall be set to line and grade and shall be braced, tied and secured in a manner which will withstand placing of the concrete and which will maintain shape and position. Forms shall be tight and be substantially assembled to prevent bulging and the leaking of concrete. Chamfer strips shall be placed in exterior corners of forms. Joints shall be arranged vertically or horizontally. Temporary openings shall be provided, where required, at the bottoms of wall forms and elsewhere to facilitate cleaning and inspecting. Lumber used once in forms shall have nails removed, and the surfaces in contact with concrete work shall be thoroughly cleaned before reusing the lumber for forms. Wall sleeves, inserts and openings shall be properly set in forms.

B. Shores shall be used where necessary. If adequate foundations for shores cannot be obtained, trussed supports shall be provided. Structural members, another work which will be subject to additional loads during construction, shall be adequately shored to protect that work from distortion and damage.

C. Forms shall not be removed until the member supported thereby has acquired sufficient strength to safely support its own weight and the load imposed on it. Tie rod clamps shall be loosened 24-hours after concrete has been placed. Standard snap ties shall be removed when forms are stripped. Care shall be taken to avoid spoiling the concrete surface. Cutting ties back from the face of the wall will not be permitted. Under normal conditions, the time elapsing before the forms may be stripped shall not be less than that shown in the following schedule.

1.	Slabs:	14 days
2.	Columns and Pedestal:	7 days
3.	Walls and Vertical Faces Not Supporting Other Work:	2 days

The use of the schedule shall not relieve the Contractor from his responsibility for the safety of the structure. Wood forms shall be completely removed from all portions of the work, so no material will remain for termite infestation.

4.13 Finishing: Exterior concrete surfaces shall be finished to levels no less than 12" below finish grade levels. Interior concrete surfaces below grade and concrete surfaces exposed to view shall be finished. Interior of basins shall be finished to a level not less than 12" below normal water level. Concrete not exposed to view shall have rough edges tooled off. Irregularities shall be filled, pointed-up with non-shrink sand, cement, mortar, and spot finished. All imperfect concrete shall be removed to dense solid concrete and repairs made as directed by the Engineer.

A. When concrete has set sufficiently to permit, forms and form ties shall be carefully removed. Depressions resulting from removal of form ties and other holes and rough places shall be thoroughly wetted with water and pointed-up.

B. Walls and Vertical Surface:

1. Procedures:

a. Surface Preparation: Grind all seams and form joints level with surrounding concrete. Patch any holes, honeycomb, tie holes, and similar imperfections with non-shrink construction grout, including bonding admixture, and allow to dry. Wall surface must have smooth level finish, approved by the Engineer's inspector, prior to beginning the finish coat.

b. Finish Coat: Apply bonding agent in front of grout application, not allowing to dry before grout is applied. Apply thin coat of non-shrink grout mix with rubber coarse sponge. Follow sponge application with carborundum stone, rubbing grout in a circular motion not allowing the grout to dry. Before grout dries, apply a light broom finish using a soft bristle brush.

2. Products:

a. Bonding Agent: Provide acrylic latex liquid bonding admixture compliant with ASTM C1059, Type II, non-yellowing, UV resistant as manufactured by Euclid, WR Meadows, or equal.

b. Non-Shrink Grout: Provide non-shrink, non-staining, non-metallic cement based grout compliant with CRD C 621 and ASTM C 1107 as manufactured by Euclid, WR Meadows, or equal.

C. Slabs on Earth: Before constructing concrete slabs on earth, all piping which will be under those slabs shall have been tested, approved and encased in Class 'C' concrete. The sub-grade shall provide a solid bearing and shall be brought to a true and even plane. Where floor drains occur, floors shall be pitched as shown on the Drawings. The concrete shall have comparatively dry consistency and shall be screeded level or to the proper grade. After compacting and vibrating the concrete, the surface shall be prepared to receive the specified finish.

D. Wood Float Finish: All floors, walks, platforms stairs and other slab work shall have a wood float finish. After screeding to the required grade while the concrete is still green but has hardened sufficiently to bear the finisher's weight, the concrete surface shall be floated with a wood float to a true and even plane, have no visible coarse aggregate and be sufficiently rough to prevent slipping.

E. Floor Topping: Floor topping shall be applied where shown. Sub-base shall be wire-brushed before sub-base has hardened, shall be swept clean, shall be thoroughly wetted and shall be slushed with bonding grout. Topping shall be floated and troweled twice in a manner which will prevent the fine material from being drawn-up. Floor hardener shall be applied in strict accordance with the

hardener manufacturer's printed instructions. Other type finishes shall be as shown on the Drawings.

F. Trowel Finish: Apply trowel finish on interior slabs to receive floor coverings or where indicated on Drawings. Troweling shall follow the float finish as previously described and when the surface has sufficiently hardened. Trowel until the surface is free of trowel marks and has a uniform appearance and texture. Any defects that may project through surface coatings or coverings shall be ground smooth.

4.14 Curing and Protecting: Freshly placed concrete shall be protected from rain and flowing water. Concrete shall not be allowed to dry-out from the time it is placed until the expiration of the specified curing period. Methods of curing unless otherwise approved by the Engineer shall be as follows:

A. Concrete shall be kept wet with clean water for period of 7 days after placing. Each day forms are left in place shall suffice for wetting.

B. Curing may be accomplished by leaving forms sufficiently wet to prevent opening of joints.

C. If formwork is removed prior to seven days following placement concrete surfaces shall be wet cured by covering the concrete with a 4-mil white polyethylene sheet. Immediately prior to installing the sheeting thoroughly wet all concrete surfaces by spraying with clean water. The sheeting shall be held close to the surface and all joints continuously taped to prevent air from getting under the sheeting. The concrete surface shall be checked once a day and concrete surfaces showing drying shall be sprayed with clean water. The sheeting may be removed after a total of 7-days have elapsed following concrete placement.

4.15 Imperfect and Damaged Work and Materials: Imperfect and damaged work and materials shall be satisfactorily removed. New work and new materials which are in accord with the requirements of the Drawings and Construction Specifications shall be furnished and installed at no additional expense to the Owner. Removal of imperfect and damaged work and materials and the installation of new work and materials shall be accomplished in a manner which will not impair the strength of the structure.

4.16 Cleaning: Upon completion of work, all forms, equipment, protective covering and rubbish resulting from the work shall be removed from the premises. Finished concrete surfaces shall be left in a condition satisfactory to the Engineer and Owner.

4.17 Payment: No separate payment will be made for the work under this Section except as may be specifically set forth in the Proposal. The cost of the work of this Section and all costs incidental thereto, except that work which may be specifically set forth in the Proposal, shall be included in the price bid for the items to which the work pertains.

SECTION 5
REINFORCING STEEL, STRUCTURAL STEEL AND MISCELLANEOUS METAL

5.01 Scope: The work covered by this section of Specifications consists of furnishing all materials and equipment and performing all labor necessary for furnishing and installing all reinforcing steel, structural steel, miscellaneous metal and appurtenances as indicated on the Drawings, as specified, and as required for completion of all work under this contract.

5.02 Drawings: The Contractor shall furnish to the Engineer for review bending and placing details for steel bar reinforcing which shall show bar size, spacing, bending and tagging identification and drawings covering structural steel work showing details of fabrication and erection of structural steel in accordance with the General Requirements section of these Specifications. No manufacturer or fabrication shall commence until such drawings have been reviewed. The Contractor shall submit to the Engineer for review the detailed location of construction joints not shown on the Drawings but required for the execution of the work prior to the detailing of any reinforcing steel in accordance with the General Requirements section of these Specifications.

5.03 Reinforcing Steel: Bar reinforcement and wire mesh reinforcement shall be furnished by domestic steel mills and shall conform to the applicable ASTM specifications and ACI Building Code, as amended to date, and in accordance with the following:

A. Bar Reinforcement: Materials, fabrication and placement of steel bar reinforcement shall be in accordance with the following:

1. Materials: Bar reinforcement shall be deformed bars and conform to the requirements of ASTM A- 615 Grade 60. The steel for bars shall be made by the open hearth, basic oxygen or electric furnace process, and the bars shall be rolled from billets or ingots of properly identified heats. The steel shall be made and the bars rolled in the United States. The use of cold twisted bars will not be permitted.

2. Fabrication: Steel bar reinforcement shall be cold bent to shapes indicated on the Drawings. Bending shall be done in the shop before shipment unless otherwise specified. Bending details for steel bar reinforcement shall conform to the requirements of the ACI Building Code (ACI-318) unless otherwise indicated on the Drawings or specified. Steel bar reinforcement shall be bent, bundled and tagged in accordance with details furnished by the fabricator.

a. Splices: Steel bar reinforcement shall be furnished full length unless otherwise indicated on the Drawings. Splices, where permitted, shall be well distributed or located at points of low tensile stress. Splices and dowels, except when used in cantilever wall or slab construction, shall lap not less than 30 times the diameter of the bar. Splices and dowels used in cantilever wall or slab construction shall lap 40 diameters. Splices in horizontal reinforcement shall be staggered. The minimum clear distance

between spliced bars, except when bar clamps are specified, shall be 1-½ bar diameters. In no case shall the minimum clear distance between spliced bars be less than 1" or less than 1-½ times the maximum size of coarse aggregate.

Design is based upon "non-contact" type vertical splices lapped and specified above as required under the applicable sections of the ACI code. Tied "contact" lapped splices will be allowed for ease in establishing the basic framework for the vertical rebar mats. However, no more than 20% of the required vertical lap splices may be "contact" type splices. All other lap splices shall conform to the minimum and maximum clear distance requirements as specified above and in the applicable sections of the ACI code.

b. Hooks: Hooks of 180° shall have a radius of bend on the axis of the bar of not less than 3 bar diameters plus an extension of 4 bar diameters at the free end. Hooks of 90° shall have a radius of bend on the axis of the bar of not less than 4 bar diameters plus an extension of 12 bar diameters at the free end.

c. Openings: Openings 12" and larger through concrete walls and slabs shall have a minimum of 8 extra diagonal bars in each face of the wall or slab of the same size as the largest bar in the wall or slab. The length of extra diagonal bars at openings shall be as shown on the Drawings or diameter of opening plus 24 bar diameters each end of bar.

d. Minimum Reinforcing: Minor concrete walls, slabs and other Class "A" concrete sections, where no reinforcement is shown on the Drawings, shall have a minimum area of steel bar reinforcing equal to 0.0025 times the cross-sectional area of the concrete work.

3. Placing: Steel bar reinforcement shall be placed in the locations shown on the Drawings and held securely in place during the placing of concrete. The pushing of short bars into new concrete work will not be permitted. Bar reinforcing in walls shall be spaced the proper distance from the face of the wall by the use of approved precast concrete mortar blocks. Precast mortar blocks used for bar reinforcement spacing shall have a minimum compressive strength equal to the concrete being placed. Bar reinforcing in slabs or beams shall be spaced the proper distance from the bottom of the slab or beams by use of precast concrete mortar blocks, steel chairs with plastic coated legs or plastic tips, or stainless steel chairs. Vertical stirrups shall always pass around main tension members and be securely attached thereto. Bar spacing, covering, minimum clearance, bond and anchorage shall conform to the requirements of the ACI Building Code (ACI-318), except as otherwise indicated on the Drawings or specified.

4. Fastening, Reinforcing and Placing Concrete: Steel bar reinforcing, when properly placed, shall be securely wired together at intersections with 18 gauge black annealed wire. Prior to the placing of concrete, all mortar and

other foreign matter which may reduce or destroy bond shall be removed from the reinforcement. No concrete shall be deposited until the placement of the reinforcing has been reviewed by the Engineer or his representative.

B. Wire Mesh Reinforcement: Wire mesh reinforcement, when shown on the Drawings or specified to be required in the work to be done, shall be furnished and placed in accordance with the following:

1. Materials: Wire mesh reinforcement shall conform to the requirements of ASTM A-185 and unless otherwise indicated in the Drawings shall be 4" by 4" mesh of 6-gauge wire.

2. Placement: Wire mesh reinforcement shall be secured in position by spacer bars and chairs. Spacer bars shall be lapped not less than 5". Precast concrete mortar blocks may be used in lieu of metal chairs in slabs on ground. Mesh shall be checked for position during placing of concrete and any displacement corrected. Mesh shall overlap 1" at edges unless otherwise indicated on the Drawings and shall be securely tied at ends and overlap.

C. Reinforcement – Storage and Protection: Steel reinforcement shall be stored above the surface of the ground upon platforms, skids or other supports, and shall be protected as far as is practicable from mechanical injury and surface deterioration. When placed in the work, it shall be free from rust, dirt, scale, paint, oil or other foreign matter which may reduce or destroy bond.

5.04 Iron Castings: The Contractor shall furnish all miscellaneous iron castings, including catch basins, manhole frames and covers, steps, floor drains, bolt inserts, brackets, supports and such other iron castings as are shown on the Drawing in accordance with the applicable ASTM Specifications, as amended to date. All materials furnished shall be installed in a good workmanlike manner.

A. Castings: Castings, unless otherwise specified, shall be of gray-iron conforming to ASTM A-48. Manhole and step castings shall be the Owner's standard unless otherwise specified.

B. Malleable Castings: Malleable castings shall conform to ASTM A-47.

C. Quality: All castings shall be tough, close-grained and smooth and free from blow holes, blisters, shrinkage stains, cracks, cold shots and like defects. No plugging of defective castings will be permitted.

D. Workmanship: All castings shall be made accurately to dimensions shown on the Drawings or ordered and shall be planned or ground where necessary whether marked or not to secure perfectly flat bearing surfaces. Allowance shall be in the patterns so that the specified thickness of metal will not be reduced.

E. Weights: No castings the weight of which is less than the theoretical weight, based on required dimensions, by more than 5% will be accepted.

F. Cleaning and Painting: All castings shall be thoroughly cleaned and painted before rusting begins. All castings except those to be embedded in concrete shall be cleaned and given a priming coat of paint in the shop. Castings, which will be exposed in buildings, shall be painted in accordance with the painting section of these Specifications. Castings which are to be installed outdoors, such as manhole frames, covers and steps, shall be given one coat of an asphaltic or bituminous paint which results in a smooth and tough well-bonded coating.

5.05 Nosings for Concrete Treads: Nosings of all concrete steps, interior and exterior, shall be 3" in width and shall be Wooster Type 101 Alumogrit or American Abrasive Metal Company Style A, or equal abrasive safety treads, securely anchored to concrete.

5.06 Stainless Steel: Unless otherwise specified, all fabricated work indicated on the Drawings and/or specified to be stainless steel shall be Type 316, in accordance with ASTM A-276 as amended to date.

5.07 Bolts, Nuts and Screws: Steel bolts and nuts for jointing miscellaneous steel shall conform to ASTM A-325 or A-490 and shall be American National Standard dimensions. Anchor bolts, in general, shall be placed in forms prior to placing concrete. When expansion bolts must be used, they shall be Rawl, National, or equal. Anchor bolts and expansion bolts shall be Type 302, 304, or 316 stainless steel. Steel and aluminum weir plates, aluminum railing, miscellaneous aluminum, galvanized steel and stainless steel jointing shall be fastened with Type 302 or 304 stainless steel bolts, nuts, and screws as required.

5.08 Aluminum: Aluminum shall be of the following alloys:

- Sheet or plate: 6061-T6
- Structural or rolled shapes: 6061-T6
- Extruded shapes: 6061-T6
- Tubing or pipe: 6061-T6 or 6063-T6
- Nuts and bolts: 2024-T4 with #205 aluminum finish

A. Aluminum Grating and Treads: All grating, except otherwise shown, shall be equal to Borden Aluminum Plank "Standard," or Liskey extruded aluminum grating, "Duro-Grip," with rectangular punch. The grating shall be of the depth shown and shall be of aluminum alloy 6061-T6 or 6063-T6. Weld end plates to all bearing bars and band all cutouts. Exposed welds and welding beads on the exposed top surface of the grating and/or end plates and bands will not be acceptable. Samples, which represent the finished product, shall be submitted to the Engineer for review in accordance with the General Requirements section of these Specifications. Seat angles in concrete shall be ¼" thick aluminum angles of a size which will properly accommodate the depth of the grating bars. Stair treads shown as being of aluminum shall be of the same aluminum alloys as the grating. The types shall be as shown or approved equivalent. Field paint all aluminum surfaces which will be in contact with concrete or carbon steel with suitable asphaltic paint.

B. Aluminum Pipe Railing: All rails and posts shall be fabricated size 1 ½" Schedule 40 aluminum pipe of 6061-T6 or 6063-T6 alloy. Railing may be shop fabricated with continuous welded joints and mill finish or may be assembled from approved factory fabricated one piece extrusion machined fittings and pipe with 305 stainless steel blind rivets and self- tapping screws all with 7 mil anodized finish. Welding shall be by inert gas shielded arc method with all welds ground smooth.

C. Aluminum Gates and Frames: Aluminum gates and frames shall be built of structural or extruded shapes as shown on the Drawings and shall be given an anodizing finish.

5.09 Welding/Inspection and Testing: Welders working on job shall meet the following qualifications.

A. Experience of Welders and Welding Operators: Welders and Welding Operators, shop and field, shall be qualified by an independent laboratory using test procedures covered in AWS D1.1 and shall have been employed as a Welder/Welding Operator using the positions for which he/she is qualified during the previous 90 days. The Contractor shall provide the Engineer and laboratory inspector with the (a) names of Welders and/or Welding Operators to be employed in the shop and field, (b) certification of the position, (c) date of the last qualification test and (d) the name of the qualifying laboratory.

1. All welders employed in the field on the erection of the steel work shall be qualified for the most difficult welding position during field erection.

2. The Contractor shall require any welder to retake the test, when, in the opinion of the Engineer, the work of the welder creates a reasonable doubt as to the proficiency of the welder. Recertification of the welder shall be made to the Engineer only after the welder had taken and passed the specified test. The Engineer may require radiographic or ultrasonic testing or may require coupons to be cut from any location in any joint for testing.

3. All Section of welds found defective shall be chipped or cut out to base metal and rewelded before proceeding with the work.

4. Costs of all qualifications, tests and retests shall be borne by the Contractor.

B. Joint Qualification: All joints shall comply with AWS D1.1.

C. Inspection and Testing: Inspection and testing shall be as follows:

1. Inspections and Tests: Inspection and tests shall be performed by an independent laboratory complying with ASTM E-329. The testing laboratory shall be directed by the Engineer. All material to be furnished shall be subject to inspections and tests in the shop and field.

2. Shop Inspections: Shop inspections and tests shall include fit-up, preparation of surfaces and welding.

3. Field Inspections: Field inspections and tests shall include fit-up, preparations of surfaces, welding and bolting.

4. Reports: Reports of shop and field inspections and testing shall be made by the laboratory on a weekly basis. One copy of each shop and field inspection report shall be submitted directly to each of the following: Engineer, Inspector, Contractor, Fabricator and Erector.

5.10 Structural Steel:

A. Shop Drawings and Erection Procedures:

1. The Contractor shall prepare and submit shop and erection plans covering all structural in accordance with the General Requirements section of these Specifications. All dimensions for checking of structural steel details shall be shown on the drawings.

2. The Contractor shall be responsible for the confirmation of all steel details to the typical and special details shown on the drawings and for all details, notes and schedules appearing on the drawings. The Contractor shall be responsible for giving information for the fabrication and erection of the structural steel. Related items shall be shown on the erection or shop drawings. Drawings shall include all shop and erection details including cuts, copes, connections, hole, bolts and welds. For bolted, the type, size and length of bolts including washers shall be shown. All welds, both shop and field, shall be indicated by standard welding symbols as noted by AWS D1.1. Drawings shall show the size, length and type of each weld.

3. The Contractor shall prepare and submit 2 copies of a detailed erection procedure with the shop and erection drawings in accordance with the General Requirements section of these Specifications. The procedure shall include the sequence of erection with temporary staying and bracing. No copies of such procedure will be returned.

B. Applicable Specifications and Codes: The following specifications and codes form a part of this section of these specifications:

1. American Institute of Steel Construction Publications, Manual of Steel Construction, Eighth Edition.

a. Code of Standard Practice for Steel Buildings and Bridges.

b. Specification for the design, Fabrication and Erection of Structural Steel for Buildings with commentary.

2. American Society for Testing and Materials: As amended to date.

a. A 36, Specifications for Structural Steel.

b. A 572, Specifications for High-Strength Low Alloy Columbium-Vanadium Steels for Structural Quality.

c. A 325, Specifications for High-Strength Steel Bolts for Structural Steel Joints. Including Suitable Nuts and Bolts and Washers.

d. A 490, Specifications for Quenched and Tempered Alloy Steel Bolts for Structural Steel Joints.

e. E 329, Recommended Practice for Inspection and Testing Agencies for Concrete and Steel as Used in Construction.

3. American Welding Society: Shall be D1.1 as amended to date, Structural Welding Code.

4. Specifications for Structural Joints: Using ASTM A 325 or A 490 bolts.

5. Fabrication and Erection of Structural Steel for Buildings: Unless otherwise indicated on the drawings or in the Specifications for the design, the publication, Fabrication and Erection of Structural Steel for Buildings of the American Institute of Steel Construction, hereafter designated AISC, shall govern structural steel work. Welding shall be in accordance with American Welding Society Standard Code D1.1.

C. Substitutions of Sections: Substitutions of sections or modifications of details, or both, and the reasons for such substitutions or modifications shall be submitted with the shop drawings in accordance with the General Requirements section of these Specifications for approval. Approved substitutions, modifications, and/or changes in related portions of the work shall be coordinated by the Contractor and shall be accomplished at no additional cost to the Owner.

D. Responsibility for Errors: The Contractor shall be responsible for all errors of detailing, fabrication and for the correct fitting of the structural members. The Contractor shall make all measurements in the field to verify or supplement dimensions shown on the Drawings and shall assume responsibility for fitting new work to existing work.

E. Templates: Templates with instructions for the setting of anchors, anchor bolts and bearing plates shall be furnished by the fabricator to the job. The Contractor shall ascertain that the items are set during the progress of the work.

F. Qualifications:

1. Experience of Fabricator: Fabrication Shop and Erector shall have fabricated and erected projects of similar size and complexity for at least ten years.

2. Experience of Welders and Welding Operators: Welders and Welding Operators, shop and field, shall be qualified by an independent laboratory using test procedures covered in AWS D1.1, and shall have been employed as a Welder/Welding Operator using the positions for which he/she is qualified during the previous 90 days. The Contractor shall provide the Engineer and laboratory inspector with the (a) names of Welders and/or Welding Operators to be employed in the shop and field, (b) certification of the position, (c) date of the last qualification test and (d) the name of the qualifying laboratory.

a. All welders employed in the shop on the fabrication of the steel work shall be qualified for the most difficult welding position during shop fabrication.

b. All welders employed in the field on the erection of the steel work shall be qualified for the most difficult welding position during field erection.

c. The Contractor shall require any welder to retake the test, when, in the opinion of the Engineer, the work of the welder creates a reasonable doubt as to the proficiency of the welder. Recertification of the welder shall be made to the Engineer only after the welder had taken and passed the specified test. The Engineer may require radiographic or ultrasonic testing or may require coupons to be cut from any location in any joint for testing.

d. Should any two radiographic or ultrasonic tests or coupons cut from the work of any welder show strengths or undertests less than that of the base metal, it will be considered evidence of negligence or incompetence and such welder shall be removed from the work.

e. When coupons are removed from any part of a structure:

1) The members cut shall be repaired at no additional cost to the Owner in a neat and workmanlike manner.

2) Joints will be of a type to develop the full strength of the members.

f. Joints will be cut with peening to relieve residual stress.

g. All sections of welds found defective shall be chipped or cut out to base metal and re-welded before proceeding with the work.

h. Costs of all qualifications, tests and retests shall be borne by the Contractor.

3. Joint Qualification: All joints shall comply with AWS D1.1.

G. Inspection and Testing:

1. Inspections and Tests: Inspections and tests shall be performed by an independent laboratory complying with ASTM E-329. The testing laboratory shall be directed by the Engineer. All material to be furnished shall be subject to inspections and tests in the shop and field.

2. Shop Inspection: Shop inspections and tests shall include fit-up, preparation of surfaces and welding.

3. Field Inspections: Field inspections and tests shall include fit-up, preparations of surfaces, welding and bolting.

4. Reports of Inspections: Reports of shop and field inspections and testing shall be made by the laboratory on a weekly basis. One copy of each shop and field inspection report shall be submitted directly to each of the

following: Engineer, Resident Engineer, Inspector, Contractor, Fabricator and Erector.

H. Materials: Materials shall be of domestic manufacture, within trade tolerances, new, undamaged and without splices. Structural material, plain or fabricated, shall be stored above the ground upon platforms, skids or supports. Materials shall be kept free of dirt, grease and foreign matter and shall be protected from corrosion.

1. Structural Steel:

a. Structural steel shall comply with ASTM A-36 unless indicated otherwise on the Drawings.

b. The Contractor shall furnish two copies of all mill reports covering the chemical and physical properties of the steel used.

2. Bolts, Nuts and Washers:

a. All bolts, nuts and washers shall comply with ASTM A-325 or A-490.

b. ASTM A-325 and A-490 bolts shall be used for connections as indicated on the Drawings.

3. Welding Electrodes and Flux:

a. Electrodes and flux used for submerged arc welding shall be of the same manufacture. The flux shall be free of the contamination of dirt, mill scale and foreign material. Fused flux used in welding shall not be reused. Bare electrodes and flux used in combination shall conform to the requirements of AWS D1.1.

b. Electrodes for manual shielded metal-arc welding shall conform to AWS D1.1.

4. Grout: Non-shrink grout beneath base and bearing plates shall be Embeco by the Master Builders Company, Five Star Grout by U.S. Grout Corp., or equal.

I. Welding Equipment: Welding equipment shall be capable of providing the welding required by the Drawings and/or Specifications and in compliance with the requirements of joint qualification in AWS D1.1.

J. Fabrication:

1. Structural Material: Structural material shall be fabricated and assembled in the shop. Assembled pieces shall be taken apart for the removal of burrs, and shavings produced by the reaming operation. Parts not connected in the shop shall be secured by bolts to prevent damage in shipment and handling.

2. Connections: Connections shall be as shown on the Drawings. Connections not indicated shall be made to conform with the AISC Specification. One-sided or other types of eccentric connections will not

be permitted. Surfaces of joints for welded and bolted connections shall be clean bright metal. Fit up of the parts shall be inspected and approved by the laboratory inspector prior to making final connection.

a. Holes shall be cut, drilled or punched at right angles to the surface of the metal and shall not be made or enlarged by burning. Holes in base or bearing plates shall be drilled. Holes shall be clean-cut without torn or ragged edges. Outside burrs resulting from drilling or reaming operation shall be removed. Holes for bolts shall be 1/16" larger than the diameter of the bolt except as noted on the drawing.

b. Welded connections will be permitted only where indicated on the Drawings. Welded construction shall conform to the AISC and AWS Specifications.

c. Bolted connections using ASTM A-325 or A-490 bolts shall conform to the Specifications for Structural Joints using ASTM A-325 or A-490 bolts. Indicator washers shall be used to show that bolts are properly tightened. Both threads shall be excluded from the shear planes of the contact surfaces between the connected parts. Load indicator washers shall be Cornet Load Indicator by Cooper + Turner, Inc. or equal.

3. Milled Surfaces: Milled surfaces shall comply to the AISC Specification and the Drawings.

4. Allowance: Allowance shall be made for draw in all tension bracing.

K. Erection:

1. Splices: Splices and field connections shall be made as shown or noted on the Drawings. Errors in shop fabrication or deformation resulting from handling and transportation that prevent the assembly and fitting of parts shall be reported immediately to the Engineer for directions as to the method of correction. Corrections shall be made at no additional cost to the Owner.

2. Leveling Plates: Leveling plates shall not be used under base plates.

3. Anchor Bolts: Anchor bolts and anchors shall be located and built into connecting work. Bolts and anchors shall be preset by the use of templates to locate the anchors and anchor bolts.

4. Column Bases: Column bases and bearing plates may be attached or loose as approved on the shop drawings. Plates shall be supported and aligned on steel wedges or shim. After the supported members have been plumbed and positioned and the anchor nuts tightened, the entire bearing area under the plate shall be dry-packed solidly with non-shrink grout. Wedges and shims shall be cut off flush with the edge of the column base and bearing plates, and shall be left in place.

5. After Assembly: After assembly, the various members forming parts of a completed frame or structure shall be aligned and adjusted before being fastened. Tolerance shall conform to AISC. Fastening of splices of compression members shall be done after the abutting surfaces have been brought completely into contact. Bearing surfaces and surfaces that will be in permanent contact shall be cleaned before the members are assembled. As erection progresses, the work shall be fastened to take care of all dead load, wind and erection stresses. Splices will be permitted only where indicated on the Drawings. Erection bolts used in welded construction shall be tightened and left in place. Welding for redrilling will not be permitted.

6. Driftpins: Driftpins may be used only to bring together the several parts, and shall not be used in such manner as to distort or damage the metal.

7. Gas Cutting Torch: The use of a gas cutting torch in the field for correcting fabrication errors is prohibited unless the Engineer has specifically approved such procedure for each case individually in writing.

L. Painting:

1. Cleaning: All steel work shall be cleaned of loose mill scale, loose rust, accessible weld slag or flux deposit, dirt, and foreign matter. Oil and grease deposits shall be removed by solvent. No paint shall be applied when steel temperature is below the dew point of the atmosphere.

2. After Cleaning: After cleaning and connections are approved by the laboratory inspector, all steel work except surfaces to be fireproofed, or surfaces to be welded shall be given a shop coat of primer. The primer shall be applied at a rate to provide a minimum dry film of two (2.0) mils. The primer shall be applied without holidays or paint runs.

3. After Erection: After erection all field connections shall be cleaned. All connections, including welds and bolts, and all abraded surfaces on the shop primer shall be painted to give one complete coat of primer. Paint for field touch-up shall be the same paint used for the shop coat.

5.11 Payment: No separate payment will be made for the work of this Section. The cost of the work, and all costs incidental thereto, shall be included in the amount bid in the Proposal for every item to which the work pertains.

SECTION 6
SITE PREPARATION, EXCAVATION, BACKFILLING, GRADING AND FENCING

6.01 Scope: The work covered by this Section of the Specifications consists of furnishing all materials and equipment, and performing all labor necessary for clearing, excavating, backfilling and grading for site development, and to permit construction of the structures, buildings, roads, helical piles and embankment construction in strict conformity with the contract Drawings, the Specifications and the directions of the Engineer.

6.02 Site Conditions and Soil Investigation: The Contractor's attention is directed to the Instruction to Bidders and General Requirements sections of these Specifications special provisions relating to site examination. Contours and existing topography shown on the Drawings are believed to be reasonably correct. It shall be the Bidder's responsibility to determine any major difference which would affect his bid and make allowance for such differences in his bid.

6.03 Clearing Site: The area shall be cleared and grubbed of all existing structures, pavements and other obstructions interfering with, or in the way of construction of new work. The area shall be cleared of trees, stumps, roots, brush, rubbish and other such materials to limits at least 10' outside of limits of tops of cuts and toes of fill. Trees and shrubs designated to be left in place and those outside of limits shall not be damaged. Top soil and vegetable matter shall be carefully stockpiled and preserved for surfacing completed slopes.

A. Disposal of Waste Material: All waste materials resulting from clearing operations shall be disposed of in accordance with applicable regulations of the Georgia Department of Natural Resources, Environmental Protection Division.

B. Damage to Existing Facilities: Any structure, pavement, fences or other such work removed for construction purposes or damaged by reason of construction operations; but not in the way of new work, shall be replaced or repaired.

6.04 Grading: Before the beginning of construction operations, the Contractor will grade the site to the proposed elevations above as indicated on the Drawings. The Drawings show both existing contour elevations and finished contour elevations.

A. Finish Grading: Upon completion of construction operations, the area shall be finish graded in accordance with finish contour elevations and grades shown on the Drawings. Graded areas shall be made to blend into conformation with remaining ground surfaces. All surfaces shall be left smooth and free to drain. The tops of all cuts shall have berm ditches.

B. Additional Material: If additional material other than that to be obtained from excavation is required for backfilling and grading, the Contractor shall obtain such additional material from borrow at his own expense.

C. Excess Material: Any excess earth excavation and all rock excavation shall be placed on or near the site as directed by the Engineer. Surfaces on slopes of waste fills shall be left smooth and free to drain.

D. Borrow Material: Borrow material if required shall be obtained on site where indicated. The borrow site shall be graded and regrassed as directed by the Engineer.

6.05 Excavations: The Contractor shall perform all excavating of every description and of whatever substances encountered to the dimensions and levels shown on the Drawings and/or as specified. Excavation may be accomplished by any customary method.

A. Earth Excavation: Earth excavation shall include all substances to be excavated other than rock.

1. Excavate soil to the lines, grades, and dimensions shown on the Drawings and as necessary to accomplish work. Do not over excavate without authorization from the Engineer.

2. Excavated soil shall be stockpiled in locations designated on the Drawings. If a stockpile area is not designated, soil shall be stockpiled in a manner such that it will not obstruct the work nor endanger the workers or the public, obstruct sidewalks, driveways, roadways or other structures.

3. Excavated soil shall not be placed against tree trunks.

4. Excavated soil that is unsuitable or exceeds the quantity required for fill or backfill shall be disposed of offsite.

B. Rock Excavation: Rock excavation shall comprise of solid rock in the original bed or in well-defined ledges, the removal of which in the opinion of the Engineer requires drilling, blasting or the use of jack hammers and bull points, and shall also include all boulders and detached pieces of rock 8-cubic feet or more in content.

1. When rock excavation is necessary, all rock shall be removed to provide a clearance below and on each side of all pipe, valves and fittings of at least 6" for nominal pipe sizes of 24" or less and at least 9" for nominal pipe sizes greater than 24". Clearance for structures shall be at least 12".

2. Contractor shall obtain written approval from the Engineer prior to conducting any blasting activities.

3. Rock blasting shall be conducted in accordance with Chapter 120-3-10-0.4 of the “Rules and Regulations for Explosives and Blasting Agents” and all other applicable local, state and federal regulations.

