5/24/95(Rev.)

SECTION 02100

SITE PREPARATION

PART 1 GENERAL

1.01 SCOPE OF WORK

A. This Section covers clearing, grubbing and stripping of the project site and/or along the pipeline route.

B. The Contractor shall clear and grub all of the area within the limits of construction or as required, which includes, but is not limited to utility easements. The width of the area to be cleared shall be reviewed by the Engineer prior to the beginning of any clearing.

C. The Contractor's attention is directed to any Soil Erosion and Sediment Control Ordinances in force in Manatee County. The Contractor shall comply with all applicable sections of these ordinances.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 CLEARING

The surface of the ground, for the area to be cleared and grubbed shall be completely cleared of all timber, brush, stumps, roots, grass, weeds, rubbish and all other objectionable obstructions resting on or protruding through the surface of the ground. However, trees shall be preserved as hereinafter specified unless otherwise designated by the Engineer. Clearing operations shall be conducted so as to prevent damage to existing structures and installations and to those under construction, so as to provide for the safety of employees and others. Soil erosion control devices such as hay bales and silt fences shall be installed to satisfy all Federal, State and County requirements.

3.02 GRUBBING

Grubbing shall consist of the complete removal of all stumps, roots larger than 1-1/2 inches in diameter, matted roots, brush, timber, logs and any other organic or metallic debris not suitable for foundation purposes, resting on, under or protruding through the surface of the ground to a depth of 18 inches below the subgrade. All depressions excavated below the original ground surface for or by the removal of such objects, shall be refilled with

suitable materials and compacted to a density conforming to the surrounding ground surface.

3.03 STRIPPING

In areas so designated, topsoil shall be stockpiled. Topsoil so stockpiled shall be protected until it is placed as specified. The Owner shall have the option to receive all excess topsoil materials. The Contractor shall pay all equipment and labor cost to deliver excess top soil material to a remote site chosen by the Owner within a five mile radius of the construction site. Should Owner not choose to receive any or all excess topsoil materials, the Contractor shall dispose of said material at no additional cost to Owner.

3.04 DISPOSAL OF CLEARED AND GRUBBED MATERIAL

The Contractor shall dispose of all material and debris from the clearing and grubbing operation by hauling such material and debris off site. The cost of disposal (including hauling) of cleared and grubbed material and debris shall be considered a subsidiary obligation of the Contractor; the cost of which shall be included in the prices bid for the various classes of work.

3.05 PRESERVATION OF TREES

Those trees which are not designated for removal by the Engineer shall be carefully protected from damage. The Contractor shall erect such barricades, guards and enclosures as may be considered necessary by him for the protection of the trees during all construction operation.

3.06 PRESERVATION OF DEVELOPED PRIVATE PROPERTY

A. The Contractor shall exercise extreme care to avoid unnecessary disturbance of developed private property adjacent to proposed project site. Trees, shrubbery, gardens, lawns and other landscaping, which are not designated by the Engineer to be removed, shall be replaced and replanted to restore the construction easement to the condition existing prior to construction.

B. All soil preservation procedures and replanting operations shall be under the supervision of a nursery representative experienced in such operations.

C. Improvements to the land such as fences, walls, outbuildings and other structures which of necessity must be removed, shall be replaced with equal quality materials and workmanship.

D. The Contractor shall clean up the construction site across

developed private property directly after construction is completed upon approval of the Engineer.

3.07 PRESERVATION OF PUBLIC PROPERTY

The appropriate paragraphs of these Specifications shall apply to the preservation and restoration of public lands, parks, rights-of-way, easements and all other damaged areas. This includes, but is not limited to the trimming of trees damaged by contractor's equipment.

END OF SECTION

SECTION 02220

EXCAVATION, BACKFILL, FILL AND GRADING FOR STRUCTURES

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Structural excavation shall consist of the removal of material for the construction of foundations for structures and other excavation designated on the drawings or in these specifications.

B. Structural excavation and backfill shall consist of furnishing material, if necessary and placing and compacting backfill material around structures to the lines and grades designated on the drawings, as specified or directed by the Engineer.

C. Structural excavation and backfill shall include the furnishing of all materials, equipment and other facilities which may be necessary to perform the excavations, place and compact the backfill, install sheeting and bracing, and carry out any necessary dewatering. It shall also include the wasting or disposal of surplus excavated material in a manner and in locations approved by the Engineer.

D. The Contractor is responsible for the protection of every tree which is scheduled to remain in the project area. This includes trees which may or may not be shown on the plans. Every tree shall be adequately protected in place at no additional cost to the County. This includes, but is not limited to, protecting the root systems and adjusting grades as necessary for tree/root protection.

1.02 QUALITY ASSURANCE

A. Testing Agency:

1. In place soil compaction tests shall be performed by a qualified testing laboratory.

2. Compaction tests shall be taken every 500 feet, except in the road crossings or road shoulders. Tests are to be taken according to current FDOT Standards.

B. Reference Standards:

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

a. ASTM D1557, Moisture-Density Relations of Soils Using 10-lb. (4.5-kg) Rammer and 18-in. (457-mm) Drop.

1.03 JOB CONDITIONS

A. The Contractor shall provide, operate and maintain all necessary pumps, discharge lines, well points, etc., in sufficient number and capacity to keep all excavation, bases, pits, etc., free from seepage, sanding or running water at all times throughout the period of construction.

B. The Contractor shall assume all responsibility for the security of the excavation required, employing bracing, lining or other accepted means necessary to accomplish same.

C. Excavated areas shall be cleared of all debris, water, slush, muck, clay and soft or loose earth and shall be conditioned to the entire satisfaction of the Engineer.

D. All excavated material unsuitable for use or which will not be used shall be disposed of in a manner consistent with State and County regulation.

E. All unsuitable organic materials, roots, logs, etc., found during excavation shall be removed by the Contractor and the trench shall be refilled with suitable material.

PART 2 PRODUCTS

2.01 MATERIAL FOR CONTROLLED FILL

A. Composition: Only approved material free from organic matter and lumps of clay, shall be used for backfill. Excavated earth free from debris or organic material may be used for backfilling foundations or fill.

B. Crushed stone and shell shall meet or exceed current FDOT Standards.

2.02 UNSUITABLE MATERIAL

Unsuitable material shall be defined as highly organic soil per ASTM D2487 Group PT. This includes, but is not limited to, such items as topsoil, roots, vegetable matter, trash, debris, and clays that cannot be dried sufficiently to obtain specified compaction.

PART 3 EXECUTION

3.01 INSPECTION

A. The Contractor shall verify that work preceding the affected work of this Section has been satisfactorily completed.

B. Conditions adversely affecting the work of this Section shall be corrected to the satisfaction of the Engineer.

3.02 REMOVAL OF UNSUITABLE MATERIALS

A. The Contractor shall remove unsuitable material from within the limits of the Work.

B. Materials meeting requirements for controlled fill shall be stockpiled as necessary and in such a manner satisfactory to the Engineer.

C. All material excavated shall be placed so as to minimize interference with public travel and to permit proper access for inspection of the work.

3.03 EXCAVATION

A. When concrete or shell subbase footing is to rest on an excavated surface, care shall be taken not to disturb the natural soil. Final removal and replacement of the foundation material and subbase compaction to grade shall not be made until just before the concrete or masonry is placed.

B. When any structural excavation is completed, the Contractor shall notify the Engineer who will make an inspection of the excavation. No concrete or masonry shall be placed until the excavation has been approved by the Engineer.

C. The elevations of the footing bottom and the base slab as shown on the Drawings, shall be considered as approximate and the Engineer may order in writing, such changes in dimensions or elevations of the footings and slab base as necessary to secure satisfactory foundations.

D. All excavation shall be made within an area bounded by lines five feet outside and parallel to the exterior walls of the structure to allow for correct forming, shoring and inspection of foundation work. Pouring of concrete against earth side walls shall not be permitted.

E. If the ground is excavated below the grade called for by the Drawings or becomes unstable due to the Contractor's carelessness or operations, the ground shall be excavated

to undisturbed native soil before continuing concreting operations.

F. If in the opinion of the Engineer, the material at or below the normal grade of the bottom of the trench is unsuitable for pipe or structure foundation, it shall be removed to the depth directed by the Engineer and if so directed, replaced by crushed stone or washed shell.

3.04 STRUCTURAL BACKFILL

A. Structural backfill shall not be placed until the footings or other portions of the structure or facility have been inspected by the Engineer and approved for backfilling.

B. A minimum of 1-1/2" layer of lean concrete shall be placed as a working mat for the concrete base slabs and footings.

C. Fill shall be placed in uniform layers not more than 12" thick and compacted to a minimum of 98 percent of the maximum density determined by ASTM D1557, Method A or C, or as directed by the Engineer. The Contractor shall securely tamp the backfill with pneumatic rammer around all wall foundations. The method of compaction shall be satisfactory to the Engineer.

D. Compaction of structural backfill by ponding and jetting shall be permitted when, as determined by the Engineer: the backfill material is of such character that it will be self-draining when compacted; foundation materials will not soften or be otherwise damaged by the applied water; no damage from hydrostatic pressure will result to the structure. Ponding and jetting within two feet below finished subgrade shall not be permitted in roadway areas. At the discretion of the Engineer, ponding and jetting may be permitted with compaction layers not to exceed four feet. The work shall be performed without damage to the structure or embankment and in such a manner that water will not be impounded.

E. Surplus material not used on-site shall be removed and disposed of off-site by the Contractor. In no case shall surplus material be deposited on adjacent lands. Fill used for grading shall be placed in layers not to exceed 12 inches in thickness and shall be compacted to a density equal or greater to that of the surrounding natural ground.

3.05 BACKFILLING AROUND STRUCTURES

A. Common fill and structural fill are specified for use as backfill against the exterior walls of the structures. Fill shall be placed in layers having a maximum thickness

of eight (8) inches in loose state and shall be compacted sufficiently to prevent settlement. If compaction is by rolling or ramming, material shall be wetted down as required. Where material can be suitably compacted by jetting or puddling, the Contractor shall use one of these methods. No boulders shall be allowed to roll down the slopes and hit the walls.

B. Backfilling shall be carried up evenly on all walls of an individual structure simultaneously. A variation of two (2) feet in elevation will be the maximum allowable. No backfill shall be allowed against walls until the walls and their supporting slabs, if applicable, have attained sufficient strength. Backfilling shall be subjected to approval by the Engineer.

C. In locations where pipes pass through building walls, the Contractor shall take the following precautions to consolidate the refill up to an elevation of at least one foot above the bottom of the pipes:

1. Place structural fill in such areas for a distance of not less than three feet either side of the center line of the pipe in level layers not exceeding 6-inches in depth.

2. Wet each layer to the extent directed and thoroughly compact each layer with a power tamper to the satisfaction of the Engineer.

3. Structural fill shall be of the quality specified under Part 2 of this Section.

D. The surface of filled areas shall be graded to smooth true lines, strictly conforming to grades indicated on the grading plan. No soft spots or uncompacted areas shall be allowed in the work.

E. Temporary bracing shall be provided as required during construction of all structures to protect partially completed structures against all construction loads, hydraulic pressure and earth pressure. The bracing shall be capable of resisting all loads applied to the walls as a result of backfilling.

3.06 FIELD QUALITY CONTROL

A. The density of soil in place shall be a minimum of 98 percent in accordance with ASTM test 1557-70T, Method A or C.

END OF SECTION

SECTION 02221

TRENCHING, BEDDING AND BACKFILL FOR PIPE

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, equipment and incidentals necessary to perform all excavation, backfill, fill, grading, trench protection or other related work required to complete the piping work shown on the Drawings and specified herein. The work shall include, but not be limited to: vaults; duct conduit; pipe; roadways and paving; backfilling; required fill or borrow operations; grading; disposal of surplus and unsuitable materials; and all related work such as sheeting, bracing and dewatering.

B. Prior to commencing work, the Contractor shall examine the site and review test borings if available, or undertake his own subsurface investigations and take into consideration all conditions that may affect his work.

C. The Contractor is responsible for the protection of every tree which is scheduled to remain in the project area. This includes trees which may or may not be shown on the plans. Every tree shall be adequately protected in place at no additional cost to the County. This includes, but is not limited to protecting the root systems and adjusting grades as necessary for tree/root protection.

1.02 PROTECTION

A. Sheeting and Bracing in Excavations:

1. In connection with construction of underground structures, the Contractor shall properly construct and maintain cofferdams. These shall consist of: sheeting and bracing as required to support the sides of excavations, to prevent any movement which could in any way diminish the width of the excavation below that necessary for proper construction and to protect adjacent structures, existing yard pipe and/or foundation material from disturbance, undermining, or other damage. Care shall be taken to prevent voids outside of the sheeting, but if voids are formed, they shall be immediately filled and rammed.
2. Trench sheeting for pipes: no sheeting is to be withdrawn if driven below, mid-diameter of any pipe and no wood sheeting shall be cut off at a level lower than one foot above the top of any pipe unless otherwise directed by the Engineer. During the progress of the work, the Engineer may direct the Contractor in writing to leave additional wood sheeting in place. If steel sheeting is used for trench sheeting, removal shall be as specified above, unless written approval is given for an alternate method of removal.
3. All sheeting and bracing not left in place shall be carefully removed in such a manner as not to endanger the construction or other structures, utilities, existing piping, or property. Unless otherwise approved or indicated on the Drawings or in the Specification, all sheeting and bracing shall be removed after completion of the piping or structure, care being

taken not to disturb or otherwise injure the pipeline or finished masonry. All voids left or caused by withdrawal of sheeting shall be immediately refilled with sand by ramming with tools specifically made for that purpose, by watering, or as may otherwise be directed.

4. The Contractor shall construct, to the extent he deems it desirable for his method of operation, the cofferdams and sheeting outside the neat lines of the pipeline trench or foundation unless otherwise indicated on the Drawings or directed by the Owner/Engineer. Sheeting shall be plumb and securely braced and tied in position. Sheeting, bracing and cofferdams shall be adequate to withstand all pressures to which the pipeline or structure will be subjected. Pumping, bracing and other work within the cofferdam shall be done in a manner to avoid disturbing any construction of the pipeline or the enclosed masonry. Any movement or bulging which may occur shall be corrected by the Contractor at his own expense so as to provide the necessary clearances and dimensions.
5. Drawings of the cofferdams and design computations shall be submitted to the Engineer and approved prior to any construction. However, approval of these drawings shall not relieve the Contractor of the responsibility for the cofferdams. The drawings and computations shall be prepared and stamped by a Registered Professional Engineer in the State of Florida and shall be in sufficient detail to disclose the method of operation for each of the various stages of construction, if required, for the completion of the pipeline and substructures.

B. Dewatering, Drainage and Flotation

1. The Contractor shall construct and place all pipelines, concrete work, structural fill, bedding rock and limerock base course, in-the-dry. In addition, the Contractor shall make the final 24" of excavation for this work in-the-dry and not until the water level is a minimum of 6" below proposed bottom of excavation.
2. The Contractor shall, at all times during construction, provide and maintain proper equipment and facilities to remove promptly and dispose of properly all water entering excavation and keep such excavations dry so as to obtain a satisfactory undisturbed subgrade foundation condition until the fill, structure, or pipes to be built thereon have been completed to such extent that they will not be floated or otherwise damaged by allowing water levels to return to natural elevations.
3. Dewatering shall at all times be conducted in such a manner as to preserve the natural undisturbed bearing capacity of the subgrade soils at proposed bottom of excavation.
4. Wellpoints may be required for dewatering the soil prior to final excavation for deeper in-ground structures or piping and for maintaining the lowered groundwater level until construction has been completed to avoid the structure, pipeline, or fill from becoming floated or otherwise damaged. Wellpoints shall be surrounded by suitable filter sand and no fines shall be removed by pumping. Pumping from wellpoints shall be continuous and standby pumps shall be provided.
5. The Contractor shall furnish all materials and equipment to perform all work required to install and maintain the proposed drainage systems for handling groundwater and surface water encountered during construction of structures, pipelines and compacted fills.

6. Where required, the Contractor shall provide a minimum of two operating groundwater observation wells at each structure to determine the water level during construction of the pipeline or structure. Locations of the observation wells shall be at structures and along pipelines as approved by the Engineer prior to their installation. The observation wells shall be extended to 6 inches above finished grade, capped with screw-on caps protected by 24" x 24" wide concrete base and left in place at the completion of this Project.
7. Prior to excavation, the Contractor shall submit his proposed method of dewatering and maintaining dry conditions to the Engineer for approval. Such approval shall not relieve the Contractor of the responsibility for the satisfactory performance of the system. The Contractor shall be responsible for correcting any disturbance of natural bearing soils for damage to pipeline or structures caused by an inadequate dewatering system or by interruption of the continuous operation of the system as specified.
8. As part of his request for approval of a dewatering system, the Contractor shall demonstrate the adequacy of the proposed system and wellpoint filter sand by means of a test installation. Discharge water shall be clear, with no visible soil particles in a one quart sample. Discharge water shall not flow directly into wetlands or Waters of the State as defined by FDEP and SWFWMD.
9. During backfilling and construction, water levels shall be measured in observation wells located as directed by the Engineer.
10. Continuous pumping will be required as long as water levels are required to be below natural levels.

PART 2 PRODUCTS

2.01 MATERIALS

A. General

1. Materials for use as fill and backfill shall be described below. For each material, the Contractor shall notify the Engineer of the source of the material and shall furnish the Engineer, for approval, a representative sample weighing approximately 50 pounds, at least ten calendar days prior to the date of anticipated use of such material.
2. Additional materials shall be furnished as required from off-site sources and hauled to the site.

B. Structural Fill

1. Structural fill shall be used below spread footing foundations, slab-on-grade floors and other structures as backfill within three feet of the below grade portions of structures.
2. Structural fill material shall be a minimum of 60 percent clean sand, free of organic, deleterious and/or compressible material. Minimum acceptable density shall be 98 percent of the maximum density as determined by AASHTO T-180. Rock in excess of 2-1/2" in diameter shall not be used in the fill material. If the moisture content is improper for attaining the specified density, either water shall be added or material

shall be permitted to dry until the proper moisture content for compaction is reached.

C. Base Course

1. Asphalt, crushed concrete, soil cement or approved equal, shall be used as base course for bituminous paved roads and parking areas.

D. Common Fill

1. Common fill material shall be free from organic matter, muck or marl and rock exceeding 2-1/2" in diameter. Common fill shall not contain broken concrete, masonry, rubble or other similar materials. Existing soil may be used to adjust grades over the site with the exception of the construction area.
2. Material falling within the above specification, encountered during the excavation, may be stored in segregated stockpiles for reuse. All material which, in the opinion of the Engineer, is not suitable for reuse shall be spoiled as specified herein for disposal of unsuitable materials by the Contractor.

E. Crushed Stone

1. Crushed stone may be used for pipe bedding, manhole bases, as a drainage layer below structures with underdrains and at other locations indicated on the Drawings.
2. Crushed stone shall be size No. 57 with gradation as noted in Table 1 of Section 901 of Florida Department of Transportation, Construction of Roads and Bridges.

PART 3 EXECUTION

3.01 FILL PLACEMENT

A. General

1. Material placed in fill areas under and around pipelines and structures shall be deposited within the lines and to the grades shown on the Drawings or as directed by the Engineer, making due allowance for settlement of the material. Fill shall be placed only on properly prepared surfaces which have been inspected and approved by the Engineer. If sufficient common fill material is not available from excavation on site, the Contractor shall provide borrows as may be required.
2. Limerock base course material, structural fill and screened limerock, may be provided as borrow.
3. Fill shall be brought up in substantially level lifts throughout the site, starting in the deepest portion of the fill. The entire surface of the work shall be maintained free from ruts and in such condition that construction equipment can readily travel over any section. Fill shall not be placed against concrete structures until they have attained sufficient strength.
4. Fill shall be dumped and spread in layers by a bulldozer or other approved method. During the process of dumping and spreading, all

roots, debris and stones greater in size than specified under Materials, shall be removed from the fill areas. The Contractor shall assign a sufficient number of men to this work to insure satisfactory compliance with these requirements.

5. If the compacted surface of any layer of material is determined to be too smooth to bond properly with the succeeding layer, it shall be loosened by harrowing or by another approved method before the succeeding layer is placed.

6. All fill materials shall be placed and compacted "in-the-dry". The Contractor shall dewater excavated areas and is required to perform the work in such manner as to preserve the undisturbed state of the natural inorganic soil.

3.02 COMPACTION

A. Structural fill, limerock base course and screened limerock in open areas, shall be placed in layers not to exceed nine inches in depth as measured before compaction. Each layer shall be compacted by a minimum of six coverages (3 passes each way) with the equipment described below, to at least 98 percent of the maximum density, as determined by AASHTO T-180. Incidental compaction due to traffic by construction equipment will not be credited toward the required minimum six coverages.

B. Common fill shall be placed and compacted in a manner similar to that described above for structural fill, with the following exceptions: layer thickness prior to compaction may be increased to 12-inches in open areas; and common fill except dike fill, required below water level in peat excavation areas may be placed as one lift, in-the-wet, to an elevation one foot above the water level at the time of filling.

C. Compaction equipment in open areas shall consist of a medium-heavy vibrator roller (minimum static weight of 10 tons) operated at resonant frequency and at a speed of 2 fps or less or other compaction equipment approved by the Engineer.

D. Areas adjacent to pipelines, structures and other confined areas inaccessible to the vibrator roller shall be compacted with a manually operated sled-type vibratory compactor. The Contractor shall also conform to additional backfill requirements at pipelines and structures as specified in the Contract Documents. Compaction of the fill by such means shall be to the same degree of compaction as obtained by the rubber-tired equipment, and the Engineer may make the necessary tests to determine the amount of compactive effort necessary to obtain equal compaction. Unless such tests indicate that modifications may be made, the fill compacted by mechanical compactors shall be placed in 6-inch layers and thoroughly tamped over the entire surface.

Compaction equipment is subject to approval by the Engineer.

E. It is the intention that the fill materials with respect to moisture be used in the condition they are excavated insofar as this is practicable. Material which is too wet shall be spread on the fill area and permitted to dry, assisted by harrowing if necessary, until the moisture content is reduced to allowable limits.

F. If the Engineer shall determine that added moisture is required, water shall be applied by sprinkler tanks or other sprinkler systems, which will insure uniform distribution of the water over the area to be treated and give complete and accurate control of the amount of water to be used. If too much water is added, the area shall be permitted to dry before compaction is continued.

G. The Contractor shall supply all hose, piping, valves, sprinklers, pumps, sprinkler tanks, hauling equipment and all other materials and equipment necessary to place the water in the fill in the manner specified.

3.03 TRENCH EXCAVATION AND BACKFILLING

A. Excavation for all trenches required for the installation of pipes and electrical ducts shall be made to the depths indicated on the Drawings and in such manner and to such widths as will give suitable room for laying the pipe or installing the ducts within the trenches.

B. Rock shall be removed to a minimum 6" clearance around the bottom and sides of all the pipe or ducts being laid.

C. Where pipes or ducts are to be laid in limerock bedding or encased in concrete, the trench may be excavated by machinery to or just below the designated subgrade provided that the material remaining in the bottom of the trench is no more than slightly disturbed.

D. Where the pipes or ducts are to be laid directly on the trench bottom, the lower part of the trenches shall not be excavated to grade by machinery. The last of the material being excavated manually, shall be done in such a manner that will give a flat bottom true to grade so that pipe or duct can be evenly supported on undisturbed material. Bell holes shall be made as required.

E. Backfilling over pipes shall begin as soon as practicable after the pipe has been laid, jointed and inspected and the trench filled with suitable compacted material to the mid-diameter of the pipe.

F. Backfilling over ducts shall begin not less than three days after placing concrete encasement.

G. All backfilling shall be prosecuted expeditiously and as detailed on the Drawings.

H. Any space remaining between the pipe and sides of the trench shall be packed full by hand shovel with selected earth, free from stones having a diameter greater than 2" and thoroughly compacted with a tamper as fast as placed, up to a level of one foot above the top of the pipe.

I. The filling shall be carried up evenly on both sides with at least one man tamping for each man shoveling material into the trench.

J. The remainder of the trench above the compacted backfill, as just described above, shall be filled and thoroughly compacted by rolling, ramming, or puddling, as the Engineer may direct, sufficiently to prevent subsequent settling.

3.04 GRADING

A. Grading shall be performed at such places as are indicated on the Drawings, to the lines, grades and elevations shown or as directed by the Engineer and shall be made in such a manner that the requirements for formation of embankments can be followed. All unacceptable material encountered, of whatever nature within the limits indicated, shall be removed and disposed of as directed. During the process of excavation, the grade shall be maintained in such condition that it will be well drained at all times. When directed, temporary drains and drainage ditches shall be installed to intercept or divert surface water which may affect the prosecution or condition of the work.

B. If at the time of excavation it is not possible to place any material in its proper section of the permanent pipeline structure, it shall be stockpiled in approved areas for later use.

C. Minute adjustments in lines or grades may be made if found necessary as the work progresses, due to discrepancies on the Drawings or in order to obtain satisfactory construction.

D. Stones or rock fragments larger than 2-1/2" in their greatest dimensions shall not be permitted in the top 6" of the subgrade line of all dikes, fills or embankments.

E. All fill slopes shall be uniformly dressed to the slope, cross-section and alignment shown on the Drawings, or as directed by the Engineer.

F. In cuts, all loose or protruding rocks on the back slopes shall be barred loose or otherwise removed to line or finished grade of slope. All fill slopes shall be uniformly dressed to the slope, cross section and alignment shown on the Drawings or as directed by the Engineer.

G. No grading is to be done in areas where there are existing pipelines that may be uncovered or damaged until such lines which must be maintained are relocated, or where lines are to be abandoned and removed, all required valves are closed and drains plugged at manholes.

END OF SECTION

SECTION 02223

EXCAVATION BELOW GRADE AND CRUSHED STONE OR SHELL REFILL

PART 1 GENERAL

1.01 SCOPE OF WORK

A. If in the opinion of the Engineer, the material at or below the normal grade of the bottom of the trench is unsuitable for pipe or structure foundation, it shall be removed to the depth directed by the Engineer and replaced by crushed stone or washed shell.

PART 2 PRODUCTS (NOT USED)

PART 3 MATERIALS

3.01 EXCAVATION AND DRAINAGE

A. Whatever the nature of unstable material encountered or the groundwater conditions, trench stabilization shall be complete and effective.

B. Should the Contractor excavate below the grade shown on the Contract drawings because of negligence or for his own convenience; due to failure in properly dewatering the trench; disturbs the subgrade before dewatering is sufficiently complete; he shall be directed by the Engineer to excavate below grade. The work of excavating below grade and furnishing and placing the approved refill material shall be performed at the Contractor's expense.

3.02 REFILL

A. Should the material at the level of trench bottom consist of fine sand, sand and silt or soft earth, the subgrade material shall be removed as directed by the Engineer and the excavation shall be refilled with crushed stone or washed shell.

END OF SECTION

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SECTION 02260

FINISH GRADING

PART 1 GENERAL

1.01 WORK INCLUDED

A. The Contractor shall finish grade sub-soil.

B. The Contractor shall cut out areas to receive stabilizing base course materials for paving and sidewalks.

C. The Contractor shall place, finish grade and compact top soil.

1.02 PROTECTION

The Contractor shall prevent damage to existing fencing, trees, landscaping, natural features, bench marks, pavement and utility lines. Damage shall be corrected at no cost to the Owner.

PART 2 PRODUCTS

A. Topsoil: Shall be friable loam free from subsoil, roots, grass, excessive amount of weeds or other organics, stones, and foreign matter; acidity range (pH) of 5.5 to 7.5; containing a minimum of 4 percent and a maximum of 25 percent organic matter. The Contractor may use topsoil stockpiles on site if they conform to these requirements.

PART 3 EXECUTION

3.01 SUB-SOIL PREPARATION

A. The Contractor shall rough grade sub-soil systematically to allow for a maximum amount of natural settlement and compaction. Uneven areas and low spots shall be eliminated. Debris, roots, branches or other organics, stones, and sub-soil shall be removed by the Contractor and disposed of in a manner consistent with the latest Manatee County Standards as well as any affected regulatory agency. Should contaminated soil be found, the Contractor shall notify the Engineer.

B. The Contractor shall cut out areas to sub-grade elevation to stabilize base material for paving and sidewalks.

C. The Contractor shall bring sub-soil to required profiles and contour graces gradually; and blend slopes into level areas.

D. The Contractor shall slope the structure grade a minimum of two (2) inches in ten (10) feet unless indicated otherwise on the Drawings.

E. The Contractor shall cultivate sub-grade to a depth of 3 inches where the topsoil is to be placed. He shall repeat cultivation in areas where equipment use has compacted sub-soil.

F. The Contractor shall not make grade changes which causes water to flow onto adjacent lands.

3.02 PLACING TOPSOIL

A. The Contractor shall place topsoil in areas where seeding, sodding and planting is to be performed. He shall place from the following minimum depths, up to finished grade elevations:

1. 6 inches for seeded areas
2. 4-1/2 inches for sodded areas
3. 24 inches for shrub beds
4. 18 inches for flower beds

B. The Contractor shall use topsoil in a dry state as determined by the Engineer. He shall place the material during dry weather.

C. The Contractor shall use fine grade topsoil eliminating rough and low areas to ensure positive drainage. He shall maintain levels, profiles and contours of the sub-grades.

D. The Contractor shall remove stone, roots, grass, weeds, debris, and other organics or foreign material while spreading the material.

E. The Contractor shall manually spread topsoil around trees, plants and structures to prevent damage which may be caused by grading equipment.

F. The Contractor shall lightly compact and place the topsoil.

3.03 SURPLUS MATERIAL

A. The Contractor shall remove surplus sub-soil and topsoil

from site at his expense.

B. The Contractor shall leave stockpile areas and entire job site clean and raked, ready for landscaping operations.

END OF SECTION

12/08/94(Rev.)

SECTION 02276

TEMPORARY EROSION AND SEDIMENTATION CONTROL

PART 1 GENERAL

1.01 DESCRIPTION

A. The work specified in this Section consists of the design, provision, maintenance and removal of temporary erosion and sedimentation controls as necessary.

B. Temporary erosion controls include, but are not limited to: grassing, mulching, netting, watering, and the reseeding of on-site surfaces and spoil and borrow area surfaces, interceptor ditches at ends of berms and other such work at those locations which will ensure that erosion during construction will be either eliminated or maintained within acceptable limits as established by the Owner/Engineer.

C. Temporary sedimentation controls include, but are not limited to: silt dams, traps, barriers, and appurtenances at the foot of sloped surfaces which shall ensure that sedimentation pollution will be either eliminated or maintained within acceptable limits as established by the Owner/Engineer.

D. The Contractor is responsible for providing effective temporary erosion and sediment control measures during construction or until final controls become effective.

1.02 REFERENCE DOCUMENTS

A. South Florida Building Code and Standard Building Code.

B. FDEP/COE Dredge and Fill Regulations and/or Permit as applicable.

C. SWFWMD Permit Regulations and/or Permit as applicable.

D. Florida Stormwater, Erosion and Sedimentation Control Inspector's Manual.

PART 2 PRODUCTS

2.01 EROSION CONTROL

A. Netting - fabricated of material acceptable to the Owner.

B. Seed and sod.

2.02 SEDIMENTATION CONTROL

A. Bales - clean, seedfree cereal hay type.

B. Netting - fabricated of material acceptable to the Owner.

C. Filter stone - crushed stone conforming to Florida Dept of Transportation specifications.

D. Concrete block - hollow, non-load-bearing type.

E. Concrete - exterior grade not less than one inch thick.

PART 3 EXECUTION

3.01 EROSION CONTROL

A. Minimum procedures for grassing shall be:

1. Scarify slopes to a depth of not less than six inches and remove large clods, rock, stumps, roots larger than 1/2 inch in diameter and debris.
2. Sow seed within twenty-four (24) hours after the ground is scarified with either mechanical seed drills or rotary hand seeders.
3. Apply mulch loosely and to a thickness of between 3/4-inch and 1-1/2 inches.
4. Apply netting over mulched areas on sloped surfaces.
5. Roll and water seeded areas in a manner which will encourage sprouting of seeds and growing of grass. Reseed areas which exhibit unsatisfactory growth. Backfill and seed eroded areas.

3.02 SEDIMENTATION CONTROL

A. The Contractor shall install and maintain silt dams, traps, barriers, and appurtenances as shown on the approved descriptions and working drawings. Deteriorated hay bales and dislodged filter stone shall be replaced by the Contractor at his expense.

3.03 PERFORMANCE

A. The Contractor, at his own expense, shall immediately take whatever steps are necessary to correct any deficiencies of the temporary erosion and sediment control measures employed if they fail to produce results or do not comply with the requirements of the State of Florida or any other federal, governmental or regulatory agency.

END OF SECTION

5/24/95(Rev.)

SECTION 02430

STORM DRAINAGE STRUCTURES

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidentals required to install the drainage pipe, precast concrete manholes, headwalls, and appurtenances as specified herein and shown on the Contract Drawings or called out in the Contract Documents.

B. All drainage structures shall be manufactured and installed in accordance with details included herein, and as shown on the Drawings.

1.02 QUALIFICATIONS

All precast structures shall be furnished by a single manufacturer who is fully experienced, reputable, and qualified in the manufacture of items to be furnished. The structures shall be designed, constructed, and installed in accordance with the best practices and methods and shall comply with these Contract Documents and the Florida Department of Transportation Specifications for Road and Bridge Construction, latest edition.

1.03 SUBMITTALS

Contractor shall submit to the Engineer for approval, shop drawings showing details of construction, reinforcing, joints, and pipe/wall connections as specified in the Contract Documents.

1.04 INSPECTION

A. The quality of all materials, the process of manufacture, and the finished sections of pipe and structures shall be subject to inspection and approval by the Owner/Engineer, or other authorized representative. Such inspection may be made at the place of manufacture, or at the work site or both places. Sections shall be subject to rejection at any time due to the failure to meet any of the Contract requirements, even if a sample section may have been accepted as satisfactory at the place of manufacture. Sections rejected after delivery to the site shall be marked for identification and shall be removed immediately from the site. All sections which have been

damaged after delivery will be rejected. If a damaged section is installed, it shall be removed and replaced at the Contractor's expense.

B. At the time of inspection, the sections shall be carefully examined for compliance with the applicable ASTM Standards, Contract Documents, and with the approved manufacturer's drawings. All sections shall be inspected for general appearance, dimension, "scratch-strength", blisters, crack, roughness, soundness, and other features. The surface shall be dense and close-textured.

C. Imperfections may be repaired, subject to the approval of the Engineer, after demonstration by the manufacturer that strong and permanent repairs result. Repairs shall be carefully inspected before final approval. Cement mortar used for repairs shall have a minimum compressive strength of 4,000 psi at the end of 7 days and 5,000 psi at the end of 28 days, when tested in 3-inch by 6-inch cylinders stored in the standard manner. Epoxy mortar may be utilized for repairs subject to the approval of the Engineer.

PART 2 PRODUCTS

2.01 MATERIALS AND DESIGN

A. Precast structures shall conform to ASTM Designation C478 and C789 or C850 and meet the following additional requirements:

1. Type II cement shall be used except as otherwise approved.

2. Holes to accommodate pipe and structures shall be precast into the section at the manufacturer's plant.

3. All sections shall be cured by an approved method and shall not be shipped or manhole rungs subjected to loading until the concrete compressive strength has attained 3,000 psi and not before 6 days after fabrication and/or repair, whichever is longer.

4. Precast concrete top slabs shall be designed for an AASHTO H-20 wheel loading.

5. The date of manufacture and the name or trademark of the manufacturer shall be clearly marked on the inside of each precast unit.

6. Minimum wall thickness for structures and manholes shall be 8 inches.

7. The minimum inside diameter for manholes shall be 48 inches.

8. The precast reinforced base shall be a minimum of 8 inches thick and be cast monolithically with the bottom section of manhole walls.

9. Manhole sections shall be a tongue and groove joint complete with flexible rubber "O" ring gasket. The O- ring type joint shall be round compression ring of butyl material set in annular spaces cast into the tongue and groove type joint. The ring shall be uniformly compressed between the positioned sections so as to form a watertight joint. After the sections are assembled, the remaining space in the joint shall be pointed up and filled with a dense cement mortar and finished so as to make a smooth, continuous surface inside and outside the wall sections. "O" ring gaskets shall meet ASTM C443 requirements.

10. The Engineer shall require the precast sections to be tested by a certified testing laboratory if he deems the precast sections are not in compliance with the Contract Documents.

B. Pipe outlets larger than six (6) inch diameters are to be precast. A minimum clearance of six (6) inches is to remain between the outlets for adjacent pipe in any single manhole section. A minimum of two (2) reinforcing bars shall remain in the wall between any two (2) outlets.

C. The Contractor shall furnish the height of structure, the alignment angle and size of all pipes entering manhole to the Manufacturer.

D. Base sections shall have sufficient clearance to allow a minimum wall of six (6) inches between top of highest outlet and the bottom of joint.

E. Pipes shall extend a minimum of four (4) inches into structure wall, but shall not extend beyond the interior wall.

PART 3 EXECUTION

3.01 INSTALLATION

A. Manholes shall be installed to meet or exceed the requirements of the State of Florida Department of Transportation and the Contract Documents.

B. Precast concrete sections shall be set 1/4-inch maximum vertical alignment. The outside and side joint shall be filled with a dry mortar consisting of one (1) part cement and two (2) parts sand. The joints shall be finished flush with the adjoining surfaces and allowed to set for 24 hours before backfilling. Backfilling operations shall carefully fill up evenly on all sides. Leaks inside the manhole shall be caulked with lead wool to the satisfaction of the Engineer. The Contractor shall install the precast sections in a manner that will result in a watertight joint.

C. Upon authorization of the Owner/Engineer, concrete pipe section repairs shall be plugged with a non-shrinking grout or by grout in combination with concrete plugs.

D. Field cutting of pipe outlets require prior authorization of the Owner/Engineer. Cutting shall be done prior to setting sections in place to prevent jarring or movement of the mortar joints.

E. As directed by the Engineer the precast concrete base shall be placed on a bed of crushed limerock and shall provide even bearing and grade control.

F. Manhole and Head Wall Pipe Connections

A beveled outlet is acceptable if it is filled with non-shrink waterproof grout after the pipe is inserted and provided the grout completely fills all the space surrounding the pipe. Concrete encasement around the stubs is required if this method is used.

G. Cast iron frames furnished and installed shall be placed, shimmed and set in portland cement mortar to the required grade as per the Contract Documents.

H. Pipes entering the manhole shall be constructed to the grades shown on the Drawings.

I. Outer surfaces of precast and cast-in-place manholes shall receive two (2) coats of bituminous dampproofing at a rate of 30-60 square feet per gallon or as directed by the Engineer and must be in accordance with the

manufacturer's instructions.

J. Manhole frames and covers shall be set to grade from the top of the structure with brick.

K. All manholes and cast-in-place structures shall be water-tight. Leaks shall be corrected to the satisfaction of the Engineer.

L. Manholes shall be provided with stubs and plugs as indicated on the Contract Drawings or specified in the Contract Documents. Pipe stubs shall be provided with suitable caps.

END OF SECTION

12/08/94(Rev.)

SECTION 02444

FENCING

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, material, equipment and incidentals necessary for complete installation of chain link fence systems. The fencing shall be installed according to manufacturer's specifications unless otherwise directed or authorized by the Owner/Engineer.

B. The Contractor's security fencing is at his expense and option and is not covered in this Section.

1.02 QUALITY ASSURANCE

A. Standards of Manufacture

1. Standards of manufacture shall comply with the standards of the Chain Link Fence Manufacturer's Institute for "Galvanized Steel Chain Link Fence Fabric" and as herein specified.

B. Provide each type of steel fence and gates as a complete unit produced by a single manufacturer, including, but not limited to accessories, fittings, fasteners and appurtenances complete and ready for use.

C. Acceptable Manufacturers:

1. Anchor
2. Cyclone
3. or approved equal

D. Erector Qualifications: The Contractor or approved subcontractor, must have a minimum of two years experience in similar fence installation.

1.03 SUBMITTALS

A. Product Data: Steel Fences and Gates

1. The Contractor shall submit for review and approval to the Owner/Engineer, eight copies of the manufacturer's technical data, details of fabrication, installation instructions and procedures for steel fences and gates. The

Contractor shall be responsible for a copy of each instruction to be given to the Installer.

B. Samples:

1. The Contractor shall submit three samples approximate size 6-inches long, or 6-inches square of fabric material, framework members and typical accessories to the Owner/Engineer for review and approval.

C. Certificates:

1. The Contractor shall provide manufacturer's certification that materials meet or exceed the Contract Document requirements.

PART 2 PRODUCTS

2.01 GENERAL

A. The pipe sizes indicated are commercial pipe sizes.

B. The tube sizes indicated are nominal outside dimension.

C. Framework and appurtenances shall be finished with not less than minimum weight of zinc per sq. ft. and shall comply with the following:

1. Pipe: ASTM A53 (1.8 oz. zinc psf)
2. Square tubing: ASTM A 123 (2.0 oz. zinc psf)
3. Hardware and Accessories: ASTM A 153 (zinc weight per Table I).

D. All fence components shall be galvanically compatible.

2.02 FABRIC

A. Fabric shall be 0.148 inch (9 gage) steel wire, 2-inch diamond mesh and both top and bottom salvages shall be twisted and barbed for fabric over 60-inches high. Finish shall be hot dipped galvanized, ASTM A 392, Class II.

2.03 POSTS, RAILS AND BRACES

A. End, Corner and Pull Posts:

1. The Contractor shall furnish end, corner and pull posts of the minimum size and weight as follows:

a. Up to 5 foot fabric height

(1) 2.375-inch OD pipe weighing 3.65 pounds per linear ft.
(2) 2.50-inch square tubing weighing 5.59 pounds per linear foot.

b. Over 5 foot fabric height
(1) 2.875-inch OD pipe weighing 5.79 pounds per linear foot.
(2) 2.50-inch square tubing weighing 5.59 lbs. per linear foot.

B. Line Post:

1. The Contractor shall furnish line posts of the minimum sizes and weight as follows. Post shall be spaced 10 foot o.c. maximum, unless otherwise indicated:

a. Up to 5 foot fabric height.
(1) 1.90-inch OD pipe weighing 2.72 pounds per linear foot.

b. Over 5 foot fabric height.
(1) 2.375-inch OD pipe weighing 3.65 pounds per linear foot.

C. Gate Posts:

1. The Contractor shall furnish gate posts for supporting single gate leaf, or one leaf of a double gate installation, for nominal gate widths as follows:

a. Up to 6 feet wide.
(1) 2.875-inch OD pipe weighing 5.79 pounds per linear foot.
(2) 2-1/2 inch square tubing weighing 5.59 pounds per linear foot.

b. Over 6 feet and up to 13 feet wide.

(1) 4-inch OD pipe weighing 9.11 pounds per linear foot.

c. Over 13 feet and up to 18 feet wide.
(1) 6.625 inches OD weighing 18.97 pounds per linear foot.

d. Over 18 feet.
(1) 8.625 inches OD weighing 28.55 pounds per linear foot.

D. Top Rails:

1. The Contractor shall furnish the following top rails unless otherwise indicated:

   a. 1.660-inch OD pipe weighing 2.27 pounds per linear foot.

E. Post Brace Assembly:

1. The Contractor shall furnish bracing assemblies at the end, gate, at both sides of corner and pull posts, with the horizontal brace located at mid-height of the fabric.

2. Use 1.660-inch OD pipe weighing 2.27 pounds per linear foot for horizontal brace and 3/8-inch diameter rod with turnbuckles for diagonal truss.

F. Tension Wire:

1. The Contractor shall furnish tension wire consisting of galvanized 0.177 inch (7 gage) coiled spring wire as per ASTM A824 at the bottom of the fabric only.

G. Barbed Wire Supporting Arms:

1. The Contractor shall furnish pressed steel, wrought iron, or malleable iron barbed wire supporting arms, complete with provisions for anchorage to posts and attaching three rows of barbed wire to each arm. Supporting arms may be attached either to posts or integral with post top weather cap. The Contractor shall provide a single 45 degree arm for each post where indicated.

H. Barbed Wire:

1. The Contractor shall furnish barbed wire. It shall be 2 strand, 12-1/2 gauge wire with 14 gauge, 4-point barbs spaced 5-inch o.c., galvanized, complying with ASTM A121, Class 3.

I. Post Tops:

1. The Contractor shall furnish post tops. Tops shall be pressed steel, wrought iron, or malleable iron of ASTM F626 designed as a weathertight closure cap (for tubular posts). The Contractor shall furnish one cap for each post unless equal protection is afforded by a combination of post top cap and

barbed wire supporting arm. The Contractor shall furnish caps with openings to permit through passage of the top rail.

J. Stretcher Bars:

1. The Contractor shall furnish stretcher bars. Bars shall be one piece lengths equal to the full height of the fabric, with a minimum cross-section of 3/16-inch x 3/4-inch. The Contractor shall provide one stretcher bar for each gate and end post and two bars for each corner and pull post, except where fabric is integrally woven into the post.

K. Stretcher Bar Bands:

1. The Contractor shall furnish stretcher bar bands. Bands shall be steel, wrought iron, or malleable iron, a maximum space of 15-inch o.c. to secure stretcher bars to end, corner, pull and gate posts.

2.04 GATES

A. The Contractor shall provide fabricated gate perimeter frames of tubular members. Additional horizontal and vertical members shall ensure proper gate operation and attachment of fabric, hardware and accessories. The maximum space of the frame members shall not be more than 8-inches apart. Fabrication is as follows:

1. Up to 5 feet high, or leaf width 8 feet or less.
   a. 1.660-inch OD pipe weighing 2.27 pounds per linear foot.
   b. 1.5 inch sq. tubing weighing 2.27 pounds per linear foot.

2. Over 5 feet high, or leaf width exceeding 8 feet.
   a. 1.90 inch OD pipe weighing 2.72 pounds per linear foot.
   b. 2-inch square tubing weighing 2.60 pounds per linear foot.

B. The Contractor shall assemble gate frames by welding or with special malleable or pressed steel fittings and rivets for rigid connections. He shall use the same fabric width as for the fence, unless otherwise indicated in the Contract Documents or authorized by the Owner/Engineer. He shall install the fabric with stretcher bars at vertical edges. The bars may also be used at the top and bottom edges. The contractor shall attach stretchers to the gate frame at a maximum spacing of 15-inch o.c. He shall attach the hardware with rivets

or by other means which will prevent removal or breakage.

C. The Contractor shall install diagonal cross-bracing consisting of 3/8-inch diameter adjustable length truss rods on gates as necessary to ensure frame rigidity without sag or twist.

D. The Contractor shall install barbed wire above the gates. He shall extend the end members of gate frames 12-inches above the top member which will be prepared for three strands of wire. The Contractor shall provide necessary clips for securing wire to extensions.

E. Gate Hardware:

1. The Contractor shall furnish the following hardware and accessories for each gate.

a. Hinges: Pressed or forged steel or malleable iron to suit gate size, non-lift-off type, offset to permit 180 degrees gate opening. Provide 1-1/2 pair of hinges for each leaf over six feet nominal height.

b. Latch: Forked type of plunger-bar type to permit operation from either side of gate with padlock eye as integral part of latch.

c. Keeper: Provide keeper for all vehicle gates, which automatically engages the gate leaf and holds it in the open position until manually released.

d. Double Gates: Provide gate stops for double gates, consisting of mushroom type of flush plate with anchors. Set in concrete to engage the center drip drop rod or plunger bar. Include locking device and padlock eyes as an integral part of the latch, using one padlock for locking both gate leaves.

e. Padlocks and Keys: One (1) solid brass padlock for each gate, with six (6) keys shall be furnished for each gate called for. Locks shall be keyed to the Owner's Master Keying System.

f. Where gates are between masonry piers, provide "J" with 4-inch square anchor plate to masonry contractor for building in.

2.05 MISCELLANEOUS MATERIALS AND ACCESSORIES

A. Wire Ties:

1. The Contractor shall tie fabric to line posts. He shall use 9 gauge wire ties spaced 12-inches o.c. For tying fabric to rails and braces, he shall use 9 gauge wire ties spaced 24-inches o.c. For tying fabric to tension wire, he shall use 11 gauge hog rings spaced 24-inches o.c. The finish of ties shall match the fabric finish.

B. Concrete:

1. The Contractor shall provide portland cement concrete in compliance with ASTM C-150 and the Contract Documents. Aggregates shall comply with ASTM C-33. The Contractor shall mix the materials to obtain a minimum 28-day compressive strength of 2500 psi, using a minimum of 4 sacks of cement per cubic yard, a maximum size aggregate of 1-inch, a maximum 3-inch slump and air entrainment of 2 percent to 4 percent.

PART 3 EXECUTION

3.01 INSTALLATION

A. The Contractor shall not start the fence installation prior to the final grade completion, and the finish elevations established, unless otherwise authorized by the Owner/Engineer.

B. Excavation:

1. For post footings, the Contractor shall drill holes in firm, undisturbed or compacted soil of the diameters and spacings shown or called out in the Contract Documents.

   a. For holes not shown or called out on the Contract Documents, the Contractor shall excavate minimum diameters recommended by the fence manufacturer.

   b. Post holes shall be in true alignment and of sufficient size to provide a permanent concrete foundation. Concrete shall be poured against undisturbed earth sides and bottom. All holes shall be 48-inches deep with posts and corner posts placed in the concrete to a depth of 36-inches The gate posts shall be set in the

concrete to a depth of 42-inches below the surface in firm, undisturbed soil. Holes shall be well centered on the posts. A minimum diameter of 12-inches shall be required for all post holes.

c. Excavated soil shall be removed from the Owner's property.

d. If solid rock is encountered near the surface, the Contractor shall drill into rock at least 12-inches for line posts and at least 18-inches for end, pull, corner or gate posts. Hole shall be drilled to at least 1-inch greater diameter than the largest dimension of the post to be place.

e. If the Contractor encounters solid rock below solid overburden, he shall drill to the full depth required; however, rock penetration need not exceed the minimum depths specified.

C. Setting Posts:

1. The Contractor shall remove loose and foreign materials from the sides and bottoms of holes, and moisten soil prior to placing concrete.

a. Center and align posts in holes 3-inches above bottom of excavation.

b. Place concrete around posts in a continuous pour and vibrate or tamp for consolidation. Check each post for vertical and top alignment and hold in position during placement and finishing operations. The top of concrete shall extend 2-inches above finish grade.

c. Trowel finish tops of footings and slope or dome to direct water away from posts. Extend footings for gate posts to the underside of bottom hinge. Set keeps, stops, sleeves and other accessories into concrete as required.

d. Keep exposed concrete surfaces moist for at least 7 days after placement, or cure with membrane curing materials, or other acceptable curing method.

e. Grout-in posts set into sleeved holes, concrete constructions, or rock excavations with non-

shrink portland cement grout, or other acceptable grouting material.

D. Concrete Strength:

The Contractor shall allow the concrete to attain at least 75% of its minimum 28-day compressive strength no sooner than 7 days after placement, before rails, tension wires, barbed wire, or fabric is installed. The Contractor shall not stretch and tension fabric or wires and shall not hang gates until the concrete has attained its full design strength.

E. Top Rails:

The Contractor shall run the rail continuously through post caps or extension arms and bend to radius for curved runs. He shall provide expansion coupling as recommended by fencing manufacturer.

F. Brace Assemblies:

The Contractor shall install braces so that posts are plumb when diagonal rod is under proper tension.

G. Tension Wire:

The Contractor shall install tension wires by weaving through the fabric and tying to each post with not less than 0.170 inch galvanized wire, or by securing the wire to the fabric.

H. Fabric:

The Contractor shall leave approximately 3-inches between finish grade and bottom salvage, except where the bottom of the fabric extends into the concrete. He shall pull the fabric taut and tie it to posts, rails and tension wires. He shall install fabric on the security side of the fence and anchor it to the framework so that the fabric remains in tension after the pulling force is released.

I. The Contractor shall repair damaged coatings in the shop or in the field by recoating utilizing manufacturer's recommended repair compounds and as applied per manufacturer's recommendations.

J. Stretcher Bars:

The Contractor shall thread through or clamp the bars to the fabric 4-inches o.c. and secure them to posts with

metal bands spaced 15-inches o.c.

K. Barbed Wire:

The Contractor shall install 3 parallel wires on each extension arm on the security side of fence, unless otherwise indicated. He shall pull the wire taut and fasten securely to each extension arm.

L. Gate:

The Contractor shall install gates plumb, level and secure for full opening without interference. He shall install ground-set items in concrete for anchorage, as recommended by the fence manufacturer. He shall adjust hardware for smooth operation and lubricate where necessary.

M. Tie Wires:

The Contractor shall use U-shaped wire, conforming to the diameter of the attached pipe, and shall clasp the pipe and fabric firmly with twisted ends of at least 2 full turns. He shall bend the end of the wire to minimize hazard to persons or clothing.

N. Fasteners:

The Contractor shall install nuts for tension band and hardware bolts on the side of fence opposite the fabric side. Pen ends of bolts or score threads to prevent removal of nuts.

END OF SECTION

SECTION 02485

SEEDING AND SODDING

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials and equipment necessary to satisfactorily return all construction areas to their original conditions or better.

B. Work shall include furnishing and placing seed or sod, fertilizing, planting, watering and maintenance until acceptance by Engineer/Owner.

1.02 RELATED WORK NOT INCLUDED

A. Excavation, filling and grading required to establish elevation shown on the Drawings are included under other sections of these Specifications.

1.03 QUALITY ASSURANCE

A. Requirements

It is the intent of this Specification that the Contractor is obliged to deliver a satisfactory stand of grass as specified. If necessary, the Contractor shall repeat any or all of the work, including grading, fertilizing, watering and seeding or sodding at no additional cost to the Owner until a satisfactory stand is obtained. For purposes of grassing, a satisfactory stand of grass is herein defined as a full lawn cover over areas to be sodded or seeded, with grass free of weeds, alive and growing, leaving no bare spots larger than 3/4 square yard within a radius of 8 feet.

All previously grassed areas where pipelines are laid shall be sodded. All sodding and grassing shall be installed in accordance with these Specifications or as directed by the Engineer.

PART 2 PRODUCTS

2.01 MATERIALS

A. Fertilizer

The fertilizer shall be of the slow-release type meeting the following minimum requirements: 12 percent nitrogen,

8 percent phosphorus, 8 percent potassium; 40 percent other available materials derived from organic sources. At least 50 percent of the phosphoric acid shall be from normal super phosphate or an equivalent source which will provide a minimum of two units of sulfur. The amount of sulfur shall be indicated on the quantitive analysis card attached to each bag or other container. Fertilizer shall be uniform in composition, dry and free flowing delivered to sites in original unopened containers bearing manufacturer's statement or guarantee.

B. Seeding/Grassing

The Contractor shall grass all unpaved areas disturbed during construction which do not require sod. All grassing shall be completed in conformance with FDOT Specifications, Sections 570 and 981. The grassed areas shall be mulched and fertilized in accordance with FDOT Specifications, except that no additional payment will be made for mulching, fertilizing and/or watering.

C. Sodding

Sod shall be provided as required on the construction drawings or at locations as directed by the Engineer in accordance with Florida Department of Transportation, Specifications Section 575 and 981. The Contractor shall furnish bahia grass sod or match existing sod. Placement and watering requirements shall be in accordance with FDOT Specifications Section 575, except that no additional payment will be made for placement and/or watering. This cost shall be included in the Contract price bid for sodding.

D. Topsoil

Topsoil stockpiled during excavation may be used as necessary. If additional topsoil is required to replace topsoil removed during construction, it shall be obtained off site at no additional cost to the Owner. Topsoil shall be fertile, natural surface soil, capable of producing all trees, plants and grassing specified herein.

E. Water

It is the Contractor's responsibility to supply all water to the site, as required during seeding and sodding operations and through the maintenance period and until the work is accepted. The Contractor shall make whatever arrangements that may be necessary to ensure an adequate supply of water to meet the needs for his work. He shall also furnish all necessary hose, equipment, attachments and accessories for the adequate irrigation of lawns and planted areas as may be required. Water shall be

suitable for irrigation and free from ingredients harmful to plant life.

PART 3 EXECUTION

3.01 INSTALLATION

A. When the trench backfill has stabilized sufficiently, the Contractor shall commence work on lawns and grassed areas, including fine grading as necessary and as directed by the Engineer.

B. Finish Grading

Areas to be seeded or sodded shall be finish graded, raked, and debris removed. Soft spots and uneven grades shall be eliminated. The Engineer shall approve the finish grade of all areas to be seeded or sodded prior to seed or sod application.

C. Protection

Seeded and sodded areas shall be protected against traffic or other use by placing warning signs or erecting barricades as necessary. Any areas damaged prior to acceptance by the Owner shall be repaired by the Contractor as directed by the Engineer.

3.02 CLEANUP

Soil or similar materials spilled onto paved areas shall be removed promptly, keeping those areas as clean as possible at all times. Upon completion of seeding and sodding operations, all excess soil, stones and debris remaining shall be removed from the construction areas.

3.03 LANDSCAPE MAINTENANCE

Any existing landscape items damaged or altered during construction by the Contractor shall be restored or replaced as directed by the Engineer.

Maintain landscape work for a period of 90 days immediately following complete installation of work or until Owner accepts project. Watering, weeding, cultivating, restoration of grade, mowing and trimming, protection from insects and diseases, fertilizing and similar operations as needed to ensure normal growth and good health for live plant material shall be included at no additional cost to the Owner.

3.04 REPAIRS TO LAWN AREAS DISTURBED BY CONTRACTOR'S OPERATORS

Lawn areas planted under this Contract and all lawn areas damaged by the Contractor's operation shall be repaired at once by proper soil preparation, fertilizing and sodding, in accordance with these Specifications.

END OF SECTION

SECTION 02575

PAVEMENT REPAIR AND RESTORATION

PART 1 GENERAL

1.01 SCOPE OF WORK

The Contractor shall furnish all labor, materials, equipment, obtain County or State right-of-way permits and incidentals required and remove and replace pavements over trenches excavated for installation of water lines and appurtenances as shown on the Contract Drawings.

1.02 GENERAL

A. The Contractor shall take before and after photographs.

B. The Contractor shall repair in a manner satisfactory to the County or State, all damage done to existing structures, pavement, driveways, paved areas, curbs and gutters, sidewalks, shrubbery, grass, trees, utility poles, utility pipe lines, conduits, drains, catch basin, flagstones, or stabilized areas or driveways and including all obstructions not specifically named herein, which results from this Project.

C. The Contractor shall keep the surface of the backfilled area of excavation in a safe traffic bearing condition and firm and level with the remaining pavement until the pavement is restored in the manner specified herein. All surface irregularities that are dangerous or obstructive to traffic are to be removed. The repair shall conform to applicable requirements of Manatee County Transportation Department requirements for pavement repair and as described herein, including all base, subbase and asphalt replacement.