4. A blasting report consisting of a pre-blast report, drilling log, and a post-blast report shall be submitted to the Owner after rock blasting is complete.

5. Rock blasting shall be conducted by a licensed blasting contractor.

6. After rock removal, trench shall be backfilled with No. 57 stabilization stone up to the grade of the pipe or structure to be installed.

7. Excavated rock shall be disposed of offsite unless otherwise approved by Engineer.

C. Damage to Existing Facilities: Any damaged structures, pipe lines, sewers or other private or public facilities shall be immediately repaired or replaced at the expense of the Contractor. Any damage to such facilities which will impair or restrict the operation of the water supply system shall be immediately repaired or replaced with no stoppage of work until such repairs or replacements are complete.

6.06 Excavation for Structures: The limits of excavation for structures shall be in accordance with the following:

A. Earth Excavation: Earth excavation for structures shall be to limits not less than 2' outside wall lines, to allow for formwork and inspection; and further, as necessary, to permit the trades to install their work. Excavations for footings shall be to footing dimensions. Excavation for slabs shall be to near bottom slab level. Earth excavation for structures shall not be machine dug below a level 6" above bottom elevations of slabs or footings unless otherwise shown or as directed by the geotechnical engineer. No excavations shall be made in the railroad right of way.

B. Rock Excavations: Rock excavations for structures shall be to limits not less than 2' outside of wall lines, with a vertical tolerance of 3" in or out, and further if necessary to allow for inspection and to permit trades to install their work. Excavation for footings shall be to a minimum depth and width not less than the footing dimensions. Excavation for slabs shall be not higher than bottom slab level.

C. Blasting: All blasting operations shall be conducted in strict accordance with existing ordinances and regulations and shall be done subject to the Engineer's approval of the method and quantity of explosive to be used. Exposed structures shall be protected from the effects of blasts, and all blasts shall be covered with blasting mats, dirt, heavy timbers or other suitable material. They shall be restricted to the extent that no appreciable shock will be transmitted to existing structures, pipe lines, sewers or other public or private facilities. All blasting supplies shall be stored in a magazine which complies with all local, state and federal laws. In no case shall caps or other exploders be kept at the place where dynamite or other explosives are stored.

D. Foundation Evaluation: All foundation excavations must be evaluated by a geotechnical engineer to observe field conditions and determine if additional undercutting is required. Additional undercutting and backfill, if required, will be paid at the unit price bid.

E. Foundation Subgrade Stabilization: The Contractor shall place a 12" thick layer of crushed stone stabilization under foundations and slabs in excavations where shown on the Drawings and where soil conditions at foundation elevations are unsuitable for construction of foundations. The subgrade conditions shall be inspected by an experienced soils technician and stabilization stone placed in accordance with his recommendations. Stone shall be a well graded crushed stone 2" or smaller in size.

The crushed stone should be stored on site before excavations reach planned subgrade elevations. Once subgrade elevations are reached, subgrade conditions shall be inspected immediately by an experienced soils technician to verify areas of low consistency are not present. Additional undercutting of soils and replacement with No. 57 stone along with geotextile fabric may be required at the request of the Engineer. Once the evaluation is completed, crushed stone shall be placed immediately to prevent soils from becoming unstable.

F. Foundation Preparation Rock Excavation: At locations where structures excavation is required in partially weathered rock and rock, over-excavation should occur to allow placement of a minimum 6" layer of crushed stone or sand beneath the bottom slabs. The stone or sand layer should provide relatively uniform support for the slabs for the variable support conditions, particularly if rocks are exposed in the subgrade.

6.07 Dewatering: The site shall be kept free of surface water at all times. The Contractor shall install drainage ditches and dikes and shall perform all pumping and other work necessary to divert or remove rainfall and all other accumulations of surface water from the excavations. The diversion and removal of surface water shall be performed in a manner that will prevent the accumulation of water behind temporary structures or at any other locations within the construction area where it may be detrimental. The Contractor shall provide, install and operate sufficient trenches, sumps, pumps, hose, piping, wellpoints, deep wells, etc., necessary to depress and maintain the groundwater level at least 3' below the base of the excavation during all stages of construction operations. The groundwater table shall be lowered in advance of excavation and maintained a minimum of 2' below the lowest excavation subgrade made until the structure has sufficient strength and weight to withstand horizontal and vertical soil and water pressures.

Groundwater control is the sole responsibility of the Contractor. The Contractor must submit a dewatering plan to the Engineer for approval prior to excavation. After construction is completed and all backfill has been placed, the temporary groundwater controls should be removed and any pipes or barrels shall be grouted or filled.

Contractor shall properly dispose of water in a manner that will not cause erosion or flooding, or otherwise damage existing facilities, completed work or adjacent property. Contractor shall be responsible for any damage caused by the dewatering operation.

Contractor shall be responsible for obtaining any permits required by regulatory agencies for discharging water from dewatering operations.

6.08 Shoring and Sloping: Temporary construction slopes or temporary shoring will be required. The Contractor should incorporate all appropriate requirements of OSHA into the design of the temporary construction slopes and shoring systems.

A. In areas next to existing foundations, we recommend that open excavations not be performed within a 45º plane extended downward from the bottom edge of adjacent foundations of any existing structures without a properly designed and installed shoring system.

B. If temporary slopes are used, typically they can be constructed no steeper than 1 ½ to 1 (horizontal to vertical) for slopes less than 15' high.

6.09 Structural Fill: After clearing and excavation operations have been completed, all structure locations shall be proof-rolled with a loaded pan or heavy pneumatic tired vehicle to densify upper soils and to locate possible areas which will require undercutting, removal and/or recompaction. This operation shall be conducted under the surveillance of an experienced soil inspector.

A. Fill Material: Fill shall be clean inorganic natural soil. Structural fill below building areas (and the upper 2' of fill beneath pavements) shall contain no rock fragments larger than 3" in longest dimension. Soils proposed for fill shall have a maximum density of 98 pounds per cubic foot or greater in Standard Proctor Compaction Test ASTM D698. Excavated materials which contain large quantities of rock or weathered rock fragments shall not be used in building areas. Fill below floors, foundations and paved areas shall be compacted at least 95% of the ASTM D698 maximum density.

Excavated materials which contain large quantities of rock or weathered rock fragments shall not be used in building areas. Fill below floors, foundations and paved areas shall be compacted at least 95% of the ASTM D698 maximum density. The upper foot of fill which will support pavements, foundations or slabs should be compacted to at least 98% of the Soils Standard Proctor maximum dry density. In areas which are at or above the finished grade and which will support pavements, foundations or slabs, the upper 8″ immediately below these systems should be scarified and recompacted to the 98% criteria. Fill material required to replace undercut areas or achieve the finish grade within a tank footprint must consist of hard, clean, graded aggregate such as No. 57 crushed stone. The exterior slope of any structural fill shall be no steeper than 2H:1V.

Structural fill shall extend horizontally beyond the outer edge of structure foundations at least 10' or a distance equal to the height of the fill to be placed, whichever is greater. In paved areas, fill slopes should extend at least 5' beyond the edge of pavement.

Aluvial soils and any other organic laden soils encountered at the site should be placed in non-structural areas or hauled off-site.

B. Compaction: Fill shall be placed in loose layers 8" or less in thickness unless noted otherwise elsewhere in these Specifications. Each layer shall be compacted by sheepsfoot or rubber tired roller operating independently of the dozer used to spread fill. If the fill soils are clayey or silty sands or sandy silts with Unified Classifications of SC, SM, SP or ML, the compaction of each fill layer shall be completed by two coverages of rolling with a loaded earth moving scraper, dump truck or large rubber tired roller before more fill is placed.

In confined areas such as utility trenches, the use of portable compaction equipment and thin lifts of 3" to 4" may be required to meet compaction.

C. Testing: Fill compaction shall be verified by field density testing conducted throughout the period of fill placement and compaction. Subgrade preparation shall be inspected by an experienced soil engineer. Field density tests shall be performed to verify that the specified degree of compaction is achieved. For

building areas, a frequency of passing tests of at least 1 test per 1,500 square feet for each 18" of new fill thickness is required.

D. Geotextile Fabric: Contractor shall furnish and install construction fabric to stabilize soil surfaces for structural fill placement where indicated in these Specifications. Construction fabric shall be a polyester continuous filament needle punched nonwoven engineering fabric such as TenCate Mirafi 500X US Fabrics US 200, or equal.

6.10 Yard Fills: Yards shall be graded to widths, gradients and limits shown on the Drawings. The fill shall be thoroughly compacted. The Contractor shall place all sub-fills to approximately 8" lower than the finish elevations shown on the Drawings for areas to be surfaced. Areas outside the surfaced areas shall be graded to the elevations shown on the Drawings. Fill shall be of selected clay materials obtained from excavation suitable for compaction to form an unyielding sub-base. All fills shall be properly compacted by the use of sheepsfoot or other approved roller. The fills shall be compacted and rolled until a solid sub-base is provided. If necessary, the fill shall be sprinkled and brought up to provide satisfactory compaction conditions. Yard fills shall be compacted to at least 90% of the ASTM D698 maximum density.

6.11 Earth Fills:

A. Materials: All fill materials shall be obtained from required excavations and designated borrow areas. The selection, blending, routing and disposition of materials in the various fills shall be subject to approval by the Engineer.

All fill material should be clean, soil, free of any organic and deletrious materials and rocks or stones over 3" in diameter. It should also have a Plasticity Index (PI) less than 30. The fill should be compacted to a minimum of 95% of the standard Proctor maximum dry density (ASTM D 698) with moisture contents being maintained between the soil's optimum moisture and 3% over optimum.

B. Foundation Preparation: Foundations for earth fill shall be stripped to remove vegetation and other unsuitable materials or shall be excavated as specified.

Except as otherwise specified, earth foundation surfaces shall be graded to remove surface irregularities and shall be scarified parallel to the axis of the fill or otherwise acceptable scored and loosened to a minimum depth of 2". The moisture content of the loosened material shall be controlled as specified for the earth fill as specified for subsequent layers of earth fill.

Earth abutment surfaces shall be free of loose, uncompacted earth in excess of 2" in depth normal to the slope and shall be at such a moisture content that the earth fill can be compacted against them to effect a good bond between the fill and the abutments.

Foundation and abutment surfaces shall not be steeper than 1 horizontal to 1 vertical unless otherwise specified. Test pits or other cavities shall be filled with compacted earth fill conforming to the Specifications for the earth fill to be placed upon the foundation.

C. Placement: Fill shall not be placed until the required excavation and foundation preparation has been completed, and the foundation has been inspected and approved by the Engineer. Fill shall not be placed upon a frozen surface, nor shall snow, ice or frozen material be incorporated in the fill.

Fill shall be placed in approximate horizontal layers. The thickness of each layer before compaction shall not exceed 8" in thickness. Materials placed by dumping in piles or windows shall be spread uniformly to not more than an 8" thickness before being compacted. Hand compacted fill, including fill compacted by manually directed power tampers, shall be placed in layers whose thickness before compaction does not exceed 4". Fill must be adequately keyed into existing foundation materials. Benching and scarification of existing materials is required to provide adequate bonding.

Fill adjacent to structures shall be placed in a manner which will prevent damage to the structures and will allow the structures to assume the loads from the fill gradually and uniformly. The height of the fill adjacent to a structure shall be increased at approximately the same rate on all sides of the structure.

Earth fill shall be placed so as to meet the following additional requirements:

1. The distribution of materials throughout each zone shall be essentially uniform, and the fill shall be free from lenses, pockets, streaks or layers of material differing substantially in texture or gradation from the surrounding material.

2. If the surface of any layer becomes too hard and smooth for proper bond with the succeeding layer, it shall be scarified parallel to the axis of the fill to a depth of not less than 2" before the next layer is placed.

3. The top surfaces of embankments shall be maintained approximately level during construction, except that a crown or cross-slope of not less than 2% shall be maintained to insure effective drainage, and except as otherwise specified for drain fill zones. If the Drawings or Specifications require or the Engineer directs that fill be placed at a higher level in one part of an embankment than another, the top surface of each part shall be maintained as specified above.

4. Embankments built at different levels as described above shall be constructed so that the slope of the bonding surfaces between embankment in place and embankment to be placed is not steeper than 3' horizontal to 1' vertical. The bonding surface of the embankment in place shall be scarified, moistened and recompacted when the new fill is placed against it to insure a good bond with the new fill and to obtain the specified moisture content and density in the junction of the in place and new fill.

5. No fill should be placed on frozen or wet ground. Any placed fill that becomes frozen, saturated or excessively dry should be undercut and replaced. Any unsuitable or damaged fill should not be covered with additional fill. The surface of each fill lift should be left in an unsmooth condition to provide adequate bonding with subsequent fill lifts. All fill

lifts should be graded to prevent surface water ponding. The fill pad should be sealed at the end of each day by proof-rolling with rubber-tired rollers.

D. Control of Moisture Content: During placement and compaction of fill, the moisture content of the materials being placed shall be maintained within the specified range.

The application of water to the fill materials shall be accomplished at the borrow areas insofar as practicable. Water may be applied by sprinkling the materials after placement on the fill, if necessary. Uniform moisture distribution shall be obtained by disking, blading or other approved methods prior to compaction of the layer.

Material that is too wet when deposited on the fill shall either be removed or be dried to the specified moisture content prior to compaction.

If the top surface of the preceding layer of compacted fill or a foundation or abutment surface in the zone of contact with the fill becomes too dry to permit suitable bond it shall be scarified and moistened by sprinkling to an acceptable moisture content prior to placement of the next layer of fill.

A heavy duty harrow shall be on site while earth fill is being placed to provide the necessary disking for moisture control.

E. Compaction: Fill adjacent to structures shall be compacted to the required density by means of hand tamping or manually directed power tampers or plate vibrators. Heavy equipment shall not be operated within 2' of any structure. Vibrating rollers shall not be operated within 5' of any structure. Compaction by means of drop weights operating from a crane or hoist will not be permitted.

1. The passage of heavy equipment will not be allowed over the following:

   a. Cast-in-place conduits prior to 14 days after placement of the concrete

   b. Cradled precast conduits prior to 7 days after placement of the concrete cradle

   c. Any type of conduit until the backfill has been placed above the top surface of the structure to a height equal to ½ the clear span width of the structure or pipe or 2', whichever is greater.

2. Compaction of fill adjacent to structures shall not be started until the following time intervals have elapsed after placement of the concrete:

Structure		Time Interval
a.	Retaining walls and counterforts	14 days
b.	Walls backfilled on both sides simultaneously	7 days
c.	Conduit and spillway risers, cast-in-place (with inside forms in place)	7 days

d.	Conduit and spillway risers, cast-in-place (inside forms removed)	14 days
e.	Conduits, precast, cradled	2 days
f.	Conduits, precast, bedded	1 day
g.	Antiseep collars	3 days

F. Removal and Placement of Defective Fill: Fill placed at densities lower than the specified minimum density or at moisture contents outside the specified acceptable range of moisture content or otherwise not conforming to the requirements of the Specifications shall be reworked to meet the requirements or removed and replaced by acceptable fill. The replacement fill and the foundation, abutment and fill surfaces upon which it is placed shall conform to all requirements of this Specification for foundation preparation, approval, placement, moisture control and compaction.

6.12 Structures and Buildings: Where slabs or structures are to be constructed, all loam, organic matter and other objectionable material shall be stripped from the area a minimum of 10' beyond construction limits. Upon completion of stripping and rough grading, the areas intended to support structures, floor slabs and pavements shall be inspected by a qualified geotechnical engineer. The Contractor shall proof roll the subgrade utilizing a 20 to 30 ton loaded truck or other pneumatic-tired vehicle of similar size and weight. Proof rolling shall locate any soft, weak or excessively wet soils present. Proof rolling activities shall be made in the presence of the geotechnical engineer. Any unsuitable soils observed during inspection and proof rolling operations shall be undercut and stabilized.

6.13 Unauthorized Excavation: Footings or slabs shall be set on undisturbed earth or rock to insure proper bearing. Therefore care shall be taken that excavation does not extend below bottom levels of footings or slabs on earth or rock. Should the excavation through carelessness or neglect be carried below such levels, the Contractor shall fill in the resulting excess excavation with concrete under footings and with crushed stone, gravel or other approved materials under slabs. Should excavation be carried beyond outside lines of footings, such excess excavation should be filled with concrete, or formwork shall be provided, as directed by the Engineer. Additional costs of corrective work made necessary by unauthorized excavation of earth or rock shall be borne by the Contractor.

6.14 Water: The Contractor shall, by the use of wellpoints, pumps, tile drains or approved methods, prevent the accumulation of water in excavated areas. Should water accumulate, the Contractor shall remove it promptly.

6.15 Preloading of Structures: All tanks shall be preloaded with water prior to making final pipe connections. Elevations of structures shall be monitored until settlement has virtually ceased.

6.16 Slabs on Earth Fill: Where slabs are to be constructed on earth fill, all loam, organic matter and other objectionable material shall be stripped from the area. In the event material excavated during construction operations from other locations is not suitable for use in compacted fill, the Contractor shall obtain select material from borrow on or near the site as directed by the Engineer. The fill shall be of select material placed in layers of

not more than 6" compacted thickness and compacted by the use of heavy rolling or power tamping equipment to secure at least 95% of the Standard Proctor Dry Density. An experienced soil engineering technician shall take adequate density tests during placement of fill to verify that the specified degree of compaction is being achieved.

6.17 Backfilling Around Structures: Backfills around structures shall be properly placed and compacted. The fills shall be brought up in layers. The layers shall be thoroughly compacted to at least 95% of Standard Proctor Dry Density, each layer to be not deeper than 6" compacted thickness. Compaction around structures shall be by use of heavy power tamping equipment. Areas to be backfilled at structures shall be free from trash and wood.

6.18 Demolition:

A. Scope: The work covered by this Section of the Specifications consists of furnishing all materials and equipment and performing all labor necessary for demolition and removal of existing structures and utilities as designated on the Drawings to be removed.

B. Site Conditions: The Contractor's attention is directed to the Instructions to Bidders and the soils investigation paragraph of these Specifications relating to site examination.

C. Procedures: The Contractor shall submit proposed procedures for demolition work to the Engineer for review and approval in accordance with the General Requirements section of these Specifications. All demolition procedures shall be accomplished in strict compliance with all state and local laws and regulations as well as shall conform to NFPA Standard 241, *Safe Guarding Building Construction and Demolition Operations*. Submittals shall include a detailed description of the methods and equipment to be used for each operation and the sequence of operation, evidence of having successfully performed similar work on other projects; permits and notices authorizing demolition where required by local and/or state regulations, and permits for transport and disposal of debris where required by local and/or state regulations.

D. Site Work: The Contractor shall not use explosives without prior approval of the Owner and Engineer. The Contractor shall conduct operations to insure minimum interference with all roadways and adjacent businesses and facilities. The Contractor shall not obstruct roadways without obtaining permits and permission from governing authorities. The Contractor shall protect all existing underground and overhead utilities from damage or interruption of service from demolition activities.

E. Dust Control: Dust resulting from demolition shall be controlled to prevent the spread of dust to occupied portions of the site as well as avoid creation of nuisance to the surrounding area. Use of water will not be permitted when it results in or creates hazardous or objectionable conditions such as ice, flooding and pollution.

F. Disconnection of Utility Service: Utilities shall be disconnected at points indicated on Drawings or as necessary for demolition of structures. The

Contractor shall arrange for, and verify, termination of utility service including removal of meters and capping of lines by representatives of utilities that are involved.

G. Preparation: The Contractor shall remove all items to be salvaged for the Owner and place in designated storage area. The Contractor shall construct barriers, fences, guard rails, enclosures, shoring, etc. to deny public access to the demolition site and to protect utilities and structures that are to remain.

H. Structures: Structures shall be completely removed where noted on the Drawings. Holes resulting from removal structures shall be backfilled and compacted in accordance with these Specifications.

I. Cleanup: The Contractor shall remove debris and rubbish from the site as soon as practicable. Debris and rubbish will not be allowed to accumulate. Remove and transport debris in a manner as to prevent spillage on streets, public rights of ways or adjacent areas. The Contractor shall obtain all permits for transport and disposal of debris as required by all local, state and federal agencies. All disturbed areas from demolition activities shall be grassed in accordance with these Specifications.

6.19 Vegetation Cleanup, Maintenance and Inspection:

A. Cleanup: Any soil, mulch or similar material which has been brought onto paved areas by hauling operations or otherwise shall be removed promptly, keeping these areas clean at all times. Upon completion of the planting, all excess soil, stones and debris which have not previously been cleaned up shall be removed from the site or disposed of as directed by the Engineer. All grassed areas shall be prepared for final inspection.

B. Maintenance: Maintenance shall begin immediately after installation and continue until final inspection and acceptance by the Engineer. Grassing shall be protected and maintained by watering and mowing. Replanting may be necessary to produce a uniform stand of grass. Weeding, fertilizing, liming, disease and insect pest control, aerating and all other procedures consistent with good horticultural practice may be necessary to insure normal, vigorous and healthy grass.

6.20 Site Clean-Up: Contractor shall remove all unused material, excess soil and rock, and all other debris from the construction site as closely behind the work as practical. If the Contractor fails to maintain clean-up responsibilities as directed by the Inspector, the Owner may issue a “Stop Work” order.

A. All trenches shall be backfilled and tamped before the end of each work day.

B. Prior to requesting final completion, the Contractor shall complete the following cleanup tasks:

1. Remove and properly dispose of all accumulated debris and all excess material of any kind from the job site.

2. Repair or replace any work, trees, lawns, shrubs, fences, flower beds, drainage culverts, or any other property damaged by the construction. All

items damaged beyond repair shall be replaced with new material of equal or better quality.

3. Clean all road surfaces.

4. Upon the complete installation of grassing, the Contractor shall request an inspection by the Engineer to determine that all required areas have been satisfactorily grassed according to the plans and specifications. Grassing shall be noted as to condition and coverage and shall be free from erosion and other damage prior to being accepted. Upon acceptance, the Owner shall assume the responsibility for maintenance.

6.21 Helical Pile: Helical piles shall consist of helically shaped bearing plates, shaft and termination or connection to the structure, all of hot dipped galvanized construction.

A. Scope: Contractor shall design and provide a helical pile deep foundation system. The helical piles shall support the Pump House Addition such that no part of the load bears on the soil below.

B. Helical Pile Installing Contractor: The helical pile system shall be installed by a sub-contractor experienced in the installation of helical piles. Provide a current project list with references for review by the Engineer as evidence of experience.

C. Helical Pile Size Selection: The helical pile shaft selected by the Contractor shall encompass the permanent design loads, the staging of installation and possible future corrosion. The Contractor shall review these prior to selecting a shaft size and bearing plate area.

1. The minimum helical pile square shaft side dimension shall be 1½ inches.

2. The minimum helical pile bearing plate number and size (area) shall be as designed by the Contractor to bear the structure loads.

3. Provide galvanized, die cast helical pile with true helix bearing plate. Helix shall be designed such that soil disturbance during installation is not measurable.

4. A central, galvanized steel shaft shall transmit torque to the helical plates. The shaft shall be designed to support the loads as shown on the plans and to resist the torque required for installation.

D. Design: Contractor shall review proposed project, site and load requirements and satisfy himself as to the general soil and geological conditions in the proximity and observe topography and drainage prior to submitting a bid.

Helical piles shall be hot dip galvanized per ASTM A153 with a class B coating thickness of 1.8 oz/ft2.

Contractor shall design helical pile system to support the loading shown, in accordance with the geotechnical investigation provided, and to provide sufficient corrosion resistance for a 120-year design life. Helical pile designs and calculations shall be designed and stamped by a professional engineer licensed in the State of Georgia regularly engaged in the design of such systems. Design and

calculations shall be submitted prior to construction. Design shall encompass compression, tension and lateral (buckling) loads.

The galvanized steel helical pile termination shall be as shown on the plans and shall mechanically connect to the foundation slab structure support.

E. Installation:

1. Helical piles shall be installed after sheet pile back fill is installed. Contractor shall certify that backfill operations meet design criteria and are suitable for helical pile installation as designed.

2. The installing torque shall be measured, and the installed pile proof load estimated by the installing contractor. The torque shall be measured by a digital indicator with data logger. Torque logs and estimated proof load calculations shall be turned over to the Engineer at the end of each week.

3. The helical pile shall be installed to bear on hard pan soil strata.

4. Installing contractor shall make note of all utilities, their existing locations and their proposed relocation prior to installation.

6.22 Method of Payment: Payment for all excavation and fill work shown on the Drawings and herein specified and required to complete the clearing, grubbing, site excavation, trench excavation, borrow excavation, backfill, sheeting, shoring, topsoil, crushed stone or gravel, drainage, pumping, embankment fills and any other excavation and fills required to construct the project as shown on the Drawings shall be included in the lump sum price bid in the Proposal, and no measurement of the quantities will be made. The contours and elevations of the present ground are believed to be reasonably correct but are not guaranteed. The Contractor shall satisfy himself by actual examination of the site work as to the existing elevations and contours and the amount of work required under this Section.

A. If the quantities of common excavation required are increased or decreased as a result of changes made in the Drawings or by direction of the Engineer in writing during construction, the Engineer will determine the quantities of such changes, and the lump sum price will be adjusted upward or downward as applicable to compensate for such changes at the applicable adjustment unit price bid for common excavation in the Proposal.

B. No adjustment payment for trench excavation in earth will be made. Adjustment payment for such excavation shall be included in the applicable adjustment unit prices bid per linear foot of various sizes of pipe laid as listed in the applicable adjustment unit prices bid in the Proposal.

C. Additional payment will be made for any additional undercutting if required due to unsuitable soils. Additional undercutting will be any undercutting below the level as shown on the Drawings, provided excavations have been made after the site has been properly dewatered. Additional payment shall include the cost of replacing and compacting unsuitable material. Undercutting due to improper

dewatering and construction operations will be at no additional expense to the Owner.

D. The cost of all soils inspections and testing shall be paid by the Owner. If compaction tests do not meet required values, the cost of additional testing as required by the Engineer shall be paid by the Contractor.

E. Payment for signs shall be included in the lump sum bid. Price shall include installation, hardware and all other items.

F. Rock excavation is unclassified. No separate payment will be made for rock excavation. The cost of such work and all costs incidentals thereto shall be included in the prices bid for the time to which the work pertains.

G. All landscaping planting and erosion control structures shown on the Drawings will be included in the lump sum bid in the Proposal.

SECTION 7

PIPING, FITTINGS, VALVES AND DRAINS

7.01 Scope: The work described by this Section consists of furnishing all materials and equipment and performing all labor necessary to install all interior and exterior piping systems and valves, complete, as shown on the Drawings or specified, and as required for proper operation of all equipment installed under this Contract. All standard test designations refer to the revision of those standards in effect on the date of issue of the Contract Documents, except when a specific revision is specified.

7.02 Drawings: The Contractor shall furnish pipe fabrication details and dimensional layouts for all piping systems for checking and review by the Engineer in accordance with the General Requirements section of these Specifications. Each joint of pipe and fittings shall be marked and dimensioned to ensure installation shall commence until those drawings have reviewed and stamped by the Engineer.

7.03 Iron Pipe and Fittings: Cast iron or ductile iron pipe shall be used in sizes 3" through 8"and ductile iron pipe shall be used in sizes 10" through 64" where shown or indicated on the Drawings. All cast iron and ductile iron pipe shall be designed for a minimum 150-psi working pressure, 100-psi surge allowance, a 2 to 1 factor of safety on the sum of working pressure plus surge pressure, single AASHO H-20 truck loading, laying condition 2, and cover required. Each pipe shall be subjected to a hydrostatic pressure test of at least 500-psi at the point of manufacture. Cast iron pipe shall be of the thickness according to ANSI A21.1. Cast iron pipe shall conform to ANSI A21.6 or ANSI A21.8. Ductile iron pipe shall conform to ANSI A21.51. The class or nominal thickness, net weight without lining, and casting period shall be clearly marked on each length of pipe. Additionally, the manufacturer's mark, year in which the pipe was produced, and the letters "D.I./C.I." or "Ductile/Gray Iron" shall be cast or stamped on the pipe. Fittings shall be cast from gray or ductile iron. Ductile iron fittings shall conform to AWWA C 110 (ANSI A 21.10), or ANSI/AWWA C153/A21.53, gray iron fittings shall conform to ANSI/AWWA C110/A21.10, or latest revision. All fittings shall have standard mechanical joints. Exterior joints for cast iron and ductile iron shall be push-on type unless otherwise shown. Interior joints shall be flanged in accordance with ANSI A21.15 and ANSI A21.10.

A. Coatings, Linings, and Gaskets:

1. Exterior Coatings:

a. Underground Pipe and Fittings: Asphaltic coating in accordance with AWWA C151

b. Exposed Pipe and Fittings: Factory applied primer compatible with painting systems specified in "Painting" section

2. Interior Lining:

a. The lining for all gravity sewer pipe shall be Tnemec 431 or Ceramic Epoxy or an equal meeting the requirements of this Specification. Lining shall be applied according to the manufacturer's recommendations.

b. Air pipe shall be unlined.

3. Gaskets:

a. Sewers: Styrene Butadiene Rubber (SBR) conforming to ANSI A21.11

b. Water: Styrene Butadiene Rubber (SBR) or EPDM in accordance with ANSI A21.11

c. Air: Viton

B. Restrained Joint Pipe and Fittings: Where indicated on the Drawings, restrained joint pipe shall be ductile iron, pressure class as indicated, with push on joints and retainer glands. Glands shall be American Fastite, U.S. Pipe Tyton, or equal. U.S. Pipe TR Flex or American Flex Ring Joints may be used at the Contractor's option. Valves and fittings in restrained joint pipe shall be mechanical joint with EBAA Iron, Inc. megalug glands.

7.04 Polyvinyl Chloride Pipe: The Contractor shall furnish polyvinyl chloride pipe as follows:

A. Polyvinyl Chloride Pipe: Polyvinyl chloride pipe shall conform to requirements of AWWA C900, latest revision, "Standard for Polyvinyl Chloride (PVC) Pressure Pipe 4" through 12" for Water." Pressure Class 235 (SDR 18), unless otherwise noted shall have iron pipe outside diameters, must be Underwriters Laboratories, Inc. listed, and must conform to ASTM D-2241 latest revision. Pipe 2" in size shall be SDR 21 (Class 200) conforming to ASTM D-2241. All pipe shall be jointed with integral thickened bell and elastomeric gaskets. All gasket materials must conform to ASTM F477. Lubricant used with PVC pipe must be non-toxic and supplied or approved for use by the pipe manufacturer. Pipe shall be furnished in standard 20' laying lengths.

1. Markings: Pipe and couplings shall bear identification markings in accordance with AWWA C 900, as amended to date, that will remain legible during normal handling, storage and installation and which have been applied in a manner that will not reduce the strength of the pipe or coupling or otherwise damage them.

2. Testing and Inspection: All pipe shall be tested and inspected at the place of manufacturer for all requirements of the AWWA C900 standards latest revision. Certified copies of the test reports covering each shipment shall be submitted to the Engineer prior to laying.

B. Interior PVC Lines: Polyvinyl chloride pipe shown on the Drawings to be installed inside of structures, or for gaseous chlorine, acid or other chemicals, shall have solvent weld joints except as noted. Sufficient unions shall be provided to facilitate maintenance of all lines. PVC pipe shall be Schedule 80, Type 1, Grade 1, National Sanitation Foundation approved and shall conform to

Commercial Standard, CS 207, latest revision, ASTM D-1734 and ASTM D-1785, latest revision, as applicable to Type 1, Grade I polyvinyl chloride plastic pipe, Schedule 80 water pressure ratings. Fittings shall comply with ASTM D-2467.

1. Valves: Valve material shall meet requirements of Type 1, Grade I polyvinyl chloride as outlined in ASTM D-1784, with seats and seals as required by usage. Ball valves shall carry a pressure rating of 150 psi, W.O.G. at 75° F. All wetted surfaces shall be of a material not affected by chemicals to be transported.

2. Testing and Inspection: Pipe shall be all tested and inspected at the place of manufacture for all requirements of the latest ASTM and Commercial Standard tests, and certified copies of the test reports covering each shipment shall be submitted to the Engineer prior to laying.

   All pipe used for liquid or gaseous chlorine shall be tested with ammonia solution as recommended by the manufacturer of the chlorination equipment.

7.05 Ductile Iron Pipe for Forcemains: Ductile Iron Pipe for forcemains shall be as specified and shall be lined with Tnemec 431 ceramic epoxy or an approved equal. Lining shall be applied according to the manufacturer's recommendations.

7.06 High Density Polyethylene Pipe and Fittings: High density polyethylene pipe (HDPE) and fittings may be bid as an alternate for use as potable water lines and sewage force mains and spray irrigation lines unless noted otherwise on the drawings or specified herein in the sizes and pressure classes indicated on the Drawings for PVC pipe.

A. Materials: The pipe and fittings shall be made of High Density, Extra High Molecular Weight (EHMW) polyethylene with a standard thermoplastic material designation code of PE 3408 and having a cell classification of 345444E per ASTM D3350. The molecular weight category shall be extra high (250, 000 to 1,500,000) as per Gel Permeation Chromatography determination procedure with a typical valve of 300,000 to 330,000. The pipe shall be manufactured in accordance with ASTM F714 and/or ASTM D3035. The pipe shall be permanently color coded indicating the pipe service as follows:

- Blue or blue stripes: potable water
- Green or green stripes: non-portable water, wastewater, sewage

1. Stripes printed or painted on the pipe outside surface shall not be acceptable.

2. The polyethylene pipe manufacturer shall provide certification that stress regression testing has been performed on the product. The certification shall include a stress life curve per ASTM D2837, the stress regression testing has been performed in accordance with ASTM D2837, and the manufacturer shall provide a product supplying a minimum Hydrostatic Design Basis (HDB) of 1,600 psi at 73° F and 800 psi at 140° F as determined by ASTM D2837.

3. The manufacturer's certification shall state that the pipe was manufactured from one specific resin in compliance with these specifications. The certification shall state the specific resin used and its source.