D. All materials and workmanship shall meet or exceed the County requirements and as called for in the Contract Documents and nothing herein shall be construed as to relieve the Contractor from this responsibility.

E. All street, road and highway repair shall be made in accordance with the FDOT and County details indicated on the Drawings and in accordance with the applicable requirements and approval of affected County and State agencies.

PART 2 PRODUCTS

2.01 PAVEMENT SECTION

A. Asphaltic concrete shall consist of asphalt cement, coarse aggregate, fine aggregate and mineral filler conforming to FDOT Type S-III Asphalt. Pavement replacement thickness shall match that removed but in no case shall be less than 1-1/2" compacted thickness. All asphalt concrete pavement shall be furnished, installed and tested in accordance with FDOT Specifications for Road and Bridge Construction.

B. Asphalt or crushed concrete or approved equal base material shall be furnished and installed under all pavement sections restored under this Contract. Asphalt base shall have a minimum 6" compacted thickness, meet requirements for FDOT ABC III (Minimum Marshall Stability of 1000) and be furnished, installed and tested in accordance with the requirements of the FDOT Standards. Crushed concrete base shall be 10" minimum compacted thickness. Crushed concrete aggregate material shall have a minimum LBR of 140 compacted to 99% T-180 AASHTO density. Asphalt base and crushed concrete base are acceptable. Other bases shall be submitted for approval.

C. Prime and tack will be required and applied in accordance with Section 300 - FDOT Specifications: Prime and Tack Coat for Base Courses.

PART 3 EXECUTION

3.01 CUTTING PAVEMENT

A. The Contractor shall saw cut in straight lines and remove pavement as necessary to install the new pipelines and appurtenances and for making connections to existing pipelines.

B. Prior to pavement removal, the Contractor shall mark the pavement for cuts nearly paralleling pipe lines and existing street lines. Asphalt pavement shall be cut along the markings with a rotary saw or other suitable tool. Concrete pavement shall be scored to a depth of approximately two (2) inches below the surface of the concrete along the marked cuts. Scoring shall be done by use of a rotary saw, after which the pavement may be broken below the scoring with a jackhammer or other suitable equipment.

C. The Contractor shall not machine pull the pavement until it is completely broken and separated along the marked cuts.

D. The pavement adjacent to pipe line trenches shall neither be disturbed or damaged. If the adjacent pavement is disturbed or damaged, irrespective of cause, the Contractor shall remove and replace the pavement. In addition, the base and sub-base shall be restored in accordance with these Specifications, Florida Dept. of Transportation Standard Specifications and as directed by the Engineer.

3.02 PAVEMENT REPAIR AND REPLACEMENT

A. The Contractor shall repair, to meet or exceed original surface material, all existing pavement cut or damaged by construction under this Contract. He shall match the original grade unless otherwise specified or shown on the Drawings. Materials and construction procedures for base course and pavement repair shall conform to those of the Florida Dept. of Transportation.

B. The Contractor's repair shall include the preparation of the subbase and base, place and maintain the roadway surface, any special requirements whether specifically called for or implied and all work necessary for a satisfactory completion of this work. Stabilized roads and drives shall be finished to match the existing grade. Dirt roads and drives shall have the required depth of backfill material as shown on the Contract Drawings.

C. The width of all asphaltic concrete repairs shall extend the full width and length of the excavation or to the limits of any damaged section. The edge of the pavement to be left in place shall be cut to a true edge with a saw or other approved method so as to provide a clean edge to abut the repair. The line of the repair shall be reasonably uniform with no unnecessary irregularities.

3.03 MISCELLANEOUS RESTORATION

Sidewalks cut or damaged by construction shall be restored in full sections or blocks to a minimum thickness of four inches. Concrete curb or curb and gutter shall be restored to the existing height and cross section in full sections or lengths between joints. RCP pipe shall be repaired or installed in accordance with manufacturer's specifications. Grassed yards, shoulders and parkways shall be restored to match the existing sections with grass sod of a type matching the existing grass.

3.04 SPECIAL REQUIREMENTS

The restoration of all surfaces, as described herein, disturbed by the installation of pipelines shall be completed as soon as is reasonable and practical. The complete and final restoration of both paved and shell

stabilized roads within a reasonable time frame is of paramount importance. To this end, the Contractor shall, as part of his work schedule, complete the restoration of any area of road within five weeks after removing the original surface. Successful leak testing shall be performed prior to restoring any area of road. All restoration and replacement or repairs are the responsibility of the Contractor.

3.05 CLEANUP

After all repair and restoration or paving has been completed, all excess asphalt, dirt and other debris shall be removed from the roadways. All existing storm sewers and inlets shall be checked and cleaned of any construction debris.

3.06 MAINTENANCE OR REPAIR

All wearing surfaces shall be maintained by the Contractor in good order suitable for traffic prior to completion and acceptance of the work.

END OF SECTION

SECTION 02612
REINFORCED CONCRETE DRAIN PIPE

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals necessary and install and test reinforced concrete pipe for drains complete as shown on the Drawings and as specified herein.

1.02 RELATED WORK

A. Section 02221 – Trenching, Bedding, and Backfill for Pipe

B. Section 02430 - Storm Drainage Structures

1.03 SUBMITTALS

A. Within 30 days of the Effective Date of the Agreement submit the name of the pipe and fitting supplier and a list of materials to be furnished.

B. Submit shop drawings, in accordance with Section 01340, showing layout and details of reinforcement, joint, method of manufacture and installation of pipe, specials and fittings, and a schedule of pipe lengths by diameter for the entire job.

C. Submit with the shop drawings certification from the manufacturer that the fine and course aggregates used in manufacture of the concrete pipe comply with the requirements of Paragraph 2.01C.

D. Prior to each shipment of pipe, submit the manufacturer's certification that the pipe for this Contract conforms to the ASTM Standards specified herein.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM C33 - Standard Specification for Concrete Aggregates.

2. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain and Sewer Pipe.

3. ASTM C150 - Standard Specification for Portland Cement.

4. ASTM C361 - Standard Specification for Reinforced Concrete Low-Head Pressure Pipe.

5. ASTM C443 - Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.

6. ASTM E329 - Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. The manufacturer shall perform the acceptance tests specified in ASTM C76, Paragraph 5.1.2.

B. Reinforced concrete pipe manufactured for this Contract may be inspected at the plant for compliance with this Section by an independent testing laboratory provided by the Owner. The manufacturer's cooperation in these inspections shall be required

C. Inspection of the pipe will be made by the Engineer or other representatives of the Owner after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the requirements specified herein, even though pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall immediately be removed from the job.

PART 2 PRODUCTS

2.01 REINFORCED CONCRETE PIPE

A. Except as otherwise specified herein, pipe shall conform to ASTM C76 Wall B. The pipe interior shall be smooth and even, free from roughness, projections, indentations, offsets, or irregularities of any kind. The concrete mass shall be dense and uniform.

B. Cement shall be non-air-entraining portland cement conforming to ASTM C150, Type II. The use of any admixture shall be subject to the specific approval of the Engineer.

C. Fine aggregate shall consist of washed inert natural sand conforming to the requirements of ASTM C33, except for gradation, with a maximum loss of 8 percent when subjected to 5 cycles of the soundness test using magnesium sulfate. Coarse aggregate shall consist of well-graded crushed stone or washed gravel conforming to the requirements of ASTM C33, except for gradation, with a maximum loss of 8 percent when subjected to 5 cycles of the soundness test using magnesium sulfate. Documentation that the aggregates to be used in

the manufacture of reinforced concrete pipe meet these requirements shall be submitted to the Engineer as stated in Paragraph 1.03 above.

D. The 28-day compressive strength of the concrete, as indicated by cores cut from the pipe shall be equal to or greater than the design strength of the concrete. The concrete mass shall be dense and uniform. Reinforcement shall be circular for all concrete pipe. Quadrant steel shall not be used. Reinforcement shall be installed in both the bell and the spigot. At least one circumferential reinforcement wire shall be in both the bell and spigot area and reinforcement in the bell and spigot shall be adequate to prevent damage to concrete during shipping, handling and after installation. When cores indicate that reinforcing steel has less than 85 percent bond the pipe shall be subjected to a 3-edge bearing test to 13 psi to verify strength and water tightness.

E. Pipe may be rejected for any of the following reasons:

1. Exposure of any steel reinforcement in any surface of the pipe.

2. Transverse reinforcing steel found to be in excess of 1/4-in out of specified position after the pipe is molded.

3. Any shattering or flaking of concrete at a crack.

4. Voids, with the exception of a few minor bugholes, on the interior and exterior surfaces of the pipe exceeding 1/4-in in depth unless properly and soundly pointed with mortar or other approved material.

5. Unauthorized application of any wash coat of cement or grout. Any pipe dressing procedures shall be subject to approval of the Engineer.

6. A hollow spot (identified by tapping the internal surface of the pipe) which is greater than 30-in in length or wider than 3 times the specified wall thickness. Repair of such defective areas not exceeding these limitations may be made as specified in Paragraph 2.01R.

7. Defects that indicate imperfect molding of concrete; or any surface defect indicating honeycomb or open texture (rock pockets) greater in size than area equal to a square with a side dimension of 2-1/2 times the wall thickness or deeper than two times the maximum graded aggregate size; or local deficiency of cement resulting in loosely bonded concrete, the area of which exceeds in size the limits of area described in Paragraph 2.01E9 above when the defective concrete is removed. Repair of such defects not exceeding these limits may be made as specified in Paragraph 2.01R.

8. Any of the following:

   a. A crack having a width of 0.005 to 0.01-in throughout a continuous length of 36-in or more.

b. A crack having a width of 0.0 to 0.03-in or more throughout a continuous length of 1-ft or more.

c. Any crack greater than 0.005-in extending through the wall of the pipe and having a length in excess of the wall thickness.

d. Any crack showing two visible lines of separation for a continuous length of 2-ft or more, or an interrupted length of 3-ft or more anywhere in evidence, both inside and outside.

e. Cracks anywhere greater than 0.03-in in width.

F. The pipe shall be clearly marked as required by ASTM C76 in a manner acceptable to the Engineer. The markings may be at either end of the pipe for the convenience of the manufacturer, but for any one size shall always be at the same end of each pipe length. Pipe shall not be shipped until the compressive strength of the concrete has attained 4,000 psi.

G. Pipe shall have a minimum laying length of approximately 8-ft, except for closure and other special pieces as approved by the Engineer. Have available at the site of the work sufficient pipe of various lengths to affect closure at manholes or structures that cannot be located to accommodate standard lengths. Short lengths of pipe made for closure etc., may be used in the pipeline at the end of construction if properly spaced. The length of the incoming and outgoing concrete pipe at each structure shall not exceed 4-ft, except where the joint is cast flush with the exterior wall of the structure, where steel wall fittings are provided or where otherwise noted on the Drawings. Maximum laying length shall not exceed 16-ft, but the installation of 16-ft lengths will depend upon the ability to handle such lengths of pipe in sheeted trenches, comply with trench width requirements, maintain the integrity of the sheeting and avoid disturbance to adjacent ground. If in the opinion of the Engineer the use of 16-ft lengths is impracticable, shorter lengths shall be used.

H. Each length of pipe shall be checked against the length noted on the shop drawings. Pipe more than 1-1/2-in longer than that shown on the shop drawings shall not be used on this project. Variations in length of the same pipe shall not exceed ASTM C76 requirements.

I. During manufacturing, measuring devices shall be used to assure joint assembly is within the tolerance of ASTM C76 and this Section.

J. At the time of inspection, the pipe will be carefully examined for compliance with the appropriate ASTM standard, as specified herein and shop drawings. All pipes shall be inspected for general appearance, dimension, "scratch-strength," blisters, cracks, roughness, soundness, etc. All pipes will be checked for soundness by being tapped and scratched at least once on every 50 sq in of pipe surface. The surface shall be dense and close-textured. Cores also shall serve as a basis for rejection of pipe, particularly if lamination or poor bond of reinforcement is apparent.

K. The manufacturer shall use measuring devices to assure joint assembly is within tolerances of ASTM C76 and as specified herein.

L. Unsatisfactory or damaged pipe will be either permanently rejected or returned for minor repairs. Only that pipe actually conforming to the specifications and accepted will be listed for approval, shipment and payment. Approved pipe will be so stamped or stenciled on the inside before it is shipped. All pipe which has been damaged after delivery will be rejected and if such pipe already has been laid in the trench, it shall be acceptably repaired, if permitted, or removed and replaced, entirely at the Contractor's expense.

M. Pits, blisters, rough spots, breakage and other imperfections may be repaired, subject to the approval of the Engineer, after demonstration by the manufacturer that strong and permanent repairs result. Repairs shall be carefully inspected before final approval. Non-shrink cement mortar used for repairs shall have a minimum compressive strength of 6,000 psi at the end of 7 days and 7,000 psi at the end of 28 days, when tested in 3-in cylinders stored in the standard manner. Epoxy mortar may be utilized for repairs subject to the approval of the Engineer.

2.02 JOINTS FOR CONCRETE PIPE

A. Joints for concrete pipe less than 72-in in diameter shall be concrete and rubber tongue and groove or bell and spigot type joint conforming to ASTM C361 with provisions for using a round rubber O-Ring gasket in a recess in the spigot end of the pipe. The bevel on the bell of the pipe shall be between 1-1/2 degrees and 2-1/2 degrees. The diameters of the joint surfaces which compress the gasket shall not vary from the true diameters by more than 1/16-in.

B. The round rubber O-Ring gaskets shall conform to ASTM C443 except as otherwise specified herein.

C. The ends of the pipe shall be made true to form and dimension and the bell shall be made by casting against steel forms. The manufacturer shall inspect all pipe joint surfaces for out-of-roundness and pipe ends for squareness. The manufacturer shall furnish to the Engineer a notarized affidavit stating all pipe meets the requirements of ASTM C76, as specified herein and the joint design.

PART 3 EXECUTION

3.01 LAYING CONCRETE PIPE

A. Care shall be taken in loading, transporting and unloading to prevent injury to the pipe or fittings and the joint surfaces. Pipe or fittings shall not be dropped. All pipe or fittings shall be examined before laying and no piece shall be installed which is found to be defective.

B. Screened gravel shall be placed and compacted to give complete vertical and lateral support for the lower section of the pipe as indicated on the Drawings. A depression shall be left in the soil at the joint to prevent contamination of the rubber gasket immediately before being forced home. Before the pipe is lowered into the trench, the spigot and bell shall be cleaned and free from dirt. Gasket and bell shall be lubricated by a vegetable lubricant which is not soluble in water, furnished by the pipe manufacturer and harmless to the rubber gasket. The pipe shall be properly aligned in the trench to avoid any possibility of contact with the side of the trench and fouling the gasket. As soon as the spigot is centered in the bell of the previously laid pipe, it shall be forced home with jacks or come-alongs. After the gasket is compressed and before the pipe is brought fully home, each gasket shall be carefully checked for proper position around the full circumference of the joint. Steel inserts shall be used to prevent the pipe from going home until the feeler gauge is used to check the final position of the gasket. The jacks or come-alongs shall be anchored sufficiently back along the pipeline (a minimum of five lengths) so that the pulling force will not dislodge the pieces of pipe already in place. Only a jack or come-along shall be employed to force the pipe home smoothly and evenly and hold the pipe while backfilling is in progress. Under no circumstances shall crowbars be used nor shall any of the motordriven equipment be used.

C. As soon as the pipe is in place and before the come-along is released, backfill shall be placed as indicated on the Drawings and compacted for at least one-half the length of pipe. Not until this backfill is placed shall the come-along be released. If any motion at joints can be detected, a greater amount of backfill shall be placed before pressure is released. When pipe laying is not in progress, including lunchtime, the open ends of the pipe shall be closed by a watertight plug or other approved means.

D. Carefully regulate the equipment and construction operations such that the loading of the pipe does not exceed the loads for which the pipe is designed and manufactured. Any pipe damaged during construction operations shall promptly and satisfactorily be repaired or replaced at the Contractor's expense.

END OF SECTION

SECTION 02615

DUCTILE IRON PIPE AND FITTINGS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, equipment and incidentals required to install ductile iron pipe, restrained joint ductile iron pipe and cast iron or ductile iron fittings, complete, as shown on the Drawings and specified in these Standards.

B. Fittings are noted on the drawings for the Contractor's convenience and do not relieve him from laying and jointing different or additional items where required.

C. Newly installed pipe shall be kept clean and free of all foreign matter.

1.02 SUBMITTALS

A. The Contractor shall submit to the Engineer, within ten days after receipt of Notice to Proceed, a list of materials to be furnished, the names of the suppliers and the appropriate shop drawings for all ductile iron pipe and fittings.

B. The Contractor shall submit the pipe manufacturer's certification of compliance with the applicable sections of the Specifications.

PART 2 PRODUCTS

2.01 MATERIALS

A. Ductile iron pipe shall conform to AWWA C150 and AWWA C151. Thickness of pipe shall be Pressure Class 350. All ductile iron pipe used in above ground applications shall be Special Thickness Class 53. The pipe exterior coating shall be a standard 1 mil asphaltic coating per AWWA C151. All ductile iron pipe shall be clearly marked on the outside of the barrel to readily identify it. All pipe materials used in potable water systems shall comply with NSF Standard 61.

B. Unrestrained joint pipe shall be supplied in lengths not to exceed 21 ft. and shall be either the rubber-ring compression-type push-on joint or standard mechanical joint pipe as manufactured by the American Cast Iron Pipe Company, U.S. Pipe and Foundry Company, or an approved equal.

C. All fittings shall be pressure rated for 350 psi for sizes 4-24 inches and 250 psi for

sizes 30 inches and larger and shall meet the requirements of AWWA C110 or AWWA C153.

D. Rubber gaskets shall conform to AWWA C111 for mechanical and push-on type joints and shall be EPDM rubber for potable water and reclaimed water pipelines. Standard gaskets shall be such as Fastite as manufactured by American Cast Iron Pipe Company, or an approved equal.

E. Water Mains and Reclaimed Water Mains:

All ductile iron pipe used in water and reclaimed water systems shall have a standard thickness cement lining on the inside in accordance with AWWA C104. All ductile iron or gray iron fittings used in water and reclaimed water systems shall have standard thickness cement linings on the inside per AWWA C104 and asphaltic exterior coatings or they shall have factory-applied fusion bonded epoxy coatings both inside and outside in accordance with AWWA C550.

F. Sewer Mains:

All ductile iron pipe and all ductile iron and cast iron fittings used in wastewater sewer systems shall have a factory applied fusion bonded minimum dry film thickness 40-mil Protecto 401 or Amine Cured Novalac_ceramic epoxy lining or minimum 60-mil Polybond Plus polyethylene lining with a fusion bonded epoxy primer layer on the inside in accordance with the manufacturer's specifications. The interior lining application is to be based on the manufacturer's recommendation for long-term exposure to raw sewage. To ensure a holiday-free lining, documentation must be provided, prior to shipment, showing each section of lined pipe has passed the holiday testing at production per ASTM G62 with a minimum 10,000 volt charge. The lining shall have a minimum ten year warranty covering failure of the lining and bond failure between liner and pipe.

G. Ductile iron or cast iron pipe and fittings used in sewer systems shall have either an asphaltic coating per AWWA C151 or a factory applied fusion bonded epoxy exterior coating.

H. Thrust restraint devices shall be provided at all horizontal and vertical bends and fittings, in casings under roads and railroads and at other locations as indicated on the construction drawings. Thrust restraint devices shall be either concrete thrust blocks or restraining glands as manufactured by Star Pipe Products, Stargrip 3000 and 3100, Allgrip 3600, or as manufactured by EBAA Iron Sales, Megaflange, 2000 PV, or other approved equal restraining gland products. Restrained joints, where used, shall be installed at bend and fitting locations and at pipe joint locations both upstream and downstream from the bends or fittings at distances as required by these Standards. Restrained joint pipe fittings shall be designed and rated for the following pressures:

350 psi for pipe sizes up to and including 24" diameter
250 psi for pipe sizes 30" diameter and above

2.02 DETECTION

A. Pipe shall have a 3-inch wide detectable metallic tape of the proper color placed directly above the pipe 12-inches below finished grade or a 6-inch detectable tape between 12-inches and 24-inches below finished grade.

B. Pipe shall have a No. 10 gauge solid, insulated wire of proper color installed along the pipe alignment as detailed in these standards.

2.03 IDENTIFICATION

A. Each length of pipe and each fitting shall be marked with the name of the manufacturer, size and class and shall be clearly identified as ductile iron pipe. All gaskets shall be marked with the name of the manufacturer, size and proper insertion direction.

B. Pipe shall be poly wrapped blue for water mains, purple (Pantone 522 C) for reclaimed water mains and green for sewer mains.

END OF SECTION

SECTION 02617

INSTALLATION AND TESTING OF PRESSURE PIPE

1.01 INSTALLING PIPE AND FITTINGS

A. The Contractor shall install all pipe in accordance with the recommendations of the pipe manufacturer and as specified herein.

B. The Contractor shall take care in handling, storage and installation of pipe and fittings to prevent injury to the pipe or coatings. All pipe and fittings shall be examined before installation and pipe which is deemed to be defective by the Owner/Engineer shall not be installed.

C. The Contractor shall thoroughly clean and keep thoroughly clean, all pipe and fittings prior to during and after installation.

D. The Contractor shall lay the pipe to the lines and grades shown on the Contract Drawings with bedding and backfill as shown on the Drawings or called out in the Contract Documents. Blocking under the pipe shall not be permitted except through casing sleeves.

E. The Contractor shall keep the open ends of all pipe closed with a tightly fitting plug when installation is not in progress or the potential exists for dirt or debris to enter the pipe.

F. The pipe or accessories shall not be dropped into the trench under any circumstances.

G. The Contractor shall construct all water mains pursuant to the provisions of "Recommended Standards for Water Works", Part 8, incorporated by reference in Rule 17-555.330(3), F.A.C.

1.02 PROCEDURE FOR TESTING WATER LINES, FORCE MAINS AND RECLAIMED WATER LINES

A. The Engineer must call in to schedule all testing. A 48-hour notice is needed prior to testing. A letter stating the reasons testing should be scheduled ahead of other jobs must accompany all emergency testing requests.

B. Engineer and Contractor must be present for all testing, except for testing tapping valves and sleeves.

C. All pressure pipe lines shall remain undisturbed for 24 hours to develop complete strength at all joints. All pipe lines shall be subjected to a hydrostatic pressure test for two (2) hours at full working pressure, but not less than 180 psi for water/reclaimed (150 psi for force main). Maximum length of pipe to be tested at one time is 2,600 feet. If line is longer than 2,600 feet and cannot be sectioned in 2,600 feet (max.) lengths, the allowable leakage will be figured at 2,600 feet.

D. Allowable leakage shall be determined by AWWA C600 table for hydrostatic tests. Leakage shall be defined as the quantity of water that must be supplied into the newly laid pipe, or any valved section thereof; to maintain the test pressure after the air in the pipe line has been expelled and the pipe has been filled with water.

E. All digging on the job site in the right-of-way must be completed before any testing of water or sewer. Any digging or boring across water or sewer lines after they have been tested may result in a retest of the lines at the County's request.

F. All water and sewer lines will be installed per approved construction plans by the County. If any revisions or changes are made after initial testing, lines will be re-tested at the County's request.

G. Disconnect water supply during test.

H. All force mains will be tested from the valves in the valve vault at the lift station to the point of connection whether it be against a valve on another force main or into a manhole.

I. All services to be aboveground during test. The services should be the correct length so they will be one (1) foot inside right-of-way line.

J. All fire hydrant gate valves to be open during test.

K. All visible leaks are to be repaired, regardless of the amount of leakage.

L. Check gauge pressure periodically during test. If test pressure drops to 175 psi for water/reclaimed lines or to 145 psi for force mains during test, the line must be repumped back to 180 psi for water/reclaimed (150 psi

force mains) and the amount of leakage measured. The test will continue on with the remaining time left. At the end of the test, the line must be repumped again back to 180 psi (150 psi for force main) and the amount of leakage measured and added to any previous leakage determined earlier in the test.

M. After the line passes the test, the pressure will be blown off from the opposite end of line from the gauge location. Fire hydrants, services and end-of-line blow offs will be opened to demonstrate they were on line during the test.

N. At end of test, the test gauge must return to zero. The pressure gauge must read 0 psi to a maximum of 300 psi in 5 psi increments.

O. The section of line being tested must be identified on the charge sheet. The length and size of pipe, the exact area being tested and the valves being tested against, must be identified. Use Station numbers if available.

P. A punch list must be made at the end of all tests.

Q. A copy of the charge sheet will be given to the Engineer and the Contractor at the end of the test.

1.03 INSPECTION/TESTING PROCEDURE COVERING BORED PIPE LINES OR CASING AND CONDUITS INSTALLED ACROSS PREVIOUSLY TESTED AND/OR COUNTY ACCEPTED WATER AND SEWER PIPE WITHIN DEVELOPMENT PROJECTS UNDER ACTIVE CONSTRUCTION

A. Prior to testing water and sewer lines, every effort will be made to install sleeves for underground utilities that will cross these water and sewer lines or services.

B. Where it has not been possible to pre-install sleeves prior to testing and bores or conduits are required, it is the responsibility of the utility company and/or their Contractor performing the work to provide Manatee County Utility Operations Department or the Engineer of Record with accurate horizontal and vertical as-built information of the sleeves, bores and conduits installed by said utility company. This applies to all bores and conduits crossing water and sewer lines.

C. Procedures to be followed for installation of conduits, pipe lines and bores that will cross, or be closer than 5'-0" horizontally and 18 inches vertically to, previously tested water and sewer lines that are still under the ownership of the developer/contractor.

1) Notify the owner and obtain the best as-built information available. Allow sufficient time for the owner to field locate the existing pipe lines.

2) Submit drawings of proposed location to the Owner and Manatee County Utility Operations Dept. Utility Locations Section for review.

3) Obtain a County Right-of-Way Use Permit if the work area is within a dedicated area of right-of-way.

4) Perform installation in the presence of a County representative. Call (941) 792-8811, ext. 5061 or ext. 5069 with at least two (2) working days notice.

5) Submit two (2) copies of as-built information to the Owner to incorporate into the record drawings to be submitted to the County.

6) Failure to follow steps 2) thru 5) will result in additional charges for retesting the previously tested water and sewer lines.

D. Procedures to be followed for installation of conduits, pipe lines and bores crossing or closer than 5'-0" horizontally and 18 inches vertically to previously tested water and sewer lines that have been previously accepted by Manatee County:

1) Obtain record drawing information from the County.

2) If roadway has been dedicated to Manatee County, obtain Right-of-Way Use Permit and copy the Project Management Department Locations Section with proposed location drawing.

3) Follow procedures in "Sunshine State One-Call", paying special attention to the requirements of Section VII.

E. Should water or sewer lines be damaged during the bore pipe line or casing installation, the cost of any repairs and retesting will be paid for by the utility company that installed the bore. The actual clearance between a bored casing crossing a water or sewer pipe should not be less than 18 inches.

END OF SECTION

SECTION 02622

POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS (AWWA SPECIFICATIONS C-900 & C-905)

PART 1 GENERAL

1.01 SCOPE OF WORK

The Contractor shall furnish all labor, materials, equipment and incidentals required to install the plastic piping, fittings and appurtenances complete and ready for use as specified in the Contract Documents and these Standards.

1.02 DESCRIPTION OF SYSTEM

The Contractor shall install the piping in the locations as shown on the Drawings.

1.03 QUALIFICATIONS

All plastic pipe, fittings and appurtenances shall be furnished by a single manufacturer who is fully experienced, reputable, qualified and specializes in the manufacture of the items to be furnished. The pipe and fittings shall be designed, constructed and installed in accordance with the best practices and methods and shall comply with these Specifications.

1.04 SUBMITTALS

A. The Contractor shall submit shop drawings to the Engineer including, but not limited to, dimensions and technical specifications for all piping.

B. The Contractor shall submit to the Engineer, samples of all materials specified herein.

C. The Contractor shall submit and shall comply with pipe manufacturer's recommendation for handling, storing and installing pipe and fittings.

D. The Contractor shall submit pipe manufacturer's certification of compliance with these Specifications.

1.05 TOOLS

The Contractor shall supply special tools, solvents, lubricants, and caulking compounds required for proper installation.

PART 2 PRODUCTS

2.01 MATERIALS

A. Pressure Class-Rated Polyvinyl Chloride (PVC) Pipe

1. Pressure class-rated PVC pipe and accessories four to twelve inches (4"-12") in diameter, where shown or as specified on the Drawings, shall meet the requirements of AWWA Specification C-900 "Polyvinyl Chloride (PVC) Pressure Pipe". Pipe shall be Class 150, meeting requirements of Dimension Ratio (DR) 18 and shall have the dimension of ductile iron outside diameters. Each length of pipe shall be hydrotested to four (4) times its class pressure by the manufacturer in accordance with AWWA C-900.

2. PVC pipe 14" through 36" shall meet the requirements of AWWA Standard C-905, Polyvinyl Chloride (PVC) Water Transmission Pipe. Pipe 14" thru 24" for potable and reclaim water shall meet the requirements for dimension ratio (DR) 18. Each length of pipe shall be tested at twice the pressure rating (PR 235 psi) for a minimum dwell of 5 seconds in accordance with AWWA C-905. Fourteen inch (14") thru 36" PVC pipe for sewer force mains shall meet AWWA C-905 requirements for dimension ratio (DR) 21. Each length of pipe shall be tested at twice the pressure rating (PR 200 psi) for a minimum dwell of five seconds in accordance with AWWA C-905. Pipe shall be listed by Underwriters Laboratories. Provisions shall be made for expansion and contraction at each joint with an elastomeric ring, and shall have an integral thickened bell as part of each joint. PVC Class pipe shall be installed as recommended by the manufacturer. Pipe shall be furnished in nominal lengths of approximately 20 feet, unless otherwise directed by the Engineer. Pipe and accessories shall bear the NSF mark indicating pipe size, manufacturer's names, AWWA and/or ASTM Specification number, working pressure, and production code.

3. Gaskets for 16" diameter and larger pipe used for potable water pipe shall be EPDM (Ethylene-Propylene Dine Monomer).

4. PVC pipe 3" and less in diameter may be constructed using pipe conforming to ASTM D2241 with push-on joints. Pipe shall be 200 psi pipe-SDR 21 unless otherwise specified by the Engineer. This PVC pipe shall not be used for working pressures greater

than 125 psi.

5. Pipe shall be blue for potable water mains, green for sewage force mains and purple for reclaimed water mains. All potable water pipe shall be NSF certified and copies of lab certification shall be submitted to the Engineer.

6. Where colored pipe is unavailable, white PVC color coded spiral wrapped pipe shall be installed.

B. Joints

1. The PVC joints for pipe shall be of the push-on type unless otherwise directed by the Engineer so that the pipe and fittings may be connected on the job without the use of solvent cement or any special equipment. The push-on joint shall be a single resilient gasket joint designed to be assembled by the positioning of a continuous, molded resilient ring gasket in an annular recess in the pipe or fitting socket and the forcing of the plain end of the entering pipe into the socket, thereby compressing the gasket radially to the pipe to form a positive seal. The gasket and annular recess shall be designed and shaped so that the gasket is locked in place against displacement as the joint is assembled. The resilient ring joint shall be designed for thermal expansion or contraction with a total temperature change of at least 75 degrees F in each joint per length of pipe. The bell shall consist of an integral wall section with a solid cross section elastomeric ring which shall meet requirements of ASTM F-477. The thickened bell section shall be designed to be at least as strong as the pipe wall. Lubricant furnished for lubricating joints shall be nontoxic, shall not support the growth of bacteria, shall have no deteriorating effects on the gasket or pipe material, and shall not impart color, taste, or odor to the water. Gaskets shall be suitable for use with potable water, reclaimed water or sanitary sewer as applicable.

2. Restrained joints shall be provided at all horizontal and vertical bends and fittings, at casings under roads and railroads and at other locations shown on the Contract Drawings. PVC joints for pipe shall be restrained by the following methods: thrust blocks, restraining glands such as Certa-Lok Restraining Joint Municipal Water Pipe by the Certain Teed Corporation of Valley Forge, PA, or approved equal. All Grip, Star Grip by Star Products, MJR by Tyler

Pipe, Tyler, Texas. Restrained joint PVC pipe shall be installed in strict accordance with the manufacturer's recommendation.

C. Fittings

1. All fittings for class-rated PVC pipe shall be ductile iron with mechanical joints and shall conform to the specifications for ductile iron fittings, unless otherwise directed. Class 200, C-900 PVC fittings are allowable for sewage force main applications up to and including 12" diameter only. DR ratio shall be the same as the pipe.

2. The manufacturer of the pipe shall supply all polyvinyl chloride accessories as well as any adapters and/or specials required to perform the work as shown on the Drawings and specified herein. Standard double bell couplings will not be accepted where the pipe will slip completely through the coupling.

PART 3 EXECUTION

3.01 INSTALLATION

The Contractor shall install the plastic pipe in strict accordance with the manufacturer's technical data and printed instructions. Direct bury pipe shall have 3" detectable metallic tape of the proper color placed directly above the pipe 12" below finished grade or 6" detectable tape between 12" and 24" below grade.

3.02 INSPECTION AND TESTING

A. All pipe lines shall remain undisturbed for 24 hours to develop complete strength at all joints. All pipe lines shall be subjected to a hydrostatic pressure test for two (2) hours at full working pressure, but not less than 180 psi for water/reclaimed (150 psi for force main). All visible leaks shall be repaired and retested for approval by the County. Prior to testing, the pipe lines shall be supported in a manner approved by the Engineer to prevent movement during tests.

END OF SECTION

SECTION 02640

VALVES AND APPURTENANCES

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, equipment and incidentals required and install complete and ready for operation all valves and appurtenances as shown on the Drawings and as specified herein.

B. All valves and appurtenances shall be of the size shown on the Drawings and, to the extent possible, all equipment of the same type on the Project shall be from one manufacturer.

C. All valves and appurtenances shall have the name of the manufacturer and the working pressure for which they are designed cast in raised letters upon some appropriate part of the body.

D. All valves shall have a factory applied, fusion bonded epoxy coating on interior and exterior.

E. The equipment shall include, but not be limited to, the following:

1. Gate valves (Sec. 2.01)
2. Pressure Sustaining and Check Valves (Sec. 2.02)
3. Ball Valves for PVC Pipe (Sec. 2.03)
4. Butterfly Valves (Sec. 2.04)
5. Plug Valves (Sec. 2.05)
6. Valve Actuators (Sec. 2.06)
7. Air Release Valves (Sec. 2.07)
8. Valves Boxes (Sec. 2.08)
9. Corporation Cocks (Sec. 2.09)
10. Flange Adapter Couplings (Sec. 2.10)
11. Flexible Couplings (Sec. 2.11)
12. Hose Bibs (Sec. 2.12)
13. Slow Closing Air and Vacuum Valves (Sec. 2.13)
14. Surge Anticipator Valve (Sec. 2.14)
15. Check Valves (Sec. 2.15)
16. Hydrants (Sec. 2.16)
17. Restraining Clamps (Sec. 2.17)
18. Tapping Sleeves and Tapping Valves (Sec. 2.18)
19. Single Acting Altitude Valves (Sec. 2.19)

1.02 DESCRIPTION OF SYSTEMS

All of the equipment and materials specified herein are intended to be standard for use in controlling the flow of potable water, reclaim water, wastewater, etc., depending on the applications.

1.03 QUALIFICATIONS

All of the types of valves and appurtenances shall be products of well established reputable firms who are fully experienced and qualified in the manufacture of the particular equipment to be furnished. The equipment shall be designed, constructed and installed in accordance with the best practices and methods and shall comply with these Specifications as applicable. Valves shall be as covered under mechanical devices in Section 8 of ANSI/NSF Standard 61.

1.04 SUBMITTALS

A. Submit to the Engineer within 30 days after execution of the contract a list of materials to be furnished, the names of the suppliers and the date of delivery of materials to the site.

B. Complete shop drawings of all valves and appurtenances shall be submitted to the Engineer for approval in accordance with the Specifications.

1.05 TOOLS

Special tools, if required for normal operation and maintenance shall be supplied with the equipment.

PART 2 PRODUCTS

2.01 GATE VALVES

A. All buried valves shall have cast or ductile iron three (3) piece valve boxes.

B. Where indicated on the drawings or necessary due to locations, size, or inaccessibility, chain wheel operators shall be furnished with the valves. Such operators shall be designed with adequate strength for the valves with which they are supplied and provide for easy operation of the valve. Chains for valve operators shall be galvanized.

C. Where required, gate valves shall be provided with a box cast in a concrete slab and a box cover. Length of box shall include slab thickness. Box cover opening shall be for valve stem and nut. Valve wrenches and extension stems shall be provided by the manufacturer to actuate the valves. The floor box and cover shall be equal to those manufactured by Rodney Hunt Machine Company,

Orange, Massachusetts, Clow, DeZurik or approved equal.

D. Gate valves with 3"-20" diameters shall be resilient seated, manufactured to meet or exceed the requirements of AWWA C509 and UL/FM of latest revision and in accordance with the following specifications. Valves shall have an unobstructed waterway equal to or greater than the full nominal diameter of the valve.

E. The valves shall have a non-rising stem of stainless steel or of cast, forged, or rolled bronze as shown in AWWA C509. Stem seals shall be provided and shall be of the O-ring type, two above and one below the thrust collar.

F. The sealing mechanism shall consist of a cast iron gate fully encapsulated with an EPDM Elastomer coating. The Elastomer type shall be permanently indicated on the disc or body of the valve. The resilient sealing mechanism shall provide zero leakage at the water working pressure when installed with the line flow in either direction.

G. The valve body, bonnet, and bonnet cover shall meet or exceed all the requirements of AWWA C509 latest edition. All ferrous surfaces inside and outside shall have a fusion-bonded epoxy coating. Wrench nut shall be provided for operating the valve.

H. Valves shall be suitable for an operating pressure of 200 psi and shall be tested in accordance with AWWA C509.

I. All bonnet bolts, nuts and studs shall be stainless steel.

2.02 PRESSURE SUSTAINING AND CHECK VALVE

A. Pressure sustaining and check valve shall be pilot operated diaphragm actuated valve with cast iron body, bronze trim, and 125-pound flanged ends. The valve shall be hydraulically operated, diaphragm type globe valve. The main valve shall have a single removable seat and a resilient disc, of rectangular cross section, surrounded on three and a half sides. The stainless steel stem shall be fully guided at both ends by a bearing in the valve cover, and an integral bearing in the valve seat. It shall be sleeved at both ends with delrin. No external packing glands are permitted and there shall be no pistons operating the main valve or any controls. The valve shall be equipped with isolation cocks to service the pilot system while permitting flow if necessary. Main valve and all pilot controls shall be manufactured in the United States of America. Valve shall be single chamber type, with seat cut to 5 degrees taper.

B. Valve shall maintain a minimum (adjustable) upstream pressure to a preset (adjustable) maximum. The pilot system shall consist of two direct acting, adjustable, spring loaded diaphragm valves.

C. Valve shall be cast iron (ASTM A48) with main valve trim of brass (QQB-B-626) and bronze (ASTM B61). The pilot control valves shall be cast brass (ASTM B62) with 303 stainless steel trim. Valve shall be similar in all respects to CLA-VAL Company, Model 692G-01ABKG, as manufactured by CLA-VAL Company, Winter Park, Florida, or similar pressure sustaining and check valve as manufactured by Golden Alderson; or approved equal.

2.03 BALL VALVES FOR PVC PIPE

A. Ball valves for PVC pipe shall be of PVC Type 1 with union, socket, threaded or flanged ends as required. Ball valves shall be full port, full flow, all plastic construction, 150 psi rated with teflon seat seals and T-handles. PVC ball valves shall be as manufactured by Celanese Piping Systems, Inc., Wallace and Tiernan, Inc., Plastiline, Inc., or approved equal.

B. All valves shall be mounted in such a position that valve position indicators are plainly visible when standing on the floor.

2.04 BUTTERFLY VALVES

A. Butterfly valves shall conform to the AWWA Standard Specifications for Rubber Seated Butterfly Valves, Designated C504, except as hereinafter specified. Valves, except as specified hereinafter, shall be Class 150A or B, except that valves furnished downstream of the high service pumps shall be Class 250 and equal to those manufactured by Henry Pratt Company, DeZurik, Kennedy, or approved equal. The valve discs shall be constructed of cast iron conforming to ASTM A-48, Class 40, ASTM A-126, Class B or ductile iron conforming to ASTM A536, Grade 65-45-12 for Class 150 or less. Ductile iron conforming to ASTM A536, Grade 65-45-12 shall be provided for all Class 250 valves. All valves shall be leak tested at 200 psi.

B. The face-to-face dimensions of flanged end valves shall be in accordance with Table 2 of above mentioned AWWA Specification for short-body valve. Adequate two-way thrust bearings shall be provided. Flange drilling shall be in accordance with ANSI B16.1.

C. Valve seats shall be an EPDM elastomer. Valve seats 24 inches and larger shall be field adjustable and replaceable without dismounting operator disc or shaft and without removing the valve from the line. All retaining segments and adjusting devices shall be of corrosion resistant material with stainless Nylock screws and be capable of the 1/8-inch adjustment. Valves 20 inches and smaller shall have bonded or mechanically restrained seats as outlined in AWWA C 504. Where the EPDM seat is mounted on the valve body, the mating edge of the valve disc shall be 18-8 stainless steel or

Nickel-Chrome, 80-20%. Where the EPDM seat is mounted on the valve disc, the valve body shall be fitted with an 18-8 stainless steel seat offset from the shaft, mechanically restrained and covering 360 degrees of the peripheral opening or seating surface.

D. The valve body shall be constructed of ductile iron or close grain cast iron per ASTM A126, Class B with integrally cast hubs for shaft bearing housings of the through boss-type. Butterfly valves of the "wafer" or "spool" type will not be accepted.

E. The valve shaft shall be turned, ground, and polished constructed of 18-8, ASTM A-276, Type 304 stainless steel and designed for both torsional and shearing stresses when the valve is operated under its greatest dynamic or seating torque. Shaft shall be of either a one piece unit extending full size through the valve disc and valve bearing or it may be of a stub shaft design. Shaft bearings shall be teflon or nylon, self-lubricated type.

F. All valves shall be subject to hydrostatic and leakage tests at the point of manufacture. The hydrostatic test for Class 250 valves shall be performed with an internal hydrostatic pressure equal to 500 psi applied to the inside of the valve body of each valve for a period of five minutes. During the hydrostatic test, there shall be no leakage through the metal, the end joints or the valve shaft seal. The leakage test for the Class 250 valves shall be performed at a differential pressure of 230 psi and against both sides of the valve. No adjustment of the valve disc shall be necessary after pressure test for normal operation of valve. The Class 150 valves shall be tested in conformance with AWWA C-504.

G. In general, the butterfly valve operators shall conform to the requirements of Section 3.8 of the AWWA Standard Specifications for Rubber Seated Butterfly Valves, Designation C504, insofar as applicable, and as herein specified.

H. Gearing for the operators shall be totally enclosed in a gear case in accordance with paragraph 3.8.3 of the above mentioned AWWA Standard Specification.

I. Operators shall be capable of seating and unseating the disc against the full design pressure of velocity, as specified for each class, into a dry system downstream and shall transmit a minimum torque to the valve. Operators shall be rigidly attached to the valve body.

J. The manufacturer shall certify that the required tests on the various materials and on the completed valves have been satisfactory and that the valves conform with all requirements of this Specification and the AWWA standard.

K. Where indicated on the Drawings, extension stems, floor

stands, couplings, stem guides, and floor boxes as required shall be furnished and installed.

2.05 PLUG VALVES

A. All plug valves shall be eccentric plug valves capable of sustaining 150 psi in either direction without leaking.

Exception: Single direction plug valves may be used if it is clearly demonstrated they will never be required to resist pressure in both directions either in service or during pipe line testing.

B. Plug valves shall be tested in accordance with current AWWA Standard C-504-80 Section 5. Each valve shall be performance tested in accordance with paragraph 5.2 and shall be given a leakage test and hydrostatic test as described in paragraphs 5.3 and 5.4. The manufacturer shall furnish certified copies of reports covering proof of design testing as described in Section 5.5.

C. Plug valves shall be of the non-lubricated eccentric type with resilient faced plugs and shall be furnished with end connections as shown on the Plans. Flanged valves shall be faced and drilled to the ANSI 150 lb. standard. Mechanical joint ends shall be to the AWWA Standard C111-72. Bell ends shall be to the AWWA Standard C100-55 Class B. Screwed ends shall be to the NPT standard.

D. Plug valve bodies shall be of ASTM A126 Class B Semi-steel, 31,000 psi tensile strength minimum in compliance with AWWA Standard C507-73, Section 5.1 and AWWA Standard C504-70 Section 6.4. Port areas for valves 20-inches and smaller shall be 80 percent of full pipe area. Valves 24 inch and larger shall have a minimum port area between 80 and 100 percent of full nominal pipe area. All exposed nuts, bolts, springs, washers, etc. shall be zinc or cadmium plated. Resilient plug facings shall be of Hycar or Neoprene.

E. Plug valves shall be furnished with permanently lubricated stainless steel or oil-impregnated bronze upper and lower plug stem bushings. These bearings shall comply with current AWWA Standards.

2.06 VALVE ACTUATORS

A. General

1. All valve actuators shall conform to Section 3.8 of the AWWA Standard Specification and shall be either manual or motor operated.

2. Actuators shall be capable of seating and unseating the disc against the full design pressure and velocity, as specified for each class, into a dry system downstream, and shall transmit a minimum torque to the valve. Actuators shall be rigidly

attached to the valve body.

3. Butterfly valve actuators shall conform to the requirements of Section 3.8 of the AWWA Standard specifications for Rubber Seated Butterfly Valves, Designated C504, insofar as applicable and as herein specified.

B. Manual Actuators

1. Manual actuators shall have permanently lubricated, totally enclosed gearing with handwheel and gear ratio sized on the basis of actual line pressure and velocities. Actuators shall be equipped with handwheel, position indicator, and mechanical stop-limiting locking devices to prevent over travel of the disc in the open and closed positions. They shall turn counter-clockwise to open valves. Manual actuators shall be of the traveling nut, self-locking type and shall be designed to hold the valve in any intermediate position between fully open and fully closed without creeping or fluttering. Actuators shall be fully enclosed and designed to produce the specified torque with a maximum pull of 80 pounds on the handwheel or chainwheel. Actuator components shall withstand an input of 450 foot pounds for 30" and smaller and 300 foot pounds for larger than 30" size valves at extreme actuator positions without damage. Valves located above grade shall have handwheel and position indicator, and valves located below grade shall be equipped with a two inch (2") square AWWA operating nut located at ground level and cast iron extension type valve box. Valve actuators shall conform to AWWA C504, latest revision.

C. Motor Actuators (Modulating)

1. The motor actuated valve controller shall include the motor, actuator unit gearing, limit switch gearing, limit switches, position transmitter which shall transmit a 4-20 mA DC signal, control power transformer, electronic controller which will position the valve based on a remote 4-20 milliamp signal, torque switches, bored and key-wayed drive sleeve for non-rising stem valves, declutch lever and auxiliary handwheel as a self-contained unit.

2. The motor shall be specifically designed for valve actuator service using 480 volt, 60 Hertz, three phase power as shown, on the electrical drawings. The motor shall be sized to provide an output torque and shall be the totally enclosed, non-ventilated type. The power gearing shall consist of helical gears fabricated from heat treated alloy steel forming the first stage of reduction. The second reduction stage shall be a single stage worm gear. The worm shall be of alloy steel with

carburized threads hardened and ground for high efficiency. The worm gear shall be of high tensile strength bronze with hobbed teeth. All power gearing shall be grease lubricated. Ball or roller bearings shall be used throughout. Preference will be given to units having a minimum number of gears and moving parts. Spur gear reduction shall be provided as required.

3. Limit switches and gearing shall be an integral part of the valve control. The limit switch gearing shall be made of bronze and shall be grease lubricated, intermittent type and totally enclosed to prevent dirt and foreign matter from entering the gear train. Limit switches shall be of the adjustable type capable of being adjusted to trip at any point between fully opened valve and fully closed valve.

4. The speed of the actuator shall be the responsibility of the system supplier with regard to hydraulic requirements and response compatibility with other components within the control loop. Each valve controller shall be provided with a minimum of two rotor type gear limit switches, one for opening and one for closing. The rotor type gear limit switch shall have two normally open and two normally closed contacts per rotor. Gear limit switches must be geared to the driving mechanism and in step at all times whether in motor or manual operation. Provision shall be made for two additional rotors as described above, each to have two normally open and two normally closed contacts. Each valve controller shall be equipped with a double torque switch. The torque switch shall be adjustable and will be responsive to load encountered in either direction of travel. It shall operate during the complete cycle without auxiliary relays or devices to protect the valve, should excessive load be met by obstructions in either direction of travel. The torque switch shall be provided with double-pole contacts.

5. A permanently mounted handwheel shall be provided for manual operation. The handwheel shall not rotate during electric operations, but must be responsive to manual operation at all times except when being electrically operated. The motor shall not rotate during hand operation nor shall a fused motor prevent manual operation. When in manual operating position, the unit will remain in this position until motor is energized at which time the valve operator will automatically return to electric operation and shall remain in motor position until handwheel operation is desired. This movement from motor operation to handwheel operation shall be accomplished by a positive

declutching lever which will disengage the motor and motor gearing mechanically, but not electrically. Hand operation must be reasonably fast. It shall be impossible to place the unit in manual operation when the motor is running. The gear limit switches and torque switches shall be housed in a single easily accessible compartment integral with the power compartment of the valve control. All wiring shall be accessible through this compartment. Stepping motor drives will not be acceptable.

6. The motor with its control module must be capable of continuously modulating over its entire range without interruption by heat protection devices. The system, including the operator and control module must be able to function, without override protection of any kind, down to zero dead zone.

7. All units shall have strip heaters in both the motor and limit switch compartments.

8. The actuator shall be equipped with open-stop-close push buttons, an auto-manual selector switch, and indicating lights, all mounted on the actuator or on a separate locally mounted power control station.

9. The electronics for the electric operator shall be protected against temporary submergence.

10. Actuators shall be Limitorque L120 with Modutronic Control System containing a position transmitter with a 4-20MA output signal or equal.

D. Motor Actuators (Open-Close)

1. The electronic motor-driven valve actuator shall include the motor, actuator gearing, limit switch gearing, limit switches, torque switches, fully machined drive sleeve, declutch lever, and auxiliary handwheel as a self-contained unit.

2. The motor shall be specifically designed for valve actuator service and shall be of high torque totally enclosed, nonventilated construction, with motor leads brought into the limit switch compartment without having external piping or conduit box.

   (a) The motor shall be of sufficient size to open or close the valve against maximum differential pressure when voltage to motor terminals is 10% above or below nominal voltage.

   (b) The motor shall be prelubricated and all bearings shall be of the anti-friction type.

3. The power gearing shall consist of helical gears fabricated from heat treated steel and worm gearing. The worm shall be carburized and hardened alloy steel with the threads ground after heat treating. The worm gear shall be of alloy bronze accurately cut with a hobbing machine. All power gearing shall be grease lubricated. Ball or roller bearings shall be used throughout.

4. Limit switches and gearing shall be an integral part of the valve actuator. The switches shall be of the adjustable rotor type capable of being adjusted to trip at any point between fully opened valve and fully closed valve. Each valve controller shall be provided with a minimum of two rotor type gear limit switches, one for opening and one for closing (influent valves require additional contacts to allow stopping at an intermediate position). The rotor type gear limit switch shall have two normally open and two normally closed contacts per toro. Additional switches shall be provided if shown on the control and/or instrumentation diagrams. Limit switches shall be geared to the driving mechanism and in step at all times whether in motor or manual operation. Each valve actuator shall be equipped with a double torque switch. The torque switch shall be adjustable and will be responsive to load encountered in either direction of travel. It shall operate during the complete cycle without auxiliary relays or devices to protect the valve should excessive load be met by obstructions in either direction of travel. Travel and thrusts shall be independent of wear in valve disc or seat rings.

5. A permanently mounted handwheel shall be provided for manual operation. The handwheel shall not rotate during electric operation except when being electrically operated. The motor shall not rotate during hand operation, nor shall a fused motor prevent manual operation. When in manual operating position, the unit will remain in this position until motor is energized at which time the valve actuator will automatically return to electric operation and shall remain in motor position until handwheel operation is desired. Movement from motor operation to handwheel operation shall be accomplished by a positive declutching lever which will disengage the motor and motor gearing mechanically, but not electrically. Hand operation must be reasonably fast. It shall be impossible to place the unit in manual operation when the motor is running.

6. Valve actuators shall be equipped with an integral reversing controller and three phase overload

relays, Open-Stop-Close push buttons, local-remote-manual selector switch, control circuit transformer, three-phase thermal overload relays and two pilot lights in a NEMA 4X enclosure. In addition to the above, a close coupled air circuit breaker or disconnect switch shall be mounted and wired to the valve input power terminals for the purpose of disconnecting all underground phase conductors.

7. The valve actuator shall be capable of being controlled locally or remotely via a selector switch integral with the actuator. In addition, an auxiliary dry contact shall be provided for remote position feedback.

8. Valve A.C. motors shall be designed for operation on a 480 volt, 3-phase service. Valve control circuit shall operate from a fuse protected 120 volt power supply.

9. Motor operators shall be as manufactured by Limitorque Corporation, Type L120 or approved equal.

2.07 AIR RELEASE VALVES

The air release valves for use in water or force mains shall be installed as shown on the Drawings. The valves shall have a cast iron body cover and baffle, stainless steel float, bronze water diffuser, Buna-N or Viton seat, and stainless steel trim. The fittings shall be threaded. The air release valves shall be Model 200A or 400A as manufactured by APCO Valve and Primer Corporation, Schaumburg, Illinois; or approved equal.

2.08 VALVE BOXES

1. Buried valves shall have cast-iron three piece valve boxes or HDPE adjustable valve boxes. Cast iron valve boxes shall be provided with suitable heavy bonnets and shall extend to such elevation at or slightly above the finished grade surface as directed by the Engineer. The barrel shall be two-piece, screw type, having a 5-1/4 inch shaft. The upper section shall have a flange at the bottom with sufficient bearing area to prevent settling and shall be complete with cast iron covers. Covers shall have "WATER", "SEWER", or "RECLAIM", as applicable, cast into the top.

2. All valves shall have actuating nuts extended to within four (4) feet of the top of the valve box. All valve extensions will have a centering guide plate two (2) inches maximum below the actuating nut. The valve extension shall be fastened to the existing nut with a set screw. Valve boxes shall be provided with a concrete base and a valve nameplate engraved with lettering 1/8-

inch deep as shown on the Drawings.

3. HDPE adjustable valve boxes shall be one complete assembled unit composed of the valve box and extension stem. All moving parts of the extension stem shall be enclosed in a housing to prevent contact with the soil. Valve box assembly shall be adjustable to accommodate variable trench depths.

4. The entire assembly shall be made of heavy wall high density polyethylene. All exterior components shall be joined with stainless steel screws. The valve box top section shall be adaptable to fit inside a valve box upper section.

5. The stem assembly shall be of a telescoping design that allows for variable adjustment length. The stem material shall be of plated steel square tubing. The stem assembly shall have a built-in device that keeps the stem assembly from disengaging at its fully extended length. The extension stem must be torque tested to 1000 foot pounds. Covers shall have "WATER", "SEWER" or "RECLAIMED" clearly and permanently impressed into the top surface.

2.09 CORPORATION COCKS

Corporation cocks for connections to cast-iron, ductile iron or steel piping shall be all brass or bronze suitable for 180 psi operating pressure and similar to Mueller Co. H-10046 or approved equal by Clow Corp., and shall be of sizes required and/or noted on the Drawings.

2.10 FLANGE ADAPTER COUPLINGS

Flange adapter couplings shall be of the size and pressure rating required for each installation and shall be suitable for use on either cast iron or ductile iron pipe. They shall be similar or approved equal to Dresser Company, Style 128. All couplings shall have a sufficient number of factory installed anchor studs to meet or exceed a minimum test pressure rating of 230 psi minimum.

2.11 FLEXIBLE COUPLINGS

Flexible couplings shall be either the split type or the sleeve type as shown on the Drawings.

1. Split type coupling shall be used with all interior piping and with exterior pipings noted on the Drawings. The couplings shall be mechanical type for radius groove piping. The couplings shall mechanically engage and lock grooved pipe ends in a positive couple and allow for angular deflection and contracting and expansion.

2. Couplings shall consist of malleable iron, ASTM

Specification A47, Grade 32510 housing clamps in two or more parts, a single chlorinated butyl composition sealing gasket with a "C" shaped cross-section and internal sealing lips projecting diagonally inward, and two or more oval track head type bolts with hexagonal heavy nuts conforming to ASTM Specification A 183 and A194 to assemble the housing clamps. Bolts and nuts shall be hot dipped galvanized after fabrication.

3. Victualic type couplings and fittings may be used in lieu of flanged joints. Pipes shall be radius grooved as specified for use with the Victaulic couplings. Flanged adapter connections at fittings, valves, and equipment shall be Victaulic Vic Flange Style 741, equal by Gustin-Bacon Group, Division of Certain-Teed Products, Kansas City, Kansas, or approved equal.

4. Sleeve type couplings shall be used with all buried piping. The couplings shall be of steel and shall be Dresser Style 38 or 40, as shown on the Drawings, or equal. The coupling shall be provided with hot dipped galvanized steel bolts and nuts unless indicated otherwise.

5. All couplings shall be furnished with the pipe stop removed.

6. Couplings shall be provided with gaskets of a composition suitable for exposure to the liquid within the pipe.

7. If the Contractor decides to use victaulic couplings in lieu of flanged joints, he shall be responsible for supplying supports for the joints.

2.12 HOSE BIBS

Hose bibs shall be 3/4" or 1" brass, polished chromium plated brass, with vacuum breaker as noted on the drawings.

2.13 SLOW CLOSING AIR AND VACUUM VALVES

A. The Contractor shall furnish and install slow closing air and vacuum valves as shown on the Drawings which shall have two (2) independent valves bolted together. The air and vacuum valve shall have all stainless steel float, guided on both ends with stainless shafts. The air and vacuum valve seat shall be Buna-N to insure drop tight closure. The Buna-N seat shall be fastened to the cover stainless shoulder screws in a manner to prevent distortion of the seat. The float shall be guided at both ends with stainless steel bushings.

B. The valve cover shall have a male lip designed to fit into the body register for accurate alignment of the

float into the Buna-N seat. The valve cover shall have 250-pound class flanged outlet connection.