4. HDPE pipe manufactured from materials meeting the specifications of this section shall have an Environmental Stress Crack Resistance of no failures in 10,000 hours when tested in accordance with ASTM F1248.

B. Pipe and Fittings: HDPE pipe and fittings shall be pressure rated using certified HDB data. Pipe supplied shall have a nominal iron pipe size (DIPS) outside diameter unless otherwise specified. The Dimension Ration (DR) and pressure rating of the pipe at 73 F shall match the following schedule:

- DR 9 - 200 psi

1. The pressure class supplied shall be as indicated on the plans for PVC pipe.

2. The pipe manufacturer shall include a print line on the pipe indicating the manufacturer's name, date of manufacture, the lot and supplier of raw material, plant location and production shift. The material designation as PE 3405 and DR or pressure class shall also be indicated.

3. Polyethylene fittings and pipe shall carry the same pressure rating. All fittings and custom fabrications shall be molded or fabricated by the pipe manufacturer. Butt fusion outlets shall be made to the same outside diameter, wall thickness and tolerances as the mating pipe. All fittings and custom fabrications shall be fully rated for the same internal pressure as the mating pipe. Pressure de-rated fabricated fittings are prohibited.

4. Molded fitting shall be manufactured and tested in accordance with the ASTM D 3261, Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.

5. Fabricated fitting shall be manufactured by heat fusion joining specially machined shapes out from PE 3408 extruded pipe or molded fittings. Fabricated fittings shall be rated for internal pressure service equivalent to the full service pressure rating of the pipe.

C. Pipe and Fittings for Forcemains: HDPE pipe for forcemains shall be one nominal size larger than shown in the drawings.

7.07 Placing Precast Concrete Manholes: Precast concrete manholes or a combination of precast concrete and brick manholes shall be placed or constructed where shown and/or directed by the Engineer. Manholes shall be 4', 5' and 6' in diameter as determined from the schedule of pipe sizes and line deflections, or as shown on the Drawings.

The top of manholes outside of roads, streets highways, and pastures and yards shall be built to grades 2' above ground surface unless otherwise shown on the Drawings. Manholes in roads, etc. shall be built to grade designated by the Engineer. Vented manholes shall be constructed to elevations as shown on the Drawings.

Manholes shall be placed and/or constructed as follows:

A. Precast Concrete Manholes: Precast concrete manholes shall be bedded on not less than 6" of compacted crushed stone at Contractor's expense. The crushed stone shall extend not less than 6" outside the walls of the manhole and shall be compacted under the entire length of pipe within manhole excavation.

1. Connection of Pipe to Manhole: Connections of pipe to manhole for 4" through 15" pipe shall be made with a flexible joint system. The joint system shall be a neoprene or synthetic rubber boot or sleeve either cast or core drilled into the wall of manhole. The boot or sleeve shall be clamped and seated to the pipe with a stainless steel band. The boot or sleeve system shall be "LOCK JOINT FLEXIBLE MANHOLE SLEEVE" as manufactured by Interpace Corporation, Parsippany, New Jersey or "KOR-N-SEAL" as manufactured by National Pollution Control Systems, Inc., Nashua, New Hampshire or equal. Connections of pipe to manhole for 18" pipe and above shall be made with a collar of mortar. The opening between the pipe and the manhole shall have a minimum clearance of 1" and shall be filled from the inside of the manhole with a non-shrink grout.

2. Adjustment: The top of the concentric top section shall have a minimum wall thickness of 8". Grade adjustment shall be performed using concrete grade rings and steel riser rings only. The maximum adjustment for setting the frame and cover to grade shall be 8". Brick will not be allowed to adjust manhole grade.

B. Drop Connections: Drop connections will be required where called for on the Drawings or as determined by the dimensions shown in "Drop Manhole Schedule," shown on the Drawings. Drop pipe shall not be smaller than 8". Generally, drop pipe shall be one size smaller than the sewer which they serve. Openings in walls of precast concrete manholes for drop connections shall not be made at joints. Drop connection fittings and riser pipe shall be encased in brick and mortar or formed Class "C" concrete. Drop connections for both brick and precast concrete manholes shall conform to typical details as shown on the Drawings. Drop connections shall be carefully backfilled to prevent dangerous side pressures.

C. Manhole Inverts: Manhole inverts shall be carefully constructed with cement grout, Class "B" concrete or cement mortar brickwork; special care shall be taken to lay the channel and adjacent pipes to grade. Cement mortar shall be made of one (1) part cement and two (2) parts clean sharp sand. Channels shall be properly formed, rounded and troweled smooth. The connections of the sewer with the wall and channel of the manhole shall be tight and smooth.

D. Manhole Steps: Manhole steps shall conform to the details shown. Steps for precast concrete manholes shall be installed along a vertical centerline on approximately 14" to 16" centers.

E. Manhole Frames and Covers: Manhole frames and covers shall be as detailed and shown on the Drawings and as called for in the Proposal and shall include setting to finished grade as required and grouting in place.

F. Payment: Payment for precast concrete manholes will be made from actual field measurements to the nearest 0.1' as stated in the Proposal. Measurement for payment will be made from manhole invert to top of precast concrete cone. Payment for drop connections will be made at the unit prices stated in the Proposal, and shall include all necessary pipe, pipe fittings, brick or concrete encasement of drop pipe and extension of manhole base slab. Measurement for payment shall be from invert of TEE to invert of ELL. Payment for manhole frames and covers will be made in accordance with the unit prices stated in the Proposal for the various types. No extra payment will be made for 6" of compacted crushed stone bedding under manhole, for manhole steps, for constructing manhole inverts, manhole testing or for furnishing and laying future sewer connections, the cost thereof to be included in the unit prices bid for manhole construction.

7.08 Unloading, Hauling, Distributing and Storing Pipe and Related Materials: The Contractor shall unload, haul, distribute, and store pipe and related materials as follows.

A. Unloading: Equipment and facilities for unloading, hauling, distributing and storing materials shall be furnished by the Contractor and shall at all times be available for use in unloading materials. Delays in unloading railroad cars, unloading trucks, or hauling from freight terminal, which incur demurrage, truck waiting charges or terminal charges shall be at the expense of the Contractor.

B. Handling: Pipe, fittings, and other material shall be carefully handled so as to prevent breaking and/or damage. Pipe may be unloaded individually by hand but shall not be unloaded by rolling or dropping off of trucks or cars. Preferred unloading is in units using mechanical equipment, such as forklifts, cherry pickers or front-end loaders with forks. If forklift equipment is not available, units may be unloaded with use of spreader bar on top and nylon strips or cables (cushioned with rubber hose sleeve) looped under the unit.

C. Distributing: Materials shall be distributed and placed so as to least interfere with traffic. No street or roadway may be closed without first obtaining permission of the proper authorities. The Contractor shall furnish and maintain proper warning signs and obstruction lights for the protection of traffic along highways, street and roadways upon which material is distributed. No distributed materials shall be placed in drainage ditches.

D. Storage: All pipe, fittings, and other materials, which cannot be distributed along the route of the work, shall be stored for subsequent use when needed. The Contractor shall make his own arrangements for the use of storage areas; except that, with permission, he may make reasonable use of the Owner’s storage yards.

1. Ductile Iron Pipe: Ductile iron pipe must be stockpiled on level ground. Timbers must be placed under the pipe for a base and to prevent dirt and debris from washing into the pipe.

2. PVC Pipe: PVC pipe must be stockpiled on level ground. If pipe is unloaded individually by hand, timbers must be used under the pipe for a base, spaced the same as factory load, with stop blocks nailed at either

end. Stockpile must be built up the same manner as it was stocked for shipment, transferring dunnage and chock-blocks from load to stockpile. Individual lengths of pipe shall not be stacked in piles any higher than 5'.

If pipe is unloaded in units, the units must be placed on level ground and shall not be stacked more than 2 units high. Units must be protected by dunnage in the same way they were protected while loaded on the truck or car. The dunnage must support the weight of all units so that pipe lengths do not carry the weight of the unit loaded above.

If pipe is to be stored outside and exposed to sunlight for a number of months, the pipe must be protected by covering with canvas or other opaque material. The cover shall be loose enough to allow for air circulation around the pipe. The use of clear plastic sheets will not be permitted.

7.09 General Provisions for Laying Exterior Metal Pipe Lines: The Contractor shall lay all pipe and fittings to accurately conform to the lines and grades established by the Engineer as follows:

A. Handling: Proper and suitable tools and equipment, for the safe and convenient handling and laying of pipe, shall be used; great care shall be taken to prevent the pipe and coatings from being damaged. All pipe shall be carefully examined for cracks and other defects, and no pipe and other castings shall be laid which are known to be defective. If pipe and other castings are discovered to be cracked, broken and defective after being laid, it shall be removed and replaced with sound material, at no additional expense to the Owner. All pipe and fittings shall be thoroughly cleaned before being laid, and shall be kept clean until accepted in the complete work.

B. Alignment and Gradient: Pipe line alignment and gradient shall be straight, or shall follow true curves as near as is practicable. Curvature in pipe lines, where required, shall be well within the allowable horizontal or vertical laying radius.

C. Schedule of Work: Excavation, cleaning, laying, jointing, and backfilling shall be kept up as closely as is possible so as to progress the work in a uniform workmanlike manner. In no case shall pipe be left in the trench overnight without completing the jointing.

The completed pipe line shall not be left exposed in the trench unnecessarily; the Contractor shall backfill and compact the trench as soon as is possible after laying and jointing is completed. Each day at the close of work, and at all times when laying is not in progress, the exposed end of the pipe line in the trench shall be closed with an approved head or barrier of wood or metal. If at any time it becomes necessary to cover the end of an incomplete pipe line with backfill, the end of that pipe shall be closed with a mechanical joint plug.

D. Cleaning: The Contractor shall clean each joint of pipe while it is suspended before it is lowered into the trench. The Contractor shall keep exposed ends of the pipe properly plugged during laying to prevent dirt and other materials from

entering the line, and shall, before the system is accepted, thoroughly clean all lines.

E. Laying Pipe in Trenches: When laying pipe in trenches, care shall be taken to give the pipe solid bearing throughout its entire length. Due to the low bearing capacity of the soil as detailed in the Geotechnical Report, Contractor shall undercut the trench 6-inches and backfill with crusher run stone or crushed stone ¾-inch in size and less. The stone shall be brought to the subgrade required by the class of bedding for the particular location and compacted. All unsuitable excavated material must be properly disposed of in a manner acceptable to the Owner in a manner that will not adversely impact the environment. The earth used in refilling trenches, from the bottom of the trench, under and up to 2' over the top of the pipe line, shall be of selected material, carefully packed, and tamped and rammed with proper tools for the purpose. Pipe in rock trenches shall be carefully bedded in 4" minimum fine selected material. Extreme care should be exercised to prevent contact with the rock. All tees and bends in pipe lines shall be firmly blocked with Class "B" concrete to the dimensions shown on the Drawings or as directed by the Engineer, placed between fittings and the vertical face of the trench; all exposed pipes, valves, hydrants, etc., shall be securely strapped, and all ends and bends shall be properly blocked.

F. Mechanical Jointing: Mechanical joints shall be made only by experienced mechanics. Sockets and spigots shall be washed with soapy water before slipping gland and gasket over spigot. The spigot shall be inserted in the socket full depth. The gasket shall be brushed with soapy water and shall be pushed into position, making sure the gasket is evenly seated in the socket. The gland shall be laid into position for compressing gasket. All bolts and nuts shall be tightened “fingertight”, after which bolts shall be tightened to a uniform permanent tightness using a torque wrench for tightening. Bolts shall be tightened alternately 180° apart. Sockets, spigots, gaskets, glands, and bolts shall be kept clean and wet with soapy water until each joint is completed. Suitable bell holes shall be cut in the bottom of the trench at the location of joints in order to secure a uniform bearing of the pipe in the trench. Gaskets of high quality EPDM meeting the requirements of ASTM D200 shall be used for air piping.

G. Flanged Connections: Flanges shall have 125# AN91 drillings. Gaskets of rainbow rubber, or equal, with cloth inserts shall be used. Flanges shall be firmly bolted with machine bolts of the proper size and threaded. The bolts and nuts shall be of the best quality refined bar iron, with good, true threads, and shall be tightened in a manner which will evenly distribute the stress in the bolts and bring the pipe into uniform alignment.

H. Jointing Bell-Spigot Connections: All bell-spigot connections shall be jointed with a molded rubber gasket. The inside of the bell, and the outside of the pipe, shall be thoroughly cleaned. Only joint runners in good condition shall be used in the work.

1. Gasket: All joints shall be made with best quality molded rubber gasket, properly installed in accord with manufacturer's printed recommendations.

2. Defective Joints: All defective joints shall be replaced to the satisfaction of the Engineer.

I. Push-On Joints: Joints shall be made in accord with the manufacturer's printed instructions.

J. Cutting: Whenever pipe and special castings are required to be cut, the cutting shall be done by skilled workmen; cutting torches shall not be used.

7.10 Installation of HDPE Pipe (by Trenching and Directional Boring): The pipe shall be installed where shown on the drawings by directional boring method.

A. Technique

1. A pilot hole shall be drilled from the limits shown and continue under the river as shown on the profile made of straight tangents and long radius arcs. The drill path shall be monitored by an electronic package housed in the pilot drill string near the cutting head.

2. After the pilot hole is complete, the hole shall be prereamed to the diameter required to accommodate the pipe. Slurry, if required, shall be pumped into the hole to maintain the integrity of the hole and flush out cuttings. The slurry shall be collected to containment pits and shall be disposed off by the boring subcontractor in a manner with federal and state rules and regulations.

3. After the drill hole is enlarged the HDPE pipe can be pulled back through it as it is being assembled on the bank. The reamer shall be attached to the drill string, and then connected to the pipeline pullhead via a swivel. Slurry, if required, shall be circulated in the hole. Pullback shall continue until the reamer and pipeline breaks the ground at the drilling rig.

B. The Contractor shall provide as-built drawings of the cross-sectional installation of the directional bore hole.

C. HDPE Pipe installed by directional boring shall be one nominal size larger than shown in the drawings.

D. HDPE Pipe installed by directional boring shall include transition fittings to PVC pipe of size shown in the plans.

E. Prior to connecting the HDPE pipe to the pipe on bank the pipe in the bore hole shall be pressure tested for 2 hours at a pressure of 150 psi. If any leakage occurs the pipe shall be removed and replaced in the bore hole.

F. Payment: The price bid for installation of the HDPE pipe shall include all necessary mobilization, setup, containment pit, slurry disposal, protective service, connection to pipe on each end of the bore, carrier pipe and miscellaneous materials and work required for a complete installation. All excavations shall be unclassified. Payment for the bore and pipe installed shall be for the total length of pipe installed in the bore hole at the unit price as bid in the Proposal.

G. Joining HDPE Pipe: Joints between plain end pipes and fittings shall be made by butt fusion, and joints between the main and saddle branch fitting shall be made using saddle fusion according to the manufacturer's recommended procedures.

1. The manufacturer shall provide training in the manufacturer's recommended butt fusion and saddle fusion procedures to the Contractor and inspector representing the Owner. The fusion equipment and operator shall be required to demonstrate success full field experience.

2. Mechanical Jointing: Polyethylene pipe and fittings may be joined together or to other materials by means of flanged connections (flanged adapters and back-up rings) or mechanical couplings designed for jointing HDPE pipe or for joining HDPE to another material. Mechanical couplings shall be full pressure rated and fully thrust restrained.

H. Trench Installation of HDPE Pipe:

1. Excavation: Trench excavations shall conform to Section 6.35 of these Specifications. Excess groundwater shall be removed by the Contractor. Where necessary, trench walls shall be shored or reinforced.

2. Large Diameter Fabricated Fittings: Fabricated directional fittings 16" IPS and larger shall be butt fused to the end of a pipe. The flanged directional outlet connections shall be made up in the trench.

3. Mechanical Joint and Flange Installation: Mechanical joints and flange connections shall be installed in accordance with the manufacturer's recommended procedure. Flange faces shall be centered and aligned to each other before assembling and tightening bolts. In no case shall the flange bolts be used to draw the flanges into alignment.

4. Foundation Bedding: Pipe shall be laid on grade and on a stable foundation. Unstable or mucky trench bottom soils shall be removed, and a six (6") inch foundation or #57 stone or sand shall be installed to pipe bottom grade. Excess groundwater shall be removed from the trench before laying the foundation or bedding and the pipe. A trench cut in rock or stony soil shall be excavated to six (6") inches below pipe rock, boulders and large stones shall be removed.

5. Pipe Handling: When lifting with slings, only wide fabric choker slings shall be used to lift, move, or lower pipe and fittings. Wire rope or chain shall not be used. Slings shall be of sufficient capacity for the load and shall be inspected before use. Worn or defective equipment shall not be used.

6. Backfilling: Backfilling shall commence as established in these specification.

7.11 Highway Crossing: The Contractor shall install pipe lines across highways in accordance with the applicable regulations of the State Department of Transportation and as shown on the Drawings. All work shall conform to the "Construction Along Highways, Streets

and Roadways" section of these Specifications. Permits for highway crossings will be obtained by the Owner.

A. Payment: No separate payment will be made for the above work. The cost of the above work, and all costs incidental thereto, shall be included in the unit prices bid for the item to which the work pertains.

7.12 Steel Pipe Casing: The Contractor shall furnish steel pipe casing and related materials as follows:

A. Steel Pipe Casing: Steel pipe casing shall be manufactured from steel conforming to ASTM A 252 Grade 2, as amended to date, with a minimum yield strength of 35,000-psi before cold forming. Pipe may be straight seam or spiral weld. A protective coating will not be required.

1. Diameter and Wall Thickness: The diameter and wall thickness of steel pipe casing shall be as shown on the Drawings.

7.13 Installation Steel Pipe Casing by Boring and Jacking: Where called for on the Drawings, casing, sewer line or force mains shall be installed by the boring and jacking method.

A. This section pertains to the boring and jacking of casing for short lengths of sewers or force mains under railroads and private right of way, highway, streets and similar features to the limits shown on the Drawings and as herein specified, including the installation of sewers (carrier pipes) generally 24" or less in diameter inside said casing pipe.

B. The work is herein defined as the operations in which both the boring auger and the jacking of the casing or carrier pipe are done mechanically, and in which the diameter of the casing pipe is too small to permit hand working at the heading of the casing pipe. Two basic methods are (1) pushing the casing into the fill or earth simultaneously as the boring auger drills out the ground; and (2) drilling the hole through the fill or earth and pushing the casing into the hole after the drill auger has completed the bore.

A suitable boring pit shall be opened adjacent to the slope of the embankment or adjacent to point of bored and jacked section as shown on the Drawings. The boring pit shall be long enough to accommodate the selected working room. The boring pit shall be solid sheeted, braced and shored as necessary to provide a safe operation. The Contractor shall take all precautions and shall comply with all requirements as may be necessary to protect private or public property. Guide timbers or rails for keeping the casing pipe on line and grade shall be accurately set and maintained in the bottom of the pit and with heavy timber back-stop supports installed at the rear of the pit to adequately take thrust of the jacks without any movement or distortion. It is important in the boring and jacking operation that extreme care be taken in setting all guides, rails and jacks such that the final position of the casing pipe be within the limits of acceptability for the placing and laying of the carrier pipe. Except as otherwise limited on the Drawings, variations in grade elevation not exceeding 4" from the established line and grade will be considered acceptable within these Specifications, subject to the Engineer's approval.

C. In general, the diameter, thickness, style, joints and materials selected for casing pipe shall be as shown on the Drawings and shall be considered as "minimum" requirements, all subject to prior approval of the Engineer. In all cases, the approval for construction by agreement with the private company and/or construction permit issued by the state, county or municipal agency will be required before construction starts.

D. Installation of Pipe Line: After installation of the casing pipe is complete, the carrier pipe shall be installed through the casing pipe as shown on the Detail Drawings. In general, carrier pipes will be PVC or cast iron/ductile iron with mechanical or push-on joints. Joints shall be assembled adjacent to the casing pipe and the assembly pushed through the casing pipe. Carrier pipe shall be inserted within a casing by use of a stainless steel casing spacer as manufactured by Cascade, PSI, or approved equal. Wooden skids shall not be acceptable. Casing spacers shall center the carrier pipe in the casing and prevent the bell of the pipe from touching casing. For non-PVC carrier pipe, one spacer shall be placed not more than 2' from each end of the casing with subsequent spacers at 8' intervals. For PVC carrier pipe, one spacer shall be placed at the spigot end of each pipe segment at the insertion limit line with subsequent spacers at 6' intervals. No joint shall be more than 2' from a spacer. For carrier pipes less than 24" diameter, the spacer shall have 4 runners. For carrier pipe greater than 24" diameter, the spacer shall have 6 runners. Each end of the casing shall be sealed using a pull-on or wrap-around rubber seal with stainless steel bands.

E. Payment: The price bid for installation of the steel casing shall include all necessary excavation and sheeting for pit, protective service and all other miscellaneous materials and work required for a complete installation. All excavation for pit and bore shall be unclassified. Payment for steel pipe casing and carrier pipe installed in casing shall be for total number of feet installed. Pipe installed through pit area shall be paid for by applicable cut bracket.

7.14 Removing and Resetting Fences, Structures, Etc.: At all locations where existing fences, railings or other existing structures must be removed to permit construction of the sewer, the Contractor shall remove the structures and as the sewer construction progresses reset the structures in their original location and to their original condition. During construction, the Contractor shall provide temporary fencing or employ other safeguards which will prevent livestock from wandering to other property.

A. Payment: Unless specifically included in the proposal form, no extra payment will be made for removing and resetting fences, the cost thereof to be included in the prices bid for sewers.

7.15 Protection of Other Utilities and Structures: Damage to existing utility lines, services, poles and structures shall be repaired or replaced by the Contractor at his own expense. The approximate positions of certain known underground lines are shown for information. A minimum clearance of 10' horizontal and 18" vertical must be maintained between new sewer lines and existing water mains. Existing small lines are not shown. The Contractor shall locate existing small lines and other possible unknown existing utility lines with an electronic pipe finder and shall excavate and expose all existing

underground lines in advance of trenching operations. Removing and relaying of those lines and appurtenances which constitute an obstruction to the completed line and grade of the new work, in the opinion of the Engineer, will be made at the expense of the Owner, unless otherwise shown on Drawings to be altered by the Contractor.

7.16 Location and Grades: The line and grade of the sewer and drain, and the positions of all manholes and other structures and other appurtenances shall be laid out by the Contractor. The Contractor shall locate existing manholes to determine alignment and grade. Alignment and grade shall match the existing unless otherwise approved. All lines and grades shall be subject to checking by the Engineer, but that checking shall in no way relieve the Contractor from responsibility for the correctness. The Contractor shall provide such field men and assistance as the Engineer may request and such hubs, stakes, spikes, nail and other fastenings as may be required in establishing and checking all controlling lines and grades.

The Contractor shall furnish the Engineer with cut sheets for each line. Cut sheets shall show line number and in 50' increments invert, center line elevation and center line cut. Sample cut sheet will be provided by the Engineer. Existing sewer lines and service lines shall be replaced to match existing line and grade unless otherwise shown or approved by the Engineer.

7.17 Laying Gravity Sewer Pipe: All sewer pipe shall be laid upgrade; the spigots shall point downgrade. Minimum cover shall be 4'. Where cover is less than 4', ductile iron pipe must be used. The pipe and specials shall be laid in the trench so that, after the line is completed, the interior surface shall conform on the bottom accurately to the grades and alignment fixed or given by the Engineer and laid out by the Contractor. The interior of all pipes shall be carefully freed of all dirt and superfluous material of every description, as pipe laying proceeds. Defective joints discovered after laying shall be repaired and made tight. Defective pipe shall be removed and proper replacement made.

A. PVC Pipe with Elastomeric Joints: Proper implements, tools and equipment shall be used for placement of the pipe in the trench to prevent damage. Under no circumstances may the pipe be dropped into the trench. In subfreezing temperatures, caution shall be exercised in handling pipe to prevent impact damage. All pipe shall be carefully examined for cracks, nicks, gouges, severe scratches, voids, inclusions and other defects before laying. If any pipe is discovered to be defective after having been laid, it shall be removed and replaced with sound material at the expense of the Contractor.

1. Assembly of Gasketed Joint: The assembly of the gasketed joint shall be performed as recommended by the pipe manufacturer. The elastomeric gaskets may be supplied separately in cartons or pre-positioned in the bell joint or coupling at the factory. When gaskets are color coded, the Contractor shall consult the pipe manufacturer or his literature for the significance. In all cases, the gasket, the bell or coupling interior, especially the groove area (except when gasket is permanently installed) and the spigot area shall be cleaned with a cloth, brush or paper towel to remove any dirt or foreign material before the assembling. The gasket pipe spigot bevel, gasket groove, and sealing surfaces shall be inspected

for damage or deformation. When gaskets are separate, only gaskets, which are designed for and supplied with the pipe shall be used. They shall be inserted as recommended by the manufacturer.

Lubricant used shall be supplied by the pipe manufacturer and shall be applied as specified by the pipe manufacturer.

2. Assembly of Pipe Joints: After lubrication, the pipe is ready to be joined. Good alignment of the pipe is essential for ease of assembly. Align the spigot to the bell and insert the spigot into the bell until it contacts the gasket uniformly. Do not swing or "stab" the joint; that is, do not suspend the pipe and swing it into the bell. The spigot end of the pipe is marked by the manufacturer to indicate the proper depth of insertion. The pipe should be inserted up to this line.

   If undue resistance to insertion of the pipe end is encountered or the reference mark does not position properly, the joint shall be disassembled and the position of the gasket checked. If it is twisted or pushed out of its seat ("fishmouthed"), the Contractor shall inspect components, repair or replace damaged items, clean the components and repeat the assembly steps. Both pipe lengths must be concentric alignment. If the gasket was not out of position, the Contractor shall verify proper location of the reference mark. The reference mark shall be relocated if it is out of position.

3. Field Cut: Field cut pipe to be joined shall be square cut using a hacksaw, handsaw or power saw with a steel blade or abrasive disc. The pipe shall be marked around its entire circumference prior to cutting to assure a square cut. A factory-finished beveled end shall be used as a guide for proper bevel angle, and depth of bevel plus the distance to the insertion reference mark. The end may be beveled using a pipe beveling tool or a wood rasp to cut the correct taper. A portable sander or abrasive disc may be used to bevel the pipe end. Any sharp edges on the leading edge of the bevel must be rounded off with a pocketknife or a file.

4. Payment: Measurement for payment of sewer lines shall be made along the top of the pipe from center to center of manholes and from center of main to end of pipe for house service lines. The unit price stated in the Proposal shall include all costs of constructing the sewer line unless otherwise specified for payment in the Proposal or these Specifications.

B. Ductile Iron Pipe with Mechanical or Push-on Joints: Proper and suitable tools and equipment shall be used for the safe and convenient handling and lying of ductile iron pipe. Care shall be taken to prevent damage to the exterior coating and interior cement lining. All pipe shall be carefully examined for cracks and other defects before laying. If any pipe or fitting is discovered to be defective after having been laid, it shall be removed and replaced with sound material at the expense of the Contractor. Whenever pipe is required to be cut, the cutting shall

be done by skilled workmen using an abrasive wheel cutter. Use of a cold chisel or oxyacetylene torch will not be permitted.

1. Mechanical Joints: Mechanical joints shall be made only by experienced mechanics. Sockets and spigots shall be washed with soapy water before slipping the gland and gasket over the spigot end of the pipe.

   The spigot shall be inserted into the socket full depth, then backed off ¼" to provide clearance for expansion. The gasket shall be brushed with soapy water and shall be pushed into position making sure that it is evenly seated in the socket. The gland shall then be moved into position for compressing the gasket. All bolts and nuts shall be made "finger- tight."

   For joints made in trenches, the bolts shall be tightened to a uniform permanent tightness using a torque wrench for tightening. Bolts shall be tightened alternately 180° apart.

2. Push-On Joints: The groove and bell socket shall be thoroughly cleaned and lubricated before the gasket is inserted. Before inserting the gasket, it shall be thoroughly lubricated and manufacturer's instructions shall be followed for proper facing and seating of gasket. After the gasket is in place and just prior to joint assembly, a generous coating of lubricant shall be applied to the exposed gasket surface. The lubricant used shall be a lubricant supplied by the pipe manufacturer.

   The plain end shall be inspected and any sharp edges which might damage the gasket shall be removed by means of a file or power grinder. Pipe that is cut in the field must be ground and beveled before assembly. Prior to inserting the plain end of the pipe into bell socket lubricant shall be applied to the beveled nose of the pipe.

   Small pipe may be pushed home with a long bar, but large pipe may require additional power such as a jack, lever or backhoe. A timber header shall be used between the bell and bar or other power to avoid damage to the pipe.

   During assembly of the pipe, the joint must be kept straight while pushing. Pipe may be deflected if desired but only after the assembly is completed.

3. Mechanical Joint or Push-On Joint Pipe on Piers: Mechanical or push-on joint pipe may be used on piers in gravity sewer lines. Pipe shall be laid with ¼" clearance in each joint to provide for expansion. Jointing of pipe shall be as described above. On mechanical joint pipe, the bolts shall be tightened alternately 180° apart but be left "finger-tight" until the sewage is diverted into the sewers; then bolts shall be further tightened a sufficient amount which will prevent leakage of the joint but which will not prevent slippage that may occur because of temperature stresses.

4. Payment: Measurement for payment of ductile iron pipe constructed on piers, in trenches, in casings or in tunnels will be from end to end or inside wall to inside wall of manhole unless lump sum payment is provided for herein.

7.18 Excavation for Trenches: Excavation of pipe trenches shall include all excavation of every description and whatever substance encountered and shall include disposal of all rock excavation and shall include disposal of excess earth excavation not required for backfilling of trenches.

A. Depth of Trenches: The minimum cover over the top of the pipe shall be 4' unless otherwise directed by the Engineer. Where obstructions are encountered, minimum depth may be changed to avoid interference.

B. Width of Trenches: Trenches shall be excavated sufficiently wide to allow proper installation of pipe, fittings and other materials, and to not less than 6" clear of the outside barrel of the pipe on any side at any point.

C. Bell Holes: Bell holes of ample depth and width shall be excavated in pipe trenches at the location of each joint to permit the joint to be properly made.

D. Earth Excavation: Earth excavation shall include all excavation of whatever substance encountered, except rock excavation, as further provided for in these Specifications. In locations where pipe is to be bedded in earth excavated trenches, the bottom of such trenches shall be fine graded to allow firm bearing for the bottom of the pipe on undisturbed earth. Where any part of the trench has been excavated below the grade of the trench, the part excavated below such grade shall be filled in with bank sand and compacted at the Contractor's expense.

E. Rock Excavation: Rock excavation shall comprise solid rock in the original bed, or in well defined ledges, the removal of which in the opinion of the Engineer requires drilling, blasting, or the use of jack hammers or bottle points, and shall also include boulders or detached pieces of rock 8 cubic feet or more in content.

Blasting operations shall be conducted in strict accordance with all blasting ordinances and regulations and all blasting shall be done as directed by the Engineer. All exposed structures shall be carefully protected from the effects of blast and all blasts shall be covered with heavy timbers, mats or suitable protection. The blasting shall be done only by experienced men. Very light charges must be used to prevent damages to adjacent structures.

No blasting operations shall be started without the Engineer’s review of method and quantity of explosive to be used. Any damage done shall be promptly repaired by the Contractor at his own expense. Where there are no local ordinances governing blasting and the storage of explosives, all blasting supplies shall be stored in a manner discussed with the Engineer and a watchman shall be stationed at all times at the place of storage. In no case shall caps or other explosives be kept at the place where dynamite or other explosives are stored.

7.19 Dewatering Trenches: Where groundwater is encountered, the Contractor shall make the effort necessary to secure a dry trench bottom before laying pipe. In sandy and in other

suitable type soils, dewatering shall be done by well pointing. If, in the opinion of the Engineer, the Contractor has failed to obtain an absolutely dry trench bottom by insufficient use of all known methods of trench dewatering, the Engineer may order the Contractor to excavate below grade and place not less than 6" of graded crushed stone fill material over the trench bottom to form trench drains to suitable located sumps and the water removed by bailing or pumping. The graded crushed stone fill material shall be placed at the Contractor's own expense and shall be of such depth that there shall be no water in bell holes at the time of coupling pipe. All unsuitable excavated material must be properly disposed of in a manner acceptable to the Engineer and in a manner that will not adversely impact the environment.

A. Payment: All costs of equipment, labor and materials required for dewatering shall be included in the bid price for sewers and/or drains.

7.20 Placing Precast Concrete Manholes: Precast concrete manholes or a combination of precast concrete and brick manholes shall be placed or constructed where shown and/or directed by the Engineer. Manholes shall be 4', 5' and 6' in diameter as determined from the schedule of pipe sizes and line deflections, or as shown on the Drawings.

The top of manholes outside of roads, streets highways, and pastures and yards shall be built to grades 2' above ground surface unless otherwise shown on the Drawings. Manholes in roads, etc. shall be built to grade designated by the Engineer. Vented manholes shall be constructed to elevations as shown on the Drawings.

Manholes shall be placed and/or constructed as follows:

A. Precast Concrete Manholes: Precast concrete manholes shall be bedded on not less than 6" of compacted crushed stone at Contractor's expense. The crushed stone shall extend not less than 6" outside the walls of the manhole and shall be compacted under the entire length of pipe within manhole excavation.

1. Connection of Pipe to Manhole: Connections of pipe to manhole for 4" through 15" pipe shall be made with a flexible joint system. The joint system shall be a neoprene or synthetic rubber boot or sleeve either cast or core drilled into the wall of manhole. The boot or sleeve shall be clamped and seated to the pipe with a stainless steel band. The boot or sleeve system shall be "LOCK JOINT FLEXIBLE MANHOLE SLEEVE" as manufactured by Interpace Corporation, Parsippany, New Jersey or "KOR-N-SEAL" as manufactured by National Pollution Control Systems, Inc., Nashua, New Hampshire or equal. Connections of pipe to manhole for 18" pipe and above shall be made with a collar of mortar. The opening between the pipe and the manhole shall have a minimum clearance of 1" and shall be filled from the inside of the manhole with a non-shrink grout.