C. The surge check valve shall be bolted to the inlet of the air and vacuum valve and consist of a body, seat, disc, and compression spring. A surge check unit shall operate on the interphase between the kinetic energy and relative velocity flows of air and water, so that after air passes through, and water rushes into the surge check, the disc starts to close, reducing the rate of flow of water into the air valve by means of throttling orifices in the disc to prevent water hammer in the air valves. The surge check orifices must be adjustable type for regulation in the field to suit operating conditions. Valve shall be rated for 250-pound class working pressure.

D. The complete slow closing air and vacuum valve with air release valve shall have been flow tested in the field, substantiated with test data to show reduction of surge pressure in the valve. Flow test data shall be submitted with initial shop drawings for approval.

E. Valve exterior to be painted Red Oxide, Phenolic TT-P86, Primer or approved equal for high resistance to corrosion.

F. All materials of construction shall be certified in writing to conform to ASTM specifications as follows:

Air Valve Cover, Body, and Surge Check Body	Cast Iron	ASTM A48, Class 30
Float	Stainless Steel	ASTM A240
Surge Check Seat and Disc	Stainless Steel	ASTM A582
Air Valve Seat	Buna-N	
Spring	Stainless Steel	T302

2.14 SURGE ANTICIPATOR VALVES

A. Surge anticipator valves shall be furnished for the pumping systems as shown on the Drawings. The valve shall be hydraulically operated, pilot controlled, and diaphragm or piston actuated. The main valve shall be cast iron conforming to ASTM A48 with bronze trim conforming to ASTM B61 and flanged ends conforming to ANSI B161.1. The main valve shall be globe type with a single removable seat and a resilient disc.

B. The diaphragm actuated valve shall have a stainless steel stem guided at both ends by a bearing in the valve cover and an integral bearing surface in the seat. No external

packing glands shall be permitted. The valve shall be fully serviceable without removing it from the line. The pilot system shall be of noncorrosive construction and provided with isolation cocks.

C. The piston actuated valve shall operate on the differential piston principle. The valve piston shall be guided on its outside diameter. The valve shall be able to operate in any position and shall be fully serviceable without removing it from the line. The pilot system shall be provided with isolation cocks, and be of noncorrosive materials of construction.

D. The valve shall be designed specifically to minimize the effects of water hammer, resulting from power failure at the pumping station, or from normal stopping and starting of pumping operators. The valve shall open hydraulically on a down surge, or low pressure wave created when the pump stops, remain open during the low pressure cycle in order to be open when the high pressure wave returns. The high pressure pilot shall be adjustable over a 20 to 200 psi range and the low pressure pilot shall be adjustable over a 15 to 75 psi range. The valve shall be the 250 Class.

2.15 CHECK VALVES

A. Check valves for cast iron and ductile iron pipe lines shall be swing type and shall meet the material requirements of AWWA Specification C508. The valves shall be iron body, bronze mounted, single disc, 175 psi working water pressure and nonshock. Valves shall be as manufactured by Mueller, Clow, American, Kennedy, M&H, or approved equal.

B. When there is no flow through the line, the disc shall hang lightly against its seat in practically a vertical position. When open, the disc shall swing clear of the waterway.

C. Check valves shall have bronze seat and body rings, extended bronze hinge pins and bronze nuts on the bolts of bolted covers.

D. Valves shall be so constructed that disc and body seat may easily be removed and replaced without removing the valve from the line. Valves shall be fitted with an extended hinge arm with outside lever and weight. Weights provided and approved by the Engineer shall be installed.

2.16 HYDRANTS

Hydrants shall be AVK Series 27 DRX Barrel (nostalgic style with stainless steel bolts) Kennedy Type K-81, American Darling B-84-B or Mueller Super Centurian A423, or approved equal and shall conform to the "Standard Specification for Fire Hydrants for Ordinary Water Works

Service", AWWA C502, and UL/FM certified, and shall in addition meet the specific requirements and exceptions which follow:

1. Hydrants shall be according to manufacturer's standard pattern and of standard size, and shall have one 4-1/2" steamer nozzle and two 2-1/2" hose nozzles.

2. Hydrant inlet connections shall have mechanical joints for 6" ductile-iron pipe.

3. Hydrant valve opening shall have an area at least equal to that area of a 5-1/4" minimum diameter circle and be obstructed only by the valve rod. Each hydrant shall be able to deliver 500 gallons minimum through its two 2-1/2" hose nozzles when opened together with a loss of not more than 2 psi in the hydrants.

4. Each hydrant shall be designed for installation in a trench that will provide 5-ft. cover.

5. Hydrants shall be hydrostatically tested as specified in AWWA C502.

6. Hydrants shall be rated at 200 psi.

7. All nozzle threads shall be American National Standard.

8. Each nozzle cap shall be provided with a Buna N rubber washer.

9. Hydrants shall be so arranged that the direction of outlets may be turned 90 degrees without interference with the drip mechanism and without the mechanism obstructing the discharge from any outlet.

10. Hydrants must be capable of being extended without removing any operating parts.

11. Hydrants shall have bronze-to-bronze seatings as per AWWA C502-85.

12. Hydrant main valve closure shall be of the compression type opening against the pressure and closing with the pressure. The resilient seat material shall meet the requirements of AWWA C-509 and shall preferably be EPDM Elastomer.

13. Internal and below ground iron parts (bonnet, nozzle section and base) shall have a fusion bonded epoxy coating per AWWA C550. Aboveground external hydrant parts (cap, bonnet and nozzle section) shall be either epoxy coated together with a UV resistant polyester coating or have two shop coats

of paint per AWWA C502. The lower stand pipe or barrel shall be protected with asphaltic coatings per AWWA C502.

14. Exterior nuts, bolts and washer shall be stainless steel. Bronze nuts may be used below grade.

15. All internal operating parts shall be removable without requiring excavation.

2.17 RESTRAINING CLAMPS

Restraining clamp assemblies as detailed in the drawings for use at hydrant connections to water mains, or at fittings where shown on the Drawings, shall be as manufactured by American Cast Iron Pipe, Star Pipe Products, U.S. Pipe; or approved equal.

2.18 TAPPING SLEEVES AND GATE VALVES

A. Tapping valves shall meet the requirement of AWWA C500. The valves shall be flanged, shall be mechanical joint outlet with nonrising stem, designed for vertical burial and shall open left or counterclockwise. Stuffing boxes shall be the "O-ring" type. Operating nut shall be AWWA Standard 2" square for valves 2" and up. The valves shall be provided with an overload seat to permit the use of full size cutters. Gaskets shall cover the entire area of flange surfaces and shall be supplied with EPDM wedges up to 30" diameter.

B. Tapping sleeves and saddles shall seal to the pipe by the use of a confined "O" ring gasket, and shall be able to withstand a pressure test of 180 psi for one hour with no leakage in accordance with AWWA C110, latest edition. A stainless steel 3/4" NPT test plug shall be provided for pressure testing. All bolts joining the two halves shall be stainless steel and shall be included with the sleeve or saddle. Sleeves and saddles shall be protected from corrosion by being fusion applied epoxy coated, or be made of 18-8 Type 304 stainless steel. Saddle straps shall be 18-8 Type 304 stainless steel.

2.19 SINGLE ACTING ALTITUDE VALVES

A. Function

1. The altitude control valve shall be of the single acting type, closing off tightly when the water reaches the maximum predetermined level in the tank to prevent overflow; and opening to permit replenishing of the tank supply when the water level drops approximately 6" to 12" below the maximum level.

2. A hand operated valve in the power water line to the top of the piston shall permit adjustment of the speed of valve closing. The tank water level

control shall be by means of a diaphragm operated, spring loaded, three way pilot which directs power water to or from the top of the main valve piston. The three way pilot shall be of bronze construction. The diaphragm surface exposed to the tank head shall be not less than 57 sq. inches. It shall be possible to adjust the spring above the diaphragm for water level control approximately 20% above or below the factory setting.

B. Description

1. The main valve shall operate on the differential piston principle such that the area on the underside of the piston is no less than the pipe area on the upper surface of the piston is of a greater area than the underside of the piston.

2. The valve piston shall be guided on its outside diameter by long stroke stationary Vee ports which shall be downstream of the seating surface to minimize the consequences of throttling. Throttling shall be done by the valve Vee ports and not the valve seating surfaces.

3. The valve shall be capable of operating in any position and shall incorporate only one flanged cover at the valve top from which all internal parts shall be accessible. There shall be no stems, stem guides, or spokes within the waterway. There shall be no springs to assist the valve operation.

C. Construction

1. The valve body shall be of cast iron ASTM A-126 with flanges conforming to the latest ANSI Standards. The valve shall be extra heavy construction throughout. The valve interior trim shall be bronze B-62 as well as the main valve operation.

2. The valve seals shall be easily renewable while no diaphragm shall be permitted within the main valve body.

3. All controls and piping shall be of non-corrosive construction.

4. A visual valve position indicator shall be provided for observing the valve piston position at any time.

D. Figure Number

The valves shall be the 20" Globe type (Fig. 3200-D) as manufactured by GA Industries of Mars, Pennsylvania, or approved equal.

PART 3 EXECUTION

3.01 INSTALLATION

A. All valves and appurtenances shall be installed in the location shown, true to alignment and rigidly supported. Any damage occurring to the above items before they are installed shall be repaired to the satisfaction of the Engineer.

B. After installation, all valves and appurtenances shall be tested at least two hours at the working pressure corresponding to the class of pipe, unless a different test pressure is specified. If any joint proves to be defective, it shall be repaired to the satisfaction of the Engineer.

C. Install all floor boxes, brackets, extension rods, guides, the various types of operators and appurtenances as shown on the Drawings that are in masonry floors or walls, and install concrete inserts for hangers and supports as soon as forms are erected and before concrete is poured. Before setting these items, the Contractor shall check all plans and figures which have a direct bearing on their location and he shall be responsible for the proper location of these valves and appurtenances during the construction of the structures.

D. Pipe for use with flexible couplings shall have plain ends as specified in the respective pipe sections.

E. Flanged joints shall be made with high strength, low alloy Corten bolts, nuts and washers. Mechanical joints shall be made with mild corrosion resistant alloy steel bolts and nuts. All exposed bolts shall be painted the same color as the pipe. All buried bolts and nuts shall be heavily coated with two (2) coats of bituminous paint comparable to Inertol No. 66 Special Heavy.

F. Prior to assembly of split couplings, the grooves as well as other parts shall be thoroughly cleaned. The ends of the pipes and outside of the gaskets shall be moderately coated with petroleum jelly, cup grease, soft soap or graphite paste, and the gasket shall be slipped over one pipe end. After the other pipe has been brought to the correct position, the gasket shall be centered properly over the pipe ends with the lips against the pipes. The housing sections then shall be placed. After the bolts have been inserted, the nuts shall be tightened until the housing sections are firmly in contact, metal-to-metal, without excessive bolt tension.

G. Prior to the installation of sleeve-type couplings, the pipe ends shall be cleaned thoroughly for a distance of 8". Soapy water may be used as a gasket lubricant. A follower and gasket, in that order, shall be slipped over

each pipe to a distance of about 6" from the end.

H. Valve boxes with concrete bases shall be installed as shown on the Drawings. Mechanical joints shall be made in the standard manner. Valve stems shall be vertical in all cases. Place cast iron box over each stem with base bearing on compacted fill and the top flush with final grade. Boxes shall have sufficient bracing to maintain alignment during backfilling. Knobs on cover shall be parallel to pipe. Remove any sand or undesirable fill from valve box.

3.02 HYDRANTS

A. Hydrants shall be set at the locations designated by the Engineer and/or as shown on the Drawings and shall be bedded on a firm foundation. A drainage pit on crushed stone as shown on the Drawings shall be filled with gravel or crushed stone and satisfactorily compacted. During backfilling, additional gravel or crushed stone shall be brought up around and 6" over the drain port. Each hydrant shall be set in true vertical alignment and shall be properly braced. Concrete thrust blocks shall be placed between the back of the hydrant inlet and undisturbed soil at the end of the trench. Minimum bearing area shall be as shown on the plans. Felt paper shall be placed around the hydrant elbow prior to placing concrete. CARE MUST BE TAKEN TO INSURE THAT CONCRETE DOES NOT PLUG THE DRAIN PORTS. Concrete used for backing shall be as specified herein.

B. When installations are made under pressure, the flow of water through the existing main shall be maintained at all times. The diameter of the tap shall be a minimum of 2" less than the inside diameter of the branch line.

C. The entire operation shall be conducted by workmen thoroughly experienced in the installation of tapping sleeves and valves, and under the supervision of qualified personnel furnished by the manufacturer. The tapping machine shall be furnished by the Contractor if tap is larger than 12" in diameter.

D. The Contractor shall determine the locations of the existing main to be tapped to confirm the fact that the proposed position for the tapping sleeve will be satisfactory and no interference will be encountered such as the occurrence of existing utilities or of a joint or fitting at the location proposed for the connection. No tap will be made closer than 30" from a pipe joint.

E. Tapping valves shall be set in vertical position and be supplied with a 2" square operating nut for valves 2" and larger. The valve shall be provided with an oversized seat to permit the use of full sized cutters.

F. Tapping sleeves and valves with boxes shall be set vertically or horizontally as indicated on the Drawings

and shall be squarely centered on the main to be tapped. Adequate support shall be provided under the sleeve and valve during the tapping operation. Sleeves shall be no closer than 30" from water main joints. Thrust blocks shall be provided behind all tapping sleeves. Proper tamping of supporting earth around and under the valve and sleeve is mandatory. After completing the tap, the valve shall be flushed to ensure that the valve seat is clean.

3.03 SHOP PAINTING

Ferrous surfaces of valves and appurtenances shall receive a coating of rust-inhibitive primer. All pipe connection openings shall be capped to prevent the entry of foreign matter prior to installation.

3.04 FIELD PAINTING

All metal valves and appurtenances specified herein and exposed to view shall be painted.

3.05 INSPECTION AND TESTING

Completed pipe shall be subjected to hydrostatic pressure test for two hours at 180 psi. All leaks shall be repaired and lines retested as approved by the Engineer. Prior to testing, the pipelines shall be supported in an approved manner to prevent movement during tests.

END OF SECTION

SECTION 02999

MISCELLANEOUS WORK AND CLEANUP

PART 1 GENERAL

1.01 SCOPE OF WORK

A. This Section includes items and operations which are not specified in detail as separate items, but may be sufficiently described as to the kind and extent of work involved. The Contractor shall furnish all labor, materials, equipment and incidentals necessary to complete all work under this Section.

B. The work of this Section may include, but is not limited to the following:

1. Restoration of roads, sidewalks, driveways, curbing and gutters, fences, guardrails, lawns, shrubbery and any other existing items damaged or destroyed.

2. Crossing utilities.

3. Relocation of existing water, reclaim water, or sewer lines less than four inches diameter, water and sanitary sewer services, low pressure gas lines, telephone lines, electric lines, cable TV lines as shown on the Contract Drawings.

4. Restoring easements (servitudes) and rights-of-way.

5. Clean up.

6. Incidental work (project photographs, testing, shop drawings, traffic control, record drawings, etc.).

7. Excavation and Embankment - As defined in the Florida Department of Transportation Standard Specifications for Road and Bridge Construction (1991 Edition or latest revision).

1.02 SUBMITTAL OF LUMP SUM BREAKDOWN

Contractor shall submit to the Owner/Engineer, a breakdown of the lump sum bid for Miscellaneous Work and Cleanup Item in the Proposal within 10 days after date of Notice to Proceed.

1.03 WORK SPECIFIED UNDER OTHER SECTIONS

All work shall be completed in a workmanlike manner by competent workmen in full compliance with all applicable sections of the Contract Documents.

PART 2 PRODUCTS

2.01 MATERIALS

Materials required for this Section shall equal or exceed materials that are to be restored. The Contractor may remove and replace or reuse existing materials with the exception of paving.

PART 3 EXECUTION

3.01 RESTORING OF ROADS, CURBING, FENCES AND GUARDRAILS

A. The Contractor shall protect existing curbing. If necessary, curbing shall be removed from joint to joint and replaced after backfilling. Curbing damaged during construction because of the Contractor's negligence or convenience, shall be replaced with curbing of equal quality and dimension at no cost to the Owner.

B. At the locations necessary for the Contractor to remove, store and replace existing fences and guardrails during construction, the sections removed shall be only at the direction of the Engineer. If any section of fence is damaged due to the Contractor's negligence, it shall be replaced at no cost to the Owner with fencing equal to or better than that damaged and the work shall be satisfactory to the Engineer.

C. Guardrails in the vicinity of the work shall be protected from damage by the Contractor. Damaged guardrails shall be replaced in a condition equal to those existing.

D. Road crossings shall be restored in accordance with the Contract Documents and current FDOT Standards. Compensation for road restoration shall be included under the Road Restoration Bid Item if specified or under Miscellaneous Cleanup if it is not specified.

3.02 CROSSING UTILITIES

This item shall include any extra work required in crossing culverts, water courses, drains, water mains and other utilities, including all sheeting and bracing, extra excavation and backfill, or any other work required or implied for the proposed crossing, whether or not shown on the Drawings.

3.03 RELOCATIONS OF EXISTING GAS LINES, TELEPHONE LINES, ELECTRIC LINES AND CABLE TV LINES

The Contractor shall notify the proper utility involved when relocation of these utility lines is required. The Contractor shall coordinate all relocation work by the utility so that construction shall not be hindered.

3.04 RESTORING THE EASEMENTS AND RIGHTS-OF-WAY

The Contractor shall be responsible for all damage to private property due to his operations. He shall protect from injury all walls, fences, cultivated shrubbery, pavement, underground facilities, including water, sewer and reclaimed water lines and services, or other utilities which may be encountered along the easement. If removal and replacement is required, it shall be done in a workmanlike manner, at his expense, so that the replacement are equivalent to that which existed prior to construction.

END OF SECTION

DIVISION 05
METALS

SECTION 05500
MISCELLANEOUS METALS

PART 1 GENERAL

1.01 SCOPE OF WORK

Furnish all labor, materials, equipment, and incidentals required to install all miscellaneous metal as shown on the Drawings and specified herein.

1.02 RELATED WORK

A. Section 13300 – Prestressed Concrete Tank

B. Division 16 – Electrical

C. Section 17010 - Instrumentation

1.03 SUBMITTALS

A. Manufacturer's literature describing standard items.

B. Shop drawings showing materials, sizes, finishes, locations, attached hardware and fittings, and details for manufactured items and fabricated metalwork, including field erection details showing cuts, copes, connections, holes, thread fasteners and welds. Indicate welds, both shop and field, by symbols conforming to AWS standards. Indicate coatings or other protection against corrosion. Submittals in accordance with Section 01340, Shop Drawings, Project Data, and Samples.

C. Setting diagrams, erection plans, templates and directions for installation of backing plates, anchors, and other such similar items.

D. Material compliance certification with standards designated.

1.04 REFERENCE STANDARDS

A. Aluminum Association

1) AA 5052 - Aluminum Sheet and Plate, Rolled Rod and Bar and Drawn Tube

2) AA 6061 T6 - Aluminum Sheet and Plate

3) AA 6061 T5 - Aluminum Extruded Shapes

4) AA 6063 T6 - Aluminum Extruded Pipe

5) AA 5005 - Sheet and Plate

6) Finishes

a) AA M31 - Mechanical Finish, Fine Satin

b) AA C22 - Chemical Finish, Medium Matte

c) AA A41 - Clear Anodic Coating, Class I

B. American Iron and Steel Institute (AISI)

1. AISI, Type 316 Stainless Steel Bolts, Bars and Shapes

2. AISI, Type 316 Stainless Steel Plate and Sheet

C. American National Standards Institute (ANSI)

1) ANSI A14.3 - Safety Requirement for Fixed Ladders

D. American Society for Testing and Materials (ASTM)

1) ASTM A36 - Specification for Structural Steel

2) ASTM A48 - Specification for Gray Iron Castings

3) ASTM A53 - Specification for Pipe, Steel, Black and Hot Dipped, Zinc Coated Welded and Seamless

4) ASTM A123 - Specification for Zinc (Hot Galvanized) Coatings on Iron and Steel Products

5) ASTM A153 - Specification for Zinc Coated (Hot Dip) on Iron and Steel Hardware

6) ASTM A167 - Standard Specification for Stainless and Heat Resisting Chromium - Nickel Steel Plate, Sheet, and Strip.

7) ASTM A269 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.

8) ASTM A276 - Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes.

9) ASTM A307 - Specification for Carbon Steel Externally Threaded Standard Fasteners

10) ASTM A312 - Standard Specification for Seamless and Welded Austenitic Stainless Pipe.

11) ASTM A325 - Specification for High-Strength Bolts for Structural Steel Joints

12) ASTM A366 - Standard Specification for Steel, Carbon, Cold-Rolled Sheet, Commercial Quality.

13) ASTM A611 - Specification for Steel, Cold-Rolled Sheet, Carbon, Structural

14) ASTM A653 - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

15) ASTM B26 - Standard Specification for Aluminum-Alloy and Castings.

16) ASTM B209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate

17) ASTM B211 - Standard Specification for Aluminum-Alloy Bar, Rod, and Wire.

18) ASTM B221 - Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes and Tubes

19) ASTM B241 - Standard Specification for Aluminum Alloy Seamless Pipe and Seamless Extruder Tube.

20) ASTM B429 - Specification for Aluminum-Alloy Extruded Structural Pipe and Tube

E. American Welding Society (AWS)

1) AWS "Structural Welding Code", D1.1

2) AWS Specification for Arc Welding (Type E70XX) Welding Rods for Steel

F. ASME International (ASME)

1) ASME B18.2.1 Square and Hex Bolts and Screws Inch Series

G. SSPC: The Society of Protective Coatings (SSPC)

1) SSPC – Paint 20 – Paint Specification No. 20 Zinc-Rich Primers (Type I, "Inorganic" and Type II, "Organic")

H. National Fire Protection Association (NFPA)

1) 101 Life Safety Code

1.05 QUALITY ASSURANCE

A. The work of this section shall be completely coordinated with the work of other Sections. Verify at the site both the dimensions and work of other trades adjoining items of work in this section before fabrication and installation of items herein specified.

B. Furnish to the pertinent trades all items included under this section that are to be built into the work of other sections.

1.06 DELIVERY, STORAGE AND HANDLING

A. Identify and match-mark all materials, items and fabrications, for installation and field assembly.

B. Deliver items to job-site as complete units, wherever practicable, ready for installation or erection, with all anchors, hangers, fasteners and miscellaneous metal items required for installation.

C. Carefully handle and store materials, protected from weather, rusting and other damage.

D. Store structural shapes, pipes, tubes and sheets off the ground on suitable supports, with webs or flanged shapes vertical.

PART 2 PRODUCTS

2.01 MATERIALS

A. Steel Shapes and Plates

1) Steel: ASTM A36

2) Nuts, Bolts, Rivets, Washers, and Anchorage Devices: ASTM A325 and AISC Specification referenced under Part 1.

3) Steel Sheets: Cold-rolled or hot-rolled carbon steel, ASTM A366, or ASTM A569.

4) Steel Pipe: ASTM A53, Standard Specifications for Pipe, Steel, Black and, Zinc-Coated, Welded and Seamless; Type S, Grade B, Schedule 40, black finish.

B. High-Strength, Low Alloy Corrosion - Resistant Steel:

1) Plates, shapes, and bars: ASTM A242 or A588.

2) Sheet and strip ASTM A606 Type A.

C. Stainless Steel

1) Type 316 unless otherwise indicated or specified.

2) Shapes and Bars: ASTM A276.

3) Plate, Sheet, and Strip: ASTM A167.

4) Tubing: ASTM A269.

5) Pipe: ASTM A312, Schedule 40S.

D. Aluminum

1) Plates, rolled or extruded shapes, sheets or castings conforming (unless otherwise permitted or indicated) to Aluminum Association alloy and temper designations.

2) Rolled structural shapes and plates 6061-T6.

3) Extruded structural shapes 6063-T5.

4) Castings 214.

5) Sheets Alclad 3003-H14 and 3003.

6) Bolts and nuts 2024-T4.

7) Pipe railings Schedule 40, ASTM, B241, 6063-T6.

8) Finishes (pipe railings only) - NAAMM Class 1 AA-A41 clear coating.

E. Fasteners: Provide hot-dip galvanized or stainless steel fasteners for exterior use of where built into exterior walls and pillars. Select fasteners for the type, grade, and class required per the approval of the Engineer. Refer to Paragraph 2.2 for specific material requirements for anchors, bolts, and other fastening devices.

1) Bolts and nuts: Regular hexagon head type, ASTM A307, Grade A.

2) Lag bolts: Square head type, FS FF-B-561.

3) Machine screws: Steel, FS FF-S-92.

4) Masonry and concrete anchorage devices: Expansion shields FS FF-S325.

F. Galvanizing: Provide a zinc coating for those items specified to be galvanized as follows:

1) ASTM A153, for galvanizing steel hardware.

2) ASTM A123, for galvanizing assembled steel products.

G. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC – Paint 20

2.02 ANCHORS, BOLTS, AND FASTENING DEVICES

A. All necessary bolts, anchor bolts, nuts, washers, plates and bolt sleeves shall be furnished by the Contractor in accordance herewith. Anchor bolts shall have suitable washers and, where so required, their nuts shall be hexagonal.

B. Bolts, anchor bolts, nuts, screws, washers, and related appurtenances specified to be stainless steel shall be Type 316 stainless steel unless noted otherwise.

C. Expansion bolts shall be stainless steel unless otherwise specified.

D. Unless otherwise specified, stud, tap, and machine bolts, and nuts shall conform to the requirements of ASTM A307. Hexagonal nuts of the same quality of metal as the bolts shall be used. All threads shall be clean cut and shall conform to ANS B1.1 for Unified Inch Screw Threads (UN and UNR Thread Form I).

E. Bolts, anchor bolts, nuts, and washers, specified to be galvanized, shall be zinc coated, after being threaded, by the hot-dip process in conformity with ASTM A123, or ASTM A153, as is appropriate.

F. Anchor bolts and expansion bolts shall be set accurately. If anchor bolts are set before the concrete has been placed, they shall be carefully held in suitable templates of acceptable design. Where indicated on the Drawings, specified, or required, anchor bolts shall be provided with square plates at least 4 in. by 4 in. by 3/8 in. or shall have square heads and washers and be set in the concrete forms with suitable sleeves, or both. If anchor or expansion bolts are set after the concrete has been placed, all necessary drilling and grouting or caulking shall be done by the Contractor and care shall be taken not to damage the structure or finish by cracking, chipping, spalling, or otherwise during the drilling and caulking.

PART 3 EXECUTION

3.01 GENERAL

A. Anchorage: Provide anchorage for fastening work securely in place. Set anchors in concrete as the work progresses and space not more than 2 feet on centers unless indicated otherwise. Sizes, kinds, and spacing of anchors not indicated or specified shall be as necessary for the purpose, as approved. Anchorage not otherwise specified or indicated includes slotted inserts, expansion shields, and powder-driven fasteners, when approved for concrete; toggle bolts and through bolts for masonry; machine and carriage bolts for steel; through bolts, lag bolts, and screws for wood. Provide inserts of suitable and approved types where required for support or anchorage of equipment and finish construction.

B. Fastenings: Do not use wood plugs in any material. Use nonferrous attachments for non-ferrous metal. Make exposed fastenings of compatible materials, generally matching in color and finish, and harmonizing with the material to which fastenings are applied. Conceal fastenings where practicable. Drill and punch to produce clean true lines and surfaces. Countersink metal work to receive hardware.

C. Threaded Connections: Make threaded connections tight so that threads are entirely concealed. Make bolted work tight and nick the threads or bush the stem to prevent loosening. Abutting bars shall be shouldered and headed, de-welled and pinned. Pass small bars through larger bars and pin. Rivet, bolt, and screw heads shall be flat and countersunk in exposed work and elsewhere as required. Carefully machine removable member and fit and secure by means of screws or bolts of proper size and approved spacing.

3.2 FABRICATION

A. All miscellaneous metal work shall be formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability.

B. Connections and accessories shall be sufficient strength to safely withstand stresses and strains to which they will be subjected. Steel accessories and connections to steel or cast iron shall be steel, unless otherwise specified. Threshold connections shall be made so that the threads are concealed by fitting.

C. Welded joints shall be rigid and continuously welded or spot welded as specified or shown. The face of welds shall be dressed flush and smooth. Exposed joints shall be close fitting and jointed where least conspicuous.

D. Welding of parts shall be in accordance with the Standard Code for Arc and Gas Welding in Building Construction of the AWS and shall only be done where shown, specified, or permitted by the Engineer. All welding shall be done only by welders certified as to their ability to perform welding in accordance with the requirements of the AWS Code. Component parts of built-up members to be welded shall be adequately supported and clamped or held by other adequate means to hold the parts in proper relation for welding.

E. Welding of aluminum work shall be on the unexposed side as much as possible in order to prevent pitting or discoloration.

F. All aluminum finish exposed surfaces, except as otherwise specified, shall have manufacturer's standard mill finish. Aluminum handrails shall be given an anodic oxide treatment in accordance with the Aluminum Association Specification AA-C22-A41.

G. All steel finish work shall be thoroughly cleaned, by effective means, of all loose mill scale, rust, and foreign matter before shipment and shall be given 1 shop coat of primer compatible with finish coats specified in Section 09941 - Field Painting after fabrication but before shipping. Paint shall be applied to dry surfaces and shall be thoroughly and evenly spread and well worked into joints and other open spaces. Abrasions in the field shall be touched up with primer immediately after erection.

H. Galvanizing, where required, shall be the hot dip zinc process after fabrication. Following all manufacturing operations, all items to be galvanized shall be thoroughly cleaned, pickled, fluxed, and completely immersed in a bath of molten zinc according to ASTM A653. The resulting coating shall be adherent and shall be the normal coating to be obtained by immersing the items in a bath of molten zinc and allowing them to remain in the batch until their temperature becomes the same as the bath. Coating shall be not less than 2 ounces per square foot of surface.

I. Zinc coating, which has been burned by welding, abraded, or otherwise damaged, shall be cleaned and repaired after installation. The damaged area shall be thoroughly cleaned by wire brushing and all traces of welding flux and loose or cracked zinc coating removed prior to painting. The cleaned area shall be painted

with two coats of zinc oxide-zinc dust paint conforming to the requirements of SSPC – Paint 20. The paint shall be properly compounded with a suitable vehicle in the ratio of 1 part zinc oxide to 4 parts zinc dust by weight.

3.3 INSTALLATION

A. Install all items furnished except items to be embedded in concrete, which shall be installed under Division 3. Items to be attached to concrete or existing masonry after such work is completed shall be installed in accordance with the details shown. Fastening to wood plugs in masonry will not be permitted. All dimensions shall be verified at the site before fabrication is started.

B. Where aluminum contacts a dissimilar metal, apply a protective paint. Apply protective paint to both the aluminum metal components and to the dissimilar metal(s).

C. Where aluminum contacts masonry or concrete, apply a heavy coat of approved alkali resistant paint to the masonry or concrete.

D. Where items are cast into concrete, backpaint contact areas before setting.

END OF SECTION

DIVISION 13
SPECIAL CONSTRUCTION

SECTION 13200
PRESTRESSED CONCRETE TANK

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidentals required to construct a prestressed circular concrete tank with doomed roof for reclaimed water storage as shown on the Drawings and described herein.

B. Furnish all labor, materials, equipment, and incidentals required to install accessories for tank as shown on the Drawings and described herein.

1.02 RELATED WORK

A. Section 01600 - Material and Equipment

B. Section 02615 – Ductile Iron Pipe and Fittings

C. Section 05500 – Miscellaneous Metals

D. Section 16601 – Lightning Protection System

E. Section 17010 - Instrumentation

1.03 REFERENCES

A. ACI 372R-03 – Design and Construction of Circular Wire- and Strand-Wrapped Prestressed Concrete Structures.

B. AWWA D110-04 – Wire- and Strand-Wound, Circular, Prestressed Concrete Water Tanks.

C. AWWA C652 – Disinfection of Potable Water Storage Tanks.

1.04 SUBMITTALS

A. Shop Drawings: Provide complete plan, elevation, and sectional views showing critical dimensions including:

1. Size, location and number of all reinforcing bars.

2. Thickness of all parts of the tank structure including floor, core wall, dome, and covercoat.

3. Prestressing schedule including number and placement of prestressing wires on the tank wall and total applied force per foot of wall height.

4. Location and details of all accessories required.

5. Minimum size of shop drawings shall be 18" by 24".

B. Product Data: Submit concrete design mixes including ingredient proportions, minimum cementitious content, and water/cementitious ratio in accordance with these specifications.

C. Design Data: Submit structural calculations for the tank, signed and sealed by a professional engineer in accordance with Section 1.05 C. of these specifications.

D. Disinfection Plan: Submit disinfection plan with Shop Drawing submittals.

E. Paint System. Submit painting system product information including data sheets, preparation and application recommendations, storage and handling requirements, and color chips.

F. Test Reports: Submit concrete strength reports for 7-day and 28-day breaks.

G. Warranty Document: Submit warranty document in Owner's name in accordance with Section 1.06A of these specifications.

H. Project Record Documents: Record actual location layout and final elevations and configuration of tank and accessories on shop drawings and submit 5 signed and sealed copies to the Engineer after construction of the tank is complete.

1.05 QUALITY ASSURANCE

A. Tank Construction Company: Shall be a firm with ten years of experience in the design and construction of wire-wound, circular prestressed composite tanks with satisfactory evidence that it has the skill, reliability, and financial stability to build and guarantee the tank in accordance with the quality required by these specifications. The company constructing the tank shall have built completely in its own name in the past five years, and be presently responsible for, a minimum of five (5) dome-covered prestressed composite tanks of equal or greater size than that required for this project which meet these specifications and are now providing satisfactory service.

B. Construction: The entire tank, including all portions of the floor, wall, and roof shall be built by the tank construction company, using its own trained personnel and equipment.

C. Design: All design work for the tank shall be performed by a professional engineer with no less than five years of experience in the design and construction of circular prestressed composite tanks. The professional engineer shall be a full-time staff member of the tank construction company and shall be licensed to work in the state where the project is located.

D. The steel shell design and epoxy injection procedure (covered by U.S. Patent 5,150,551) shall have been used in the ten tanks required in the tank construction company's experience record.

1.06 WARRANTY

A. Provide warranty for workmanship and materials on the complete structural portion of the tank for a five-year period from date of acceptance of the work. In case leakage or other defects appear within the five-year period, the tank construction company shall promptly repair the tank at its own expense upon written notice by the Owner that such defects have been found. Leakage is defined as a stream flow of liquid appearing on the exterior of the tank, the source of which is from the inside of the tank. The tank construction company shall not be responsible for, nor liable for, any subsurface condition.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURER

A. The tank construction company shall be the Crom Corporation, Gainesville, Florida, the Precon Corporation, Gainesville, Florida, or approved equal.

2.02 PERFORMANCE

A. The design shall be in conformance with applicable portions of American Concrete Institute (ACI) 372R-03 Design and Construction of Circular Wire- and Strand-Wrapped Prestressed Concrete Structures, AWWA D110-04 Wire- and Strand-Wound, Circular, Prestressed Concrete Water Tanks, and currently accepted engineering principles and practices for the design of such facilities.

B. Capacity: 10 Million Gallons

C. Dimensions: Inside Diameter: 190 feet Sidewall Depth. 47'-2" feet

D. Roof Design Loads: Consideration shall be given to all applicable roof design loads in accordance with AWWA D110-04, Section 3.3 and ASCE 7-02. The minimum roof live load for the structure shall be 12 psf.

E. Earthquake Design: Fixed percentage method as specified in AWWA D110-04, Section 4.1.

F. The thickness of the core wall shall be calculated so as to accept the initial compressive forces applied by prestressing, hydrostatic stresses induced by contents, and other applicable loads such as soil backfill and wind.

G. Backfill loads shall not be used in the design of the core wall to counteract hydraulic loads or provide residual compression in the wall.

H. Concrete:

1. Use Type I / II cement.

2. A maximum of 20% of cementitious material may be fly ash for all concrete mixes.

3. Floor Concrete: Minimum 4000 psi compressive strength at 28 days, maximum ¾" aggregate, 5% +/-1% air content, 4" +/-1" slump, soft broom finish.

4. Dome Concrete: Minimum 4000 psi compressive strength at 28 days, maximum ⅜" aggregate, maximum 5% +/-1% air content, 4" +/-1" slump, soft broom finish.

5. Pipe Encasement: Minimum 2500 psi compressive strength at 28 days, maximum ¾" aggregate, 5% +/-1% air content, 4" +/-1" slump.

I. Shotcrete:

1. Use Type I / II cement.

2. A maximum of 20% of cementitious material may be fly ash for all concrete mixes.

3. Core Wall Shotcrete: Minimum 4000 psi compressive strength at 28 days, 4" +/-1" slump.

4. Covercoat Shotcrete: Minimum 3500 psi compressive strength at 28 days, 4" +/-1" slump.

5. Allowable compressive stress due to final prestressing force, fg:

   a. 1250 psi + 75t psi/in. with 0.45 f'g maximum (where f'g is defined as compressive strength required for final prestressing force and t is the thickness of the core wall in inches).

   b. Maximum of 2000 psi.

6. Allowable compressive stress due to initial prestressing force, fgi:

   a. 1250 psi + 75t psi/in. with 0.5 f'gi maximum or less (where f'gi is defined as compressive strength at time initial prestressing force is applied and t is the thickness of the core wall in inches).

   b. Maximum of 2250 psi.

J. Prestressing Wire:

1. The prestressing wire shall conform to the requirements of ASTM A821, Type B.

2. Wire size shall be 0.162" (8 gauge), 0.192" (6 gauge) or larger, but no larger than 0.250".

3. Working stress for the tank wall, fs shall be a maximum of 115,000 psi.

4. Working stress for the dome ring, fsd shall be a maximum of 120,000 psi.

5. Allowable design tensile stress before losses, fsi shall be 145,600 psi or no greater than 0.63 fu.

6. Ultimate tensile strength, fu shall be, 231,000 psi or greater for 8 gauge wire, 222,000 psi or greater for 6 gauge.

K. Non-prestressed Mild Reinforcing Steel:

1. Allowable design tensile stress, fs shall be a maximum of 18,000 psi.

2. Yield strength of reinforcing steel, fy shall be 60,000 psi.

2.03 FLOOR

A. Concrete membrane floors shall be a minimum of 4" thick and have a minimum thickness of 8" of concrete over all pipe encasements and around sumps.

B. A minimum percentage of 0.60% reinforcing steel shall be used in the membrane floor. The minimum percentage shall apply to all thickened sections and shall extend a minimum of 2' into the adjacent membrane floor.

2.04 CORE WALL

A. The core wall shall be constructed of shotcrete, encasing a steel diaphragm, continuous the full wall height without horizontal splices.

B. The thickness of the core wall shall be calculated so as to accept the initial compressive forces applied by prestressing, backfill, and other applicable loads, but in no case be less than 3½" thick.

C. Horizontal sections of the wall shall form true circles without flat areas, excessive bumps or hollows.

D. Interior and exterior surfaces of the core wall shall be water cured for a minimum of 7 days or until prestressing begins.

E. To compensate for bending moments, shrinkage, differential drying, and temperature stresses, the following reinforcing steel shall be incorporated in the core wall.

1. The top 2' of core wall shall have not less than 1% circumferential reinforcing.

2. The bottom 3' of core wall shall have not less than 1% circumferential reinforcing.

3. Inside Face:

   a. 26 gauge steel shell diaphragm continuous the full wall height without horizontal splices.

   b. Additional vertical and horizontal reinforcing steel bars as required by design computations.

4. Outside Face:

   a. Vertical reinforcing steel: Minimum of #4 bars at 12" center to center.

   b. Additional vertical and horizontal reinforcing steel bars as required by design computations.

2.05 STEEL SHELL DIAPHRAGM

A. A 26 gauge steel tank shell, complying with ASTM A-1008 for Commercial Quality Cold Rolled Steel, shall be used throughout the core wall, providing a waterstop. The steel shell diaphragm shall be encased and protected with shotcrete no less than 1" thick at all places.

B. The steel shell is to be formed and erected so that a mechanical key is created between the shotcrete and diaphragm.

C. The sheets of steel diaphragm shall be continuous from top to bottom of wall; horizontal joints or splices will not be permitted.

D. All vertical joints in the diaphragm shall be sealed watertight by epoxy injection in accordance with U.S. Patent No. 5,150,551.

E. Epoxy injection shall be carried out from bottom to top of wall, using a pressure pumping procedure, after the steel shell has been fully encased, inside and outside, with shotcrete.

F. The sealant shall conform to the requirements of ASTM C881, Type III, Grade 1, and shall be 100% solids, moisture insensitive, low modulus epoxy system. When pumped, maximum viscosity of the epoxy shall be 10 poises at 77°F.

G. The epoxy sealant shall be suitable for bonding to concrete, shotcrete, and steel.

H. In all tanks designed to use a waterstop at the floor/wall joint, the steel shell diaphragm shall be epoxy bonded to this waterstop.

I. No nail or other holes shall be made in the steel for erection or other purposes except for inserting pipe sleeves, reinforcing steel, bolts, or other special appurtenances. Such penetrations shall be sealed with an approved epoxy sealant.

2.06 SHOTCRETE

A. All shotcrete shall be applied by or under direct supervision of experienced nozzlemen certified by the American Concrete Institute (ACI) as outlined in ACI certification publication CP-60.

B. Shotcrete mixes shall have a minimum of 1 part cementitious material to 3 parts of sand.

C Up to 20 percent of cementitious materials may by fly-ash.

D. Each shotcrete layer shall be broomed prior to final set to effect satisfactory bonding of the following layer.

E. No shotcrete shall be applied to reinforcing steel or diaphragm that is encrusted with overspray.

F. No less than ⅛" thick shotcrete shall separate reinforcing steel and prestressing wire.

2.07 DOME ROOF

A. The dome roof shall be constructed of reinforced concrete and circumferentially prestressed.

B. Dome shell reinforcement shall consist of reinforcing bars or welded wire fabric meeting ASTM A185, not galvanized. Bolsters for wire fabric and reinforcing bars shall be plastic tipped. Wire ties shall be galvanized.

C. The dome ring girder shall be prestressed with sufficient wire to withstand the dome dead load and design live loads. The ring girder shall have cross section suitable to accept the applied prestressing forces.

D. The high water level in the tank shall be permitted to encroach on the dome shell no higher than the upper horizontal plane of the dome ring girder.

E. Overflow outlets or the overflow pipe shall be capable of providing an overflow open area three times the area of the largest tank pipe.

F. The dome roof shall be cured for a minimum of 7 days or until prestressing begins.

G. The dome shall be designed as a free-span, spherical thin shell with one-tenth rise in accordance with the following:

1. Typical Dome Design: The typical dome thickness and steel reinforcement shall meet the requirements of AWWA D110-04, Section 3.6.3. "Thickness and reinforcement". In all cases, the thickness of the dome shall be no less than 3".

2. Dome Edge Design: The dome edge and upper wall shall be designed to resist the moments, thrusts, and shears that occur in this region due to dome and wall prestressing and loading conditions. The following design parameters shall be used.

    a. Dome Edge Thickness:

(1) A determination of the buckle diameter shall be made, as defined by:

$$d_b = 2.5 \cdot \sqrt{r_d \cdot t_d}$$ rounded up to the next foot

Where: d_b = buckle diameter in feet
r_d = dome radius in feet
t_d = typical dome thickness in feet

(2) Dome edge thickening shall begin at a radial location on the dome, defined as s_2 which is at least one buckle diameter away from the tank wall.

(3) A springline haunch shall be provided, which extends radially from the inside face of the tank wall to radial locations s_1 which is defined as:

$$s_1 = 0.6 \cdot \sqrt{1.5 \cdot r_d \cdot t_d}$$ rounded up to the next foot

This springline haunch shall begin at the inside face of the tank wall with a springline thickness as required by paragraph (6) below and shall end at radical location s_1 with the following thickness:

$$t_{d1} = 1.33 \cdot t_d$$

Where: t_{d1} = minimum thickness at s_1 in feet
t_d = typical dome thickness in feet at one buckle diameter from tank wall

(4) Beginning at s_1 and continuing to s_2 the dome shell shall be a straight line taper.

(5) Parameters (2), (3), and (4) above are not required for domes where the calculated typical dome thickness is less than 75% of the actual typical dome thickness.

(6) Sufficient concrete thickness at the springline of the dome shall be provided so that no more than 2' of the springline haunch is considered in calculating the effective dome edge ring cross sectional area. Compressive stress in this area shall not exceed 1000 psi when subjected to initial prestressing, offset by dead load only.

b. Dome Edge Steel Reinforcement

(1) Throughout the dome edge, the percentage of steel reinforcement, both radially and circumferentially, shall be no less than 0.25% of the gross cross sectional area of concrete.

(2) Along the dome edge, steel reinforcement shall be distributed between the upper and lower layers unless finite element analysis calculations indicate that tensile stress does not exist in the concrete along the bottom face of the dome edge. In that case, only top bars are required radially and circumferentially. In addition, radial and circumferential reinforcing bars will not be required along the bottom face of the dome edge where the calculated typical dome thickness is less than 75% of the actual typical dome thickness.

(3) Where reinforcing bars are required in the bottom layer, they shall be anchored near the tank wall to insure adequate development at the intersection between dome and wall.

(4) In all cases, the percentage of circumferential steel reinforcement in the first 2' of the dome edge shall be no less than one percent of the gross cross sectional area of concrete.

(5) Where bottom dome edge steel reinforcement is required, vertical steel reinforcement along the inside face of the tank wall shall be no less than 0.5% of the cross sectional area of wall shotcrete.

2.08 HORIZONTAL PRESTRESSING

A. Circumferential prestressing of the tank shall be achieved by the application of cold-drawn, high-carbon steel wire complying with ASTM 821 Type B, placed under high tension. A substantial allowance shall be made for prestressing losses due to shrinkage and plastic flow in the shotcrete and due to relaxation in the prestressing steel.

B. Placement of the prestressing steel wire shall be in a continuous and uniform helix of such pitch as to provide in each lineal foot of core wall height an initial force and unit compressive stress equal to that shown on the design drawings. Splicing of the wire shall be permitted only when completing the application of a full coil of wire or when removing a defective section of wire.

C. Areas to be prestressed will contain not less than 10 wires per foot of wall for 8 gauge and 8 wires per foot of wall for 6 gauge. A maximum of 24 wires per layer

per foot for 8 gauge and 20 wires per layer per foot for 6 gauge will be allowed. Shotcrete shall be used to completely encase each individual wire and to protect it from corrosion. To facilitate this encasement, the clear space between adjacent wires is to be no less than one wire diameter.

D. Prestressing shall be accomplished by a machine capable of continuously inducing a uniform initial tension in the wire before it is positioned on the tank wall. Tension in the wire shall be generated by methods not dependent on cold working or re-drawing of the wire. In determining compliance with design requirements, the aggregate force of all tensioned wires per foot of wall shall be considered rather than the force per individual wire, and such aggregate force shall be no less than that required by the drawings.

E. The tank construction company shall supply equipment at the construction site to measure tension in the wire after it is positioned on the tank wall. The stress measuring equipment shall include: electronic direct reading stressometer accurate to within 2%, calibrated dynamometers and a test stand to verify the accuracy of the equipment.

F. After circumferential prestressing wires have been placed, they shall be protected by encasement in shotcrete. This encasement shall completely encapsulate each wire and permanently bond the wire to the tank wall.

G. When multiple layers of wire are required, shotcrete cover between layers shall be no less than ⅛" thick.

H. After all circumferential prestressing wires have been placed, a shotcrete cover having a thickness of no less than 1" shall be placed over the prestressing wires.

2.09 WALL OPENINGS

A. When it is necessary for a pipe to pass through the tank wall, the invert of such pipe or sleeve shall be no less than 18" above the floor slab, and the prestressing wires required at the pipe elevation shall be distributed above and below the opening leaving an unbanded strip around the entire tank.

B. Unbanded strips shall have a vertical dimension of no more than 36" unless an axi-symmetric shell analysis is performed to account for shear and moments caused by displacement of the prestressing wires into adjacent bands.

C. All wall pipes and sleeves passing through the wall shall be sealed to the steel shell diaphragm by epoxy injection.

2.10 TANK ACCESSORIES

A. The tank construction company shall furnish, install, and guarantee the tank accessories.

B. The tank shall have two 1' 3" x 4' 4" rectangular Type 316 stainless steel wall manholes for access to the interior of the tank. The cover and the bolts shall be of Type 316 stainless steel. One of the manholes shall have a sample port.

C. Exterior ladder made of T6061 aluminum with TS safety rail, safety cage, and lockable security gate or safety climbing device conforming to applicable OSHA standards.

D. Interior fiberglass ladder with Type 316 stainless steel fasteners and TS safety rail or climbing device conforming to applicable OSHA standards.

E. Roof hatch cover, 50" roof ventilator, liquid level indicator (with precast curb), and vortex plates shall be made of fiberglass with Type 316 stainless steel fasteners.

F. Precast concrete overflows, 675 square inch.

G. Precast access hatch with curb.

H. Pipe brackets for risers shall be constructed of 316 stainless steel.

I. Dome handrail made of T6061 aluminum with toe-board, chain with hook, and self closing gate.

J. Dome probe.

K. Through-wall pipe sleeves shall be Type 316 stainless steel sleeves with neoprene modular-seal units using stainless steel tightening bolts.

2.11 PAINTING

A. Exterior paint system shall consist of the following:

1. Apply one coat of Thoroseal on walls only.

2. Allow Thoroseal to cure for at least 3 days.

3. Apply two coats of Tnemec Series156 Enviro-Crete Modified Waterborne Acrylate on walls and dome at 4.0 to 6.0 mils DFT per coat after tank has been hydrostatically tested. All surfaces must be clean and dry prior to application.

4. Owner shall select color from manufacturer's full range. Color chips shall be provided with Shop Drawing submittal.

B. Interior paint system shall consist of the following:

1. Allow new concrete to cure for at least 28 days.

2. All concrete surfaces shall be prepared by brush-off blast clean per SSPC-SP 13 to establish a surface profile equal to ICRI CSP 3 to 4.

3. On the underside of the dome from the wall up to 12 inches above HWL, fill all voids, bugholes and other surface imperfections with Tnemec Series 218 MortarClad.

4. Apply two coats of Tnemec Series N140 Pota-Pox Plus Modified Epoxy at 4.0 to 6.0 mils DFT per coat to floor, walls, and portion of dome 6 inches above HWL.

5. Allow paint to cure for 7 days before placing tank into service.

C. Ductile Iron Piping Risers for 24" inlet and 24" overflow lines.

1. Shop Painting

a. Surface Preparation. Remove all visible asphalt paint, oil, grease, dirt, dust, loose annealing oxide, loose rust and other foreign matter per NAPF 500-03-04.

b. Apply one coat of Tnemec Series N140-1211 (red) Pota-Pox Plus Modified Epoxy at 4.0 to 6.0 mils DFT.

2. Field Painting

a. If shop primed piping is exposed to sunlight for more than 60 days, primed surface shall be scarified by abrasive blast SSPC-SP 7 prior to overcoating.

b. Touch up shop primer. Spot repair of damaged areas per NAPF 500-03-04. Spot prime bare metal with Tnemec Series N140 Pota-Pox Plus Modified Epoxy at 3.0 to 5.0 mils DFT. All surfaces must be clean and dry.

c. Apply two coats of Tnemec Series N140 Pota-Pox Plus Modified Epoxy at 4.0 to 6.0 mils DFT per coat.

d. Owner shall select color from manufacturer's full range. Color chips shall be provided with Shop Drawing submittal.

D. Safety

1. The Contractor's work forces should comply with the provisions outlined in the following documents:

   SSPC-PA-3 "A Guide to Safety in Paint Application"
   NACE Pub. "A Manual for Painter Safety"

2. The Contractor shall provide personnel with all safety equipment necessary to protect them during any phase of the work.

3. Workers doing abrasive blasting operations shall wear a fresh air supplied protective helmet and hood and personal protective clothing acceptable to industry standards and all government regulations.

4. Fireproof areas by proper storage and disposal of flammable materials (paint, solvents, rags, etc.); keeping heat, spark, and flames sources away from flammable materials; and have fire extinguishers available.

E. Follow manufacturer's instructions for storage, mixing, surface preparation, application, and coverage rates.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify elevations, placement and grading for tank prior to starting tank construction.

3.02 INSTALLATION

A. Tank Floor:

1. The floor shall be vibratory screeded to effect consolidation of concrete and proper encasement of floor reinforcing steel.

2. The floor shall be continuously water cured until tank construction is completed.

B. Tank Wall:

1. The wall shall be constructed in a predesigned manner utilizing steel shell diaphragm, layers of shotcrete and prestressing wire.

2. The diaphragm shall be protected against damage before, during, and after erection. Nail or other holes shall not be permitted in the steel shell for erection or other purposes except for inserting wall pipes or sleeves, reinforcing steel, bolts, or other special appurtenances. Such penetrations shall be sealed with an approved epoxy sealant.

3. Interior and exterior portions of the shotcrete wall shall be water cured for a minimum of 7 days or until prestressing is started.

C. Roof:

1. All concrete shall be consolidated by means of a vibrator for proper encasement of reinforcing steel and welded wire fabric.

2. All surfaces at the joint between the wall and the dome shall be coated with an approved bonding epoxy.

3. Dome shall be water cured for 7 days after casting or until prestressing is started.

D. Prestressing: The initial tension in each wire shall be read and recorded to verify that the total aggregate force is no less than that required by the design. Averaging or estimating the force of the wire on the wall shall not be considered satisfactory evidence of correct placement of prestressing wires.

3.03 FIELD QUALITY CONTROL

A. Inspection and Testing:

1. Concrete and Shotcrete Testing: Test all concrete and shotcrete used in the tank structure in accordance with ACI C31/ C39. One set of cylinders shall be made per 50 cubic yards. Each set shall contain five cylinders. Test one cylinder at 7 days, two cylinders at 28 days, and hold two.

2. Hydrostatic Testing: Test completed tank for liquid tightness by filling tank to its overflow elevation with water provided by Owner for 48 hours. Report any leaks to Engineer.

3.04 CLEANING AND DISINFECTION

A. Cleaning and disinfection shall be performed once the Hydrostatic Test has been completed.

B. Clean interior and exterior of tank to remove debris, construction items, and equipment.

C. Disinfection Procedure: Use AWWA C652.

END OF SECTION

DIVISION 16
ELECTRICAL

SECTION 16010

BASIC ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1. 01 SUMMARY

A. Related Documents: Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Specification Sections, apply to this Section.

1. 02 DEFINITIONS

A. "Contract Documents" shall be understood to include the Contract Specifications, Contract Drawings, official addenda, official revision bulletins, and all other official documents.

B. "Electrical equipment and materials" shall be understood to include all electrical related equipment, apparatus, components, devices, assemblies, materials, accessories, and appurtenances.

C. "Owner" shall be understood to include the Owner's Designated Representative.

D. "Provide" shall be understood as "furnish and install."

1. 03 BASIC REQUIREMENTS

A. Contractor's Charge: It shall be this Contractor's responsibility to complete the Work of this project as conveyed in these Contract Specifications and on the Contract Drawings.

B. Site Inspection: Prior to the bid, the Contractor shall thoroughly inspect the Project Site and shall become familiar with project areas and existing site conditions.

C. Hazardous Materials/Conditions: Advise the Owner and Engineer/Architect in writing of any suspected hazardous materials and hazardous conditions discovered during the course of the Work. Make this notification as soon as the discovery is made.

D. General: Installations shall conform to the requirements of NFPA 70, NFPA 101, and IEEE C2, unless more stringent requirements are indicated herein or elsewhere on the Contract Drawings.

E. Workmanship: All work must be performed in a neat and workmanlike manner by a licensed journeyman electrician or a certified apprentice working under the direct supervision of a licensed journeyman electrician, and shall present a neat and professional appearance when complete.

F. Electrical Equipment and Materials: Listed and labeled as defined in NFPA 70,

Article 100, by a Nationally Recognized Testing Laboratory meeting the requirements of OSHA 29 CFR 1910.

G. Electrical Equipment and Materials described in these specifications and on the Contract Drawings establish the minimum standards for quality and style, shall be the basis of the bid, and shall be new unless otherwise indicated as existing. Manufacturer names are indicated as basis of design, or suggested alternate manufactures. Alternates shall be considered upon approval of the engineer.

H. Electrical Equipment and Materials shall be installed in accordance with the manufacturer's recommendations using the best methods known to the trade.

I. Onsite Storage: Onsite storage of electrical equipment and materials, and tools will be at the Owner's discretion and the Contractor's risk. The Contractor shall follow the pathways as directed by the Owner for the movement of electrical equipment and materials, and tools in and out of the building, and to and from the project areas. Such pathways will be established by the Owner, and are subject to change at the Owner's discretion.

J. Delivery, Storage, and Handling: Equipment and materials shall be visually inspected by the Contractor when received and prior to acceptance from conveyance. Stored items shall be protected from the environment in accordance with the manufacturer's published instructions. Damaged items shall be replaced at the Contractor's expense. Stored items shall be protected from theft.

K. Maintenance of Work Areas: The Contractor shall maintain all work areas in a neat and orderly fashion. The Contractor shall employ means as necessary including, but not necessarily limited to, dust curtains, to prevent the migration of dust, dirt, and debris from the immediate project areas to other areas accessible to the public and/or other building occupants. The Contractor shall clean all work areas of dust, dirt, and debris at the end of each workday and more frequently if directed to do so by the Owner.

L. Protection: The Contractor shall make every effort to ensure a safe work environment for his employees, contractors, and agents, and for the public. The Contractor shall follow the applicable requirements and recommendations of OSHA. All exposed energized equipment, components, and wiring shall be shielded from accidental contact by employees, workers and building visitors. In no case shall exposed energized equipment, components, or wiring be left unprotected or unguarded. The Contractor shall provide all warning apparatus and materials required to cordon off the Project Site from those not directly associated with the Project including, but not necessarily limited to, warning tape and barriers, cones, signs, and dust curtains. The placement and erection of warning apparatus and materials shall be coordinated with, and to the satisfaction of the Owner and/or Engineer/Architect.