2. Adjustment: The top of the concentric top section shall have a minimum wall thickness of 8". Grade adjustment shall be performed using concrete grade rings and steel riser rings only. The maximum adjustment for setting the frame and cover to grade shall be 8". Brick will not be allowed to adjust manhole grade.

B. Precast Concrete and Brick Manholes: Manholes may be precast concrete or other material as approved by the Engineer.

C. Drop Connections: Drop connections will be required where called for on the Drawings or as determined by the dimensions shown in "Drop Manhole Schedule," shown on the Drawings. Drop pipe shall not be smaller than 8". Generally, drop pipe shall be one size smaller than the sewer which they serve. Openings in walls of precast concrete manholes for drop connections shall not be made at joints. Drop connection fittings and riser pipe shall be encased in brick and mortar or formed Class "C" concrete. Drop connections for both brick and precast concrete manholes shall conform to typical details as shown on the Drawings. Drop connections shall be carefully backfilled to prevent dangerous side pressures.

D. Manhole Inverts: Manhole inverts shall be carefully constructed with cement grout, Class "B" concrete or cement mortar brickwork; special care shall be taken to lay the channel and adjacent pipes to grade. Cement mortar shall be made of 1 part cement and 2 parts clean sharp sand. Channels shall be properly formed, rounded and troweled smooth. The connections of the sewer with the wall and channel of the manhole shall be tight and smooth.

E. Manhole Steps: Manhole steps shall conform to the details shown. Steps for precast concrete manholes shall be installed along a vertical centerline on approximately 14" to 16" centers.

F. Manhole Frames and Covers: Manhole frames and covers shall be as detailed and shown on the Drawings and as called for in the Proposal and shall include setting to finished grade as required and grouting in place.

G. Payment: Payment for precast concrete manholes will be made from actual field measurements to the nearest 0.1' as stated in the Proposal. Measurement for payment will be made from manhole invert to top of precast concrete cone. Payment for drop connections will be made at the unit prices stated in the Proposal, and shall include all necessary pipe, pipe fittings, brick or concrete encasement of drop pipe and extension of manhole base slab. Measurement for payment shall be from invert of TEE to invert of ELL. Payment for manhole frames and covers will be made in accordance with the unit prices stated in the Proposal for the various types. No extra payment will be made for 6" of compacted crushed stone bedding under manhole, for manhole steps, for constructing manhole inverts, manhole testing or for furnishing and laying future sewer connections, the cost thereof to be included in the unit prices bid for manhole construction.

7.21 Bracing and Sheeting: The sides of all trenches and excavations for sewer shall be securely held by stay bracing or by skeleton or solid sheeting and bracing as required by the soil conditions encountered unless otherwise permitted by the Engineer.

A. Non Steel Sheeting: No timber for shoring, bracing and sheeting exceeding that size customarily used will be paid for unless the use of larger sizes shall have been ordered in writing by the Engineer. Timber sheeting near the bottom of

trenches over 10' deep, for pipe 15" size and larger, shall remain in place and shall be cut off no less than 2' above the top of the completed line. When in the opinion of the Engineer sheeting and bracing cannot be safely removed above this level, it shall be left in place. Sheeting left in place shall be cut off at least 2' below the surface. Bracing and sheeting may be removed in units when the level of the backfilling has reached the point necessary to protect the pipe and adjacent property.

1. Payment: No extra payment will be made for sheeting required for pipeline installation.

B. Steel Sheeting: Continuous interlocking steel sheeting may be substituted for timber sheeting when approved by the Engineer. Steel sheeting may be removed without cutting provided the rate of removal is in pace with tamping and backfilling operations to assure complete filling of the void created by the withdrawal of the sheeting. Complete withdrawal of the sheeting in advance of tamping and backfilling will not be permitted.

1. Payment: No extra payment will be made for sheeting required for pipeline installation.

7.22 Crushed Stone Stabilization: Wherever the subgrade is by nature too soft or mucky for the proper installation of the pipe, in the opinion of the Engineer, he may order the Contractor to undercut the trench and backfill with crusher run stone or crushed stone ¾" in size and less. The stone shall be brought to the subgrade required by the class of bedding for the particular location and compacted. All unsuitable excavated material must be properly disposed of in a manner acceptable to the Owner in a manner that will not adversely impact the environment.

A. Payment: Payment for crushed stone stabilization, only where ordered by the Engineer, will be made in accord with the unit price bid for the item under "Extra Work," measured before placing and shall include the removal and disposal of unsuitable subgrade materials.

7.23 Existing Pipe Lines: Where new pipe line parallels or crosses existing pipe lines, the Contractor shall take precautions as necessary to ensure that such existing pipe lines are not disturbed. Any damage to existing pipe lines shall be promptly repaired at the Contractor's expense.

7.24 Connections to Existing Pipe Lines: Connections to existing pipe lines shall be made with the necessary fittings and valves as indicated on the drawings.

A. Location: The Contractor shall, before opening pipe line trenches, locate the various points of connections to be made into existing pipe lines and shall uncover as necessary for the Engineer to prescribe the type of connections and fittings to be installed.

B. Interruption of Service: Connections to existing pipe lines shall be made only at such times and in such manner as will meet operating requirements. No cut shall be made in existing lines until the permission of the Owner's Superintendent of Utilities has been obtained as to time and manner of making the cuts and

connections. All existing vales shall be operated only by authorized representatives of the Owner.

7.25 Existing Underground Utilities and Obstructions: Certain existing water lines, culverts and cross drains are shown on the Drawings, according to the best information available to the Engineer. The Drawings indicate the pipe lines to be laid over, under or around underground utilities or obstructions where such utilities or obstructions are known to exist. Where these or unforeseen underground utilities or obstructions are encountered, minimum depth of cover or the location and alignment may be changed upon written concurrence by the Engineer to avoid interference. The location of the existing utilities are approximate only. The Contractor is responsible for determining the exact location of all utilities before beginning construction.

The Contractor shall furnish and have available at all times an Electronic Pipe and Cable Finder in working order, for the purpose of locating existing pipe lines or other obstructions in the way or are along the route of the new work.

7.26 Removing Pavement: The Contractor shall remove pavement as necessary for installing the new pipe lines and appurtenances and for making connections to existing pipe lines.

A. Marking: Before removing any pavement, the pavement shall be marked for cuts nearly paralleling pipe lines and existing street lines. Pavement shall be cut back from the top edges of trenches for a distance of at last 12" on each side of the trench to provide solid bearing for the edges of pavement to be replaced. Tunneling will be permitted under existing sidewalks, curbs and gutters, but not under pavement.

Power saws shall be used to cut all types of pavement along marked lines. The pavement shall be sawed to a depth of at least 2" or deeper if the Engineer so directs. "Sawing" is not a separate pay item and the cost thereof shall be included in the overall bid submitted.

B. Machine Pulling: No pavement shall be machine pulled until completely separated along the marked cuts.

C. Damage to Adjacent Pavement: The pavement adjacent to pipe line trenches must not be disturbed or damaged. If the adjacent pavement is disturbed or damaged due to any cause, such as caving ditch banks, indiscriminate use of construction machinery, etc., the Contractor shall remove the damaged pavement and shall replace at his own expense.

D. Stone or Pre-Cast Concrete Curb: The Contractor shall remove and replace or tunnel under any stone or pre-cast concrete curb encountered. No additional payment will be made for removing, replacing or tunneling under said curb.

7.27 Concrete Blocking: The Contractor shall furnish all materials and perform all labor as necessary for installing concrete blocking for fittings, including elbows, tees, and other fittings as shown on the drawings and/or as specified herein.

Concrete blocking shall be formed and poured at the backs of fittings, including elbows, tees, and other fittings as shown on the Drawings and as directed by the Engineer.

Concrete mix shall be 1:2-1/2:3-1/3, and have a compressive strength of not less than 2500 psi after 28 days. Blocking shall be poured against undisturbed earth.

7.28 Organization of Work: The Contractor shall so organize his work that backfilling and cleanup shall closely follow pipe laying operations and manhole construction.

In general, not more than one block of a street or roadway shall be closed for construction at any one time. Before proceeding with trenching operations in a succeeding block, the preceding section shall be backfilled, cleanup completed and the street opened to traffic.

For work outside the streets and roadways, backfilling and windrowing, in accordance with the provisions of "General Backfilling" paragraph shall be performed in such manner that not more than 500' of trench shall remain open at any one time.

Failure on the part of the Contractor to comply with the above provisions in a reasonable manner, in the opinion of the Engineer, shall be sufficient cause for the Engineer to order a temporary shut-down of further trenching and pipe laying operations until the provisions have been met.

7.29 Assembling, Jointing and Laying Pipe and Fittings for Force Main: The Contractor shall assemble, joint and lay all pipe and fittings to accurately conform to the lines and grades established by the Engineer and as follows:

A. Handling: Proper and suitable tools and equipment for the safe and convenient handling and laying of pipe shall be used. Care shall be taken to prevent ductile iron pipe or fittings coating from being damaged, particularly the cement lining on the interior of the ductile iron pipe. All pipe shall be carefully examined for cracks, broken lining or other defects. PVC pipe shall be carefully examined for cracks, nicks, gouges, severe scratches, voids, inclusions and other defects before laying. No pipe or fitting shall be laid which is known to be defective. If any pipe or fitting is discovered to be defective after being laid it shall be removed and replaced with sound material without further charge.

B. Alignment and Gradient: In general, pipe line alignment and gradient shall be straight; however, pipe line may be laid on a curve but must be within the limits of curvature as recommended by the pipe manufacturer. All force mains shall be laid on a minimum rising grade of 0.10% unless otherwise shown on the Drawings. Minimum cover shall be 4'. Where cover is less than 4', ductile iron pipe must be used.

C. Dewatering Trenches: All excavation shall be dewatered properly before laying pipe. Where running sand is encountered, dewatering shall be done by well pointing whenever possible. Where soil conditions are not favorable for use of well point, french drains of graded stone shall be constructed to suitably located sumps, and the water removed by bailing or pumping. All costs of equipment, labor and materials required for dewatering shall be included in the prices bid for pipe lines.

D. Sequence of Work: Excavation, laying, jointing and backfilling shall be kept up as closely as is possible to progress in a uniform, workmanlike manner. The Contractor will be required to backfill and compact the trench as soon as is possible after lying and jointing is completed.

E. Laying Pipe in Trenches: When laying pipe in trenches, care shall be taken to give the pipe solid bearing throughout its entire length. Bell holes shall be excavated in a manner which will relieve pipe bells of all load.

F. Assembling and Installing Ductile Iron Pipe and Fittings: Proper care shall be exercised in the assembly and installation of ductile iron pipe and fittings.

1. Pipe Lines in Earth Trenches: Where pipes are laid in earth excavated trenches, the bottom of such trenches shall be fine graded by skilled workmen to a true line and shall not be laid on loose rock or other hard materials but be bedded on fine, clean undisturbed earth. Over excavation in the bottom of trenches shall be filled to grade with granular material and compacted. Backfill shall be performed as specified herein.

2. Pipe Line in Rock Trenches: Where pipe is laid in rock trenches the bottom of such trenches shall be undercut and the pipe shall be bedded in at least 6" of crushed stone conforming to ASTM C 33, as amended to date, gradation #67, and the trench shall be backfilled with earth, rock dust, clay or sand as specified herein.

3. Installing Ductile Iron Pipe with Mechanical Joints: Pipe and fittings with mechanical joints shall be installed by experienced mechanics. Sockets and spigots shall be washed with soapy water before slipping gland and gasket over spigot. The spigot shall be inserted in the socket full depth. The gasket shall be brushed with soapy water and shall be pushed into position, making sure the gasket is evenly seated in the socket. The gland shall be slid into position for compressive gasket. All bolts and nuts shall be tightened "fingertight," after which bolts shall be tightened to a uniform permanent tightness using a torque wrench for tightening. Bolts shall be tightened alternately 180° apart. Sockets, spigots, glands and bolts shall be kept wet with soapy water until each joint is completed. Any joints which leak shall be remade.

4. Installing Ductile Iron Pipe with "Push-On" Type Joints: The groove and bell socket shall be thoroughly cleaned and lubricated before the gasket is inserted. Before inserting the gasket it shall be thoroughly lubricated, and manufacturer's instructions shall be followed for proper facing and seating of gasket. After the gasket is in place and just prior to joint assembly, a generous coating of lubricant shall be applied to the exposed gasket surface. The lubricant used shall be a lubricant supplied by the pipe manufacturer.

The plain end shall be beveled and inspected, and any sharp edges which might damage the gasket shall be removed by means of a file or power grinder. Pipe that is cut in the field must be ground and beveled before assembly. Prior to inserting the plain end of the pipe into bell socket, lubricant shall be applied to the beveled nose of the pipe.

Small pipe may be pushed home with a long bar. but large pipe will require additional power such as a jack, lever or backhoe. A timber header shall be used between the bell and bar or other power to avoid damage to the pipe.

During assembly of the pipe, the joint must be kept straight while pushing. Pipe may be deflected if necessary but only after the assembly is completed.

7.30 Selected Backfilling: All trenches shall be backfilled immediately after pipes are laid therein, and joints have been inspected by the Engineer, unless other protection of the pipe line is directed. Selected backfill material shall consist of finely divided earth, stone dust, sand, crushed stone, or other approved material carefully placed about the pipe and up to a height of at least 12" above the top of the pipe barrel, and in uniform layers not exceeding 6" in thickness, each layer thoroughly compacted with proper hand tools in a manner which will not disturb and/or injure the pipe. Backfilling shall be carried on simultaneously on both sides of the pipe and in a manner, which will prevent injurious side pressures. If suitable select materials are not available from the trench excavation, the Contractor will be required to obtain the select materials elsewhere.

A. Payment: No extra payment will be made for selected backfill unless on-site material is not acceptable. If borrow material is required for road cut backfill, the cost of furnishing, installing and wasting bad material shall be paid per cubic yard as bid.

7.31 General Backfilling: After selected backfill material has been placed and tamped, the remainder of the trench may be backfilled with general excavated material, except that no rock unless in small shattered fragments will be permitted to be mixed with other backfill material.

A. Street and Road Right of Way, Yards and Other Traveled Areas: In streets and road right of ways, yards and other traveled areas open to vehicular or pedestrian travel the ditch shall be backfilled and each layer shall be tamped to a density equivalent to at least 95% of the Standard Proctor maximum dry density in accordance with ASTM D 698, as amended to date.

Backfill material shall be placed in uniform layers not exceeding 6" in thickness with each layer thoroughly compacted with heavy duty tampers (“Whacker” or equal) to a height of at least 36" or 48" above the top of the pipe barrel.

The remainder of the ditch may be backfilled and tamped in the same manner or if the Contractor so elects he may place backfill in layers not exceeding 12" and use wheel loading or heavy duty power tamping equipment (“Hydro-Hammer” or equal). Pipe shall have at least 36" of cover before wheel loading and at least 48" of cover before using heavy duty tamping equipment (“Hydro-Hammer” or equal).

1. Areas Requiring Pavement Replacement: Mechanical tamping will be required of all backfilling of excavated portions. After backfilling and

tamping as described above is completed the top 6" of the ditch shall be backfilled with compacted crushed stone, ASTM C 33, as amended to date, gradation #67 or #57, with sufficient fines for compaction. Further compaction shall be accomplished by leaving the backfilled trench open to traffic while maintaining the surface with stone. Settlement in trenches shall be refilled with stone, and such maintenance shall continue until replacement of pavement is authorized by the Engineer.

The cost of the 6" of stone and any additional stone used shall be included in unit price bid for replacing pavement.

2. Other Areas: Other areas, including woodlands, fields, pastures and areas not open to vehicular travel and the remainder of the ditch, may be backfilled by placing fill in the ditch and "walking-in" the fill with wheel loaded equipment. Backfill material may be windrowed and maintained in a suitable manner so as to concentrate and pond rainfall runoff over the trench. After sufficient settlement has been obtained, the Contractor shall complete surface dressing, remove surplus material and clean up in accordance with these Specifications. Wherever trenches have not been properly filled or if settlement occurs, they shall be refilled, smoothed off and finally made to conform to the surface of the ground. Backfilling shall be carefully performed and the original surface restored as specified herein. Surplus material shall be disposed of by the Contractor.

B. Payment: No extra payment will be made for general backfill, the cost thereof to be included in the prices bid for sewers.

7.32 Placing Precast Concrete Manholes: Precast concrete manholes or a combination of precast concrete and brick manholes shall be placed or constructed where shown and/or directed by the Engineer. Manholes shall be 4', 5' and 6' in diameter as determined from the schedule of pipe sizes and line deflections, or as shown on the Drawings.

The top of manholes outside of roads, streets highways, and pastures and yards shall be built to grades 2' above ground surface unless otherwise shown on the Drawings. Manholes in roads, etc. shall be built to grade designated by the Engineer. Vented manholes shall be constructed to elevations as shown on the Drawings.

Manholes shall be placed and/or constructed as follows:

A. Precast Concrete Manholes: Precast concrete manholes shall be bedded on not less than 6" of compacted crushed stone at Contractor's expense. The crushed stone shall extend not less than 6" outside the walls of the manhole and shall be compacted under the entire length of pipe within manhole excavation.

1. Connection of Pipe to Manhole: Connections of pipe to manhole for 4" through 15" pipe shall be made with a flexible joint system. The joint system shall be a neoprene or synthetic rubber boot or sleeve either cast or core drilled into the wall of manhole. The boot or sleeve shall be clamped and seated to the pipe with a stainless steel band. The boot or sleeve system shall be "LOCK JOINT FLEXIBLE MANHOLE SLEEVE" as manufactured by Interpace Corporation, Parsippany, New Jersey or

"KOR-N-SEAL" as manufactured by National Pollution Control Systems, Inc., Nashua, New Hampshire or equal. Connections of pipe to manhole for 18" pipe and above shall be made with a collar of mortar. The opening between the pipe and the manhole shall have a minimum clearance of 1" and shall be filled from the inside of the manhole with a non-shrink grout.

2. Adjustment: The top of the concentric top section shall have a minimum wall thickness of 8". Grade adjustment shall be performed using concrete grade rings and steel riser rings only. The maximum adjustment for setting the frame and cover to grade shall be 8". Brick will not be allowed to adjust manhole grade.

B. Precast Concrete and Brick Manholes: Manholes may be precast concrete or other material as approved by the Engineer.

C. Drop Connections: Drop connections will be required where called for on the Drawings or as determined by the dimensions shown in "Drop Manhole Schedule," shown on the Drawings. Drop pipe shall not be smaller than 8". Generally, drop pipe shall be one size smaller than the sewer which they serve. Openings in walls of precast concrete manholes for drop connections shall not be made at joints. Drop connection fittings and riser pipe shall be encased in brick and mortar or formed Class "C" concrete. Drop connections for both brick and precast concrete manholes shall conform to typical details as shown on the Drawings. Drop connections shall be carefully backfilled to prevent dangerous side pressures.

D. Manhole Inverts: Manhole inverts shall be carefully constructed with cement grout, Class "B" concrete or cement mortar brickwork; special care shall be taken to lay the channel and adjacent pipes to grade. Cement mortar shall be made of one (1) part cement and two (2) parts clean sharp sand. Channels shall be properly formed, rounded and troweled smooth. The connections of the sewer with the wall and channel of the manhole shall be tight and smooth.

E. Manhole Steps: Manhole steps shall conform to the details shown. Steps for precast concrete manholes shall be installed along a vertical centerline on approximately 14" to 16" centers.

F. Manhole Frames and Covers: Manhole frames and covers shall be as detailed and shown on the Drawings and as called for in the Proposal and shall include setting to finished grade as required and grouting in place.

G. Payment: Payment for precast concrete manholes will be made from actual field measurements to the nearest 0.1' as stated in the Proposal. Measurement for payment will be made from manhole invert to top of precast concrete cone. Payment for drop connections will be made at the unit prices stated in the Proposal, and shall include all necessary pipe, pipe fittings, brick or concrete encasement of drop pipe and extension of manhole base slab. Measurement for payment shall be from invert of TEE to invert of ELL. Payment for manhole frames and covers will be made in accordance with the unit prices stated in the Proposal for the various types. No extra payment will be made for 6" of

compacted crushed stone bedding under manhole, for manhole steps, for constructing manhole inverts, manhole testing or for furnishing and laying future sewer connections, the cost thereof to be included in the unit prices bid for manhole construction.

7.33 Bypass Pumping: The Contractor is required to furnish all materials, labor, equipment, power, maintenance, etc. to implement a temporary pumping system for the purpose of diverting the existing sewer flow around the project area during periods of existing sewer pipe replacement. The design, installation and operation of the temporary pumping system shall be the Contractor's responsibility. The Contractor shall employ the services of Godwin Pumps, Rain for Rent, or approved equal. The vendor shall provide at least 5 references of projects of a similar size and complexity as this project performed by his firm within the past 3 years. The bypass system shall meet the requirements of all codes and regulatory agencies having jurisdiction.

A. Equipment:

1. All pumps used shall be fully automatic self-priming units that do not require the use of foot valves or vacuum pumps in the priming system. The pumps shall be diesel powered. All pumps used must be constructed to allow dry running for long periods of time to accommodate the cyclical nature of effluent flows.

2. The Contractor shall provide the necessary stop/start controls for each pump.

3. The Contractor shall include one standby pump of each size utilized to be maintained on site.

4. Back-up pumps shall be on-line, isolated from the primary system by a valve.

5. All pumps shall be provided with float switches and a pump operator to be on call 24 hours a day located within the County for the duration of the bypass pumping.

6. Discharge Piping: In order to prevent the accidental spillage of flows all discharge systems shall be temporarily constructed of rigid pipe with positive, restrained joints. Under no circumstances will aluminum “irrigation” type piping or glued PVC pipe be allowed. Discharge hose will only be allowed in short sections and by specific permission from the Engineer.

B. Design Requirements:

1. Bypass pumping systems shall have sufficient capacity to pump a peak flow at installed head conditions. Bypass shall be capable of passing a solid 3" diameter sphere. The Contractor shall provide all pipe line plugs, pumps of adequate size to handle peak flow and temporary discharge piping to ensure that the total flow of the main can be safely diverted around the section to be repaired. Bypass pumping system will be required to be operated 24 hours per day.

2. The Contractor shall have adequate standby equipment available and ready for immediate operation and use in the event of an emergency or breakdown. One standby pump for each size pump utilized shall be installed at the mainline flow bypassing locations, ready for use in the event of primary pump failure.

3. Bypass pumping system shall be capable of bypassing the flow around the work area and of releasing any amount of flow up to full available flow into the work area as necessary for satisfactory performances of work.

4. The Contractor shall make all arrangements for bypass pumping during the time when the main is shut down for any reason. System must overcome any existing system pressure on discharge.

C. Performance Requirements:

1. It is essential to the operation of the existing sewerage system that there be no interruption in the flow of sewage throughout the duration of the project. To this end, the Contractor shall provide, maintain and operate all temporary facilities such as dams, plugs, pumping equipment (both primary and backup units as required), conduits, all necessary power and all other labor and equipment necessary to intercept the sewage flow before it reaches the point where it would interfere with his work, carry it past his work and return it to the existing sewer downstream of his work.

2. The design, installation and operation of the temporary pumping system shall be the Contractor's responsibility. The bypass system shall meet the requirements of all codes and regulatory agencies having jurisdiction.

3. The Contractor shall provide all necessary means to safely convey the sewage past the work area. The Contractor will not be permitted to stop or impede the main flows under any circumstances.

4. The Contractor shall maintain sewer flow around the work area in a manner that will not cause surcharging of sewers, that will not cause damage to sewers and that will protect public and private property from damage and flooding.

5. The Contractor shall protect water resources, wetlands and other natural resources.

D. Field Quality Control and Maintenance:

1. Test: The Contractor shall test the system for 4 hours during peak flows before dismantling existing pump system.

2. Inspection: Contractor shall inspect bypass pumping system every two hours to ensure that the system is working correctly.

3. Maintenance Service: The Contractor shall insure that the temporary pumping system is properly maintained and a responsible operator shall be on hand at all times when pumps are operating.

4. Extra Materials:

a. Spare parts for pumps and piping shall be kept on site as required.

b. Adequate hoisting equipment for each pump and accessories shall be maintained on the site.

E. Payment: The price bid for bypass pumping shall include all labor, equipment, piping and materials to meet the requirements of these Specifications for the duration of the bypass pumping period.

7.34 Yard Hydrants: Yard hydrants shall be 1" post hydrant with galvanized casings ¾" inlet and discharge hose connections, non-freeze with vacuum breaker and sanitary siphon drain system.

Yard hydrants shall be Series 71400 as manufactured by Josam, Watts, or equal.

7.35 Plug Valves: All plug valves shall be of the non-lubricated eccentric type with resilient faced plugs and flanged or mechanical joint ends as shown on the Drawings. Valves shall be designed for 150-psi working pressure. Port areas of 4-20 inch valves shall be at least 92% of full pipe area. Port areas of 24" and larger valves shall be at least 100% of full pipe area. Valve bodies shall be semi-steel with raised seats. Seats in 3" and larger valves shall either have a welded in overlay of not less that 90% pure nickel on all surfaces contacting the plug face or shall be bronze ASTM B-62 and attached to the body by stainless steel set screws. Valves through 20" shall have stainless steel permanently lubricated upper and lower body bearings, and Buna-N-0-Ring silt seals will be acceptable. Valves 24" and larger shall be designed, so they can be repacked without removing the bonnet from the valve. Packing on all valves shall be zinc plated. Means of actuation shall be as required for the service intended or as indicated on the Drawings.

Flanged valves shall be faced and drilled to ASA 125# standard. Flanges of valves through 12" shall have face-to-face dimensions of standard gate valves. Valves for buried service shall have seals on all shafts and gaskets on valve and covers to prevent the entry of water.

A. Plug Valve Accessories: Valves, unless otherwise indicated or specified, shall be equipped with 2" square operating nut. Valves buried in the ground and located in tanks and wells shall have extensions provided by the manufacturer for socket operation. The top of the operating nut shall be 6" below ground for valves below ground. Two (2) T-handle operating wrenches shall be provided. Valves shall be geared for handwheel operation where shown on the Drawings. Valves shall be installed with the stem in the vertical position. All valves 6" and larger shall be equipped with a gear actuator.

B. Valve Boxes: A cast iron adjustable valve box shall be furnished and set for each outside plug valve. Installation shall be so that the top is flush with a concrete protecting slab. Concrete protective slabs shall be not smaller than 24" square by 6" deep.

7.36 Gate Valves: Valves shall be manufactured and tested to meet the requirements of ANSI/AWWA C515. Valves shall meet or exceed the requirements of Underwriters

Laboratories Standard UL262 and Factory Mutual Standard 1130. Valves shall be certified to NSF/ANSI 61 and 372. The rated working pressure of the valve shall be 250 psi. The body, bonnet, wedge and seal plate shall be made of ductile iron in accordance with ASTM A536. The wedge shall be totally encapsulated in rubber. This rubber coating shall be permanently bonded to the ductile iron wedge casting and shall meet ASTM D429 tests for rubber to metal bonding. No paint shall be allowed in the wedge and the wedge must not be hollow. Containment of the stem nut must only be on two sides to facilitate easy removal. There shall be three stem seal O-rings: two in the seal plate which shall be replaceable with the valve in the full open position at rated working pressure and one under the stem thrust collar. All gaskets shall be O-ring seals. O-rings set in a cartridge shall not be allowed. A grit seal must be present above the seal plate to prevent dirt intrusion. Valves are to be open left (OL). Operating nuts are to be painted black (OL) or painted red (OR). The NRS valves shall be provided with a 2" square operating nut (2"-24"). Valves 2" to 16" must have two polymer thrust washers, one above and one below the thrust collar. Stainless steel thrust washers are not acceptable. All fasteners are to be 304 stainless steel. Socket head bolts shall not be allowed. If only two bolts are used to secure the seal plate, the bolts must be fastened to the bonnet with a drilled and tapped hole in the bonnet. The body, bonnet and seal plate shall be epoxy coated in accordance with ANSI/AWWA C550 certified to NSF 61. This coating shall be on the interior and the exterior of the valve. The manufacturer's name, valve size, year of manufacture, pressure rating ("250W"), C515 and "DI" shall be cast on the valve. Each valve shall be tested in accordance with ANSI/AWWA C515, UL262 and FM1130 and shall include hydrostatic pressure testing at 500 psi. A certification of manufacture and testing shall be provided at the municipality's request. All parts of valves to be considered must be manufactured, assembled and tested in the contiguous USA, and letters of certification must accompany any and all products at the request of municipality. Valves with a bury depth greater than 4' shall be supplied with valve nut extension stem. Valves shall be M&H, Flowmatic, Pratt, Crispin or approved equal.

7.37 Vacuum and Air Relief Valves: Vacuum and air relief valves shall be of the sizes shown in the Drawings and shall be a type that will release air and prevent the formation of a vacuum. The valves shall automatically release air from the lines when the lines are being filled with water, and shall admit air into the lines when water is being withdrawn in excess of the inflow. It shall also allow accumulating air to escape while the line is in operation and under pressure. Valves shall be cast iron body, 316 stainless steel float and stainless steel for all other interior metal parts. Valves shall be equipped with an inlet valve and drain valve. Valve shall be Valmatic Air/Vacuum Valve or approved equal.

7.38 Check Valves: Check valves shall be constructed of ductile iron with bronze and stainless steel fittings. It shall prevent reverse flow back through the valve when the inlet pressure decreases below the delivery pressure. The valve must be tight seating and must operate without hammer or shock. The seat ring must be renewable and shall be securely held in place by a threaded joint. The valve disc shall be of Buna-N w/ Alloy Steel and shall be hinged above its seat at a 35 degree disc stroke so that perfect closure is always attained. The valve shall effectively prevent slamming. Valves shall be manufactured by Cla Val, Crispin, APCO or equal.

7.39 Wall Sleeves: Where piping connects with, or passes through, concrete walls, furnish and install wall sleeves of cast iron, as specified in these Specifications. Pipe shall run continuous through walls. Formed openings in concrete walls for inserting cast iron piping will not be allowed. Wall sleeves shall be accurately located and securely fastened in place before concrete is placed. In a similar manner, wall sleeves shall be used in locations where small piping and electric wiring connects to, and passes through, concrete walls. Wall sleeves shall be furnished with water stops.

7.40 Pipe Couplings: Pipe couplings for cast iron pipe shall be of gasketed, sleeve type, with diameter to properly fit the pipe. Each coupling shall consist of one steel middle ring, two steel followers, two rubber-compounded wedge section gaskets, and sufficient track-head steel bolts to properly compress the gaskets. Couplings shall be Dresser Style 38, Rockwell Series 411 or equal.

The middle ring and followers of the coupling shall be true circular sections free from irregularities, flat spots, or surface defects. They shall be formed from mill sections with the follower-ring section of such design as to provide confinement of the gasket.

Coupling bolts shall be of the elliptic-neck track-head design with rolled threads. All bolt holes in the followers shall be oval for greater strength.

Baskets shall be composed of crude or synthetic rubber base compounded with other products to produce a material which will not deteriorate with age, from heat, or exposure to air under normal storage conditions. It shall also possess the quality of resilience and ability to resist cold flow of the material so that the joint will remain sealed and tight indefinitely when subjected to shock, vibration pulsation, and temperature or other adjustments of the pipe line.

7.41 Flanged Adaptor: Contractor shall furnish and install cast iron flange adapters to joint plain-end pipe to flanged pipe where shown on the Drawings. Adapters shall be manufactured to meet ASTM A-126, Class B, cast-iron. Flange end of adapter shall mate with ASA 16.1 and B16.5 flanges of the same nominal size. Adapters shall be locking type with special high-strength steel pins. Adapters shall be Sigma SigmaFlange, Mega Flange Series 2100 or equal.

7.42 Testing and Cleaning: Before acceptance of any sewer or systems of sewers, lines shall be cleaned and tested in accordance with these Specifications. Where any obstruction is met, the Contractor will be required to clean the sewers by means of rods, swabs, or other instruments. Lines and manholes shall be clean before final inspection. Pipe lines shall be straight and shown a uniform grade between manholes. The Contractor shall be required to correct any variations therefrom which may be disclosed during the inspection.

A. Deflection Testing: The maximum deflection in the installed PVC pipe line shall not exceed 5% of the pipes original internal diameter. The sewer alignment shall be checked by a visual inspection including either laser or lamping alignment. Deflection testing will be required using either a deflectometer or a "GO-NO-GO" mandrel. The Engineer shall randomly select portions of the project to be deflection tested after a period of 30 days has elapsed after backfilling has occurred. Such portions shall consist of not less than 5% of the total reaches

(reach being length of pipe between 2 manholes) in the project (excluding house leads).

The Contractor when using a mandrel shall use a pull line and a retrieve line. The pull line shall be blown in the line by means of air or water. The mandrel shall be placed in the pipe and be pulled up or down the pipe to the next manhole or defect. Testing shall be done in accordance with ASTM D 3034 Standards.

Where deflection is found to be in excess of 5% of the original pipe diameter, the Contractor shall excavate to the point of excess deflection and carefully compact around the point where excess deflection was found. The line shall then be retested for deflection. However, should after the initial testing the deflection pipe fail to return to the original size (inside diameter) the line shall be replaced.

In the event that deflection occurs beyond the 5% limit in any section of 5% or more of the reaches tested, the entire system shall be tested.

B. Manhole Vacuum Testing: All manholes shall be vacuum tested in accordance with ASTM C 1244, "Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test" as amended to date. All pipes entering the manhole should be plugged, taking care to securely place the plug from being drawn into the manhole. The test head shall be placed near the top of the manhole frame and cover and the seal inflated in accordance with the manufacturer's recommendations. A vacuum pump of 10" of mercury shall be drawn and the vacuum pump shut off. With the valves closed, the time shall be measured for the vacuum to drop to 9". Following are minimum allowable test times for manhole acceptance at the specified vacuum drop:

Depth	***Time (Seconds)***		
	48" Diameter	***60" Diameter***	***72" Diameter***
4'	10	13	16
8'	20	26	33
12'	30	39	49
16'	40	52	67
20'	50	65	81
24'	59	78	97
Add 2' more depth	5	6.66	8

Note: These numbers have been taken from ASTM C 1244-93 (reapproved 2000).

1. If the manhole fails the initial test, repairs and adjustments necessary due to extenuating circumstances (i.e. pipe joint, plug sealing) should be made. Retesting shall proceed until a satisfactory test is obtained.

2. A final visual inspection shall be made by the inspector and Contractor. Any deficiencies noticed shall be repaired accordingly.

3. The cost for testing each manhole shall be included in the cost per vertical foot to install the pre-cast concrete manhole. Retest cost required due to defects in the Contractor's work, shall be paid by the Contractor.

4. Testing shall be performed on all new or refurbished manholes.

C. Leakage Tests: All new or rehabilitated sewer lines, including house service lines, shall be tested for leakage, in the presence of the Engineer or his representative, before being placed into service. Tests shall be conducted by one or a combination of the following three methods:

1. Low Pressure Air Test Method: Low pressure air testing shall be performed in accordance with ASTM F1417 or UNI-B-6-90, as amended to date. Prior to air testing the section of sewer between manholes shall be thoroughly cleaned and wetted. Immediately after cleaning or while the pipe is water soaked, the sewer shall be tested with low-pressure air. At the Contractor's option, sewers may be tested in lengths between manholes or in short sections (25' or less) using air-lock balls pulled through the line from manhole to manhole. Air shall be slowly supplied to the plugged sewer section until internal air pressure reaches approximately 4.0-psi. After this pressure is reached and the pressure allowed to stabilize (approximately 2 to 5 minutes), the pressure may be reduced to 3.5-psi before starting the tests. If a 1.0 psi drop does not occur within the test time, then the line has passed the test. If the pressure drops more than 1.0 psi during the test time, the line is presumed to have failed the test, and the Contractor will be required to locate the failure, make necessary repairs and retest the line. Minimum test time for various pipe sizes, in accordance with Uni-Bell PVC Pipe Assoc. UNI-B-6-90, as amended to date, is as follows:

Specification Time required for a 1.0 PSIG Pressure Drop for Size and Length of Pipe Indicated for Q = 0.0015

Pipe Diameter	*Minimum Time (minutes:second)*	*Length for Minimum Time*	*Time for Longer Length (second)*
4"	3:46	597'	0.380
6"	5:40	398'	0.854
8"	7:34	298'	1.520
10"	9:26	239'	2.374
12"	11:20	199'	3.418
15"	14:10	159'	5.342
18"	17:00	133'	7.692
21"	19:50	114'	10.470

Pipe Diameter	*Minimum Time (minutes:second)*	*Length for Minimum Time*	*Time for Longer Length (second)*
24"	22:40	99'	13.674

Required test equipment includes air-lock balls, braces, air hose, air source, timer, rotometer as applicable, cut-off valves, pressure reducing valve, 0-15 pressure gauge, 0-5 pressure gauge with gradations in 0.1 psi and accuracy of ± 2 percent.

The Contractor shall keep records of all tests made. Copy of such records will be given to the Engineer or the Owner. Such records shall show date, line number and stations, operator and such other pertinent information as required by the Engineer.

The Contractor is cautioned to observe proper safety precautions in performance of the air testing. It is imperative that plugs be properly secured and that care be exercised in their removal. Every precaution shall be taken to avoid the possibility of over-pressurizing the sewer line.

a. Repairs: All visible leaks shall be repaired regardless of whether the air test is within allowable limits. No sewer will be accepted until leakage tests demonstrate compliance with the leakage test method.

b. Payment: The Contractor shall furnish all materials, labor and equipment and necessary for testing and retesting as required and shall make all necessary repairs. No extra payment will be made for testing and repairs, the cost thereof to be included in the unit prices bid for sewers.

2. Testing Force Main: When a section of pipe of a length deemed adequate by the Engineer is ready for testing, the line shall be thoroughly blown free from air and a leakage test made. The Contractor shall furnish all labor, materials and equipment for carrying out these tests. Wherever conditions will permit, in the opinion of the Engineer, pipe lines shall be tested before the trench is backfilled. All joints then shall be examined during open trench test and all leaks entirely stopped. The Contractors shall furnish a test pump and means for accurate measurement of water introduced into a line during testing, and shall furnish and install corporation stops at all high points in the line as required for blowing lines free from air and at the test pump location.

a. Temporary Bulkheads: The Contractor shall furnish, install and remove all temporary bulkheads, flanges or plugs to permit the required pressure test and shall furnish all equipment and labor to properly carry out such tests and to replace defective material.

b. Test Pressure and Leakage: Pressure and leakage testing shall be conducted in accordance with the latest version of AWWA

Standard C-600. Test pressures shall be at least 1.5 times the shutoff head of the pump or 150 pounds per square inch, whichever is greater, for force mains measured at the pipe line low point. Test pressure shall not be less than 1.25 times the working pressure at the highest point along the test section. Test pressures shall not vary by more than ± 5-psi for the duration of the test. Leakage allowed during the test shall be calculated using the following formula:

$$L = \frac{SD\sqrt{P}}{133{,}200}$$

Where: L is allowable leakage is gallons/hour
S is the length of pipe tested in feet
D is pipe diameter in inches
P is test pressure is pounds per square inch (psi)

Minimum test period shall be 2-hours; however, in the opinion of the Engineer, if additional testing is required, such additional testing shall be performed by the Contractor at no additional expense to the Owner.

c. Defective Materials and Workmanship: Any cracked or broken material such as pipe, fittings, valves or hydrants shall be removed and replaced with sound pieces at the expense of the Contractor. Joints which leak shall be carefully remade. Remade joints and replaced material shall be retested under the same conditions of operation. If joints or materials are then found to be defective they shall be remade and replaced until the line passes the required test.

d. Payment: No separate payment will be made for the above work. The cost of the above work and all cost incidentals thereto, shall be included in the unit prices bid for the item to which the work pertains.

3. Video Inspection: All sewer lines and manholes shall be televised and recorded. The video should be of a quality that any and all deficiencies such as cracked pipes, rolled gaskets, leaking joints, deviations from line and grade (pipe line shall show more than three-quarters of the opening at the opposite end of the pipe line), pipe deformations, etc., can be easily identified and located. The video should also contain all pertinent information including but not limited to location, line size, material, starting manhole, direction headed, distance from starting manhole to service connection and length of line.

a. Payment: No extra payment will be made for televising and recording new or dig and replace pipe, the cost thereof to be included in the prices bid for sewers.

7.43 Jointing Dissimilar Pipe: Dissimilar pipes shall be joined together using flexible couplings manufactured for the specific pipe materials to be joined. The inside of the pipe shall be free of foreign material to the satisfaction of the Engineer.

A. Payment: Payment for jointing dissimilar pipe will be made in accordance with the unit prices stated in the Proposal.

B. Assembling and Installing PVC Pipe with Elastomeric - Gasket Bell Ends D.I. Fittings: All dirt or foreign material must be removed from the groove of pipe. If necessary, groove shall be wiped with a clean, dry cloth. Care shall be taken to insure that the proper ring is used. The rubber ring shall be wiped clean before it is inserted into the groove. The GROOVE OR RUBBER RING MUST NOT BE LUBRICATED. Apply lubricant to beveled spigot and push lubricated end past the gasket into the bell housing. Manufacturer's recommendations must be strictly adhered to in assembling rubber ring in groove and installing pipe into the bell.

The assembling of D.I. mechanical joint fittings must be done by experienced mechanics. The gasket shall be brushed with soapy water before slipping the gasket and gland into place. Bolts shall be tightened fingertight and then tightened alternately 180° apart to a uniform tightness using a torque wrench.

1. Cutting PVC Pipe: Wherever pipe or special castings are required to be cut, the cutting shall be done by skilled workmen, using hacksaw, handsaw or a power saw with a steel blade or abrasive disc. The end may be beveled using a beveling tool or wood rasp which will cut the correct taper.

2. PVC Pipe, Trench and Bedding: The trench bottom must be free of large stones, large dirt clods or frozen earth. Place 4" of select material on trench bottom to provide smooth cushion for pipe. Excavation for pipe bells shall be provided so that the pipe is uniformly supported along its length. When an unstable trench bottom is encountered, and in the opinion of the Engineer will not support the pipe, the Contractor shall remove the bad material and replace with a minimum depth of 12" of No. 67 stone.

3. Depth of Bedding and Marking Tape: Minimum depth of bedding shall be 6". Compaction to the centerline of the pipe shall be of the same material used in the bedding. Backfill shall then be carried to a point 18" above the top of pipe, using hand tools for tamping. Puddling will not be allowed as a method of compaction. Before replacing the remaining backfill, **DETECTABLE** marking tape shall be placed in the ditch for the entire length of force main. Tape shall be 3" in width, imprinted with the words "BURIED SEWER," and shall be as manufactured by Black Burn, Allen Systems, Inc. or equal. The remaining backfill shall be as specified in the "Selected Backfill" and "General Backfill" paragraphs of these Specifications. Pipe shall have at least 36" of cover before wheel loading

and at least 48" of cover before using heavy-duty tamping equipment such as a hydrohammer.

C. Payment: Payment for laying and jointing pipe and laying and jointing D.I. mechanical joint fittings for force mains will be made as separate items based on the measured quantity of the various materials actually installed at the unit prices bid in the Proposal. Cost of installing marking tape and tracing wire shall be included in the unit prices bid for the item to which the work pertains.

7.44 Construction Along Highways, Streets and Roadways: The Contractor shall install pipe lines and appurtenances along highways, streets and roadways in accordance with the applicable regulations of the State Department of Transportation and the Owner with reference to construction operations, safety, traffic control, road maintenance and repair.

A. Protection of Traffic: The Contractor shall provide suitable signs, barricades and lights for protection of traffic in locations where traffic may be endangered by construction operations. All signs removed because of construction shall be replaced as soon as the condition which necessitated their removal has been cleared. No highway, street or roadway shall be closed without first obtaining permission from the proper authorities.

B. Construction Operations: The Contractor shall construct all work along highways, streets and roadways using the following sequence of construction operations so as to least interfere with traffic.

1. Stripping: Where the pipe line is laid along road shoulders, all sod, topsoil and other material suitable for shoulder restoration shall be stripped and stockpiled for replacement.

2. Trenching, Laying and Backfilling: The Contractor shall open trenches, install pipe line and backfill. The trench shall not be opened ahead of pipe laying operations any further than is necessary for proper laying operations. Trenches shall be progressively backfilled and consolidated; excess material shall be removed immediately behind laying operations.

3. Shaping: The Contractor, immediately after completing backfilling operations, shall re- shape damaged cut and fill slopes, side ditches and ditch lines and shall replace topsoil, sod and other materials removed from shoulders in accordance with the requirements, and to the full and complete satisfaction of the proper highway personnel and the Owner. The Contractor shall provide sufficient personnel and equipment to simultaneously carry out all of the above operations when installing pipe lines and appurtenances.

C. Excavated Material: Excavated material shall not be placed along highways, streets and roadways in a manner which would cut off traffic. No scattered excavated material shall be allowed to remain on the pavement; all such material shall be kept swept away.

D. Drainage Structures: All pipe, side ditches, culverts, cross drains and other drainage structures shall be kept clear of excavated material and be free to drain at

all times. Any drainage structure that must be temporarily removed during construction operations must be replaced immediately after construction has been completed in the vicinity. All structures damaged must be replaced at no additional cost to the Owner.

E. Maintaining Highways, Streets, Roadways and Driveways: The Contractor shall furnish proper construction equipment which shall be available for use at all times for maintaining highways, streets and roadways upon which work is being performed. All such highways, streets and roadways shall be maintained in suitable condition for movement of traffic until completion and final acceptance of the work.

F. Payment: No separate payment will be made for the above work. The cost of such work, and all cost incidental thereto, shall be included in the unit prices bid for the item to which the work pertains. The Contractor shall be responsible for fully informing himself with regard to all regulations relating to pipe line installation along roadways.

7.45 Connections to Structures: At all structures, including manholes, provide a flexible joint for all pipe not more than 24" from the face of the structure. It shall be the responsibility of the Contractor to submit details of the proposed connection to the Engineer for approval. Connections not approved will be subject to removal and replacement by an approved flexible joint.

A. Payment: Payment for connections to structures will be made as separate items based on the measured quantity of the various materials actually installed at the unit prices bid in the Proposal.

7.46 Connections to Existing Manholes: At locations where new sewers are shown to be connected to existing manholes the Contractor may temporarily block and/or divert sewage flows to facilitate construction operations. The work shall consist of coring the opening in the manhole wall, installing a flexible rubber boot, inserting the new pipe to the elevation shown, filling the space in the wall around the pipe with mortar, and constructing and remodeling manhole inverts.

The bypassing of raw wastewater onto the ground or into a receiving stream is prohibited.

High-early strength cement shall be used for mortar in order that proper channels may be formed in manhole bottoms with a minimum interruption of service to the existing sewer.

A. Payment: The price bid for this work shall include all costs of labor, material and equipment required to complete each connection and shall include the costs involved in blocking and/or diverting sewage flows, and shall include all cost of delays, temporary works and maintaining existing sewers in service. No payment will be made for a connection to an existing pipe or manhole stub.

7.47 Manhole Repair and Lining: The Contractor shall furnish all labor and materials to completely repair and line manholes. Repairs shall include pressure washing, removal of roots and debris, and plugging or sealing all points of infiltration. Lining of manhole shall include the application of a corrosion-resistant, spray-applied, polymer, monolithic lining for protection of municipal wastewater collection and treatment systems subject to

hydrogen sulfide and acid attack from microbiological sources. All manhole rehabilitation shall have 10-year warranty on material and installation.

A. Manhole Rehabilitation:

1. Application of 100 mils of 100% solids epoxy as manufactured by Madewell Products Corporation, Raven, Tnemec EpoxyTec or approved equal.

B. Pre-Inspection: Prior to beginning work, each manhole shall be visually inspected and the results reported to the Engineer.

C. Cleaning: Pressure clean the manhole (minimum 3,500-psi) to remove all dirt, grease, sand and surface contaminants on the wall and floor leaving a clean, wet or dry surface. If a detergent or degreaser solution is used, the surface shall be thoroughly rinsed and neutralized prior to the installation of the liner system. All loose bricks, mortar, unsound concrete and roots shall be removed.

D. 100% Solids Epoxy System:

1. Pre-Coat Inspection: The applicators' vehicles and equipment must be able to access the structures to be coated under their own power.

a. All surfaces including benches, inverts, joints, lift holes and walls shall be made smooth and suitable for application of the interior surfacing system. All benches and inverts shall be in place and complete.

b. The entire manhole, walls, bench and invert, from the bottom of the ring to the low water line in the invert shall be properly prepared and lined in accordance with these Specifications, manufacturer's recommendation and current industry standards.

c. Active flows shall be dammed, plugged or diverted as required to ensure that the liquid flow is maintained below the surfaces to be coated.

d. Installation of the protective coating shall not commence until the concrete substrate has properly cured.

2. Surface Preparation: Applicator shall inspect all surfaces specified to receive the monolithic surfacing system prior to surface preparation. Applicator shall notify Owner of any noticeable disparity in the surfaces that may interfere with the proper preparation or application of the monolithic surfacing system.

a. All concrete that is not sound or has been damaged by chemical exposure shall be restored to a sound concrete surface using a 100% calcium aluminate profile-restoring formulation designed as substrate for epoxy application. All contaminants including all oils, grease, incompatible existing coatings, waxes, form release, curing compounds, efflorescence, sealers, salts or other contaminants shall be removed.

b. Surface preparation method(s) shall be based upon the conditions of the substrate and the requirements of the monolithic surfacing system to be applied.

c. Surface preparation method(s) should be based upon the conditions of the substrate, service environment and the requirements of the epoxy protective coating to be applied.

d. Surfaces to receive protective coating shall be cleaned and abraded to produce a sound surface with adequate profile and porosity to provide a strong bond between the protective coating and the substrate. Generally, this can be achieved with a low pressure water cleaning using equipment capable of 5,000 psi at 4-gpm. Other methods such as high pressure water jetting (refer to NACE Standard No. 5/SSPC-SP12), abrasive blasting, shotblasting, grinding, scarifying or acid etching may also be used. Detergent water cleaning and hot water blasting may be necessary to remove oils, grease or other hydrocarbon residues from the concrete. Methods used shall be performed in a manner that provides a uniform, sound clean neutralized surface that is not excessively damaged.

e. Infiltration shall be stopped by using a material, which is compatible with the specified repair mortar and is suitable for top-coating with the specified epoxy protective coating.

f. Test prepared surfaces after cleaning but prior to application of the epoxy coating to determine if a specific pH or moisture content of the concrete is required according to manufacturer's recommendations.

g. The area between the manhole and the manhole ring and any other area that might exhibit movement or cracking due to expansion and contraction shall be grouted with a flexible or elastomeric grout or gel.

3. Application of Field Applied Interior Surfacing System: Application procedures shall conform to the recommendations of the interior surfacing system manufacturer, including material handling, mixing and environmental controls during application, safety and equipment.

a. The equipment shall be specially designated to accurately ratio and apply the specified materials and shall be regularly maintained and in proper working order. The specified materials must be applied by an approved installer of the monolithic surfacing system.

b. All specified concrete and smooth surfaces shall be lined with the monolithic surfacing system to provide a thickness as previously specified based on the condition of the existing structure. The cured surfacing shall be monolithic with proper sealing connections to all unsurfaced areas and shall be placed and cured

in accordance with the recommendations of the monolithic surfacing system manufacturer. Specially designed spray and/or spincast application equipment shall be used to apply each coat of the system. After application of the epoxy, liner a broadcasting of sand shall be applied to the bench to provide a non-slip surface.

c. During application, a wet film thickness gage, such as those available through Paul N. Gardner Company, Inc. meeting ASTM C4414 "Standard Practice for Measurement of Wet Film Thickness of Organic Coatings" by Notched Gages, shall be used to ensure a monolithic coating and uniform thickness during application.

7.48 Testing and Cleaning Sewer and Drain Lines: Before acceptance of any sewer or systems of sewers, lines shall be cleaned and tested in accordance with these Specifications. Where any obstruction is met, the Contractor will be required to clean the sewers by means of rods, swabs, or other instruments. Lines and manholes shall be clean before final inspection. Pipe lines shall be straight and shown a uniform grade between manholes. The Contractor shall be required to correct any variations therefrom which may be disclosed during the inspection.

No extra payment will be made for testing and cleaning.

7.49 Water Service Connections: Contractor shall furnish all equipment, labor and material necessary to install service connections as detailed on the Drawings and as specified herein. Contractor shall also connect existing services to new water main. Connections shall include pipe saddle, corporation stop, tubing, meter, and meter box. Location of services shall be as directed by the Engineer. Connections shall be completed to edge of Division 2 location and completed by Division 2 Contractor prior to testing. Connection shall be made with ¾" corporation stop at main and 1" schedule 80 PVC pipe from corporation stop to 1″ meter.

A. Corporation Stops: Shall have standard corporation stop thread conforming to AWWA Standard C800 latest revision on the inlet end with pack joint connection for connection to ¾" Schedule 80 PVC pipe.

B. Service Line: Service lines shall be 1" Schedule 80 PVC pipe as called for in the Proposal. Fittings shall be Schedule 80 PVC. All pipe and fitting joints shall be glued with solvent cement. The solvent cement shall be rated for use with potable water.

C. Pipe Saddle: Saddles shall be used with corporation stop for service connections to PVC water mains 6" and larger. Saddle shall be double strap service saddle with ductile iron body, carbon steel straps and grade 60 nitrile rubber (Buna-N) gaskets. Saddles shall be Watts, Smith-Blair Model No. 313, or equal. Connections to small lines shall be made with Ford Meter Box Company brass saddle Model No. S70, Watts or equal.

D. Backflow Preventer: Backflow preventer shall be a Watts or Zurn Series LF7 Dual Check for ¾" and 1" services, Watts or Zurn LF719 for 1½" and 2" services, and Watts or Zurn 757 for 3" and larger services or approved equal. Backflow

preventer shall be installed on customer side of meter. Install flow arrow towards customer. Price bid for backflow preventer shall include price for meter box.

E. Water Meters: Meters shall be the displacement type conforming to ANSI/AWWA Standard C710 with bronze main case, high density synthetic polymer measuring chamber, reinforced hard rubber oscillating piston or disc polycarbonate plastic register box and cast iron or bronze bottom plate. Maximum operating pressure shall not be more than 150-psi. Meters shall be 1", and shall be provided by the Owner.

F. Meter Boxes: Meter box shall be constructed of HDPE with cast iron lid The approximate dimensions of box shall be 14" wide × 19" long × 12" deep.

7.50 Testing Water Lines: When a section of pipe of a length deemed adequate by the Engineer is ready for testing, the line shall be thoroughly blown free from air and a leakage test made, and the Contractor shall furnish all labor, materials and equipment for carrying out these tests. Wherever conditions will permit, in the opinion of the Engineer pipe lines shall be tested before the trench is backfilled. All joints then shall be examined during open trench test and all leaks entirely stopped. The Contractor shall furnish a test pump and means for accurate measurement of water introduced into a line during testing, and shall furnish and install corporation stops at all high points in the line as required for blowing lines free from air and at the test pump location.

A. Temporary Bulkheads: The Contractor shall furnish, install and remove all temporary bulkheads, flanges or plugs, to permit the required pressure tests, and shall furnish all equipment and labor to properly carry out such tests and to replace defective material.

B. Test Pressure and Leakage: Test pressures shall be 200 pounds per square inch. Leakage allowed during the test per 1,000' of pipe shall be:

- 4" - .43 gallons / hour
- 6" - .64 gallons / hour
- 8" - .85 gallons / hour
- 10" - 1.06 gallons / hour

C. Minimum test period shall be 2 hours. However, if, in the opinion of the Engineer, additional testing is required, such additional testing shall be performed by the Contractor at no additional expense to the Owner.

7.51 Sterilizing Potable Water Lines: All pipe lines and all appurtenances which have been exposed to contamination by reason of this construction shall be sterilized by the Contractor before being placed in service.

A. Sterilization: Pipe lines shall remain filled for a 24-hour period with a solution of water and chlorine in amounts to provide a free chlorine residual of not less than 25 mg/l. Disinfection of the new main and the disposal of the heavily chlorinated water following disinfection shall be accomplished in accordance with the latest edition of AWWA Standard C651. The quality of the water used during the disinfection procedures shall meet the required drinking water standards. The

heavily chlorinated water shall be retained in the main for at least 24 hours during which time all valves and hydrants shall be operated to ensure disinfection of the appurtenances. At the end of the 24-hour period the treated water in all portions of the main shall have a residual of not less than 10 mg/l free chlorine.

The Contractor shall obtain bacteriological analysis of samples of water taken from the distribution system which are satisfactory to the Engineer before the line will be accepted by the Owner. The Contractor shall furnish all liquid chlorine required for sterilization and shall furnish all equipment and labor required for the work and shall provide for the bacteriological test which will be paid for by the Owner.

B. Flushing: Upon completion of the sterilization, all mains and piping shall be thoroughly flushed before placing in service. All chlorinated water shall be disposed of in a procedure acceptable to the Georgia Environmental Protection Division. The heavily chlorinated water must not be disposed in a manner that will harm the environment. Neutralizing chemicals such as sulfur dioxide, sodium bisulfite, sodium sulfite or sodium thiosulfate can be used to neutralize the chlorine residual remaining in the water to be wasted. Flush all lines until residual is equal to existing system. After final flushing and before the water main is placed into service, water samples shall be collected from the main and tested for microbiological quality in accordance with Georgia Rules for Safe Drinking Water, Chapter 391-3-5. The laboratory results must show the absence of coliform organisms in the water. Reflux and redisinfect the lines as necessary until satisfactory bacteriological results are obtained.

7.52 Connections to Structures: At all structures, including manholes, provide a flexible joint no more than 24" from the face of the structure. It shall be the responsibility of the Contractor to submit details of the proposed connection to the Engineer for review in accordance with the General Requirements section of these Specifications. Connections not accepted will be subject to removal and replacement by an accepted flexible joint.

7.53 Pipe Insulation and Heat Tracing: Exterior pipe and fittings, where indicated on the Drawings, shall be insulated and heat traced as follows:

A. Pipe insulation shall be 1" thick formed cellular glass insulation weighing 8 to 10 pounds per cubic foot. The insulation shall be specifically shaped for use with pipes, shall be formed true to shape and roundness, shall exhibit negligible water absorption and shall have a "k" value of not less than 0.3813 tu/hr/sf at 50° F. The insulation shall be installed and jacketed with dry aluminum foil 4 mils thick in accordance with directions of the manufacturer.

B. Heating cable shall be rated at a constant 4 watts per foot at 120 V and shall be P.V.C. sheathed. Cable shall be U.L. listed and shall be installed with thermostat in complete accordance with manufacturer's instructions. Heating cable shall be Emerson Model NC4 or Chromolox Model CWM 4-1CT or equal.

7.54 Washdown Connections: Saddles shall have an AWWA C800 brass body with stainless steel straps and ASTM D2000 EPDM rubber gaskets. Saddles shall be Ford Meter Box

Company model number 202BS or equal. Provide a 2" brass corporation stop for each connection by Ford Meter Box Company or equal.

7.55 Cleaning Up: Before the work shall be considered complete, all material not used, and rubbish of every character, must be removed from the streets and placed at some point to be designated by the Owner; and all streets, sidewalks, curbs, fences and other private or public facilities and structures disturbed must be essentially in as good condition as existed before the work was done. Any subsequent settlement of backfill or pavement over trenches -shall be replaced by the Contractor and the surfaces brought to grade.

7.56 Payment: No separate payment will be made for the work of this Section. The cost of the work and all cost incidental thereto shall be included in the bid in the Proposal. Rock excavation is unclassified for all work. Payment for the complete work shall be made upon the basis of measured or completed quantities actually installed at the unit prices bid in the Proposal.

Fittings for extra work shall be paid for on the basis of the published weights of the fittings itself exclusive of followers rings and gaskets. Lump sum items will be paid at the price bid in the Proposal or as specified.

SECTION 8
MECHANICAL EQUIPMENT

8.01 Scope: The Contractor shall furnish all materials, labor and equipment necessary for complete installation of mechanical equipment as shown on the Drawings and/or specified and the furnishing of the services of a competent factory representative to supervise and/or inspect the installation and initial operation of the equipment. The duration of the service to be furnished during the periods of installation and initial operation is estimated as specified below:

Article Number	Equipment	Days of Service
9.13	Submersible Sewage Pumps	2

A. The Contractor shall furnish, install, test, adjust and paint in accurate, satisfactory, workmanlike manner, all machinery, equipment, apparatus, accessories, and fittings required for the completion of the work in accord with the Drawings, Specifications and equipment manufacturer.

B. The Contractor shall furnish and install all materials including electric wiring, conduits, and controls not furnished by the equipment manufacturers. The Contractor's attention is directed to the General Requirements with reference to requirements for furnishing working drawings.

C. The Contractor shall refer to electrical drawings for all voltage requirements for mechanical equipment.

8.02 Supervisory Services: The periods of installation and initial operation shall be assumed to occur on successive days, unless otherwise stated herein. If the Contractor fails to arrange his work so that all services may be performed on successive days, he will be required to furnish such services at a later date, at no additional expense to the Owner. Periods of service on more than one (1) item furnished by the same manufacturer may run concurrently, if so approved and permitted by the Engineer. Manufacturers, who are required to furnish supervisory and/or inspection services, shall extend those services to include all equipment furnished by them for the Project, whether listed or no

8.03 Equipment Bids:

A. Manufacturer: Any reference to an item of equipment or material by a specific manufacturer's trade name in these Specifications is intended merely as a standard. Even though named in the Specifications, equipment offered with smaller or lightweight mechanism or devices compared to that specified will not be approved for the project. Each bidder is required to state in his bid the name of at least one (1) manufacturer or supplier named in these Specifications for each major item of equipment and his bid price for that item as required in the Proposal. This requirement is to prevent rejection of the bid should a piece of substitute equipment be rejected. Other equipment shall be considered as specified in the "General Condition," if offered by the bidder under "Substitute Equipment," in the Proposal:

provided, it is equal in functional design, mechanical and structural details, to the one specified.

If no named manufacturers are specified, the Contractor shall include the name of the manufacturer to be used in the Proposal.

B. Substitute Equipment: Equipment offered under "Substitute Equipment" of the Proposal shall comply with requirements of these Specifications. It shall be the responsibility of the Bidder to determine that equipment offered in the Proposal is in accordance with the Specifications. Substitute equipment offered at a lower price by reason of smaller or lightweight members, inferior to or inefficient mechanism or devices will not be considered.

C. Substitute Equipment Bid: The price for substitute equipment shall include the cost of all changes in the structure, mechanical, electrical work, and in other appurtenances for the accommodation of such equipment as determined by the Engineer, at the expense of the Contractor.

1. Information Required: It shall be the responsibility of the Bidder to ascertain that each manufacturer named in his Proposal has submitted to the Engineer at least two (2) weeks in advance of the letting date complete information in regard to the equipment offered. For makes of equipment named in the Specifications this may be a statement that the equipment offered is in strict accordance with the Engineer's Specifications, listing any and all exceptions. To all substitute items of equipment, complete drawings, specifications, thickness and weights of principle parts shall be furnished to the Engineer two (2) weeks prior to the letting date. A list of all substitute equipment which has been submitted in accordance with the above will be provided to all bidders one (1) week prior to the receipt of bids.

   For makes of equipment with no named manufacturers, the manufacturer must either submit a statement that equipment is in strict accordance with the Specifications or list any exceptions.

2. Experience and Manufacturer: It is desired that only equipment which has undergone thorough development as provided by successful service in similar installations for at least two (2) years shall be accepted for installation unless specified elsewhere in these Specifications. Manufacturers and/or equipment which does not meet the two (2) year experience period will be considered if the manufacturer or supplier provides a bond or cash deposit which will guarantee replacement of the equipment or process in the event of failure or unsatisfactory service. The amount of bond or cash deposit shall be sufficient to cover all labor and equipment costs for replacement in addition to any costs incurred by the Owner because of failure or unsatisfactory service. The period of time for which the bond or cash deposit is required shall be two (2) years.

D. Standardization: To avoid a division of responsibility among several manufacturers for items of equipment having functions related to each other or to the same portion

of the treatment process, and to avoid unnecessary duplication of replacement parts and service calls by the Owner, unless otherwise permitted herein, the equipment supplied under any numbered paragraph shall be the product of, or furnished and guaranteed by, one (1) manufacturer.

8.04 Equipment Obtained from Equipment Manufacturer: The Contractor shall obtain all equipment specified, and that required for the safe operation and use of that equipment from the manufacturer or the equipment, unless excluded by provisions in this paragraph or Specifications for the item.

Unless otherwise stated in the Specifications, the following type of materials shall not be considered to be a part of the equipment: Connecting piping and valves, railing set in the tank or structure, motor starters and wiring, steps and manholes installed separately from equipment, finish painting, etc.

8.05 Equipment Approval: Each manufacturer furnishing equipment shall submit the following information to the Engineer for approval.

A. Six (6) sets of certified drawings, guaranteed performance curves, wiring diagrams, specifications, and lists of electrical controls, including manufacturer's name and catalog number; furnish horsepower, normal full load maximum load ampere rating of each motor.

B. Estimated weight of each unit

C. Six (6) sets of certified test curves for each pump with capacity of greater than 100 gpm prior to shipment

D. List spare parts and tools furnished with equipment. Unless otherwise specified herein, tools shall be only such special tools required by the particular equipment.

E. Within six (6) weeks after above approval, three (3) sets of complete installation and operation instructions and parts list.

8.06 Mechanical Testing: After each unit has been installed and is ready for operation, it shall be operated continuously for a period of 24 hours. During that period, the equipment will be inspected for defects and weakness. Parts of the unit, which show a defect or weakness, or both, shall at once be removed and be replaced with new parts or be made good in a satisfactory manner, at no additional expense to the Owner.

A. Continuous 24-hour test shall be made after all defects have been remedied, at no additional expense to the Owner.

B. After installation and final testing, each equipment manufacturer furnishing supervision and/or inspection services shall make written certification to the Engineer and the Owner that the equipment and controls have been properly installed in accord with the Drawings, Specifications and manufacturer's requirements, and that the required operating and maintenance instructions have been furnished to the Engineer.

8.07 Piping for Equipment: The Contractor shall furnish completely dimensioned layouts for all piping, fittings, valves, specialties, and other equipment. Deviations from the dimensions shown on the drawings caused by equipment dimensions shall be taken into

consideration by the Contractor and changes in piping, electrical conduit, and other similar items shall be done at no additional expense to the Owner.

A. All piping and appurtenances shall be properly supported by a system of hangers, pipe stands, saddles, base ells, and concrete piers as required. Concrete insets, bolts, anchors, etc., shall be placed in the forms before placing concrete.

B. Drip piping, ¾" in size, shall be provided for all pumps; use crosses and plugs at all changes of direction. Piping shall be run to nearest drain in a manner, which will not constitute a hazard to floor traffic. Furnish plug valve, or stop cock, bleeds for high points in piping for all pumping units.

8.08 Shop Painting: All shop painting of equipment shall be as specified in "Painting" Section, unless otherwise specified.

8.09 Operation and Maintenance Manuals: Before the equipment is placed in service, three (3) sets of operation and maintenance manuals for the equipment, clean and unused, shall be delivered to the Engineer by the Contractor. A digital version on compact disc shall be included with each manual.

8.10 Guarantees: The Contractor shall guarantee the equipment to be free from defects in workmanship, design, and material for a period of one (1) year after initial operation begins; the Contractor shall replace at no additional expense to the Owner, every defective part, and every part showing undue wear during that guarantee period. The date of initial operation shall be only after approval by the Engineer and shall be furnished in writing to the Contractor.

8.11 Spare Parts and Allowance: The Contractor shall allow $10,000.00 in his bid for spare parts in addition to those specified for individual pieces of equipment. The Contractor shall submit a list of spare parts recommended by the manufacturers along with a price list for the Engineer's approval.