M. Installations: The Contract Drawings indicate the extent and the general location and arrangement of equipment, conduit, and wiring. The Contractor shall become familiar with all details of the Work and verify all dimensions in the field so that equipment and materials shall be properly located and readily accessible. The

Contractor shall sequence, coordinate, and integrate the various elements of electrical equipment and materials and comply with the following:

1. Verify all dimensions by field measurement.
2. Coordinate the installation of electrical equipment and materials with other building systems, features, and components.
3. Sequence, coordinate, and integrate the installation of electrical equipment and materials for efficient flow of the Work.
4. Install electrical equipment and materials to conform with approved submittal data to the greatest extent possible. Conform to the arrangements indicated on these drawings recognizing that portions of the work are shown only in diagrammatic form.
5. Any confusing, conflicting, or unclear information on these drawings shall be referred to the Engineer/Architect prior to the bid for his resolution. By failing to refer confusing, conflicting, or unclear information in the Contract Documents to the Engineer/Architect for his resolution prior to the bid, the Contractor thereby acknowledges the Contract Documents as error free.
6. In general, install electrical equipment and materials level and plumb, parallel and perpendicular to building lines and features.
7. Install electrical equipment and materials to facilitate servicing and maintenance, and repair or replacement of component parts. To the greatest extent possible, connect electrical equipment for ease of disconnecting with a minimum of interference with other installations.

N. Power Outages: The Contractor shall schedule power outages as required to complete the Work of this Project. The number and duration of power outages shall be kept to an absolute minimum. Power outages must be coordinated and scheduled with the Owner with a minimum of fourteen-(14) calendar days advance notice.

O. Temporary Power and Lighting:

P. Permits / inspections: Obtain (arrange, apply, pay for, and maintain) and post all required construction permits. Obtain (arrange, apply, and pay for) inspection of all electrical work performed under this Contract.

Q. Quality Control: Upon completion of the Work, but prior to the punchlist inspection, the Contractor shall complete the following:

1. General: Verify that all electrical equipment is installed, operational, and fully functional in accordance with the manufacturer's requirements and tolerances.
2. Connections and Terminals: Verify all electrical connectors and terminals have been tightened in accordance with the manufacturers published torque-tightening values. If manufacturers torque values are not indicated, use those specified in UL 486A and UL 486B.

R. Facilitate Punchlist Inspection: The Contractor shall make one journeyman

electrician available to accompany the Engineer/Architect during the punchlist inspection. The journeyman electrician shall assist the Engineer/Architect including, but not necessarily limited to, the removing of equipment covers to facilitate inspection of equipment interiors. The punchlist inspection shall be scheduled by the Engineer/Architect with a minimum of 7 calendar days advance notice following the Contractor's notification of his successful checkout and testing of the completed installations. During the punchlist inspection, the Engineer/Architect will survey the completed installations for compliance with Contract Requirements. Subsequent to the punchlist inspection, the Engineer/Architect will compile a list of installation deficiencies. The Owner's notification to the Contractor of Final Acceptance will not be issued until all installation deficiencies have been corrected to the satisfaction of the Owner and/or Engineer/Architect.

S. Record Drawings: The Contractor shall maintain at the site a clean undamaged set of blue or black-line white prints of the Contract Drawings. This record set drawings shall be marked to show the actual installation, and where the actual installation varies substantially from the Work as originally shown. Mark whichever drawings are most capable of showing conditions fully and accurately. Give particular attention to concealed elements that would be difficult to measure and record at a later date. Mark record drawings with red erasable pencil; use other colors to distinguish between variations in separate categories of the Work.

END OF SECTION

SECTION 16020

INSTALLATION OF UNDERGROUND ELECTRICAL DUCT BANKS, CONDUIT, MANHOLES AND HANDHOLES

PART 1 GENERAL

1. 01 DESCRIPTION OF WORK

A. This item shall consist of underground electrical ducts or conduits installed in accordance with this specification at the locations and in accordance with the dimensions, designs, and details shown in the Contract Drawings for the new feeder system work. It shall also include all concrete encasement, mandrelling, installation of pull wires and duct markers, capping, core drilling, and the testing of the installation as a completed raceway system ready for the installation of cables, to the satisfaction of the Engineer.

This item shall also include furnishing and installing manholes and handholes at locations shown on the Drawings, including cable pulling rings, cable racks, bell ends, ground rods, grounding non-current carrying metal parts, core drilling existing manholes, handholes and light bases and shall also include adjusting of existing duct markers.

All trenching, backfilling, removal and restoration of all paved areas shall be covered under another section of this Specification.

1. 02 RELATED WORK

A. Carefully examine all of the Contract Documents for requirements that affect the work of this section.

1. 03 QUALITY ASSURANCE

A. Codes and Standards: Comply with provisions of following codes, specifications, and standards except where more stringent requirements are shown or specified:

1. National Board of Fire Underwriter's National Electrical Code, latest edition.
2. Underwriter's Laboratories, Inc., Standards for Cabinets and Boxes, Service Equipment, and Rubber-Covered Wires and Cables.
3. National Electrical Manufacturer's Association Standards.
4. All applicable state and local codes or ordinances.
5. Insulated Power Cable Engineer's Association Standards.
6. Occupational Safety and Health Regulations.
7. Institute of Electrical and Electronics Engineers' Standards.

B. Federal material requirements shall comply with the following:

Number	Title
A 48-76	Gray Iron Castings
A 120-79	Pipe, Steel, Black or Hot-Dipped, Zinc Coated (Galvanized) Welded and Seamless, for ordinary uses
A 123-78	Zinc (hot-galvanized) on Products Fabricated from Rolled, Pressed and Forged Steel Shapes, Plates, Bars, and Strip
A 615-79	Deformed and Plain Billet-Steel Bars for Concrete Reinforcements

1. 04 SHOP DRAWINGS

A. Shop drawings and design calculations showing precast concrete electrical handholes and/or manholes, if used, reinforcement size and location, inserts, grout holes, bolt holes, slab, wall and roof openings shall be submitted to the Engineer for approval.

PART 2 PRODUCTS

2. 01 MATERIALS

A. All equipment and materials covered by referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the acceptable specification when so requested by the Engineer.

2. 02 STEEL CONDUIT

A. Rigid steel conduit and fittings shall be galvanized and conform to the requirements of Underwriters Laboratories Standard 6514 and 1242. Rigid steel conduit installed underground without concrete encasement shall be PVC coated. All PVC coated conduits and fittings installed underground shall be coated with 40-mil polyvinyl chloride, bonded to the conduit with an epoxy primer. PVC coated conduits shall conform to NEMA RN1-1980 (Type 40).

2. 03 PVC CONDUIT

A. PVC conduit shall be schedule 40 and shall conform to NEMA TC2. Fittings shall match conduit type and material and shall be provided by the same manufacturer as the conduit. Cement for connections of conduit and fittings shall be approved by the manufacturer of the conduit.

2. 04 CONCRETE

A. Concrete shall conform to the requirements for Portland cement concrete, using 1-

inch maximum size coarse aggregate, of Section 03010 "Concrete Work" of this Specification.

2. 05 CAST-IN-PLACE ELECTRICAL MANHOLES AND HANDHOLES

A. Precast units may be substituted for cast-in-place. Shop drawings must be provided and establish the ability of the precast units to support required loadings. Covers shall be imprinted with the work "ELECTRIC" or shall be imprinted as shown or called for on the Drawings.

Ground rods for the electric manhole shall be installed inside. Non-current carrying metal parts in the manholes, including metallic sheathes of cables shall be connected to the ground rods with bare copper conductors.

PART 3 EXECUTION

3. 01 GENERAL

A. The Contractor shall install underground ducts, manholes and handholes at the approximate locations indicated in the Contract Drawings. The Engineer may indicate specific locations as the work progresses. Ducts shall be of the size, material, and type indicated in the Contract Drawings or Specifications. Where no size is indicated in the Contract Drawings or Specifications, the ducts shall be not less than 4 inches inside diameter. All duct lines shall be laid so as to grade toward handholes, manholes, vaults, and duct ends for drainage. Grades shall be at least 3 inches per 100 feet. On runs where it is not practicable to run the grade all one way, the duct lines shall be graded from the center in both directions toward manholes, handholes, or duct ends. Pockets or traps where moisture may accumulate shall be avoided.

B. The Contractor shall utilize large radius sweeps for all duct and conduit direction changes and for all elbows entering concrete slabs. The minimum inside radius shall be 30" for all ducts and conduits larger than 1-½" nominal.

C. The Contractor shall mandrel each duct. An iron-shod mandrel, not more than ¼-inch smaller than the bore of the duct shall be pushed through each duct by means of jointed conduit rods. The mandrel shall have a leather or rubber gasket slightly larger than the duct hole.

D. Any non-metallic ducts which terminate in concrete walls of new manholes or handholes shall terminate in bell ends, flush with the inside wall. Non-metallic ducts which terminate in concrete walls of existing manholes or handholes shall be brought through the wall in core drilled holes, trimmed flush with the inside wall, grouted into place.

E. All new ducts and conduits installed and all empty/spare extended ducts shall be provided with a ¼ inch polyprophylene monofilament rope for pulling the permanent wiring. Sufficient length shall be left in manholes or handholes to tie the drag wire

back to prevent it from slipping back into the duct.

F. All ducts shall be securely fastened in place during construction and progress of the work and shall be plugged to prevent seepage of grout, water, or dirt. Any duct section having a defective joint shall not be installed.

G. All nonmetallic ducts installed under paved areas shall be encased in a concrete envelope.

H. Where turf is well established and the sod can be removed, it shall be carefully stripped and properly stored.

3. 02 DUCTS ENCASED IN CONCRETE

A. Unless otherwise shown in the plans, concrete-encased ducts shall be installed so that the top of the concrete envelope is not less than 24 inches below the finished subgrade where installed under paved areas, and not less than 18 inches below finished grade in unpaved areas. Ducts, conduits and duct banks, which terminate in infield areas, but not in manholes or handholes shall extend beyond the pavement edge at least 5 feet and shall have keyed ends to provide for future extension. Trenches for concrete-encased ducts shall be opened the complete length between bases, manholes, handholes, etc., before concrete is laid so that if any obstructions are encountered, proper provisions can be made to avoid them. All ducts for concrete encasements shall be supported on plastic spacers designed for the purpose. Spacer bases shall be installed on wooden planks. The wooden planks shall be installed on a base of 3" of compacted sand in the bottom of the trench. Where two or more ducts are encased in concrete, the contractor shall space them not less than 1½ inches apart (measured from outside wall to outside wall) using spacers applicable to the type of duct. As the duct laying progresses, concrete not less than three inches thick shall be placed around the sides and top of the duct bank. Couplings shall be installed flush with the edge of the concrete encasement where it is required to terminate the duct bank in earth.

B. When pouring ducts for consecutive days, between each day's pour shall be a reinforced joint. When pouring ducts for future extensions, there shall be a keyed joint with no reinforcement as detailed on the Drawings. All costs for keying and reinforcing bars are considered incidental to the Item.

C. When specified, the Contractor shall reinforce the bottom, side and top of concrete encasements with steel reinforcing mesh or fabric or other approved metal reinforcement. When directed, the Contractor shall supply additional supports where the ground is soft and boggy.

3. 03 DUCTS OR CONDUITS WITHOUT CONCRETE ENCASEMENT

A. Trenches for single duct lines shall be not less than 12 inches or more than 16 inches wide, and the trench for 2 or more ducts installed at the same level shall be proportionately wider. Trench bottoms for ducts without concrete encasement shall be made to conform accurately with the grade so as to provide uniform support for

the duct along its entire length.

B. A layer of fine earth material, at least 4 inches thick (loose measurement) shall be placed in the bottom of the trench as bedding for the duct. The bedding material shall consist of soft sand or other fine fill, and it shall contain no particles that would be retained on a ¼ inch sieve. The bedding material shall be tamped until firm.

C. Unless otherwise shown in plans, ducts for direct burial shall be installed so that the tops of all ducts are at least 18 inches below the finished grade.

D. When two or more ducts are installed in the same trench without concrete encasement, they shall be spaced not less than 2 inches apart (measured from outside wall to outside wall) in a horizontal direction and not less than 6 inches apart in a vertical direction.

E. Trenches shall be opened the complete length between bases, manholes, etc., before duct is installed so that if any obstructions are encountered, proper provisions can be made to avoid them.

F. Where steel conduits terminate in an unpaved area for transition to direct burial installation, the end of the conduit shall be equipped with an insulated throat, threaded, grounding bushing and shall be connected to the equipment ground.

3. 04 CORE-DRILLED HOLES

A. Certain conduit runs will originate or terminate at existing manholes or light bases. It will be necessary to core-drill into these units to complete the runs. Core-drilled holes into existing manholes or handholes will have the annular space between the conduit and the cored hole filled with mortar.

3. 05 REAMING EXISTING DUCTS

A. In the event that:

1. There are no empty spare ducts that can be utilized,
2. There are no abandoned cables which can be removed,
3. There are no existing cables which can be consolidated to obtain a spare duct:
    a. When directed by the engineer the Contractor may utilize a mechanical reamer or high-pressure water to ream out the blisters and debris from the duct to make it ready to receive new cables.

3. 06 ABANDONED DUCT

A. When a duct bank is to be abandoned in place, these conduits shall be sealed with grout in the manhole where they originate.

3. 07 COMPLETION OF THE WORK

A. After completion of work in any manhole or handhole, both new and existing, the

manhole or handhole shall be left in a clean condition satisfactory to the Engineer, regardless of the cause of the debris required to be cleaned.

END OF SECTION

SECTION 16050

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1. 01 SUMMARY

A. This Section includes the following:

1. Electrical Enclosures
2. Receptacles.
3. Supporting devices for electrical components.
4. Electrical identification.
5. Concrete equipment bases.
6. Electrical demolition.
7. Cutting and patching for electrical construction.
8. Touchup painting.

B. Related Documents: Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Specification Sections, apply to this Section.

1. 02 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. FMC: Flexible metal conduit.

C. IMC: Intermediate metal conduit.

D. LFMC: Liquidtight flexible metal conduit.

E. RNC: Rigid nonmetallic conduit.

1. 03 SUBMITTALS

A. Product Data: For electricity-metering equipment.

B. Shop Drawings: Dimensioned plans and sections or elevation layouts of electricity-metering equipment.

C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1. 04 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined

in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

1. 05 COORDINATION

A. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.

1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.

B. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.

PART 2 PRODUCTS

2. 01 ELECTRICAL ENCLOSURES

A. All outdoor electrical enclosures and panels shall be NEMA 4X 316SS unless specifically indicated otherwise on plans.

2. 02 RECEPTACLES

A. Single and double receptacles shall be 20 ampere, 125 volts, back and side wired, with grounded pole.

B. Receptacle shall be enclosed in rain-tight cast iron alloy device box and include die cast metal constructed receptacle cover designed to maintain Nema type 3R rating "while-in-use".

C. Products: Provide products by one of the listed manufacturers:

1. Appleton

2. Crouse-Hinds

3. Thomas & Betts

D. Provide device plates for each and every outlet box requiring same, and of the type required for the service and device involved; furnish in gangs as necessary. Plates and screws shall be the product of the same manufacturer of the devices installed. Finish of the plates shall be 0.04 stainless steel, finish 302 satin unless otherwise noted.

E. Ground-Fault Interrupter: Provide heavy-duty duplex receptacles, ground-fault circuit interrupters; feed-thru type, capable of protecting connected downstream receptacles on single circuit, grounding type UL-rated Class A, Group 1, 20-amperes rating, 120-volts, 60 Hz; with solid-state ground-fault sensing and signaling; with 5 miliamperes ground-fault trip level; equip with 20-ampere plug configuration, NEMA 5-20R.

F. Receptacles installed outdoors or within 6'-0" from plumbing fixtures and waterpipes shall be ground fault circuit interrupter type.

2. 03 SUPPORTING DEVICES

A. Material: Cold-formed steel, with corrosion-resistant coating acceptable to authorities having jurisdiction.

B. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel.

C. Slotted-Steel Channel Supports: Flange edges turned toward web, and 9/16-inch diameter slotted holes at a maximum of 2 inches o.c., in webs.

D. Slotted-Steel Channel Supports: Comply with Division 5 Section "Metal Fabrications" for slotted channel framing.

1. Channel Thickness: Selected to suit structural loading.

2. Fittings and Accessories: Products of the same manufacturer as channel supports.

E. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.

F. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.

G. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Plugs shall have number and size of conductor gripping holes as required to suit individual risers. Body shall be constructed of malleable-iron casting with hot-dip galvanized finish.

H. Expansion Anchors: Carbon-steel wedge or sleeve type.

I. Toggle Bolts: All-steel springhead type.

J. Powder-Driven Threaded Studs: Heat-treated steel.

2. 04 ELECTRICAL IDENTIFICATION

A. Identification Devices: A single type of identification product for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, and these Specifications.

B. Raceway and Cable Labels: Comply with ANSI A13.1, Table 3, for minimum size of letters for legend and minimum length of color field for each raceway and cable size.

1. Type: Preprinted, flexible, self-adhesive, vinyl. Legend is overlaminated with a clear, weather- and chemical-resistant coating.

2. Color: Black letters on orange background.

3. Legend: Indicates voltage.

C. Colored Adhesive Marking Tape for Raceways, Wires, and Cables: Self-adhesive vinyl tape, not less than 1 inch wide by 3 mils thick.

D. Underground Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape with the following features:

1. Not less than 6 inches wide by 4 mils thick.
2. Compounded for permanent direct-burial service.
3. Embedded continuous metallic strip or core.
4. Printed legend that indicates type of underground line.

E. Tape Markers for Wire: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.

F. Color-Coding Cable Ties: Type 6/6 nylon, self-locking type. Colors to suit coding scheme.

G. Engraved-Plastic Labels, Signs, and Instruction Plates: Engraving stock, melamine plastic laminate punched or drilled for mechanical fasteners 1/16-inch minimum thickness for signs up to 20 sq. in. and 1/8-inch minimum thickness for larger sizes. Engraved legend in black letters on white background.

H. Interior Warning and Caution Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145. Preprinted, aluminum, baked-enamel-finish signs, punched or drilled for mechanical fasteners, with colors, legend, and size appropriate to the application.

I. Exterior Warning and Caution Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch, galvanized-steel backing, with colors, legend, and size appropriate to the application. 1/4-inch grommets in corners for mounting.

J. Fasteners for Nameplates and Signs: Self-tapping, stainless steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers.

2. 05 TOUCHUP PAINT

A. For Equipment: Equipment manufacturer's paint selected to match installed equipment finish.

B. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

C. Color shall be as directed by Owner.

PART 3 EXECUTION

3. 01 ELECTRICAL EQUIPMENT INSTALLATION

A. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide the maximum

possible headroom.

B. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.

C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.

D. Right of Way: Give to raceways and piping systems installed at a required slope.

3. 02 ELECTRICAL SUPPORTING DEVICE APPLICATION

A. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, U-channel system components.

B. Dry Locations: Steel materials.

C. Support Clamps for PVC Raceways: Click-type clamp system.

D. Selection of Supports: Comply with manufacturer's written instructions.

E. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four; minimum of 200-lb (90-kg) design load.

3. 03 SUPPORT INSTALLATION

A. Install support devices to securely and permanently fasten and support electrical components.

B. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.

C. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.

D. Size supports for multiple raceway installations so capacity can be increased by a 25 percent minimum in the future.

E. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.

F. Install 1/4-inch- diameter or larger threaded steel hanger rods, unless otherwise indicated.

G. Spring-steel fasteners specifically designed for supporting single conduits or tubing may be used instead of malleable-iron hangers for 1-1/2-inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to slotted channel and angle supports.

H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.

I. Simultaneously install vertical conductor supports with conductors.

J. Separately support cast boxes that are threaded to raceways and used for fixture support. Support sheet-metal boxes directly from the building structure or by bar hangers. If bar hangers are used, attach bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches from the box.

K. Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.

L. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.

M. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Perform fastening according to the following unless other fastening methods are indicated:

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

3. 04 IDENTIFICATION MATERIALS AND DEVICES

A. Install at locations for most convenient viewing without interference with operation and maintenance of equipment.

B. Coordinate names, abbreviations, colors, and other designations used for electrical identification with corresponding designations indicated in the Contract Documents or required by codes and standards. Use consistent designations throughout Project.

C. Self-Adhesive Identification Products: Clean surfaces before applying.

D. Identify raceways and cables with color banding as follows:

1. Bands: Pretensioned, snap-around, colored plastic sleeves or colored adhesive marking tape. Make each color band 2 inches wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side.

2. Band Locations: At changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (8-m) maximum intervals in congested areas.

3. Colors: As follows:

a. Fire Alarm System: Red.

b. Security System: Blue and yellow.

c. Telecommunication System: Green and yellow.

E. Tag and label circuits designated to be extended in the future. Identify source and circuit numbers in each cabinet, pull and junction box, and outlet box. Color-coding may be used for voltage and phase identification.

F. Install continuous underground plastic markers during trench backfilling, for exterior underground power, control, signal, and communication lines located directly above power and communication lines. Locate 6 to 8 inches below finished grade. If width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches, overall, use a single line marker.

G. Color-code 208/120-V system secondary service, feeder, and branch-circuit conductors throughout the secondary electrical system as follows:

1. Phase A: Black.

2. Phase B: Red.

3. Phase C: Blue.

H. Color-code 480/277-V system secondary service, feeder, and branch-circuit conductors throughout the secondary electrical system as follows:

1. Phase A: Brown.

2. Phase B: Orange.

3. Phase C: Yellow.

4. Coordinate two paragraphs below with Drawings.

I. Install warning, caution, and instruction signs where required to comply with 29 CFR, Chapter XVII, Part 1910.145, and where needed to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.

J. Install engraved-laminated emergency-operating signs with white letters on red

background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.

3. 05 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.

B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

C. Provide additional means and materials that shall contain dust and debris.

3. 06 FIELD QUALITY CONTROL

A. Inspect installed components for damage and faulty work, including the following:

1. Raceways.
2. Building wire and connectors.
3. Supporting devices for electrical components.
4. Electrical identification.
5. Electrical demolition.
6. Cutting and patching for electrical construction.
7. Touchup painting.

3. 07 REFINISHING AND TOUCHUP PAINTING

A. Refinish and touch up paint. Paint materials and application requirements are specified in Division 9 Section "Painting."

1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3. 08 CLEANING AND PROTECTION

A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.

B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

END OF SECTION

SECTION 16060

GROUNDING AND BONDING

PART 1 GENERAL

1. 01 SUMMARY

A. This Section includes grounding electrodes and conductors, equipment grounding conductors and bonding. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

B. Related Documents: Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Specification Sections, apply to this Section.

1. 02 SUBMITTALS

A. Data Sheets: Submit as a minimum the following information on each different item. The information shall be in the form of a manufacturer's standard data sheets.

1. Rod Electrodes.
2. Rod Material.
3. Dimensions.
4. Coupling Type.
5. Mechanical Connectors.
6. Material.
7. Connector Type.
8. Exothermic Connections.
9. Process Description.
10. Mold Types.
11. Weld Material.
12. Starting Material.
13. Ground Well.
14. Dimensioned Picture or Drawing of Grounding Well and Cover.
15. Well Pipe Material.
16. Well Cover Material and Legend.

B. Test Reports: Indicate overall resistance to ground and resistance of each electrode.

C. Manufacturer's Instructions: Include instructions for storage, handling, protection,

examination, preparation and installation of exothermic connectors.

1. 03 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100.

B. Comply with NFPA 70.

C. IEEE Std 81 – Guide.

D. UL 467 – Electrical Grounding and Bonding Equipment.

E. UL 486A – Wire Connectors and Soldering Lugs for Use with Copper Conductors.

F. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.

PART 2 PRODUCTS

2. 01 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Division 16 Section "600 Volt or Less Cable."

B. Material: Copper.

C. Equipment Grounding Conductors: Insulated with green-colored insulation.

D. Grounding Electrode Conductors: Stranded cable.

E. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.

F. Bare Copper Conductors: Comply with the following:

1. Solid Conductors: ASTM B 3.
2. Assembly of Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.

G. Copper Bonding Conductors: As follows:

1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4-inch in diameter.
2. Bonding Conductor: No. 4 AWG, stranded copper conductor.
3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

H. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulators.

2. 02 CONNECTOR PRODUCTS

A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

B. Bolted Connectors: Bolted-pressure-type connectors, or compression type.

C. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

2. 03 GROUNDING ELECTRODES

A. Ground Rods: Size: ¾" diameter by 120 inches. Copper clad steel sectional type with high strength steel core and electrolytic grade copper outer sheath, molten welded to the core with tapered point.

2. 04 EXOTHERMIC CONNECTIONS

A. UL 486A.

B. Process: Exothermic process that produces molecular bonding of connected items.

C. Approved for exposure or direct burial without degradation.

D. Use graphite molds of proper size and design for the weld and connected items.

E. Starting Weld material: Copper oxide and aluminum mixture with a minimum 3 percent tin.

F. Weld material: Aluminum, copper and iron oxides ignited only by spark ignitor designed for the purpose.

G. Miscellaneous: Provide tools and other devices required for a complete weld.

H. All welding material shall be of the same manufacturer.

2. 05 WIRE

A. UL 486A.

B. Materials: Copper, 98 percent conductivity; insulated copper for all feeders, branch circuits; bonding jumpers and transformer grounds; solid for #10 AWG and smaller, stranded for larger than #10 AWG. See Section 16123 for insulation types.

C. Foundation Electrodes: Bare, tinned, stranded copper #4/0 AWG.

D. Grounding Electrode Conductor: Insulated copper, size as indicated.

E. Counterpoise: Bare, tinned stranded, copper, #3/0 AWG.

2. 06 GROUNDING WELL

A. UL 467.

B. Well Pipe: 8-inch diameter by 36-inch long concrete pipe with belled end.

C. Well Cover: Cast iron with legend "GROUND" embossed on cover.

2. 07 GROUND BUS BARS

A. Building Master Ground Bar – MGB:

1. Tin plated copper ground bar.

2. ¼-inch thick.
3. 4-inch wide with two sets of holes drilled and tapped.
4. Minimum 4-foot long unless otherwise indicated on the Drawings.
5. Wall mounted on 2-inch insulated standoffs.

PART 3 EXECUTION

3. 01 APPLICATION

A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

B. In raceways, use insulated equipment grounding conductors.

C. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells.

D. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.

E. Ground Rod Clamps at Test Wells: Use bolted pressure clamps with at least two bolts.

F. Ground Bus Bars: Install in each electrical and communication rooms and elsewhere as indicated.

1. Use insulated spacer; space 1 inch from wall and support from wall 6 inches above finished floor, unless otherwise indicated.
2. At doors, route the bus up to the top of the doorframe, across the top of the doorway, and down to the specified height above the floor.

3. 02 EQUIPMENT GROUNDING CONDUCTORS

A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

B. Install insulated equipment grounding conductors in all raceways. Terminate each end on suitable lug, bus or bushing.

C. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for voice and data cables.

D. Metal Poles Supporting Outdoor Lighting Fixtures: Provide a grounding electrode in addition to installing a separate equipment grounding conductor with supply branch-circuit conductors.

E. Common Ground Bonding with Lightning Protection System: Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

F. Where expansion joints or telescoping joints occur, provide bonding jumpers.

G. Where flexible metallic conduit is employed, provide a green insulated grounding jumper installed in the flexible conduit.

H. Provide grounding bushings on all service and feeder raceways terminating within switchboards, motor control centers, panelboards, cabinets, and all other enclosures. Provide grounding conductors form such bushings to the frame of the enclosure and to the ground bus or equipment grounding strap.

I. Where paralleled conductors in separate raceways occur, provide grounding conductor in each raceway.

3. 03 COUNTERPOISE

A. Ground the steel framework of the structure with a driven ground rod at the base of every corner column and at intermediate exterior columns at distances not more than 60 feet apart. Provide a grounding conductor (counterpoise), electrically connected to each ground rod and to each steel column, extending around the perimeter of the building. Use tinned-copper conductor not less than No. 3/0 AWG for counterpoise and for tap to building steel. Bury counterpoise not less than 18 inches below grade and 24 inches from building foundation.

3. 04 INSTALLATION

A. Ground Rods: Install at least two rods, spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes.

1. Drive ground rods until tops are 6 inches below finished floor or final grade, unless otherwise indicated. Proper driving studs and sleeves shall be used when driving ground rods. Water shall be continuously applied to the ground at point where the rod penetrates during the driving process.

2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.

B. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

C. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

D. Metal Water Service Pipe: Provide insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding clamp connectors. Where a dielectric main water

fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

E. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.

F. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.

G. Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.

H. Install one test well for each service at the ground rod electrically closest to the service entrance. Set top of well flush with finished grade or floor in addition to test well shown on drawings.

3. 05 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.

2. Make connections with clean, bare metal at points of contact.

3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.

4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.

5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable. Use exothermic welded connections for connections to structural steel and for underground connections except those at test wells. Install at connections to ground rods and other electrodes. Comply with manufacturer's written recommendations. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically

noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

E. Connections at Test Wells: Use compression-type connectors on conductors and make bolted- and clamped-type connections between conductors and ground rods.

F. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

G. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

H. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3. 06 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

A. Manholes and Handholes: Install a driven ground rod close to wall and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide a No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, non-shrink grout.

3. 07 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing:

1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.

2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests, by the fall-of-potential method according to IEEE Standard 81. Perform tests on each individual grounding electrode prior to connection to grounding system.

3. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather

and other phenomena that may affect test results. Describe measures taken to improve test results.

a. Equipment Rated 500 kVA and Less: 10 ohms.

b. Equipment Rated 500 to 1000 kVA: 5 ohms.

c. Equipment Rated More Than 1000 kVA: 3 ohms.

d. Manhole Grounds: 10 ohms.

4. Excessive Ground Resistance: If resistance to ground exceeds specified values. Install additional rod electrodes or add additional sections of a sectional type rod as required to achieve specified resistance to ground.

END OF SECTION

SECTION 16123

600 VOLT OR LESS CABLE

PART 1 GENERAL

1. 01 SUMMARY

A. This Section includes requirements for insulated copper stranded conductors and associated connections for general power and control use at voltages below 600 volts.