8.12 Motors: Motors for operating mechanical equipment shall satisfy the latest requirements of the Institute of Electrical and Electronic Engineers, American National Standards Institute, and the National Electrical Manufacturer's Association. Motors shall be manufactured by Weg, Baldor, NIDEC or approved equivalent. All single and three-phase motors (except fan motors which may be of an approved manufacturer standard) shall be ball bearing, and have either sealed-in lubricant or be designed for external oil or grease lubrication. The equipment manufacturer shall supply motors having sufficient torque to start equipment under load and to accelerate the equipment smoothly and quickly to full speed without exceeding the motor nameplate ratings, including service factor. Motors shall have 1.15 service factor, except totally enclosed and inverter duty rated motors unless otherwise specified.

A. Motors 25 horsepower and larger shall be equipped with embedded stator thermostats (normally closed) connected internally in series and brought out through motor junction box for connection to starter pilot relay 115V control circuit. Large motor protection will be covered under the paragraph applying to the individual motor.

B. Motors ½ horsepower and larger shall be 3-phase, 60 hertz, induction type and be designed for full voltage starting. Motors shall have either 40° C rise Class

insulation or 60° C rise Class B insulation, be open drip-proof for indoor installation, be vertical splash-proof and drip-proof for outdoor installation or have 70° C Class B rating rise for totally enclosed, non-ventilated, outdoor, horizontal installation.

C. Motors smaller than ½ horsepower shall be single phase, induction, capacitor-run type, unless otherwise specified. Very small motors, and those for special purposes, may be shaded pole type; their use shall be subject to approval by the Engineer.

8.13 Submersible Pumps: The Contractor shall furnish and install submersible pumps as manufactured by Flygt Pump Company or approved equal. Pumps shall be as shown on the Drawings and in accord with the following:

• Pump Station:	Goodyear Pump Station
• Quantity:	2
• Discharge Size:	4-inch
• Capacity:	1,158 gpm
• Static Head:	77 feet
• TDH:	157 feet
• Shutoff Head (minimum):	242 feet
• RPM (maximum):	1775
• Horsepower (minimum	70
• Voltage	460v

A. Discharge Connection: A sliding bracket shall be an integral part of the pump unit. The volute casing shall have a machined discharge flange to automatically and firmly connect with the cast iron discharge connection which when bolted to the floor of the sump and discharge line will receive the pump discharge connecting flange without the need of adjustment, fasteners, clamps or similar devices. Installation of the pump unit to the discharge connection shall be the result of a simple linear downward motion of the pump unit guided by no less than two (2) guide bars.

B. Guide Bars: Lower guide bar holders shall be integral with the discharge connection. Two (2) guide bars shall be installed for each pump, to permit raising and lowering the pump. Guide bars shall be of two inch (2") stainless steel, schedule 40 pipe of sufficient length to extend from the lower guide holders on the pump discharge connection to the upper guide holders, as shown on the Drawings. Manufacturer to supply intermediate guide brackets as required. Threaded guide bars ends will not be allowed. Mixer shall also be provided with stainless steel guide bars.

C. Motor: The pump motor shall be housed in an air-filled watertight casing and shall have moisture resistant Class F 155°C insulation, NEMA Design B and designed

for continuous duty or shall be a U.L. listed submersible motor designed for Class 1, Group D, Division 1 hazardous locations.

D. Motor Cable: The pump motor cable shall be suitable for submersible pump applications. Cable sizing shall conform to NEC Specifications for pump motors and shall be of adequate size to allow motor conversion without replacing the cable. The cable entry water seal design shall be such that precludes specific torque requirements to insure a watertight and submersible seal. The cable entry junction box and motor shall be separated by a stator lead sealing gland or terminal board which shall isolate the motor interior from foreign materials gaining access through the pump top.

E. Cooling System: Each unit shall be provided with an adequately designed cooling system. Thermal radiators integral to the stator housing cast in one unit are acceptable. Where water jackets alone or in conjunction with radiators are used, separate circulation shall be provided. Cooling media channels and ports shall be non-clinging by virtue of their dimensions. Provision for external cooling and flushing shall be provided.

F. Pump Design: The pumps shall be capable of handling raw, unscreened sewage. The design shall be such that the pump unit will be automatically and firmly connected to discharge piping when lowered into place on its mating discharge connection, permanently installed in the wetwell. The pump shall be easily removable for inspection or service requiring no bolts, nuts or other fastenings to be disconnected. For this purpose, they shall be fitted with a stainless steel chain of adequate strength and length to permit raising and lowering the pump for inspection or removal. A safety chain hook shall be provided for attachment of the chain to the access door frame. The pump with its appurtenances and cable shall be capable of continuous submergence under water without loss of watertight integrity to a depth of 65 feet. All major parts, such as the stator casing, oil casing, sliding bracket, volute and impeller shall be of gray iron.

G. Impeller: The impeller shall be gray cast iron of non-clogging design capable of handling solids, fibrous material, heavy sludge and other matter found in normal sewage applications. The impeller shall be constructed with a long throughlet without acute turns. The impeller shall be dynamically balanced. Static and dynamic balancing operations shall not deform or weaken it. The impeller shall be a slip fit to the shaft and key driven. Non-corroding fasteners shall be used.

H. Seals: Each pump shall be provided with a mechanical rotating shaft seal system running in an oil reservoir having a separate, constantly hydro-dynamically lubricated lapped seal faces. The seal unit between the pump and oil chamber shall contain one (1) stationary tungsten-carbide ring and one (1) positively driven rotating carbon or ceramic ring. Each interface shall be held in contact by its own spring system supplemented by external liquid pressures. The seal shall require neither maintenance nor adjustment but shall be easily inspected and replaceable. No seal damage shall result from operating the pumping unit out of its liquid environment. The seal system shall not rely upon pumped media for lubrication.

8.05 Pump Station Control Panel:

A. Pump Station Control Panel: An automatic control center equipped for the voltage and service required complete with main circuit breaker, phase failure relay w/ front panel indicator light, 120kA/phase transient voltage surge suppressor, circuit breaker combination reduced voltage Reduced Voltage Soft Starters (RVSS), 3-phase, with overload protection, hand-off-automatic switch, electrical alternator, automatic transfer to non-operating pump in event of overload in the operating pump, overload switch, run indication lights, elapsed time meters, 24 volt control circuit transformer, separate high-water alarm light and audible alarm, 15kVA 240V to 120/208V three phase transformer shall be mounted / installed externally and all components shall be housed in a corrosion resistant NEMA 4X enclosure. The starting level and stopping level for each pump shall be independently adjustable. Provide an adjustable time delay relay (0-30 seconds) for control of the lag pumps. Upon activation of the lag pump "on" regulator, the lag pump shall have a delay prior to start-up to prevent pumps from starting simultaneously. Control panel to be manufactured to accommodate connection to the existing SCADA panel. A terminal strip shall be provided to monitor pump auto mode, power failure alarm, pump run station, and high-level alarm. Control panel shall be supplied by the pump manufacturer.

All conduits from control panel to wet well shall be sealed at both ends with "FST Duct Seal" closed cell foam or approved equal to prevent sewer gases from entering the control panel.

B. General: The control system shall be designed to operate the required number of pumps specified on the drawings at the power characteristics shown on the plans.

The control function shall provide for the operation of the pumps under normal conditions, and shall alternate the pumps on each pump down cycle to equalize the run time. In the event the incoming flow exceeds the capacity of the lead pump, subsequent pumps shall automatically startup to handle the increased flow. As the flow decreases the pump shall cut off at the elevations as shown on the plans.

The control shall function as described below. The equipment listed below is a guide and does not relieve the supplier from supplying a system that will function as required.

C. Enclosure: The enclosure shall be a 14 gauge, NEMA 4X rated enclosure manufactured from 304 stainless steel. The enclosure shall be a wall mounted type with a minimum depth of 12", sized to adequately house all the components. The door gasket shall be rubber composition with a retainer to assure a positive weatherproof seal. The doors shall open a minimum of 180 degrees. Doors shall close via a quarter turn locking handle, with a three-point latch. Electrical schematics of the panel shall be affixed to the inside of the door.

D. Inner Dead Front Door: A polished, aluminum dead front shall be mounted on a continuous aircraft type hinge. It shall contain cutouts for mounted equipment, and provide protection of personnel from live, internal wiring. Cutouts for breaker handles shall be provided to allow operation of breakers without entering the compartment. All control switches, indicator pilot lights, elapsed time meters, duplex receptacle, and other operational devices shall be mounted on the external

surface of the dead front. The dead front shall open a minimum of 150 degrees to allow access to equipment for maintenance. A 3/4" break shall be formed around the perimeter of the dead front to provide rigidity.

E. Back Plate: The back plate shall be manufactured of 12 gauge steel and be finished with a primer coat and two (2) coats of baked on, white enamel. All hardware mounted to the subpanel shall be attached with machine thread, tapped holes. Sheet metal screws are not acceptable. All devices shall be permanently identified.

F. Power Distribution: The panel power distribution shall include necessary components and be completely wired stranded copper conductors rated at 90 degrees C. All conductor terminations shall be as recommended by the device manufacturer.

G. Circuit Breakers: All circuit breakers shall be heavy-duty thermal magnetic or motor circuit protectors similar and equal to Square D Type FAL. Each motor breaker shall be adequately sized to meet the pump motor operating characteristics and shall have a minimum of 14,000 amps interrupting capacity at 240 VAC. Heavy-duty breakers shall control the control circuit. Provide a 800 A/3P main circuit breaker to feed entire control panel.

Circuit breakers shall be indicating type, providing “on-off-trip” positions of the operating handle. When the breaker is tripped automatically, the handle shall assume a middle position indicating “trip.”

Thermal magnetic breakers shall be quick-make and quick-break on manual and automatic operation and have inverse time characteristics secured through the use of bimetallic tripping elements supplemented by a magnetic trip.

Breakers shall be designed so that an overload on one pole automatically trips and opens all legs. Field installed handle ties shall not be acceptable.

H. Control System: Pump starts and discharge shall be controlled by a submersible transducer provided by the pump manufacturer. The controller shall be MPE SC2000 or equal. The submersible transducer shall be MPE model LM with cable length and pressure range to suit installation. The submersible transducer shall be supplied with a transducer vent bellows (TVB1) to prevent moisture from entering the vent tube. Provide a two stage surge suppressor circuit using both an MOV and TVS to provide high voltage transient protection for the transducer circuitry. A stainless steel diaphragm and silicone oil fill shall be provided.

A complete float control type system shall be installed as a backup to the pressure transducer system. The float system shall take over operation of the pumps in the event the pressure transducer system fails. Floats shall incorporate simple relay circuit, 24 volts.

Pump moisture sensors shall notify the operator of a fault condition but shall not cut off the pump.

I. Level Control Systems: The control system shall provide for the automatic and manual control and alternation of the pumps to maintain a pumped down condition

of the wet well. Levels shall be sensed through a measurement device adjusted to the specified levels. The device shall sense the "off", "lead", "lag", and "alarm" levels. As the level in the wet well rises, the lead pump, as determined by the alternator, shall start and pump the station to the "off" level. In the event the incoming flow exceeds the capacity of the lead pump, the lag pump shall start and both pumps shall run to the "off" level. If the level continues to rise, alarm functions shall be activated. The control system shall include, but not be limited to, the ancillary equipment listed below.

J. Ancillary Equipment [BOM (Bypass/Off/ SC2000) switches]: A three-position BOM switch shall be provided for each motor. The switch shall be NEMA 4X rated with 10 amp contacts. A position indicating legend plate shall be provided. The BOM switches shall be mounted on the dead front door. The BOM in the bypass position will allow the pump to run and bypass all safety shutdowns except for the overloads. In the SC2000 position the SC2000 will control the pumps while monitoring all shutdowns and stop the pump.

K. Run Indicators: A green run pilot indicator shall be mounted on the dead front door. All pilot lights shall be push to test LED type. Fluorescent lighting shall be provided inside the panel.

L. Elapsed Time Meter: An elapsed time meter shall be mounted on the dead front door. The meter shall operate on 120 VAC, shall indicate in hours (6 digits) and tenths and shall not be re-settable.

M. Moisture and Thermal Measurement: A plug-in, solid state control and status relay with indicating LED's shall be provided to measure motor thermal overload and moisture in the pump housing. Any thermal condition shall signal failure and stop the pump, any moisture conditional shall indicate but shall not stop the pumps. An illuminated light on the SC2000 controller shall also indicate the failure mode.

N. Heater: An internal 100-watt heater shall be provided to maintain temperature above the dew point. The unit shall be thermostatically controlled.

O. Alarm System: The alarm light shall be a weatherproof, shatterproof, red light fixture with a 40-watt bulb to indicate alarm conditions. The alarm light shall be turned on by the alarm relay.

P. Lightning-Transient Protection: Each complete suppression unit shall be UL listed as a secondary surge arrestor and bear CSA certification and meet ANSI/IEEE C62-11-1987; suitable for indoor and outdoor applications; suitable for use in service entrance location; meet requirements of NEC Article 280; rated at 650V phase-to-ground maximum.

Q. Transformers: Control transformers shall be provided to produce the 120 VAC and/or 24 VAC for control circuits. Transformers shall be fused on the primary and secondary circuits. The secondary circuits shall be grounded.

Provide a 15 KVA transformer and 5-20 A/IP breakers for 120-volt loads (receptacle, generator block heater, generator battery charger, mag meter, 120-volt controls).

R. Phase Monitor: A line voltage rated, adjustable phase monitor shall be installed to sense low voltage, loss of power, reverse phase, and loss of phase. Control circuit shall de-energize upon sensing any of the faults and shall automatically restore service upon return to normal power. A phase fault indicator light shall be installed in the dead front door.

S. Pump Control Panel shall be provided with the following:

1. H.O.A. switch for each pump.

T. Drawings: A final, "as-built" drawing encapsulated in mylar shall be attached to the inside of the front door. A list of all legends shall be included.

U. Panel Markings: All component parts in the control panel shall be permanently marked and identified as they are indicated on the drawing. Marking shall be on the back plate adjacent to the component. All control conductors shall be identified with wire markers at each end, as close as practical to the end of the conductor. Laminated electrical schematics shall be displayed on the inner face of the outer door.

V. Testing: All panels shall be tested to the power requirements as shown on the plans to assure proper operation of all components. Each control function shall be activated to check for proper indication.

W. Guarantee: All equipment shall be guaranteed for a period of three (3) years from date of shipment. The guarantee is effective against all defects in workmanship and/or defective components. The warranty is limited to replacement or repair of the defective equipment.

X. Manufacturer: The manufacturer shall be a UL listed shop for industrial control systems and shall serialization evidence of such on the control panel enclosure.

Y. Pressure Transducer: The Pump Manufacturer shall furnish and install 2 submersible pressure transducers. The pressure transducer shall be 4-20mA with reverse polarity protection and under/over current limitation. The pressure transducer shall be Seimens SITRANS LH100 or equal. The transducer shall be supplied with stainless steel cage, cable length as required, anchor clamp cable hanger, cable box and transmitter. Conduit shall be installed as necessary for third level transducer in Wetwell Two.

Z. Float Switch: Four (4) float switches shall be installed as high/low level cut off in each wetwell; two (2) floats per wetwell shall be provided. Conduit shall be installed as necessary for future floats. Float shall be Seimens 9G-EF or equal.

8.06 Payment: No separate payment will be made for the work of this Section. The cost of the work, and all costs incidental thereto, shall be included in the amount bid in the proposal for the item to which the work pertains.

SECTION 9

INSTRUMENTATION AND CONTROL

9.01 Scope: The Contractor shall furnish all materials, labor and equipment necessary for the complete installation of instrumentation and control and mechanical systems as shown on the Drawings and/or specified. The furnishing of the installation and initial operation shall be a minimum of one working day.

A. The Contractor shall furnish, install, test, adjust and paint in accurate, satisfactory, workmanlike manner all machinery, equipment, apparatus, accessories and fittings required by the completion of the work in accordance with the Drawings, these Specifications and in accordance with the drawings, specifications and directions for erection furnished by each equipment manufacturer.

B. The Contractor shall furnish and install all materials including electric wiring, conduits and controls not furnished by the equipment manufacturers. The Contractor's attention is directed to the General Requirements section of these Specifications with reference to requirements for furnishing working drawings.

C. The Contractor shall furnish all materials, labor and equipment necessary for complete installation of mechanical equipment as shown on the Drawings and/or specified and the furnishing of the services of a competent factory representative to supervise and/or inspect the installation and initial operation of the equipment. The duration of the service to be furnished during the periods of installation and initial operation is estimated as specified below.

9.02 Equipment Bids:

A. Equipment Manufacturer: Any reference to an item of equipment or material by a specific manufacturer's trade name in these Specifications is intended merely as a standard. Even though named in the Specifications, all manufacturers must be able to furnish equipment as specified. Even though named in the Specifications, equipment offered with smaller or lightweight members, inferior or inefficient mechanism or devices compared to that specified will not be approved for the project. Where so stated, only one manufacturer's name is given in order to match existing equipment in order to provide for the necessary interchangeability of parts and equipment. Each bidder is required to state in his bid the name of at least 1 manufacturer or supplier named in these Specifications for each major item of equipment and his bid price for that item as required in the Proposal. This requirement is to prevent rejection of the bid should a piece of substitute equipment be rejected. Other equipment shall be considered as specified in the "General Conditions", if offered by the Bidder under "Substitute Equipment", in the Proposal; provided, it is equal in functional design and mechanical structural details to the one specified.

1. Substitute Equipment: Equipment offered under "Substitute Equipment" of the Proposal shall comply with requirements of these Specifications. It

shall be the responsibility of the Bidder to determine the equipment offered in the Proposal is in accordance with the Specifications. Substitute equipment offered at lower price by reason of smaller lightweight members, inferior of inefficient mechanism or devices will not be considered.

2. Substitute Equipment Bid: The price of substitute equipment shall include the cost of all changes in the structure, mechanical and electrical work, and other appurtenances for the accommodation of such equipment, as determined by the Engineer, at the expense of the Contractor.

B. Pre-Submittal Information Required: It shall be the responsibility of the Bidder to ascertain that each manufacturer named in his Proposal has submitted to the Engineer at least two weeks in advance of the letting date complete information in regard to the equipment offered. For makes of equipment named in the Specifications this may be a statement that the Engineer's Specifications, listing any and all exceptions. For all substitute items of equipment, complete drawings, specifications, thickness, and weights of principal parts shall be furnished to the Engineer two weeks prior to the letting date. A list of all substitute equipment, which has been submitted in accordance with the above, will be provided to all bidders one week prior to the receipt of bids.

C. Experience and Manufacturer: It is desired that only equipment which has undergone thorough development as provided by successful service in similar installation for at least two years shall be accepted for installation unless specified elsewhere in these Specifications. Manufacturers and/or equipment which do not meet the two year experience period will be considered if the manufacturer or supplier provides a bond or cash deposit which will guarantee replacement of the equipment or process in the event of failure or unsatisfactory service. The amount of bond or cash deposit shall be sufficient to cover all labor and equipment costs for replacement in addition to any costs incurred by the Owner because of failure or unsatisfactory service. The period of time for which the bond cash deposit is required shall be two years.

9.03 Operation and Maintenance Manuals: Before the equipment is placed in service, operation and maintenance manuals for the equipment, clean and unused, shall be delivered to the Engineer by the Contractor in accordance with the General Requirements section of these Specifications.

9.04 Standards: All work shall conform to applicable standards of ANSI, IEEE, ISA, NEMA, UL, and NEC.

9.05 Submittals: Complete shop drawings showing the panel outline dimensions, instruments and control configurations, wiring schematics, field termination types of devices, block diagrams, bill of materials and description of operation for review prior to fabrication shall be provided in accordance with the General Requirements section of these Specifications.

9.06 Qualifications: Attention is directed to the fact that instrumentation is an integrated system and shall be furnished by a single system vendor where possible. The Contractor

is responsible for coordinating the compatibility of equipment furnished by various manufacturers. The Contractor shall be responsible for the satisfactory operation of the entire system.

9.07 Manufacturer/Supplier: The telemetry system shall be provided by Electric Machine Control (EMC), Inc. (205) 661-3998

9.08 Supervisory Control and Data Acquisition Equipment (SCADA):

A. Equipment Supplied by the Manufacturer: EMC will provide the following equipment and services:

1. Process Automation Controller (PAC) drawings will be included with the panel.

2. The PAC will be programmed to monitor and control I/O for the lift station.

3. Integrate the PAC with the City of Valdosta SCADA system to include a graphical display for the pump station.

4. Provide start-up services for material provided below. Provide a manufacturer's representative for start-up, testing and training for a minimum of one 8-hour day for onsite start-up, test and customer sign off.

5. Hardware:

a. One ControlWave Micro RTU panel assembly

b. One Enclosure, NEMA 4, steel, dimensions approx. 30" h x 24" w x 10" d

c. AC power distribution assembly including surge protector, circuit breaker, fuses and distribution blocks

d. DC power distribution assembly including fuses and distribution blocks

e. One CW Micro 8 Slot Chassis

f. One CW Micro 12-24V System Controller

g. One CW Micro CPU, 1-Ethernet, 2-RS232, 1-RS485 Ports

h. One CW Micro 25 button keypad, 4 line x 20-character display

i. One CW Micro I/O module, Local - 16 DI with LEDs (24 VDC Input) Isolated.

j. One CW Micro I/O module, Local - 8 DO with LEDs (24 VDC Input) Isolated.

k. One CW Micro I/O module, Local - 8 AI Isolated.

l. One CW Micro I/O module, Local - 8 AO Isolated.

m. One Bulkhead lightning arrestor

n. One Power Supply (Phoenix Contact QUINT-PS/1AC/24DC/5); 120 Vac input, 24Vdc @ 5A out

o. One UPS (Phoenix Contact 2320212); 24 Vdc input, 24Vdc nominal @ 10A output

p. One 24Vdc-7.2Ah battery backup, (Phoenix Contact 2320319)

q. Two 12Vdc 7Ah batteries Power Sonic PS-1270 F2 or equal

6. Radio Equipment:

a. One 4RF Radio – 450 – 470 MHz

b. One Polyphaser RF lightning arrester

c. Reuse existing Yagi antenna

d. Mount new Yagi antenna on new 40 foot telescoping mast: Aluma Tower Company Model T-40HN tower with an Aluma Model MP-2 base

e. Replace existing antennae cable with ldf4-50 coaxial cable.

B. Signals: The Contractor shall terminate all field wiring as required for the signals listed herein allowing for an increase of up to a twenty percent by Field Order. The following shall report to the SCADA system:

DI1	Power Failure (SCADA panel)
DI2	Pump No. 1 Fault
DI3	Pump No. 2 Fault
DI4	Pump No. 1 Run
DI5	Pump No. 2 Run
DI6	Pump No. 1 Auto Mode
DI7	Pump No. 2 Auto Mode
DI8	RTU low battery
DI9	Generator Running
D10-16	Spares
DO1	Pump No. 1 Call to Run
DO2	Pump No. 2 Call to Run
DO3-8	Spares

AI1	Pump No. 1 Speed Reference
AI2	Pump No. 2 Speed Reference
AI3-8	Spares
AO1	Pump No. 1 Speed
AO2	Pump No. 2 Speed
AO3	Wetwell Level
AO4-8	Spares

C. Deduct Number One: For deduct number one the contractor shall relocate the existing SCADA panel where shown on the drawings. The Owner will add the required I/O modules. Owner may take the SCADA panel to their shop then return to the Contractor.

9.09 Payment: No separate payment will be made for the work of this Section. The cost of the work and all costs incidental thereto shall be included in the amount bid in the Proposal for the item to which the work pertains.

SECTION 10

ELECTRICAL – BASIC MATERIALS AND METHODS

10.01 Scope of Work: Work covered by this Specification consists of furnishing all labor, equipment, supplies and materials, and performing all operations including cutting, trenching and backfilling, etc., necessary for the installation of complete wiring systems as shown on Drawings and as hereinafter specified.

Work shall include power distribution and controls, lighting systems, instrumentation and metering, wiring and telephone service (where required).

10.02 Quality Assurance: Installation shall comply with all laws applicable to electrical installations which are enforced by local authorities, with the regulations of National Electrical Code where such regulations do not conflict with local laws, and with regulations of the utility company that serves the facility. Contractor shall obtain all permits required by local authorities and, after completion of work, and shall furnish Engineer and Owner a certificate of final inspection and approval from inspection bureau having jurisdiction. Contractor shall notify Engineer and Owner that certificate has been furnished to utility company so that application for service can be filed.

All materials shall be new and shall bear a U.L. label or be listed by Underwriter's Laboratories as conforming to its standards where such a standard has been established for the particular type of material in question.

Catalog numbers of devices, fixtures, equipment, etc., are used for ease in describing standard of quality desired. Devices, fixtures, equipment, etc., by other manufacturers performing the same functions and considered equal in quality by the Engineer will be acceptable.

10.03 Reference: All work shall conform to applicable standards of ANSI, ICEA, IEEE, ISA, NEMA, UL and NEC.

10.04 Submittals:

A. Contractor's submittal shall include a list of manufacturers of principal items of equipment and material including wire, raceways, devices, boxes, panelboards, connectors, etc. Full information shall be furnished on products of manufacturers not named in the Contract Documents.

B. Shop drawings shall be submitted giving performance data, physical size, wiring diagrams, materials, etc., for control centers, lighting fixtures, motor controllers, panelboards, conduit and duct, and cable and wire.

C. The requirements of each electrical system shall be identified by the Contractor before submission of shop drawings, and all necessary accessory parts required between items of electrical equipment shall be identified in sufficient detail to prove that the total equipment furnished and installed will operate as specified and shown on the Drawings.

D. Shop drawings and samples shall be thoroughly checked and coordinated by the Contractor for details and fulfillment of Contract requirements prior to submittal. Approval of any item does not relieve Contractor of responsibility for coordinating dimensions and work required by other trades.

E. Refer to the General Requirements of these Specifications for submittal requirements and quantities.

10.05 Delivery, Storage and Handling: All materials shall be unloaded and stored in a manner to avoid physical damage or detrimental effects of exposure to weather.

10.06 Variable Frequency Drives (VFD): This specification describes a complete adjustable speed AC drive (ASD) used to control the speed of NEMA design B induction motors used in areas where low harmonic content is desired or mandated. The drive manufacturer shall supply the drive and all necessary controls as herein specified. The ASD shall be manufactured by a company with at least 10 years' experience in the production of this type of equipment. Drive shall be by Rockwell Automation, specified substitutes have been included in the Proposal as alternates.

The drives shall be adjustable speed AC drives that comply with standard IEEE 519 at the VFD input power terminals. The drive shall be equipped with a compact input filter with nine bi-directional switches arranged in a matrix to convert three-phase AC input voltage directly into a three-phase AC output voltage.

A. Manufacturers:

	Item	***Quantity***	***Manufacturer Item No.***
1.	70 horsepower 480 volts /3 phase / 60 hertz	2	• Base Bid – Rockwell Automation • Add / Deduct No. 2 – ABB Ultra Low Harmonic Drive • Add / Deduct No. 2 – Danfoss VLT Low Harmonic Drive
2.	150 horsepower 480 volts /3 phase / 60 hertz,	1	• Base Bid – Rockwell Automation • Add / Deduct No. 2 – ABB Ultra Low Harmonic Drive • Add / Deduct No. 2 – Danfoss VLT Low Harmonic Drive

The drives shall be adjustable speed AC drives that comply with standard IEEE 519 at the VFD input power terminals. The drive shall be equipped with a compact input filter with nine bi-directional switches arranged in a matrix to convert three-phase AC input voltage directly into a three-phase AC output voltage.

This specification describes a complete adjustable speed AC drive (ASD) used to control the speed of NEMA design B induction motors used in areas where low harmonic content is desired or mandated. The drive manufacturer shall supply the drive and all necessary controls as herein specified. The ASD shall be manufactured by a company with at least 10 years' experience in the production of this type of equipment. Drive shall be by Rockwell Automation or approved equal.

1. Quality Assurance:
    a. In circuit testing of all printed circuit boards is conducted, to ensure proper manufacturing.
    b. Final printed circuit board assemblies are functionally tested, via computerized test equipment.
    c. All fully assembled controls are computer tested with induction motor loads to assure unit specifications are met.
    d. The average mean time between failure (MTBF) is 28 years.
2. Qualifications: The ASD shall meet the following specifications:
    a. UL 508A and 508C – Underwriter's Laboratory Listed
    b. CAN/CSA-C22 No. 14-95 – Canadian Standards Association
    c. Institute of Electrical and Electronic Engineers (IEEE): IEE 519-1992, and IEE C642.41
    d. CE Mark 2006/95/EC LVD and 2004/108/EC
    e. IEC 618000-50-(LVD)
3. Submittals: The submittals shall include the following information in accordance with the General Requirements section of these Specifications:
    a. Outline dimensions and weight
    b. Customer connection and power wiring diagrams
    c. Complete technical product description including a complete list of options provided
4. Description:
    a. The U1000 Matrix is a high performance PWM (pulse-width-modulated) AC drive. Three-phase input line power is converted to a sine-coded, variable frequency output, which provides optimum speed control of any conventional squirrel cage induction motor. The use of bidirectional switches, with a carrier frequency range of 3 kHz to 10 kHz, permits quiet motor operation.
    b. This drive has one control logic board for all horsepower ratings. Printed circuit boards employ surface mount technology, providing both high reliability and small physical size. The dual 32 bit microprocessors deliver the computing power necessary for complete three phase motor control in building automation systems.

c. Operating Principle: VFD input three phase power is directly converted to variable AC output power. The main circuit consists of a compact input filter and bidirectional switches. Using pulse width modulation (PWM) inverter technology, produces an output waveform in a series of variable-width pulses. Unique firmware algorithms optimize motor magnetization through control of voltage, current and frequency applied to generate a nearly sinusoidal output waveform.

d. The U1000 Matrix drive has superior harmonic mitigation of less than 5% THD at the input of the drive.

5. Construction: Matrix technology employs a main power circuit consisting of input line semiconductor fuses, a compact input filter and a system of 9 bidirectional switches that are arranged in a matrix, to convert a three-phase AC input voltage directly into a three-phase AC output voltage. It eliminates the need for a rectifying and DC smoothing circuit, that are used in traditional AC drive "inverters". This results in a compact drive with power regenerative capability and reduced harmonic distortion.

   a. NEMA 1 with gasketed doors

   b. Microprocessor based control circuit

   c. Non-Volatile memory (NV RAM); all programming memory is saved when the VFD is disconnected from power.

   d. Current transformers detect the output current for motor control and protective functions

   e. Digital operator keypad and display, with copy function, provides local control and readout capability.

   f. Heat sink cooling fan with programmable on/off control

   g. USB Type B port for quick and easy PC Connection

6. Drive Features:

   a. Full 100% continuous regenerative operation

   b. Low Input Current Harmonics at All Speeds/Loads

   c. Facilitates IEEE 519 Compliance

   d. VFD efficiency: 96% at half-speed; 98% at full-speed

   e. Eliminate Harmonics with Embedded Across-the-Line Operation

   f. Near Unity True Power Factor at Full Load (0.98 or better)

   g. Higher Efficiency than Common Low Harmonic Solutions

   h. Compact Design

   i. Integrated Input Fusing Provides 100kA SCCR

   j. High Reliability with MTBF in Excess of 28 Years

k. Induction and Permanent Magnet Motor Control

l. Safe Torque Off (SIL3 and PLe)

m. 0-400 Hz Output Frequency

n. 120% Overload for 60 Seconds (ND)

o. 150% Overload for 60 Seconds (HD)

p. Embedded Modbus RTU Communications

q. Removable Terminal Block

r. High Carrier Frequency (Low Motor Noise) Capability

s. Multi-Language LCD Display with Copy Function

t. DriveWizard® Industrial Programing Software

u. Embedded PLC capability (DriveWorks EZ)

v. Start into Spinning Motor (Speed Search)

w. Open/Closed loop operation

x. Input phase insensitive; sequencing of the three phase input is unnecessary

y. Volt meter, ammeter, kilowatt meter elapsed run time meter and heat sink temperature monitoring functions

z. PI feedback Control

aa. Feedback signal low pass filter

bb. Feedback signal loss detection and selectable response strategy

cc. Feedback signal inverse

dd. 24 Vdc, 150ma transducer power supply

ee. Input and output terminal status indication

ff. Diagnostic fault indication

gg. “S-curve” soft start / soft stop capability

hh. Run/Fault output contacts

ii. Serial communication loss detection and selectable response strategy

jj. “Up/Down” floating point control capability (digital MOP)

kk. Critical frequency rejection capability: 3 selectable, adjustable bandwidths

ll. Remote speed reference (speed command) signal: 0 to10 VDC / -10 to +10 VDC (20 kΩ), 4 to 20 mA / 0 to 20mA DC (250 Ω)

mm. Adjustable carrier frequency, from 4 kHz to 10 kHz

nn. Programmable security code

oo. 16 preset speeds

pp. 8 programmable multi-function input terminals (24Vdc) providing 60+ programmable features, including: Preset Speeds, Customer Fault, Fault reset, Speed/Torque control Switch over, External Baseblock, Jog Control

qq. 3 programmable multi-function output relays (2 Form A and 1 Form C) rated 1 amps @ 250Vac & 30Vdc), providing 50+ functions, including: During Run, Zero Speed

rr. Speed Agree

ss. One fixed "Fault" form C output relay (Rated 1 amps @ 250Vac & 30Vdc)

tt. Built-in Modbus/Memobus communication

uu. Protocols are accessible via RS-422/485 communication, which is standard'

vv. Stationary and Rotational motor auto-tuning

ww. LCD keypad: Local/remote functions with a built-in copy feature

xx. Flash upgradeable firmware

yy. Customizable monitor display

zz. Heat sink over temperature speed fold-back feature

aaa. Fan failure detection and selectable drive action

7. Operation:

a. Output frequency and speed display can be programmed for other speed-related and control indications, including: Hz, RPM, % of maximum, or custom

b. Power loss ride-thru (2 seconds or greater capable)

c. Time delay on start, peak avoidance

d. VFD accepts a bi-polar speed command signal

e. Bi-directional "Speed Search" capability, in order to start into a rotating load. Two types: current detection and residual voltage detection

f. DC injection braking, to prevent fan "wind milling"

g. Remote Run/Stop command input

h. Two programmable 0 to +/-10 VDC or 4-20ma analog outputs, proportional to drive monitor functions including: output frequency, output current, output power, PI feedback, output voltage and more.

i. 5-Line 16 Character LCD display provides readout functions that include: output frequency, output voltage, output current, output power, DC bus voltage, interface terminal status, PI feedback and fault status.

j. Programmable industrial specific application macros

k. Over 100 programmable functions, resettable to factory presets

l. User parameter initialization, re-establish project specific parameters

m. Ramp-to-stop or coast-to-stop selection

n. Auto restart capability: 0 to 10 attempts with adjustable delay time between attempts

o. Flexible motor control: one custom selectable Volts/Hertz pattern and multiple preset Volts/Hertz patterns, Open loop vector control, and closed loop vector control for induction and permanent magnet motors.

p. Auto speed reference input signal, adjustable for bias and gain

q. While the VFD is running, operational changes in control and display functions are possible, including: Acceleration time (0 to 6000 seconds), Deceleration time (0 to 6000 seconds), Frequency reference command, Local/remote commands, Monitor display, Removable digital operator

r. Automatic energy saving, reduced voltage operation

8. Protection:

a. Output current overload rating of 150 % of drive's continuous heavy duty current rating for 60 seconds or 110% of drive's continuous normal duty current rating for 60 seconds

b. Output short circuit protection

c. Current limited stall prevention (overload trip prevention) during acceleration, deceleration, and run conditions

d. Optically isolated operator controls

e. Fault display and last 10 faults storage

f. "Hunting" prevention logic

g. Electronic ground fault protection

h. Electronic thermal motor overload protection (UL approved)

i. Power supply charge indication

j. Heat sink over temperature protection

k. Cooling fan operating hours recorded

l. Input/Output phase loss protection

m. Reverse prohibited selectable

n. Short circuit withstand rating of 100K amps RMS

9. Options:

a. Network communication options include:

- DeviceNet™ w/ ADR
- EtherNet IP (single and dual Port)
- EtherCAT
- MECHATROLINK-II
- MECHATROLINK-III
- Modbus TCP/IP (single and dual Port)
- PROFIBUS DP
- PROFINET

b. Analog input option for high speed reference resolution

c. 120VAC logic interface (8-input) option

d. Digital input option for high speed reference resolution (8, 12, or 16 Bit).

e. Analog output option for high monitor reference resolution

f. Analog output option for high monitor reference resolution

g. Digital output expansion option (8 additional outputs)

h. Motor feedback, including, open collector, line driver and resolver

10. Installation: The drive manufacturer shall provide adequate drawings and instruction material to facilitate installation of the drive by qualified electrical and mechanical personnel employed by others. Drive manufacturer shall provide all switches, relays, and contacts as required to interface with the SCADA RTU and pump motor as shown on the Drawings.

11. Start-Up: Certified factory start-up shall be provided for each ASD by a factory authorized service center. A certified start-up form shall be filled out for each ASD with a copy provided to the Owner and a copy kept on file at the manufacturer

12. Product Support: Factory trained application engineering and service personnel that are thoroughly familiar with the ASD products offered shall be locally available at both the specifying and installation locations.

13. Warranty: Warranty shall be 24 months from the date of start-up. The warranty shall include all parts, labor, travel time, and expenses.

B. Field Services: Provide a manufacturer's representative for start-up and testing for a minimum of two trips of two 8-hour days. Manufacturer's representative shall be present at the start-up and commissioning of the relocated filter units.

C. Warranty: The equipment shall materially conform to the description in this Specification and the Contract Documents and shall be free from defects in material and workmanship. Warranty period shall be three years from beneficial use.

10.07 Grounding: All equipment, building steel and main service must be effectively and permanently grounded with a cross section as required by the NEC and of capacity sufficient to ensure effectiveness of the ground connections for fault current. Ground conductors must be as short and straight as possible and protected from mechanical injury, if practical, without splice or joint.

A. Grounding Conductors:

1. All ground conductors shall be at least 12 AWG soft drawn copper cable or bar, bare or green-insulated in accordance with the National Electrical Code.

2. Main service conduits, entering switchgear, panels, control center, switches, etc., shall be provided with insulating bushings with ground lug and connected to building ground system.

3. Bonding jumpers shall be copper tape, braided conductors, terminated with copper ferrules sized in accordance with the National Electrical Code table on sizes of equipment grounding electrode conductors.

4. All flexible conduits making final connections to motors, lights, vibrating equipment, etc., shall contain a green copper bonding conductor which shall extend from outlet box where flexible conduit originates or from nearest box in line to the equipment served.

B. Devices: Each receptacle and switch device shall be furnished with a grounding screw connected to the metallic device frame. Bond equipment grounding conductor to each outlet box. For isolated ground receptacles, bond equipment grounding conductor to box, and bond isolated ground conductor to device grounding screw.

C. Ground Rods: Ground rods shall be a minimum of ⅝" in diameter by 10' long, with a copper jacket bonded to a steel core.

D. Ground cable splices and joints, ground rod connections, and equipment bonding connections shall meet the requirements of IEEE 837, and shall be exothermic weld connections or irreversible high-compression connections. Models shall be Cadweld "Exothermic" or Burndy "Hyground". Mechanical connectors will not be acceptable. Cable connections to bus bars shall be made with high-compression two-hole lugs.

E. Raceways, boxes, outlets, cabinets, etc., shall be bonded together to form a continuous metallic grounding circuit in accordance with NEC.

F. All powered equipment, including lighting fixtures and receptacles, shall be grounded by a copper ground conductor in addition to the conduit connection.

G. Test wells and covers for non-traffic areas shall be molded high density polyethylene. Test wells for traffic areas shall be precast concrete construction rated for traffic duty with concrete or cast iron covers.

10.08 Equipment Identification:

A. Engraved Plastic Nameplates: Nameplates shall be engraving stock, melamine plastic laminate, minimum 1/16" thick plates with engraved white letters on black face legend. Painted, stenciled or indented tape identification is not acceptable.

B. Item Identification: Install identification on each unit of equipment, including central or master unit of each system. Power, lighting, communication, signal and alarm systems shall be furnished with identification unless units are specified with their own self-explanatory identification.

1. Unless otherwise indicated, provide a single line of text with ½" high lettering on 1½" high label; where 2 lines of text are required, use labels 2" high. Use white lettering on black field. Apply labels for each unit of the following categories of equipment using mechanical fasteners:

2. All electrical apparatus such as wiring troughs, panelboards, switchgear, switchboards, motor control centers, enclosed circuit breakers, electrical cabinets and enclosures, motor starters, push-button stations, contactors, transformers and disconnect switches shall have laminated plastic identification plates. Identification shall match labeling shown on Drawings.

3. Circuit breakers and disconnects shall identify the equipment served and circuit and panel from which it is served.

10.09 Cables and Conductors:

A. All conductors shall be type THHN-THWN #12 AWG minimum, insulated, color coded, and in accordance with ASTM B3, B8 and B787, UL 83, 758,1063 and 1581.

B. Instrument Cable: Cable for electronic circuits to instrumentation, metering and other signaling and control equipment shall be 2 or 3 conductor instrument cable twisted for magnetic noise rejection and protected from electrostatic noise by a total coverage shield.

C. Installation:

1. Conceal cables in finished walls, ceilings and floors unless otherwise indicated.

2. Conductor splices and connections shall be made with approved solderless lugs and mechanical connections to ensure positive electrically and mechanically strong joints. Use of connectors without internal spiral spring (wire nuts) is not acceptable.

3. Where bolted connectors are used for makeup of cables or for termination, they must be exact size to suit cable being used. Trimming, shimming or cutting of conductor strands are not permitted. Where branch circuit conduits are jointed or spliced using crimp-on or twist-on connectors, wires must first be twisted together full length and then connector installed.

4. Conductors within switchboards, panelboards, terminal cabinets, starters, control centers, etc., shall be neatly formed and trained to run parallel to or at right angles to the device. Conductors shall be bundled together and laced using nylon tie straps.

5. Use pulling means, including fish tape, cable, rope and basket-weave wire/cable grips, that will not damage cables or raceway.

6. Control cable shall be minimum #14 AWG single or multiple conductor, 600V insulation.

7. Control raceway and wiring shall be installed and fully connected to make system operational.

10.10 Junction and Pull Boxes: Pull boxes no less than the minimum size required by the National Electrical Code Article 370 shall be constructed of cast aluminum with gasketed covers. Boxes shall be furnished with screw fastened covers. Boxes located on the exterior of the structures shall be watertight. Covers shall be secured with tamper proof screws. Boxes and outlets shall be cast alloy type and securely attached to building structure using expansion bolts for masonry or concrete construction.

A. Cabinets: Galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel may be provided where approved. Cabinets shall include the following:

1. Hinged door in front cover with flush latch and concealed hinge

2. Key latch to match panelboards

3. Include metal barriers to separate wiring of different systems and voltage and includes accessory feet where required for freestanding equipment.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Handholes and boxes shall be molded sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two.

C. Precast Concrete Electric Manhole: Precast concrete electrical manholes shall include thin-wall knockout, pull irons, sump box with grate, ground rod sleeve, fiberglass ladder, neck extension, where required, and a cast or ductile iron ring and cover marked "ELECTRIC".

D. All outlet or junction boxes of pressed or sheet steel type shall be galvanized, sheradized, bonderized or treated with a similar approved corrosion inhibitor.

E. Installation:

1. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

2. Concealed conduit systems shall have flush-mounted switches and convenience outlets. Exposed conduit systems shall have surface-mounted switches and convenience outlets. Conduits shall be concealed where practicable.

3. Covers and collars for manholes shall be level with the finished grade. Build up masonry wall between manhole top and manhole cover collar as required for leveling with finished grade.

10.11 Raceways: All raceways shall conform to Underwriter's Laboratories and NEMA standards and be fully UL labeled. Contractor shall be responsible for routing all conduits, including all conduits indicated on the one-lines, riser diagrams, and home-runs shown on the plan Drawings. Conduits shall be routed as defined in these Specifications. Where conduit routing is shown on Drawings, it shall be considered a general guideline and shall be field verified to avoid interferences.

A. Submittals: Submit manufacturer's literature for each type of conduit or tubing and fittings used in the project in accordance with the General Requirements section of these Specifications.

B. Manufacturers:

1. Acceptable manufacturers of rigid galvanized steel, aluminum and electrical metallic tubing conduit are: Allied Tube and Conduit Co., Wheatland Tube Co., Triangle, L.T.V., American Brass, E.T.P., Robroy, or equal.

2. Acceptable manufacturers of polyvinyl chloride (PVC) conduit are: Allied Tube and Conduit Co., Certainteed, Georgia Pipe, Carlon, Cantex, Queen City, or equal.

3. Acceptable manufacturers of PVC coated rigid galvanized conduit and fittings are: Plasti-bond Red H_2OT, Calbond, or equal.

4. Acceptable manufacturers of liquid tight flexible metal conduit and fittings are: Electric-Flex Company, Hubbell, Ideal Industries, Southwire, or equal.

5. Acceptable manufacturers of conduit fittings, bushings, and locknuts are: O-Z/Gedney, Thomas and Belts, Raco, or equal.

C. Wiring: All wiring shall be in a raceway or conduit, and the following shall govern type used throughout the project except as otherwise specified:

1. Rigid Galvanized Steel or Aluminum Conduit: Use for all exposed indoor raceways except as otherwise noted. Exposed conduit shall be rigidly supported by hot-dip galvanized or aluminum hardware and framing materials. Conduit shall be listed UL 6 (6A) and be manufactured in accordance with ANSI C80.1 (C80.5).

2. Electrical Metallic Tubing (EMT): Use for all concealed raceways in ceilings and walls. EMT galvanized raceways shall have a sheradized, bonderized, galvanized or similar approved coating. Conduit shall be listed UL 797 and be manufactured in accordance with ANSI C80.3.

3. Liquid-Tight Flexible Steel Conduit: Use for final connections, maximum 72", to all dry-type transformers, motors, vibrating equipment and in wet or damp installations. Outer covering shall be polyvinyl chloride, and inner core shall be galvanized steel. Provide UL listed watertight connectors installed without sharp bends.

4. Rigid Non-Metallic PVC Plastic Conduit: Use for outside underground for feeders and branch circuits except as otherwise noted and where specifically indicated on Drawings. A grounding conductor shall be installed in each non-metallic conduit to maintain grounding continuity. Follow manufacturer's recommendations for heat bends and cement application. Install plastic to rigid adapter before emerging from ground or running under building. Install expansion fittings for each 100' of unbroken PVC run. Rigid non-metallic PVC plastic raceways shall be listed UL 651 and be manufactured in accordance with NEMA TC2.

5. Rigid, PVC Coated Galvanized Conduit: Use for all exposed outdoor raceways and corrosive environments (RAS pump station, chemical feed and storage rooms, sludge dewatering building). PVC coated galvanized steel conduit shall be listed in accordance to UL6 and ANSI C80.1. The conduit shall be hot dipped galvanized inside and out with hot galvanized threads. The exterior PVC coating shall have a series of longitudinal ribs 40 mils thick to protect from damage during installations. All threaded connections shall be urethane coated. Interior and threaded connection urethane coating shall be a nominal 2 mil thickness. Mounting hardware, which includes nuts, bolts, and anchors, shall be PVC coated or stainless steel. All damaged coatings shall be repaired according to the manufacturer's instructions.

D. Accessories:

1. Sleeves: Sleeves shall be cast or fabricated wall pipe, equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

2. Sleeve Seals: Sleeve seals shall be a modular sealing device and designed for field assembly to fill annular space between sleeve and cable.

3. Stainless Steel Pressure Plate: Include 2 for each sealing element and include stainless steel bolts and nuts of length required to secure pressure plates to the sealing elements.

4. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold down straps, end caps, and other fittings to match and mate with wire ways required for complete system. All couplings and

connections in locations where water or other liquid or vapor might contact the conduit shall be watertight.

5. Conduit Boxes: Exposed conduit boxes and pulling elbows shall be of die-cast aluminum with threaded body and removable gasketed cover.

6. Duct Sealant: Duct sealant shall be Polywater FST™ Filoform Filoseal +HD, or equal foam sealant. Duct sealant shall be a 2-part, 98% closed-cell urethane foam. It shall react and set in 5 to 10 minutes at 70°F. It shall be capable of sealing ¾" to 10" conduits with multiple cable configurations. Duct sealant shall be re-enterable. It shall be capable of withstanding temperatures from -40°F to 200°F and be chemically resistant to gasoline, oils, dilute acids and bases. Duct sealant shall not affect the physical or electrical properties of wire and cable.

   Duct sealant shall provide good adhesion to duct and cable jacket surfaces with good structural strength. It shall have 120 pound compressive strength (ASTM D1621). Duct sealant shall be capable of holding 22' waterhead pressure continuous or 90' waterhead pressure short-term. It shall block up to 5 psi gas or vapor continuous. It shall meet NEC codes for raceway seals, meet UL 94 fire rating HBF and be UL recognized.

E. Installation:

1. Keep raceways at least 12" away from parallel runs of flues and steam or hot water pipes. Install horizontal raceway runs above water and steam piping.

2. Complete raceway installation before starting conductor installation.

3. All raceway stubs shall be sufficiently plugged or capped during construction to prevent entry of water, debris, mortar, etc.

4. Where non-metallic PVC plastic conduit is installed underground in groups of three or more, it shall be installed in duct banks as indicated on the Drawings. Duct banks shall be encased in 3,000 psi concrete with red dye added.

5. All conduits entering boxes, cabinets, panels of similar equipment shall have double locknuts and insulating bushing.

6. In all liquid-tight flexible steel conduit, provide a green grounding conductor sized per NEC. Bond at fixture, motor, etc., and also bond at box where flexible conduit originates or the next box in line.

7. A code sized grounding conductor shall be installed in all raceways.

8. All raceways shall be rigidly supported from building structure by rods or hangers attached to building structure. Raceways shall not be attached to any rods or hangers required by other trades. Raceways shall be supported from building construction at intervals as required by the NEC not to exceed 8' with straps and expansion bolts for masonry or concrete construction.

9. All raceways entering cabinets, panels, switchboxes, switchgear, junction boxes, etc. shall be fitted with double bonding locknuts and bushings. One locknut inside and one outside box shall be used. Where conduits terminate in steel or cast NEMA enclosures with no factory installed threaded hubs, a threaded hub shall be installed.

10. Feeder cable conductors shall be pulled into raceways using an approved soapstone product lubricant. Pull conductors with a pulling eye attached to conductor so not to stretch or injure insulation.

    a. Contractor shall be responsible for coordinating proper connection at each item of equipment requiring service and connect accordingly. The term “stub-up and connect” or “connect” used on Drawings implies a full connection as required for each piece of equipment to place it in satisfactory operation. If equipment is equipped with cord and plug, install proper matching receptacle.

    b. All aluminum conduit installed in contact with concrete or earth shall be protected with aluminum bitumastic paint or tape wraps approved for the purpose.

    c. Conceal conduit within finished walls, ceilings and floors unless otherwise indicated. Install concealed raceways with a minimum of bends in the shortest practical distance considering type of building construction and obstructions, unless otherwise indicated.

    d. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200 pound tensile strength. Leave at least 12" of slack at each end of pull wire.

10.12 Wiring Devices: Metallic and nonmetallic conduit boxes and fittings shall be installed in the following locations:

A. Switches: Switches shall be specification grade, totally enclosed, brown composition, back and side wired, 20 amp, 227V and comply with UL 20.

1. Manufacturer:

    a. Hubbell: CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224(four way)

    b. Leviton: 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way)

    c. Pass & Seymour: 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way)

    d. or equal

2. Switches shall be installed 4' above floor to top of boxes except as otherwise noted.

3. After circuits are energized, all wall switches shall be tested for proper operation.

B. Receptacles: All receptacles shall conform to current NEMA configurations and be UL listed.

1. Duplex Wall Receptacle: Duplex wall receptacles shall be of grounding pole type, 125 V., 20 amperes, brown composition, back and side-wired and comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498. Acceptable manufacturers are: Hubbell: HBL5351 (single), CR5352 (duplex), Leviton: 5891 (single), 5352 (duplex), Pass & Seymour: 5381 (single), 5352 (duplex), or equal.

2. GFCI Receptacles: Receptacles shall be straight blade, non-feed-through type, shall include device trip indicator light, and comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A. Acceptable manufacturers are: Hubble: GF20, Leviton: AGTR2, Pass & Seymour: 2084, or equal.

3. Receptacles shall be installed vertically 1'-4" above the floor except as noted otherwise.

4. Outlets outdoors and in garages, basements, shops, storerooms, and rooms where equipment may be hosed down; shall be 4' above floor or grade.

5. Conduit and wire for receptacle installation not shown on the Drawings shall be, sized, furnished and installed by the Contractor. Conductors shall be minimum 12 AWG, and conduit shall be minimum ¾" for convenience outlet installation.

C. Cover Plates: Provide and install single and combination types to match corresponding wiring devices. Oversized plates shall be installed where standard-sized plates do not fully cover the wall opening.

1. Plate-Securing Screws: Metal with head color to match plate finish

2. Material for Finished Spaces: 0.05" thick anodized aluminum

3. Material for Unfinished Spaces: Galvanized steel

4. Material for Wet Locations: Weatherproof covers for duplex receptacles shall be NEMA 3R weather resistant die-cast aluminum with spring loaded lift and lockable cover.

D. Installation:

1. Install devices and assemblies level, plumb and square with building lines.

2. Unless otherwise indicated, mount flush, with long dimension vertical, and with grounding terminal of receptacles on top. Group adjacent switches under single, multi-gang wall plates.

3. Remove wall plates and protect devices and assemblies during painting.

4. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

E. Testing: After installing wiring devices and after electrical circuitry has been energized, test for proper polarity, ground continuity, and compliance with

requirements. Test GFCI operation with both local and remote fault simulations according to manufacturer's instructions.

10.13 Motor Control Center: The Contractor shall furnish and install the motor control centers as specified herein and as shown on the Drawings. The motor control centers and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of NEMA, ANSI and UL 845. Motor control center shall be manufactured by GE or approved equal.

A. Submittals: The following information shall be submitted to the Engineer: Master drawing index, front view elevation, floor plan, top view, unit wiring diagrams, nameplate schedule, starter and component schedule, conduit entry/exit locations, cable terminal sizes, product data sheets, assembly ratings including: short-circuit rating, voltage, continuous current, and major component ratings including: voltage, continuous current, interrupting ratings in accordance with the General Requirements section of these Specifications.

B. Structures shall be totally enclosed, dead-front, free-standing assemblies. They shall be 90" high and 16" to 21" deep for front-mounted units and 21" deep for back-to-back mounted units. Structures shall contain a horizontal wireway at the top, isolated from the horizontal bus via metal barriers and shall be readily accessible through a hinged cover. Structures shall also contain a horizontal wireway at the bottom 9" tall that is open to the full rear of the structure. Adequate space for conduit and wiring to enter the top or bottom shall be provided without structural interference.

C. All full voltage starter units through NEMA Size 5 and all feeder breakers through 400 Amp shall be of the draw-out type. Draw-out provisions shall include a positive guide rail system and stab shrouds to absolutely ensure alignment of stabs with the vertical bus. Draw-out units shall have a tin-plated stab assembly for connection to the vertical bus. No wiring to these stabs shall extend outside of the draw-out unit. Interior of all units shall be painted white for increased visibility. Units shall be equipped with side-mounted, positive latch pull-apart type control terminal blocks rated 600 volts. Knockouts shall be provided for the addition of future terminal blocks.

D. Bus: Each structure shall contain a main horizontal tin-plated copper bus, with minimum ampacity as shown on the Drawings. The horizontal bus shall be rated at 65° C temperature rise over a 40° C ambient in compliance with UL standards. Vertical bus feeding unit compartments shall be tin-plated copper and shall be securely bolted to the horizontal main bus. All joints shall be front-accessible for ease of maintenance. The vertical bus shall have a minimum rating of 600 amperes or as shown on the Drawings. Both vertical and horizontal bus shall be fully rated; but shall not be tapered. Tapering of vertical bus via a center feed is not acceptable. Both top and bottom of this type bus must be individually fully rated.

The vertical bus shall be completely isolated and insulated by means of a labyrinth design barrier. It shall effectively isolate the vertical buses to prevent any fault-generated gases to pass from one phase to another. The vertical bus shall include a

shutter mechanism that will allow the unit stabs to engage the vertical bus every 6" and provide complete isolation of the vertical bus when a unit is removed.

A neutral bus and/or neutral lugs shall be provided for all 4 wire motor control centers.

E. Motor Controllers: Combination starter units shall be full-voltage non-reversing, unless otherwise shown, and shall utilize an instantaneous trip, magnetic only, motor circuit protector (MCP).

Each combination unit shall be rated 65,000 AIC symmetrical at 480 Volt. The MCP shall provide adjustable magnetic protection and be adjustable to 1700% motor nameplate full load current to comply with NEC requirements. All MCP combination starter units shall have a "tripped" position on the unit disconnect and a push-to-test button or a green "Ready" LED that blinks slowly when the electronic trip unit is ready. Type MCP motor circuit protectors through size 4 shall include transient override feature for motor inrush current.

Each controller shall be equipped with a fused control power transformer, two (2) indicating lights, Hand-Off-Auto (HOA) selector switch, and two (2) normally open contacts, unless otherwise scheduled on the Drawings. All controllers shall be combination type and shall include options as specified.

1. Across the Line Motor Starters: Magnetic starters through NEMA Size 9 shall be equipped with double-break silver alloy contacts. The minimum motor starter size is NEMA 1; IEC rated starters are not allowed. The starter must have straight-through wiring. Coils shall be of molded construction through NEMA Size 9. All coils to be color-coded through size 5 and permanently marked with voltage, frequency and part number. Provide a solid-state overload relay for protection of the motors. The relay shall be GE CR324X, Square D Motor Logic, or equal.

2. Reduced Voltage Starters: Solid-state reduced-voltage starters, GE ASTAT, Square D ATS-22, or equal shall be provided where shown on the Drawings. The solid-state reduced-voltage starter shall be UL and CSA listed in the motor control center and consist of an SCR-based power section, logic board and paralleling bypass contactor. The paralleling bypass contactor shall be energized when the motor reaches full speed.

3. Adjustable (Variable) Frequency Drives: Adjustable frequency drives shall be provided in MCC(s) where scheduled. Adjustable frequency drives shall be GE AF-600, Square D ATV-630, or equal. Drives for variable torque loads shall be rated a minimum of 110% over-current for one minute. Drives shall be provided with remote, door mounted, key pad. Drives shall be capable of providing 200% starting torque.

F. Metering: Where indicated on the Drawings, provide a separate, owner metering compartment with front hinged door. Provide a minimum of three current transformers for each meter. Current transformers shall be wired to shorting-type terminal blocks. Potential transformer shall not be necessary unless otherwise noted on the Drawings.

G. Enclosure: The type of enclosure shall be in accordance with NEMA standards rated as shown on the Drawings. All enclosing sheet steel, wireways and unit doors shall be NEMA 1A gasketed unless noted otherwise on the Drawings.

H. Factory Testing: Representative motor control centers shall have been tested in a high-power laboratory to prove adequate mechanical and electrical capabilities. All factory tests required by the latest ANSI, NEMA and UL standards shall be performed. A certified test report of all standard production tests shall be submitted to the Engineer.

I. Services: Provide the services of a qualified factory-trained manufacturer's representative to perform startup and testing of the equipment specified under this section as recommended by the manufacturer. Factory services start-up shall automatically extend the manufacturer's warranty by 12 months at no additional cost to the Owner.

J. Installation: Contractor shall follow the installation instructions supplied by the manufacturer. Control wiring shall be as shown on the Drawings except as modified by the approval and submittal process. Interface all local and remote devices into the control wiring and operational systems for each load.

10.14 Panelboards: The Contractor shall furnish and install the panelboards as specified and as shown on the Drawings. The panelboards and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of NEMA PB-1 and UL 67. Panelboards shall be manufactured by ABB, GE, Square D, or equal.

A. Submittals: The following information shall be submitted to the Engineer in accordance with the General Requirements section of these Specifications: breaker layout drawing with dimensions indicated and nameplate designation, component list, conduit entry/exit locations, cable terminal sizes, product data sheets, assembly ratings including: short-circuit rating, voltage, continuous current.

B. Ratings: Panelboards rated 240 VAC or less shall have short-circuit ratings as shown on the Drawings or panelboard schedules, but not less than 10,000 amperes RMS symmetrical. Panelboards rated 480 VAC shall have short-circuit ratings as shown on the Drawings or panelboard schedules, but not less than 14,000 amperes RMS symmetrical. Panelboards shall be labeled with a UL short-circuit rating.

C. Construction: Interiors shall be completely factory assembled. They shall be designed such that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors. Trims for branch circuit panelboards shall be supplied with a hinged door over all circuit breaker handles. Doors in panelboard trims shall not uncover any live parts. Door-in-door trim shall be provided. Distribution panelboard trims shall cover all live parts. A directory card with a clear plastic cover shall be supplied and mounted on the inside of each door.

D. Bus: Main bus bars shall be copper, sized in accordance with UL standards to limit temperature rise on any current carrying part to a maximum of 65° C above an ambient of 40° C maximum. A system ground bus shall be included in all panels. Full-size (100%-rated) insulated stand-off neutral bars shall be included for

panelboards shown with neutral. Bus bar taps for panels with single-pole branches shall be arranged for sequence phasing of the branch circuit devices. Neutral busing shall have a suitable lug for each outgoing feeder requiring a neutral connection.

E. Branch Circuit Panelboards Circuit Breakers: The minimum short-circuit rating for branch circuit panelboards shall be 10,000 amperes symmetrical at 240 volts, and 14,000 amperes symmetrical at 480 volts, or as indicated on the Drawings. Panelboards shall be fully rated. All circuit breakers shall be thermal-magnetic type with common handle for all multiple pole circuit breakers. Circuit breakers shall be minimum 100-ampere frame. Ratings through 100-ampere trip shall take up the same pole spacing. Circuit breakers shall be UL listed as type SWD for lighting circuits.

F. Distribution Panelboards Circuit Breakers: Distribution panelboards equipped with bolt-on devices shall have interrupting ratings as indicated on the Drawings. Panelboards shall be fully rated. Panelboards shall have molded case circuit breakers as indicated below. Where indicated, provide circuit breakers UL listed for application at 100% of their continuous ampere rating in their intended enclosure. Main breakers with 1200A frames, if furnished, shall be equipped with microprocessor based trip units that have integral arc flash reduction trip feature. Distribution circuit breakers shall be fixed mounted type and equipped with either microprocessor based trip units or thermal magnetic trip units as scheduled on the contract Drawings. Provide shunt trips, bell alarms, and auxiliary switches as shown on the contract drawings.

G. Surge Protective Devices (SPD): Where shown on the Drawings, provide an integral SPD as specified in the Specifications.

H. Enclosures: Enclosures shall be at least 20" wide made from galvanized steel. Provide minimum gutter space in accordance with the National Electrical Code. Where feeder cables supplying the mains of a panel are carried through its box to supply other electrical equipment, the box shall be sized to include the additional required wiring space. At least 4 interior mounting studs with adjustable nuts shall be provided. Enclosures shall be provided with blank ends.

I. Factory Testing: The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of NEMA and UL standards.

J. Installation: The Contractors shall install all equipment per the manufacturer's recommendations and the Drawings.

10.15 Safety Switches: The Contractor shall furnish and install heavy duty rated low-voltage fused and non-fused switches as specified herein and as shown on the Drawings. The switches and all components shall be designed, manufactured and tested in accordance with the latest applicable version of NEMA and UL standards. Provide switches rated for the voltage, current and NEMA enclosure rated for the environment as shown on the Drawings. Switches shall be manufactured by ABB, GE, Square D, or equal.

10.16 Dry Type Transformer: The Contractor shall furnish and install single-phase and three-phase general purpose individually mounted dry-type transformers of the two-windings

type, self-cooled as specified herein, and as shown on the Drawings. Transformers shall be manufactured by ABB, GE, SolaHD, Square D, or equal.

The kVA and voltage ratings shall be as indicated on the Drawings. Transformers shall be designed for continuous operation at rated kVA, for 24 hours a day, 365 days a year operation, with normal life expectancy as defined in ANSI C57.96. Transformers shall meet the requirements of the most current version of federal law 10 CFR Part 431 "Energy Efficiency Program for Certain Commercial and Industrial Equipment". Transformers efficiency shall be measured according to federal law 10 CFR Part 431. Transformer sound levels shall not exceed the ANSI and NEMA levels for self-cooled ratings.

A. Taps: Three-phase transformers shall be provided with six 2½% taps: two above and four below rated primary voltage.

B. Enclosure: The enclosure shall be made of heavy-gauge steel. All transformers shall be equipped with a wiring compartment suitable for conduit entry and large enough to allow convenient wiring. The maximum temperature of the enclosure shall not exceed 90° C per UL requirement. The core of the transformer shall be grounded to the enclosure.

C. Factory Testing: The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards.

D. Installation: The Contractors shall install all equipment per the manufacturer's recommendations and the Drawings.

10.17 Lighting Fixtures: Lighting fixtures shall be furnished as described in the fixture schedule and as indicated on the Drawings. Lighting fixtures submitted as equal to those in the schedule without accompanying equivalent digital IES photometric data will be rejected. Lighting fixtures shall be furnished complete with lamps, ballast and/or LED drivers as required for proper operation.

A. Installation: Provide and install mounting system compatible with ceiling system shown on the Drawings. Coordinate fixtures, mounting hardware, and trim with ceiling system and other items, including work of other trades required to be mounted on ceiling or in ceiling space. The fixture installation shall comply with applicable local code requirements of the authority having jurisdiction and the NEC. Contractor is responsible for the proper support and mounting of lighting fixtures in accordance with NEC Article 410 Part IV. If required, lighting fixtures shall be provided with disconnects in accordance with NEC requirements.

B. Adjusting and Cleaning: Clean interior lighting fixtures of dirt and construction debris upon completion of installation. Install all fuses. Clean fingerprints and smudges from lenses and lamps. Use methods and materials recommended by manufacturer. All lighting fixtures shall be clean at time of final acceptance. Adjust aimable fixtures to provide required light intensities.

10.18 Execution:

A. Inspection: Inspect preceding work to ensure satisfactory completion prior to electrical work.

B. Preparation: Coordinate work with power company and Owner to minimize delays in operation of new facilities.

C. Wiring layouts or schematics are not intended to show exact location of raceways, outlets, etc. Contractor shall refer to building plans and details for dimensions and shall fit his work to conform to details of building construction. The right is reserved to shift any switch, receptacle, ceiling or other outlet a maximum of 10' from its location as shown on Drawings before it is permanently installed without incurring additional expense.

10.19 Lighting Contactor: Remote control lighting contactors shall be provided as indicated on the Drawings. Contactors shall have positive locking features and shall be non-combination mechanically held in both positions. Main contacts shall be double-break, continuous-duty rated 30 amperes, 600 volts ac, for all types of loads. Contactors shall be GE CR460, Square D Class 8903, or equal.

A. Contactor Control Panel: Contactor control panel shall be UL 508A listed and NEMA 3R rated for the environment unless noted otherwise. The short circuit current rating shall meet or exceed the available short circuit current indicated on the bus feeding the contactor.

B. Lighting Control: Enclosed lighting control shall be provided with control power transformer and HOA selector switch.

C. Photoelectric Controls: Photoelectric controls shall be weatherproof, swivel adjustable, with built-in time delay to prevent accidental turnoff by momentary brightness. The photocell shall be rated 1800 VA, 120 volts ac, and shall be field adjustable from 1 ft/c turn-on to 15 ft/c turn-off.

10.20 Installation: Contractor shall furnish all labor and furnish, install, connect, test and adjust all equipment and materials to form a complete operating installation, including wiring hangers, supports for equipment, cables, conduits, cable tray, cable trench, pull boxes anchors and inserts, identification plates, signs, and tags for equipment, conduits, wiring and wiring labels.

A. The electrical work shall be installed in such a manner and at such times as will require a minimum of cutting and patching of the building structure.

B. Provide all wiring for testing and trials, for all required corrections, changes, additions, completions and adjustments until final acceptance of the work.

C. Coordinate numbers and label all field wiring between equipment of the various electrical equipment suppliers.

D. Any damage to work already in place as a result of electrical work shall be repaired and made good at no expense to the Owner.

10.21 Testing and Acceptance: Prior to acceptance by the Owner, all control systems shall function as required, and all motors shall be connected to protective devices and control devices associated with a machine or a group of machines to produce the correct operating, timing and sequencing necessary for the proper functioning of the mechanical equipment.

10.22 As-Built Drawings: Submit one blueline print of the Drawings marked to show as-built locations and description of all electrical work.

10.23 Payment: No separate payment will be made for the work of this Section. The cost of the work, and all costs incidental thereto, shall be included in the price bid for the item to which the work pertains.

SECTION 11
GENERATOR SETS AND EQUIPMENT

11.01 Work Included:

A. Diesel Engine Driven Standby Generator Sets

B. Fuel System

C. Exhaust System

D. Weatherproof Enclosure

E. Base Mounted Fuel Tank

F. Installation and Start Up

11.02 Quality Assurance:

A. The selling agency shall maintain a permanent parts and service facility no more than 100 miles from the job site from which parts and service may be obtained in necessary quantities at any time during the day or night, and any day of the week. The selling agency shall be required to prove that he continuously maintains in stock at the above specified location and at the bid date at least one piston-rod-liner set, fuel injector nozzle and pump set, air fuel, and oil filter set, and starter for each unit supplied. In addition, the selling agency shall have established and documented some means of parts procurement from an accessible depot which shall result in 95% or greater parts availability within 24 hours from order.

B. The performance of the engine-generator unit shall be tested as a unit and the factory performance characteristics shall be supplied to the Engineer indicating the results as to the sets full load ratings, voltage and frequency regulation.

C. Shall comply with all applicable codes

D. The units offered under these specifications shall be covered by the manufacturer's standard warranty or guarantee on new machines. But in no event shall it be for a period of less than 2 years from date of initial start-up of the system.

E. Acceptable manufacturers shall have in operation at time of bid, engine generator sets of similar size and design at least 3 years previous to bid opening, operating in a weather exposed, exterior environment.

11.03 Submittals:

A. General: All requirements concerning supervisory services, equipment bids, equipment obtained from manufacturer, equipment approved, mechanical testing, piping for equipment, shop painting, operation and maintenance manuals, guarantees, and motors specified in Section 10 shall apply to this section of the Specification unless otherwise specified.

B. Complete shop drawings shall be submitted for review and shall include detailed specification data and information on the specific engine-generator proposed as specified in the General Requirements section of these Specifications. General

manufacturer's product bulletins alone shall not be considered sufficient for review. Options and accessories to be furnished shall be clearly noted and drawings and/or literature provided.

The Contractor shall also include as a portion of the submittal the following job drawings: Generator plan layout showing the engine generator set, accessories, and pertinent conditions. Plan shall be ¼" scale minimum.

11.04 General Requirements:

A. Furnish and install a diesel engine driven emergency generator, complete with all accessories as required for a complete emergency generator system. The generator shall be rated as specified.

B. All materials and parts comprising the units herein specified shall be new and unused, of current manufacture, and of the highest grade, free from all defects or imperfections affecting performance. Workmanship shall be of the highest grade, in accordance with modern practice. All major components shall be manufactured in the United States.

11.05 Testing: The performance of the generator sets shall be tested, as to the sets full power rating, voltage and frequency regulation. A copy of the above performance chart shall be supplied to Engineer.

11.06 Job Conditions:

A. Raw Sewage PS Generator:

1. 125 KW standby, 150 kVA-Minimum. See Drawings for load requirements.

B. Accessories:

1. Water jacket heater, complete with thermostat
2. Muffler, critical silencing type
3. Weatherproof, sound attenuating enclosure
4. Base mounted

C. Acceptable Manufacturer: Caterpillar or approved equal

11.07 Generator:

A. The diesel electric generator set shall be the product of a firm regularly engaged in the manufacture of this product. The components of the plant other than the diesel electric generator set shall be the products of a firm regularly engaged in the manufacture of the products of this type.

B. Electric set rating shall be based on operation at 1,800 rpm when equipped with all necessary operating accessories. Electric set shall be capable of producing the required KW at 0.8 PF for continuous standby electric set applications. All ratings shall be readily accessible in public literature; no factory special ratings are acceptable. Ratings shall be based on SAE standard ambient conditions of 29.38" of mercury and 85° F. Engine shall be rated with jacket cooling water

pump radiator fan and other required appurtenances; no two core radiators or separate after cooler water circuits shall be allowed.

C. Generator shall be 3 phase, 4 wire, 60 cycle, 1,800 RPM, rated as shown. It shall be single bearing of heavy-duty ball bearing construction connected to engine flywheel through a suitable flexible coupling. Regulator shall have adjustments for gain, level and droop.

D. Exciter shall have sufficient capacity to produce ample excitation under all normal load conditions. Exciter shall be brushless type. The alternator shall be rated for 125° temperature rise at full load.

E. The generator mounted control panel shall be vibration isolated 14 gauge with the following equipment:

1. Voltmeter, 2% accuracy
2. Ammeter, 2% accuracy
3. Frequency meter, Dial type
4. Voltmeter-ammeter transfer switch
5. Voltage adjustment level rheostat
6. 4 fault indicator lights (low oil pressure, high coolant temperature, overspeed, overcrank)
7. Panel illumination lights

F. A main line molded case circuit breaker rated at 600 volts shall be provided as a load circuit interrupting and protection device and be mounted on the generator. It shall operate both manually for normal switching functions and automatically during overload and short circuit conditions. Generator/Exciter field circuit breakers do not meet the above electrical standards and are unacceptable for line protection. The circuit breaker shall meet standards established by Underwriters Laboratories, NEMA, and the National Electrical Code.

11.08 Engine:

A. The engine shall be a full compression ignition four-cycle, single-acting, solid-injection unit.

B. Engine output capacity shall not be less than the required horsepower to drive the specified generator 1,800 RPM under the rating conditions specified.

C. Engine speed shall not exceed 1,800 RPM at normal full load operation.

D. Governor shall be of the hydro-mechanical type and shall maintain frequency regulation within 3% from no load rated load.

E. Satisfactory performance on No. 2 domestic burner oil is a requirement. Diesel engines requiring premium fuel will not be considered.

F. Injection pumps and injection valves shall not require adjustment in service. The engine shall have an individual mechanical injection valve for each cylinder, any one of which may be removed and replaced from parts stock.

G. A gear-type lubricating oil pump with lube oil cooler will supply oil under pressure to main bearings, crank pin bearings, camshaft bearings, and valve mechanism. Pistons shall be spray cooled. Effective full flow lubricating oil filters of the replaceable resin impregnated cellulose type shall be provided and so located that lubricating oil is continuously filtered. Filter system shall be equipped with a spring-loaded bypass valve as an insurance against stoppage of lubricating oil circulation in event the filters become clogged. All lubricating oil piping and lube oil temperature controls shall be factory fabricated. Generator manufacturer shall pipe a valved oil drain pipe to the edge of the skid with flexible hose to facilitate oil removal. Engine shall be filled with SAE 10W oil.

H. One or more engine mounted dry-type air cleaners of sufficient capacity to protect engine working parts from dust and grit shall be provided.

I. Provide suitable engine-mounted instrument panel including the following instruments:

1. Lubricating Oil Pressure Gauge
2. Water Temperature Gauge
3. Engine Hour Meter

J. Shutdown devices shall be provided which automatically shut down the engine in the event of low oil pressure, high coolant temperature, overcrank or overspeed.

K. The engine shall be equipped with a steel sheathed immersion type electric jacket water heater for maintaining the engine jacket water at approximately 100° F. The heater shall be equipped with an adjustable thermostat and mounted on the engine, circulating the water by means of natural convection. Heater shall operate from the 240 volt, single phase electric system.

L. A 12 or 24 volt battery charging alternator with D.C. Ammeter shall be provided to provide a quick charge of battery during operation of Engine-Generator set.

M. A battery charger with at least 10A fast charge rate and trickle charge rate with ammeter and voltmeter and low/high rate indicator lamps shall be furnished for remote mounting for maintaining the battery charge while the engine is idle.

11.09 Fuel System:

A. The fuel system shall be in accordance with the engine manufacturer's recommendations and shall include all piping, pumps, filters, storage tanks, etc. All fuel lines shall be sized and type as recommended by the manufacturer. A flexible section of tubing shall be used between the engine and the fuel supply line. A replaceable element fuel filter shall be conveniently located for servicing. The engine shall be equipped with a built-in fuel transfer pump.

B. All main fuel lines shall be copper or black iron pipe as recommended by the manufacturer. Do not use galvanized pipe, fittings, or tank in system. Fuel system shall be complete with return lines.

C. Base mounted, double walled fuel storage tanks with 1,000 gallon capacity shall be furnished and installed. The fuel storage tank shall be sized to provide a

minimum of 24 hours run time at 100% load. The tank shall be equipped with all openings required, including fill, drain & vent.

11.10 Cooling System:

A. The engine shall be equipped with an engine mounted radiator, fan, fan drive, and water pump for circulation of coolant through the water jackets of the cylinder block, cylinder head, exhaust manifold and lube oil cooler. The water pump shall be engine mounted and gear driven. Water temperature shall be thermostatically controlled.

B. Radiator shall be equipped with a capped filler opening, overflow line and drain cock. The radiator fan shall blow cooling air through the radiator. All engine cooling water piping shall be factory fabricated requiring only main supply and return connection to radiator. Cooling system shall be designed to operate in 125° F ambient rated output and shall be filled with a 50% emylene glycol solution.

11.11 Starting System:

A. System shall include 12 or 24 volt automatic starting motor, sufficient Amp/H capacity batter set with rack and cables, and other wiring, controls, and equipment as required for heavy duty, long life operation.

B. Batteries shall be mounted in suitable battery rack 2" off floor. Rack shall be made of non-corrosive materials (but not wood). However, a wood base plate shall be provided to isolate battery from floor. Coat terminals with grease. Batteries shall be of size recommended in manufacturers published literature. Batteries shall be Delco, Willard, Exide or equal.

11.12 Mounting System: The engine generator shall be mounted on corfund vibration isolators, the complete engine-generator and all auxiliary devices shall be housed within a WP enclosure with hinged side doors and hinged door over the instrument panel.

11.13 Installation:

A. All equipment shall be properly supported and additional support provided where necessary.

B. Installation shall be according to the manufacturer’s recommendations, shall be done in a neat workmanlike manner and shall be installed under the supervision of a manufacturer's representative.

C. The manufacturer’s representative shall be present during start-up and testing and shall provide certification of the system.

11.14 Wiring:

A. One 20A, 120V, and one 30A, 240V single phase circuits with plug and cord shall be provided and wired to a receptacle on the engine generator for the crankcase heater and battery charger.

B. All wiring shall conform to manufacturers wiring diagrams and shall be installed in a neat manner and in accordance with all other sections of the specification. Wiring shall be stranded and terminated in the box type terminals.

11.15 Exhaust System:

A. Avoid sharp bends, use sweeping long radius elbows, and use a section of seamless stainless steel flexible exhaust pipe between the engine manifold and the rigid piping.

B. Exhaust piping shall be sized according to the engine manufacturer's recommendations. Exhaust piping shall be wrought iron with adequate support to stand severe service and allow for expansion as required by operating temperatures. No weight shall be supported by the engine manifold.

11.16 Generator Enclosure:

A. A weatherproof, enclosure shall be provided to house the engine/generator and accessories. The enclosure is to be in compliance with the National Electrical Code (NEC) and the National Fire Protection Association (NPPA) with regard to clearance around electrical equipment as specified.

B. Housing shall consist of a weather proof enclosure to completely enclose the engine generator and accessories. Housing shall protect the engine generator from the environment yet be conductive to easy maintenance. Housing shall have removable swing out doors on each side and lockable rear door for access to meters and controls. Side doors shall have a means to pad lock. Construction of housing shall be a minimum 14-gauge sheet steel and painted manufacturer’s standard color.

11.17 Automatic Transfer Switch:

A. Automatic transfer switch shall be furnished and installed as shown on the plans. Automatic transfer switch shall be provided with contacts and logic to allow start/stop of the generator. Terminal strips shall be provided in the automatic transfer switch, clearly marked for each control or status point.

B. The rating shall be as shown on the plans for use on 277 Y 480V, 3 phase, 4 wire system.

C. The automatic transfer switch shall be U L 1008 as listed and be manufactured by Generac as described in the Drawings. Accessories to be included are time delay on start (30 seconds) to ignore momentary outages, adjustable time delay transfer to normal (2 to 30 minutes), cool down timer, test switch to simulate outages and to load the plant, pilot contacts to initiate starting of the engine, insulated neutral pad, 3 sets of auxiliary contacts for remote indication of switch position on normal and emergency, weekly exercise timer, charger, described previously may be housed in the switch enclosure. The transfer switch shall be housed in a NEMA 12 type enclosure as shown on the Drawings. For allowing motor and transformer voltage decay prior to transfer, the transfer switch shall have either a timed programmed neutral or timed contacts that may be wired into the motor starter circuits that will drop out selected motor starters then re-energize them after the transfer is made. The time shall be adjustable up to 10 seconds.

11.18 Information Furnished to the Owner:

A. A factory authorized technician shall inspect the installation and initial operation of the genset, and instruct the Owner's representative in the proper operation and maintenance of the equipment for a period of one 8-hour day. Furnish operating and maintenance instruction manuals covering the engine-generator and such auxiliary equipment as may require published instructions or periodic maintenance in accordance with the General Requirements section of these Specifications.

B. The nearest and most convenient source of replacement parts and service shall also be furnished.

11.19 Payment: No separate payment will be made for the work of this Section. The cost of the work, and all costs incidental thereto, shall be included in the price bid for the item to which the work pertains.

SECTION 12
PAINTING

12.01 Scope: Contractor shall furnish all materials and equipment and perform all labor necessary for painting all surfaces constructed under this Contract, and specified to require painting, gas proofing or coating as indicated on the Drawings, and in accordance with the following Specifications.

12.02 Material: Materials for use in this work shall be delivered in unbroken original containers, bearing the manufacturer's name and shall be mixed and applied in conformance with the manufacturer's specifications and directions.

12.03 General: Painting shall be done in a first-class, workmanlike manner, and no paint shall be applied upon damp or frosty surfaces or in wet, foggy or freezing weather. All surfaces shall be brushed free of dust, and all foreign matter removed before any paint is applied. All surfaces shall be completely dry before any paint is applied. All iron and steel and other steel work which is shop primed shall have all abrasions in the priming coat cleaned by wire brushing, sandpaper or an approved method to bright metal, so as to remove all scale, ridges, rust or faults in the prime coat. All welding splatter shall be removed and this area re-primed. All voids, open or hollow places shall be repaired with a material suitable to the surface to be repaired. Paint shall be evenly spread and well brushed out, so there shall be no drops, runs or sagging of the coating. Where runs and drops do occur, they shall be removed and the surface recoated to the satisfaction of the Engineer. Sufficient time, as directed by the manufacturer shall be allowed for the paint to dry before the application of succeeding coats. Drop cloths shall be used to protect other surfaces of the structure or equipment in place, and upon completion of work all paint spots shall be removed from surfaces as directed by the Engineer, and any defaced surfaces shall be refinished as directed by the Engineer. Any painting work found to be defective or applied under adverse conditions shall be removed and replaced at the direction of the Engineer.

12.04 Testing Equipment Required: Contractor will furnish the Engineer with DeFesco, BYK-Gardner, or equal PosiTector 6000, dry film thickness gauge measurements during the project.

12.05 Surfaces Requiring Painting: Surfaces requiring painting shall include all new surfaces specified under this Section of the Specifications and constructed on this project. Exterior building surfaces requiring painting shall include doors, concrete block, wood, miscellaneous iron and steel. Surfaces requiring painting in basins and structures shall consist of equipment, piping and miscellaneous iron and steel.

12.06 Manufacturer: Contractor shall submit for approval proposed paint manufacturer, coatings and color charts in accordance with the General Requirements section of these Specifications.

12.07 Painting Systems: The Contractor shall provide an acceptable painting system for each specified material. All surfaces to be painted that have an existing coating shall be patch tested.

A. Structural and Miscellaneous Iron and Steel: Surface preparation and special coatings shall be done only by crews experienced in this work and approved by the

Engineer. A representative of the paint company shall be present when work begins to instruct personnel in sandblasting and application techniques in the presence of the Engineer.

The Contractor shall furnish the Engineer a Sample No. 5 blast cleaning plate suitably sealed in plastic and purchased from the Steel Structures Painting Council to be used as a field guide. Under no circumstances shall sandblasted surfaces be permitted to rust or have condensation to form thereon prior to coating. Surfaces sandblasted shall be coated the same day. If surfaces are allowed to remain uncoated overnight or longer, the surfaces shall be sandblasted again prior to coating. All cleaning and coating application shall be performed only during daylight hours.

No coating shall be applied when temperature is below 50° F, nor when the relative humidity is greater than 85%, nor when condensation is present on base and coated surfaces, nor when ambient air temperature is falling.

1. Exterior, Non-Immersion:
    a. Surface Preparation – SSPC-SP6 “Commercial Blast Cleaning”
    b. Primer – Tnemec Series 66HS, Sherwin-Williams Macropoxy 5500LT, or equal. DFT 3.0 to 5.0 Mils.
    c. First Coat – Tnemec Series 66HS, Sherwin-Williams Macropoxy 5500LT, or equal. DFT 3.0 to 5.0 mils.
    d. Second Coat – Tnemec Series 73, Sherwin-Williams Acrolon 218HS, or equal. DFT 2.0 to 2.5 mils.
    e. Total DFT 8.0 to 12.5 mils.
2. Interior, Non-Immersion:
    a. Surface Preparation – SSPC-SP6 “Commercial Blast Cleaning”
    b. Primer – Tnemec Series 66HS, Sherwin-Williams Macropoxy 5500LT, or equal. DFT 3.0 to 5.0 Mils.
    c. First Coat – Tnemec Series 66HS, Sherwin-Williams Macropoxy 5500LT ,or equal. DFT 4.0 to 6.0 mils.
    d. Total DFT 7.0 to 11.0 Mils.
3. Immersion, Potable Water:
    a. Surface Preparation – SSPC-SP5 “White Metal Blast Cleaning”
    b. Primer – Tnemec Series 20HS, Sherwin-Williams Macropoxy 646 PW, or equal. DFT 3.0 to 5.0 Mils.
    c. First Coat – Tnemec Series 20HS, Sherwin-Williams Macropoxy 646 PW, or equal. DFT 4.0 to 6.0 mils.
    d. Total DFT 7.0 to 11.0 Mils

4. Immersion, Non-potable Water:

a. Surface Preparation – SSPC-SP5 “White Metal Blast Cleaning”

b. Primer – Tnemec Series 66HS, Sherwin-Williams Macropoxy 5500LT, or equal. DFT 3.0 to 5.0 Mils.

c. First Coat – Tnemec Series 66HS, Sherwin-Williams Macropoxy 5500LT, or equal. DFT 4.0 to 6.0 mils.

d. Total DFT 7.0 to 11.0 Mils

B. Galvanized Iron:

1. Interior:

a. Surface Preparation – Surface shall be prepared by solvent cleaning the entire substrate to be painted using xylol or xylene. The substrate should be clean, dry and free of all contaminants prior to painting.

b. Primer – Tnemec Series 66HS, Sherwin-Williams Macropoxy 5500LT, or equal. DFT 2.0 to 3.0 Mils.

c. First Coat – Tnemec Series 66HS, Sherwin-Williams Macropoxy 5500LT, or equal. DFT 2.0 to 3.0 mils.

d. Total DFT 4.0 to 6.0 Mils

2. Exterior:

a. Surface Preparation – Surface shall be prepared by abrading the surface to a SSPC-SP3 “Power Tool Cleaning” standard. The substrate should be clean, dry and free of all contaminants prior to painting.

b. Primer – Tnemec Series 66HS, Sherwin-Williams Macropoxy 5500LT, or equal. DFT 2.0 to 3.0 Mils.

c. First Coat – Tnemec Series 72/73, Sherwin-Williams High Solids Polyurethane HS, or equal. DFT 2.0 to 3.0 mils.

d. Total DFT 4.0 to 6.0 Mils

C. Ductile and Cast Iron Pipe:

1. Exterior, Non-Immersion:

a. Surface Preparation – Surface shall be prepared by applying NAPF 500-03-03 “Power Tool Cleaning.” The substrate should be clean, dry and free of all contaminants prior to painting.

b. Primer – Tnemec Series 66HS, Sherwin-Williams Macropoxy 5500LT, or equal. DFT 3.0 to 5.0 Mils.

c. First Coat – Tnemec Series 73, Sherwin-Williams Acrolon 218HS, or equal. DFT 2.0 to 3.0 mils.

d. Total DFT 5.0 to 8.0 Mils

2. Interior, Non-Immersion:

a. Surface Preparation – Surface shall be prepared by applying NAPF 500-03-03 "Power Tool Cleaning." The substrate should be clean, dry and free of all contaminants prior to painting.

b. Primer – Tnemec Series 66HS, Sherwin-Williams Macropoxy 5500LT, or equal. DFT 3.0 to 5.0 Mils.

c. First Coat – Tnemec Series 66HS, Sherwin-Williams Macropoxy 5500LT, or equal. DFT 4.0 to 6.0 mils.

d. Total DFT 5.0 to 8.0 Mils

3. Immersion, Potable Water:

a. Surface Preparation – Surface shall be prepared by applying NAPF 500-03-03 "Power Tool Cleaning." The substrate should be clean, dry and free of all contaminants prior to painting.

b. Primer – Tnemec Series 20HS, Sherwin-Williams Macropoxy 5500LT, or equal. DFT 3.0 to 5.0 Mils.

c. First Coat – Tnemec Series 20HS, Sherwin-Williams Macropoxy 5500LT, or equal. DFT 4.0 to 6.0 mils.

d. Total DFT 7.0 to 11.0 Mils

4. Immersion, Non-potable Water:

a. Surface Preparation – Surface shall be prepared by applying NAPF 500-03-03 "Power Tool Cleaning." The substrate should be clean, dry and free of all contaminants prior to painting.

b. Primer – Tnemec Series 66HS, Sherwin-Williams Macropoxy 5500LT, or equal. DFT 3.0 to 5.0 Mils.

c. First Coat – Tnemec Series 66HS, Sherwin-Williams Macropoxy 5500LT, or equal. DFT 4.0 to 6.0 mils.

d. Total DFT 7.0 to 11.0 Mils

D. Concrete:

1. Exterior Concrete, Below Grade:

a. Surface Preparation – Surface shall be prepared by applying SSPC-SP13 "Surface Preparation of Concrete." The substrate should be clean, dry and free of all contaminants prior to painting.

b. First Coat – Tnemec Series 46H-413, Sherwin-Williams Hi-Mil Sher – Tar Epoxy, or equal. DFT 14.0 to 20.0 Mils.

c. Total DFT 14.0 to 20.0 Mils

2. Immersed Concrete, Potable Water:

   a. Surface Preparation – Surface shall be prepared by applying SSPC-SP13 "Surface Preparation of Concrete." The substrate should be clean, dry and free of all contaminants prior to painting.

   b. First Coat – Tnemec Series 66HS, Sherwin-Williams Macropoxy 646 NSF, or equal. DFT 4.0 to 6.0 Mils.

   c. Second Coat – Tnemec Series 66HS, Sherwin-Williams Macropoxy NSF 646, or equal. DFT 4.0 to 6.0 Mils.

   d. Total DFT 8.0 to 12.0 Mils

3. Immersed Concrete, Non-potable Water:

   a. Surface Preparation – Surface shall be prepared by applying SSPC-SP13 "Surface Preparation of Concrete." The substrate should be clean, dry and free of all contaminants prior to painting.

   b. First Coat – Tnemec Series 46H-413, Sherwin-Williams High-Mil Sher-Tar Epoxy, or equal. DFT 10.0 to 12.0 Mils.

   c. Second Coat – Tnemec Series 46H-413, Sherwin-Williams High-Mil Sher-Tar Epoxy, or equal. DFT 10.0 to 12.0 Mils

   d. Total DFT 20.0 to 24.0 Mils

4. Interior Concrete Floors:

   a. Surface Preparation – Surface shall be prepared be prepared by acid etching the entire surface to be painted to a CSP 1 Standard. The substrate should be clean, dry and free of all contaminants prior to painting.

   b. First Coat – Tnemec Series 66HS, Sherwin-Williams Armor Seal 33, or equal. DFT 3.0 to 5.0 Mils.

   c. Second Coat – Tnemec Series 46H-413, Sherwin-Williams Armor Seal 1000 HS, or equal. DFT 3.0 to 5.0 Mils.

   d. Total DFT 6.0 to 10.0 Mils

   e. *For a non-slip surface broadcast 50/70 mesh sand into second field coat.*

5. Concrete Ceilings:

   a. Interior:

      1) Surface Preparation – The substrate should be clean, dry and free of all contaminants prior to painting. For existing structures, use dry or wet abrasive blasting removing any loose coating and etching of previous coats of paint. Feather all edges.

      2) Primer Coat – Tnemec Series 130, Sherwin-Williams

Cement-Plex 875, or equal. 75-90 S.F./gallon

3) First Coat – Tnemec Series 66HS, Sherwin-Williams Macropoxy 5500LT, or equal. DFT 3.0 to 5.0 Mils

4) Second Coat – Tnemec Series 66HS, Sherwin-Williams Macropoxy 5500LT, or equal. DFT 3.0 to 5.0 Mils

5) Total DFT 7.0 to 11.0 Mils

6. Concrete Slabs:

1) Surface Preparation – Surface shall be prepared by applying SSPC-SP13 "Surface Preparation of Concrete." The substrate should be clean, dry and free of all contaminants prior to painting.

2) First Coat – Tnemec Series 629 CT Densifyer, Euclid Eucosil liquid densifier, or equal. 300 ft^2/gallon

3) Second Coat – Tnemec Series 629 CT Densifyer, Euclid Eucosil liquid densifier, or equal. 300 ft^2/gallon

E. Concrete Masonry Units and Brick:

1. Interior:

a. Surface Preparation – The substrate should be clean, dry and free of all contaminants prior to painting. For existing structures, use dry or wet abrasive blasting removing any loose coating and etching of previous coats of paint. Feather all edges.

b. Primer Coat – Tnemec Series 130, Sherwin-Williams Cement-Plex 875, or equal. 75-90 S.F./gallon

c. First Coat – Tnemec Series 66HS, Sherwin-Williams Macropoxy 5500LT, or equal. DFT 3.0 to 5.0 Mils

d. Second Coat – Tnemec Series 66HS, Sherwin-Williams Macropoxy 5500LT, or equal. DFT 3.0 to 5.0 Mils

e. Total DFT 7.0 to 11.0 Mils

2. Exterior:

a. Surface Preparation – The substrate should be clean, dry and free of all contaminants prior to painting.

b. First Coat – Tnemec Series 660, Sherwin-Williams Loxon Siloxane Water Repellant, or equal. 75-90 S.F./gallon. Conformal stain may be added to sealant at Owner's expense.

F. Woodwork

1. Exterior:

a. Surface Preparation – The substrate should be clean, dry and free of all contaminants prior to painting.

b. Primer Coat – Tnemec Series 1028/1029, Sherwin-Williams A-100 Latex Wood Primer, or equal. DFT 2.0 to 3.0 Mils

c. First Coat – Tnemec Series 1028/1029, Sherwin-Williams DTM Acrylic, or equal. DFT 2.0 to 3.0 Mils

d. Second Coat – Tnemec Series 28/29, Sherwin-Williams DTM Acrylic, or equal. DFT 2.0 to 3.0 Mils

e. Total DFT 6.0 to 9.0 Mils

f. *Allow 4 hours drying time at 75° F between coats.*

2. Interior:

a. Surface Preparation – The substrate should be clean, dry and free of all contaminants prior to painting.

b. Primer Coat – Tnemec Series 10-99W, Sherwin-Williams PrepRite 200 Latex Primer, or equal. DFT 2.0 to 3.0 Mils

c. First Coat – Tnemec Series 1028/1029, Sherwin-Williams Water Based Catalyzed Epoxy, or equal. DFT 2.5 to 3.0 Mils

d. Second Coat – Tnemec Series 1028/1029, Sherwin-Williams Water Based Catalyzed Epoxy, or equal. DFT 2.5 to 3.0 Mils

e. Total DFT 7.0 to 9.0 Mils

f. *Allow 4 hours drying time at 75° F between coats.*

G. Drywall:

a. Surface Preparation – The substrate should be clean, dry and free of all contaminants prior to painting.

b. Primer Coat – Tnemec Series 51-792, Sherwin-Williams PrepRite 200 Latex Primer, or equal. DFT 1.0 to 2.0 Mils

c. First Coat – Tnemec Series 113/114, Sherwin-Williams Water Based Catalyzed Epoxy, or equal. DFT 2.5 to 3.0 Mils

d. Second Coat – Tnemec Series 113/114, Sherwin-Williams Water Based Catalyzed Epoxy, or equal. DFT 2.5 to 3.0 Mils

e. Total DFT 6.0 to 8.0 Mils

H. Interior Electrical Conduit:

a. Surface Preparation – Surface shall be prepared by solvent cleaning the entire substrate to be painted using xylol or xylene. The substrate should be clean, dry and free of all contaminants prior to painting.

b. Primer – Tnemec Series 66HS, Sherwin-Williams Macropoxy 5500LT, or equal. DFT 2.0 to 3.0 Mils.

c. First Coat – Tnemec Series N69HS, Sherwin-Williams Macropoxy 5500LT, or equal. DFT 2.0 to 3.0 mils.

d. Total DFT 4.0 to 6.0 Mils

I. Doors and Windows – Ferrous Metal:

1. Surface Preparation – The substrate should be clean, dry and free of all contaminants prior to painting.

2. Primer Coat – Doors & Windows shall receive a shop priming coat of Tnemec Series 1, Sherwin-Williams Corothane I MIO Zinc Primer, or equal. DFT 2.0 to 3.0 Mils

3. First Coat – Tnemec Series 72/73, Sherwin-Williams Corothane I HS, or equal. DFT 2.0 to 3.0 Mils

4. Second Coat – Tnemec Series 72/73, Sherwin-Williams Corothane I HS, equal. DFT 2.0 to 3.0 Mils

5. Total DFT 6.0 to 9.0 Mils.

12.08 Colors: Where more than one coat of paint is required, paint for each undercoat shall be job tinted off shade, sufficient to show complete coverage for each coat. The colors of paints for the various parts of the work shall be selected by the Engineer. The lower 4' of walls and partitions shall have dado strip and color darker than the upper walls and ceilings, unless otherwise specified or directed by the Engineer.

12.09 Piping Color Codes: The Contractor shall paint all exposed metallic pipe lines with the colors specified. Small diameter non-metallic lines should not be painted but should be color-coded with the colors specified using labels according to the "Signs and Labels" section.

Line	*Tnemec Color*	*Tnemec No.*	*Sherwin-Williams Color*	*Sherwin-Williams No.*
Water Lines:	Safety Blue	11SF	Safety Blue	4086
Chemical Lines:	Safety Yellow	02SF	Safety Yellow	4084
Waste Lines:	Weathered Bark	84BR	Walnut Brown	4009
Sewage:	Gray	33GR	Westchester Gray	2849
Air Line:	Safety Green	49HT	Safety Green	4085
Gas Line:	Monterrey Tile	28RD	Deck Red	4040
Reuse Line:	Safety Purple	14SF	Plum	

12.10 Signs and Labels: After other painting of pipe work has been completed as provided for herein, the Contractor shall label the pipe work by stenciled legends, all as ordered by the Engineer.

A. In addition to the color coding of piping, two legends descriptive of the function of the pipe, such as "Sludge" shall be stenciled. One legend shall be stenciled on each side of the pipe on the pipe lines, and on the side of the bands away from the valve or fittings. The legend shall be located on the pipe so that it will be in direct line

of vision. Legend may be omitted from one side if view is obstructed from that side. Where the flow in a pipe shall be at all times in one direction only, then a flow arrow shall be placed in front of each legend on the pipe. The lettering and arrows shall be cut neatly into stencils, the arrows being the same height as the letters. The size of lettering shall be:

	Outside Diameter of Pipe or Covering	***Size of Letters***
1.	¾" to 1¼"	½"
2.	1½" to 3"	¾"
3.	3¼" to 4¼"	1"
4.	4½" to 6¾"	1½"
5.	7" to 7¾"	2"
6.	8" to 9¾"	2½"
7.	10" to 11¾"	3"
8.	12" and over	3½"

B. For pipes smaller than ¾" in outside diameter, use laminated plastic or aluminum tag with the lettering etched or stamped and filled in with black or contrasting enamel.

C. The legends and flow arrows shall be stenciled with approved black or contrasting stencil paint. The above outline of intent designates the general extent of the identification work and is not exclusive of other similar work such as identification and other equipment as may be directed by the Engineer. Following the completion of the work under this item, the Contractor shall deliver to the Owner two sets of all stencils used.

D. In addition to the above labeling of pipe work, the Contractor shall paint stencil lengths in the same manner as a pipe of appropriate size on the individual units of equipment such as blowers, pumps, collector drives, compressors, silencers, etc. All push buttons, starters, switches, etc. when remote from the equipment controlled and/or power packs shall have labels of the engraved plastic type fixed to or adjacent to the remote switch, push button, starter, etc.

12.11 Payment: No separate payment will be made for the work of this Section. The cost of the work, and all cost incidentals thereto, shall be included in the price bid for the item to which the work pertains.