B. Related Documents: The provisions and intent of the Contract, the General and Supplementary Conditions, and other Specification Sections, apply to the Work as if specified in this Section.

1. 02 REFERENCES

A. ASTM (American Society for Testing and Materials) - B3, B8.

B. NECA (National Electrical Contractors Association) – National Electrical Installation Standards.

C. NEMA WC 5 - Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

D. NEMA WC 26 - (1996) Wire and Cable Packaging.

E. NFPA 70 – (1999) National Electrical Code.

F. UL 83 - (1991; Rev. through Mar. 1996) Thermoplastic – Insulated Wires and Cables.

G. UL 486A – (1991; Rev. Oct. 1991) Wire Connectors and Soldering Lugs for Use with Copper Conductors.

H. UL 510 – (1994) Insulating Tape.

1. 03 QUALITY ASSURANCE

A. Listing and Labeling: Provide wire and cable that are Listed and Labeled as defined in NFPA 70, Article 100 and marked for specific types, sizes, and combinations of conductors and connected items.

B. Comply with NFPA 70. Products shall bear the UL label.

C. Perform work in accordance with codes and standards listed.

D. Wire shall be manufactured within 12 months prior to the date of delivery to the site.

1. 04 SUBMITTALS

A. Data Sheets: Submit as a minimum the following information on each different type

of wire and connector. The information shall be in the form of manufacturer's standard data sheets or drawings.

1. Wire and cable.
2. Conductor material.
3. Conductor gage or MCM.
4. Solid or stranded conductor.
5. Insulation material.
6. Insulation type designation.
7. Insulation temperature rating.

B. Wiring Connectors:

1. Connector type.
2. Connector material.
3. Voltage, amperage, and temperature ratings.
4. Conductor size ranges.
5. Tools required.
6. Picture of connector and tools.
7. Manufacturer's installation instructions.

C. Heat Shrink Material:

1. Type of material.
2. Wall thickness.
3. Voltage and temperature ratings.
4. Conductor size ranges.
5. Tools required.
6. Picture of material and tools.
7. Manufacturer's installation instructions.

D. Insulating Tape:

1. Type of material.
2. Thickness and width.
3. Wire pulling lubricants.
4. Type of material.
5. Types of conductor, insulation and conduit for which it is approved.

E. Megger Test Reports: Indicate values obtained.

F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Codes and Standards.

1. 05 DELIVERY, STORAGE, AND HANDLING

A. Deliver wire and cables according to NEMA WC 26.

PART 2 PRODUCTS

2. 01 BUILDING WIRE AND CABLE

A. Description: UL 83, single conductor insulated wire.

1. Conductor: Copper; 98 percent conductivity; solid for 10 AWG or smaller; stranded for larger than 10 AWG as applicable.

2. Insulation Thermoplastic: 600 volts, NFPA 70, Type THHN/THWN-2, unless otherwise indicated; 90° C.

3. All building wire shall be of the same manufacturer. Do not mix wire of different manufacturer on the same project.

4. General: All wire shall be identified as required by NEC.

5. The insulation on wiring #8 or smaller shall have factory-colored insulation. For wire larger than #8, color-coding shall be colored tape wrapped around the insulation of each wire at each connection, splice and pull box. Each phase conductor of each branch circuit shall be of one color throughout the installation.

   a. Color coding shall be as described in section 16050 "Basic Electrical Materials and Methods".

2. 02 CONTROL WIRE

A. Description: UL 83, single conductor insulated wire.

1. Conductor: Copper; stranded for all sizes.

2. Insulation: Thermoplastic; 600, NFPA 70 Type MTW unless otherwise indicated; 75° C or 90° C as applicable.

3. All control wire shall be of the same manufacturer.

4. Identification: Control wire shall be color-coded throughout. Each wire shall be identified at each terminal and junction point by permanently attaching wire markers indicated the terminal number, etc. Refer to Section 16050 – for Electrical Identification requirements.

2. 03 WIRING CONNECTORS

A. Solderless Spring-Wire Connectors: UL 486A, tool-applied, twist-on type with plastic caps; rated for conductor sizes and material.

B. Compression Connectors and Taps: Mechanical set screw type or tool-applied crimp type. Split bolt connectors are not acceptable.

2. 04 ACCESSORIES

A. Heat Shrink Material: Heavy wall tubing or caps; UL listed as waterproof.

B. Insulating Type: Vinyl type; minimum 7-mil; listed for use as primary insulation and splice jacketing on 600 volt wire and cable.

C. Wire Pulling Lubricants: Compatible with all conductor, insulation and conduit types.

PART 3 EXECUTION

3. 01 PREPARATION

A. Completely and thoroughly swab raceway where moisture and/or dirt has collected inside before installing wire.

B. Do not install wire in conduit, raceways, etc. until they are complete and sealed against the entry of moisture and/or debris.

3. 02 WIRING METHODS

A. Use type THHN/THWN-2 insulation in raceway.

B. Use wiring methods in accordance with the appropriate article of NFPA 70.

C. Connect each circuit of a multi-circuit home run to a different phase.

D. Do not terminate more than one conductor in a single terminal of a lug or connector, unless noted otherwise for lighting control or other control applications.

E. Leave slack conductor at each connection and splice to allow for future additional connections.

3. 03 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install all wiring in raceways. As standard practice, route control conductors in separate raceways from power conductors. When engineering consideration dictates, control conductors may be routed in power raceway under the following conditions:

1. All conductors must have insulation rated for the highest voltage rated insulation in the raceway.

2. The largest power conductor in the raceway is #4 or smaller.

C. Use conductor not smaller than #12 AWG for power and lighting circuits.

D. Use conductor not smaller than #14 AWG for control circuits.

E. Use conductor not smaller than #10 AWG for 20 ampere, 120-volt branch circuits

longer than 115 feet to the furthest outlet.

F. Use conductor not smaller than #10 AWG conductors for 20 ampere, 277-volt branch circuits longer than 265 feet to the furthest fixture.

G. Pull all conductors into raceway at the same time.

H. Use suitable wire pulling lubricant.

I. Use a pulling means such as tape, rope, grips, etc. that will not damage the wire, cable or conduit.

J. Neatly train and lace wiring inside boxes, equipment, cabinets, switchboards, and panelboards with nylon tie straps. Three phase circuits shall be grouped by circuit.

K. Clean conductor surfaces before installing lugs and connectors.

L. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

M. Tighten set screws and bolts on connectors according to the manufacturer's torquing requirements.

N. Use compression connectors for copper conductor splices and taps, 8 AWG and larger. Tape uninsulated conductors and connector with electrical tape to 150 percent of insulation rating of the conductor.

O. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, #10 AWG and smaller.

P. Where splices and taps are made in junction boxes or handholes, etc. below grade, use tool-applied crimp type compression connectors. Insulate the conductors and the connector with heavy wall heat shrink material.

Q. For parallel conductors of a single phase, insure that conductor lengths are equal by actual length comparison before installation.

R. Provide phase testing for proper rotation of all motors.

S. Seal around cables penetrating fire-rated elements according to Division 7 Section "Firestopping."

T. Splices in raceways are not allowed. Splice only in junction or outlet boxes in accessible locations.

U. Wiring at Outlets: Install conductors at each outlet with at least 6 inches of slack.

V. Provide green colored conductor insulation for the entire length of the grounding conductors for wire size smaller than #6 AWG.

W. Provide white colored conductor insulation for the entire length of the neutral conductors for wire size smaller than #6 AWG.

3. 04 IDENTIFICATION

A. Identify wires and cables in accordance with Section 16050.

B. In pull or junction boxes where there is more than one circuit, identify each conductor with its panel and circuit number or other designation indicated on drawings.

3. 05 WIRING TEST

A. Measure the insulation resistance of all feeder conductors using a "Megger." The test voltage shall be 500 volts. Test the conductor without circuit loads applied. The minimum resistance value shall be 1,000,000 ohms.

3. 06 FIELD QUALITY CONTROL

A. Inspect wire for physical damage and proper connection.

B. Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values.

C. Verify continuity of each branch circuit conductor.

END OF SECTION

SECTION 16130

RACEWAYS

PART 1 GENERAL

1. 01 SUMMARY

A. This Section includes rigid metal conduit, intermediate metal conduit, flexible metal conduit, liquid light flexible metal conduit, electrical metallic tubing, rigid PVC conduit, fitting and conduit bodies.

B. Related Documents: Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Specification Sections apply to the work of this Section as if specified herein.

1. 02 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. LFMC: Liquidtight flexible metal conduit.

D. PVC: Polyvinyl chloride.

E. RGS: Rigid galvanized steel.

F. FMC: Flexible metal conduit.

G. EPT: Electrical polyvinyl chloride tubing.

1. 03 SUBMITTALS

A. Data Sheets: Submit as a minimum the following information for each type of conduit, conduit body, fitting and attachment device.

1. Conduit.
    a. Type of material.
    b. Thickness of material.
    c. Types of protective coatings on the outside and inside.
    d. Type of protective coating on threads, if applicable.
2. Conduit Bodies:
    a. Type of material.
    b. Type of cover material.
    c. Type of protective coatings, interior and exterior.
    d. Type of material for screws and gaskets.

3. Conduit Fittings:

   a. Type of materials such as bodies, gaskets, seals, etc.

   b. Threaded.

   c. Compression or set screw type.

   d. Liquid tight.

   e. Concrete tight.

1. 04 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100. Products shall be the UL label.

B. Comply with NFPA 70.

C. ANSI C80.1: Rigid Steel Conduit, Zinc Coated.

D. ANSI C80.3: Electrical Metallic Tubing, Zinc Coated

E. ANSI C80.5: Rigid Aluminum Conduit.

F. ANSI C80.6: Intermediate Metal Conduit (IMC).

G. ANSI/NEMA FB I: Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.

H. NECA: "Standard Installations."

I. NEMA RN 1: Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.

J. NEMA TC 2: Electrical Polyvinyl Chloride (PVC) Tubing (EPT) and Conduit (EPC-40 and EPC-80).

K. NEMA TC 3 – PVC Fittings for Use with Rigid PVC Conduit and Tubing.

L. UL 1: Flexible Metal Conduit.

M. UL 6: Rigid Metal Conduit.

N. UL 6A: Rigid Aluminum Conduit.

O. UL 360: Liquid Tight Flexible Steel Conduit.

P. UL 514B: Fittings for Conduit and Outlet Boxes.

Q. UL 651: Schedule 40 and 80 Rigid PVC Conduit.

R. UL 797: Electrical Metallic Tubing.

S. UL 886: Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations.

T. UL 1242: Intermediate Metal Conduit.

1. 05 COORDINATION

A. Coordinate layout and installation of raceways, and suspension system with other

construction that penetrates ceilings or is supported by them, including light fixtures, communication system, HVAC equipment, fire-suppression system, and partition assemblies.

1. 06 DELIVERY STORAGE AND HANDLING

A. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

B. The threads of rigid steel and IMC shall be protected by factory installed caps.

C. Protect PVC conduit from sunlight.

PART 2 PRODUCTS

2. 01 METAL CONDUIT

A. Rigid Steel Conduit (RSC): ANSI C80.1, RSC shall be threaded, hot dip galvanized inside and outside with a chromate coating outside. Threads shall be zinc coated after cutting. Elbows and nipples shall conform to the same specification.

B. Intermediate Metal Conduit (IMC): ANSI C80.6, IMC shall be threaded, hot dip or electro-galvanized outside with chromate coating. The inside shall be galvanized or coated with paint, zinc, enamel or other corrosion protection material that also provides a smooth, low friction surface. The threads shall be zinc coated after cutting. Elbows and nipples shall conform to the same specification.

C. Rigid Aluminum Conduit (RAC): ANSI C80.5, RAC shall be threaded.

D. Couplings: Couplings shall be threaded, hot dip or electro-galvanized steel with chromate coating and made by the same manufacturer as the conduit.

2. 02 PVC COATED METAL CONDUIT

A. Description: NEMA RN 1, conduit shall be rigid steel, hot dip galvanized inside and outside including the threads. The exterior surface shall be treated prior to coating. Both interior and exterior shall be coated with an epoxy acrylic primer. The exterior shall be coated with a minimum 40-mil thick PVC coating. The interior shall be coated with a nominal 2-mil thick urethane coating. The conduit shall be bendable without damage to either the PVC or urethane coating. The threads shall be coated with a nominal 2-mil thick clear urethane coating. Elbows and nipples shall conform to the same specification.

B. Couplings, Fittings and Conduit Bodies:

1. Couplings shall be galvanized steel and made by the same manufacturer as the conduit.

2. Fittings shall be malleable iron or steel.

3. Conduit bodies shall be copper free cast aluminum or malleable iron with

cast covers and stainless steel screws.

4. All couplings, conduit fittings and conduit bodies shall have the same exterior and interior coatings as specified for the conduit.

5. The exterior PVC material shall form a sleeve extending one pipe diameter or 2 inches, whichever is less, from each female opening of couplings, fittings and conduit bodies.

6. Clamps, U-bolts, and other devices used to secure the conduit shall be malleable iron or steel with the same PVC coating as the conduit.

7. Couplings, fittings, and conduit bodies shall be of the same manufacturer as the conduit.

2. 03 FLEXIBLE METAL CONDUIT

A. Description: UL 1, interlocked galvanized steel.

2. 04 LIQUID TIGHT FLEXIBLE METAL CONDUIT

A. Description: UL 360, interlocked galvanized steel with extruded PVC jacket.

2. 05 ELECTRICAL METALLIC TUBING (EMT)

A. Description: ANSI C80.3, EMT shall be hot dip or electro-galvanized on the outside with a chromate coating. The interior shall be coated with paint, zinc, enamel or other corrosion protection material that also provides a smooth low friction surface.

2. 06 NONMETALLIC CONDUIT

A. Description: PVC; Schedule 80 and 40.

B. Fittings: Fittings shall match conduit type and material and shall be provided by the same manufacturer as the conduit.

C. Cement for connections of conduit and fittings shall be approved by the manufacturer of the conduit.

2. 07 FITTINGS AND CONDUIT BODIES FOR METAL, EMT AND FLEXIBLE CONDUIT

A. Fittings:

1. All fittings, locknuts, bushings, etc. shall be malleable iron or steel.

2. For RSC or IMC, fittings shall be threaded type.

3. For EMT, fittings shall be compression type.

4. Locknuts shall have shape edges that bite into the enclosure when tightened.

5. Bushings shall be high temperature plastic, with insulating throats and grounding lugs where applicable.

6. Hub fittings shall be two-piece, liquid-tight with high temperature, plastic, insulating throats.

7. Fittings used in concrete shall be UL listed as concrete tight.

8. Fittings used in exterior and other damp or wet applications shall be UL listed as liquid-tight.

9. Fittings for flexible metal conduit shall have insulated throats and grounding lugs where applicable.

10. Refer to the PVC coated metal conduit and nonmetallic conduit specifications for fittings used with those types of conduit.

11. Sealing bushings shall have molded neoprene sealing ring with predrilled holes for each conductor, PVC coated pressure discs, stainless steel screws and washers and locking ring where applicable.

B. Conduit Bodies: Conduit bodies shall be malleable iron or cast copper-free aluminum. They shall be threaded type with cast cover and solid gasket. Where used in dry interior applications, provide coated steel screws. Where used in exterior or other damp or wet applications, use stainless steel screws. Conduit bodies 1 ¼ inches and larger shall have rollers or wire guards.

C. Expansion Fittings: Expansion fittings shall be malleable iron or steel with insulator bushing, gaskets, washers, packing, etc. as required to provide a complete unit. Provide a braided copper bonding jumper. The fittings shall be rated for interior or exterior use as applicable.

D. Seal Fittings: Seal fittings shall be malleable iron or cast aluminum, threaded type with packing, sealing compound, plugs, etc. to provide a complete unit. Fittings shall be rated for interior or exterior use as applicable.

E. Deflection Fittings: Deflection fittings shall be hot dip galvanized ductile iron, threaded type with molded neoprene outer jacket, tinned braided copper bonding jumper, molded plastic inter sleeve, stainless steel clamping bands, etc. to provide a complete unit. The fitting shall be rated for interior or exterior use as applicable. Where fittings are used below grade, they shall be PVC coated as specified under PVC coated metal conduit fittings.

PART 3 EXECUTION

3. 01 INSTALLATION

A. Underground Installation:

1. Concrete Encased: Use schedule 40 PVC conduit.

2. Direct Buried: Use schedule 80 PVC conduit.

B. Outdoor Locations, Above Grade: Use coated rigid aluminum conduit and liquid-tight flexible aluminum conduit for connection to motors and control devices.

C. Wet and Damp Locations, Above Grade: Use PVC coated rigid aluminum

conduit, flexible waterproof conduit for connection to motors and control devices.

D. Dry Locations:

1. Concealed in Concrete or Masonry Construction Above Grade, Columns, Walls and Above Suspended Ceilings: Use rigid aluminum conduit, intermediate metal conduit, and electrical metallic tubing.

2. Exposed: Use rigid aluminum, intermediate metal conduit, and electrical metallic tubing.

E. Locations Subject to Physical Damage: Use rigid aluminum conduit or intermediate metal conduit.

F. In Refrigerated or Hazardous Areas: Use rigid aluminum or intermediate metal conduit.

G. Service Entrance Conduit – Underground (600 volts or less): Use schedule 40 PVC with the underground portion encased in a minimum 3 inches of concrete and installed a minimum of 24 inches below grade. Convert PVC conduit to PVC coated rigid steel before rising through the floor slab or grade. The PVC coated rigid steel conduit shall extend a minimum of 6 inches above the floor or grade.

H. Flexible Metal Conduit: Flexible metal conduit shall be installed for:

1. Connections from the conduit system to recessed lighting fixtures, maximum 6 feet in length.

2. Connections to motors, maximum 2 feet in length.

3. Connections to electrical equipment subject to movement or vibration.

I. Liquid-Tight Flexible Metal Conduit: Liquid-tight flexible metal conduit shall be installed for:

1. Connections to motor equipment subject to movement or vibration where exposed to rain, spray, or a corrosive atmosphere.

2. Connections to equipment subject to oil or grease.

3. Connections to control equipment.

J. General Requirements:

1. Install conduit in accordance with NECA "Standard of Installation" and manufacturer's written instructions.

2. Install nonmetallic conduit in accordance with manufacturer's instructions.

3. Minimum Conduit Size: ¾-inch unless otherwise specified.

4. Verify routing and termination requirements and locations of conduit prior to rough-in.

5. Routing and termination of conduits shall be coordinated with structural, equipment, piping and ductwork to assure accessibility to junction and pull boxes.

6. Conduit routing shown on the drawings is diagrammatic unless otherwise dimensioned. Route conduit as specified and as required. Conduit offsets, risers, junction boxes, pull boxes, and fittings are not necessarily shown; however, provide these as required by the conditions involved and applicable codes for a correct and complete installation.

7. Finished Areas: Conceal conduits below floors, within slabs only where indicated, within walls, within pipe chases, above suspended ceilings, and within other building construction, unless otherwise indicated. Conduits shall be run in floor slabs except where otherwise indicated.

8. Unfinished Areas: Install above floor conduits exposed in areas where pipe chases or suspended ceilings are not indicated or concealing is otherwise impractical, in mechanical and electrical equipment rooms, and other unfinished areas.

9. Install conduits run exposed or concealed above ceilings or in walls in straight, level and plumb lines, parallel with and at right angles with beams, wall, ceilings and other building lines.

10. Route conduit in slabs above grade and in and under slabs on grade from point-to-point or shortest practical path.

11. Arrange conduit supports to prevent misalignment during wiring installation.

12. Support individual conduit using coated steel or malleable two-hole conduit straps, lay-in adjustable hangers, clevis hangers, threaded rods with conduit fasteners and split hangers.

13. Group related conduits; support using conduit rack. Construct rack using steel channel; provide space on each for 25 percent additional conduits. Each conduit shall be independently attached to the rack.

14. Fasten conduit supports to building structure. Do not fasten conduit supports to mechanical piping or ducts or their supports.

15. Do not support conduit with the tie wire or perforated pipe straps. Remove wire used for temporary supports.

16. Do not cross conduits in slab.

17. Conduit shall be installed a minimum of 12 inches from steam or hot water piping, flues or any other surface with a surface temperature exceeding 104° F (40° C) run in parallel with the conduit, and a minimum of 6 inches where run perpendicular to the conduit. Conduit shall be installed a minimum of 3 inches from cold or chilled water piping.

18. Cut conduit square using saw or pipecutter; ream and de-burr cut ends.

19. Bring conduit to shoulder of fittings; fasten wrench-tight.

20. When threads are cut in rigid steel or intermediate metal conduit in the field, the conduit and fittings shall be made up immediately. If there are

any showing, they shall be coated with a corrosion resistant compound approved by the conduit manufacturer.

21. When threads are cut in PVC coated rigid steel conduit in the field, the threads shall be coated immediately with a corrosion resistant compound supplied by the conduit manufacturer. When the PVC coating of the conduit is removed or damaged for any reason, the exposed area shall be coated with a PVC compound supplied by the conduit manufacturer. Follow the manufacturer's instructions in applying compounds.

22. Solvent weld nonmetallic conduit and fittings using cement as approved by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fittings. Allow joint to cure as instructed by the manufacturer.

23. Use conduit hubs or watertight fittings to fasten conduit to metal boxes in damp and wet locations.

24. In general, install no more than equivalent of three 90° bends between pull or outlet boxes. For communication conduits, install no more than equivalent of two 90° bends between pull or outlet boxes. Make field-made bends and offsets with hickey or conduit bending machine. Use conduit bodies to make sharp changes in direction, as around beams. Use hydraulic one-shot bender to fabricate or factory elbows for bends in metal conduit larger than 2-inch size. Do not install crushed or deformed conduits. Keep the legs of a bend in the same plane and the straight legs of offsets parallel. For banked runs, all bends and offsets shall be parallel.

25. Avoid moisture traps; provide junction box with drain fitting at low point in conduit system.

26. Provide approved adapters when PVC conduits are coupled to metallic conduits.

27. Where PVC is used underground, a PVC coated rigid steel elbow shall be provided at the point where the conduit turns up. The vertical portion of the riser shall be PVC coated rigid steel conduit.

28. Provide approved fittings that maintain conduit electrical continuity by bonding jumpers or other means to accommodate expansion and deflection where conduit crosses control and expansion joints.

29. Provide seal fittings on all conduits where they rise out of the ground or fill below slabs. If the conduit terminates in a floor mounted metal enclosure such as a switchboard, pull box, etc., provide a sealing bushing with a grounding bushing.

30. Provide seal fittings on all conduits that penetrate exterior walls or to or from interior spaces or other areas where conduit passes from one extreme temperature or moisture situation to another such as walk-in refrigerators, freezers or wash down bays.

31. Install a pull rope in each empty conduit. Pull rope shall be monofilament

plastic having a minimum 200-lb. tensile strength. Leave a minimum of 12 inches of slack at each end of the pull line and securely fasten pull rope to conduit.

32. Where conduits rise through floor slabs, curved portions or bends shall not be visible above the finished slab.

33. Support non-concrete encased underground conduits by laying with full length bearing on firm trench bottoms.

34. Support horizontal and vertical runs of conduit at intervals in accordance with the code for the types of conduit used. In addition, support each riser conduit at each building floor level.

35. Prior to wire pulling, use suitable caps to protect installed conduit against entrance of dirt and moisture and blow out or swab out conduits in which moisture or dirt has collected. Free clogged conduits of obstructions.

36. Ground and bond conduit under provisions of Section 16060 - Grounding and Bonding.

37. Identify conduit under provisions of Section within 16050 – Electrical Identification.

38. Provide all necessary sleeves for conduits and other electrical items passing through concrete and masonry construction where conduit and other electrical items are not installed prior to concrete beams shall be NPS steel pipe or rigid steel conduit, flush with finished concrete surfaces. Sleeves for all conduits passing through the floor shall be galvanized NPS pipe or galvanized rigid steel conduit extending two inches above finished floor, and flush with slab below.

39. Install conduit to preserve fire and smoke resistance rating of partitions and floors.

40. Route conduit through suitable roof flashing devices. Coordinate with roofing installation.

41. Provide insulating bushings on all feeder conduits.

42. Provide code size pull boxes, in accessible locations, in all conduits where the number and degree of bends exceed the code limitations and every 150 feet maximum for long straight runs.

43. All conduits that are stubbed out below grade shall have a threaded, watertight cap installed on the end.

44. Conduits shall be located so as not to hinder access to mechanical and electrical equipment through the ceiling tiles.

45. Exposed suspended conduits shall be located as to provide proper headroom as required by OSHA regulations.

46. Conduit runs shall be complete before conductors are installed in them.

47. Tighten set screws of threadless fittings with suitable tools.

48. Terminations:

    a. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.

    b. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.

49. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches of slack at each end of pull wire.

50. Control System Raceways, 2-Inch Trade Size (DN 53) and Smaller: In addition to above requirements, install raceways in maximum lengths of 150 feet (45 m) and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.

51. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

    a. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.

    b. Where otherwise required by NFPA 70.

52. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.

53. Flexible Connections: Use maximum of 72 inches of flexible conduit for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections.

54. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying raceways to receptacle or fixture ground terminals.

3. 02 EXCAVATION AND BACKFILL

A. Excavate and backfill as required for the electrical work (coordinate with

utilities). Cut bottoms of trenches to the proper lines and grades to provide firm and continuous support for the underground electrical work, and to provide 24-inch MINIMUM depth or as required by the NEC if more than 24 inches from finished grade to tops of all exterior underground electrical work. Sheet and brace excavations as required to protect personnel and adjacent structures.

1. After the underground electrical work has been installed and approved, place all backfill in 8-inch maximum thickness loose layers, and compact each layer to at least the density of the adjacent undisturbed site soil, using pneumatic or other suitable power tampers. Mass backfilling (backfilling without tamping) is prohibited.

2. Warning tape for buried electrical work: Install detectable warning tape directly over every device by burying tape as close to the surface as possible, but no less than 6 inches beneath finish grade. One strip of warning tape shall be placed parallel and directly above the conduit. Where conduits are banked and the width of the conduit bank is over 12 inches, strips shall be placed parallel, on 12-inch centers, centered directly above the conduit bank.

B. Conduits Embedded in Slabs:

1. Conduits shall be installed in slabs only where indicated.

2. Install in middle third of the slab thickness where practical, and leave a minimum of 1-inch concrete covers.

3. Do not stack conduits.

4. Outside diameter of the conduit shall not exceed 1/3 of the slab thickness.

5. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.

6. Space raceways laterally to prevent voids in the concrete. Conduits shall be spaced no closer than 3 diameters on center except at cabinet locations.

7. Run conduit larger than 1-inch trade size parallel to or at tight right angles to main reinforcement. When at right angles to reinforcement, place conduit close to slab support.

3. 03 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, and finishes are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3. 04 CLEANING

A. After completing installation of exposed, factory-finished raceways, inspect exposed finishes and repair damaged finishes.

END OF SECTION

SECTION 16500

LIGHTING FIXTURES AND POLES

PART 1 GENERAL

1.01 WORK INCLUDED

A. The work included under this Section consists of furnishing and installing the lighting fixtures, including all related systems and accessories, as shown on the Drawings and hereinafter specified.

1.02 SUBMITTALS

A. Product Data: Submit manufacturer's product data on each lighting fixture, pole and pole foundation.

PART 2 PRODUCTS

2.01 MATERIALS

A. Products: Refer to Lighting Fixture Schedules on the Drawings for products.

B. Each lighting fixture shall have been tested and certified for proper operation by the fixture manufacturer for the type of environment and mounting on in which it is to be installed.

C. All high intensity discharge lamp ballasts shall be constant wattage or auto-regulator, high power factor type and internally fused.

D. All fixtures shall bear the UL label.

PART 3 EXECUTION

3.01 INSTALLATION

A. Lighting fixtures shall be installed as indicated on the Drawings.

B. No wiring splice or tap shall be located within an arm, stem, etc., used for support of lighting fixture. Wire shall be continuous from splice in outlet box to lamp socket, or to ballast terminals.

C. Coordinate with other electrical work as appropriate to properly interface installation of interior lighting fixtures with other work.

D. Fasten fixtures securely to indicate structural support and check to ensure that fixtures are plumb.

E. Lighting fixtures in suspended ceilings shall be supported from building structural members and NOT from ceiling suspension system.

3.02 ADJUST AND CLEAN

A. Clean interior lighting fixtures of dirt and debris upon completion of installation.

B. Protect installed fixtures from damage during remainder of construction period.

3.03 FIELD QUALITY CONTROL

A. Upon completion of installation of interior lighting fixtures, and after building circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then re-test to demonstrate compliance; otherwise, remove and replace with new units, and proceed with re-testing.

3.04 GROUNDING

A. Provide tight equipment grounding connections for each lighting fixture installation where indicated.

END OF SECTION

SECTION 16501
LAMPS

PART 1 GENERAL

1.01 WORK INCLUDED

A. The work included under this Section consists of furnishing and installing the lamps, including all related systems and accessories, as shown on the Drawings and hereinafter specified.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Products: Provide lamps by one of the following manufacturers:

1. General Electric Company.

2. G.T.E. Sylvania.

3. N.A. Phillips Company.

2.02 MATERIALS

A. High pressure sodium lamps shall be clear with a rated life of 20,000 hours. Lamps shall be operated through a ballast designed to the lamp wattage and supply voltage as indicated on the Drawings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Lamps installed in lighting fixtures shall be as specified in the fixture schedule on the Drawings and as specified herein. All lamps shall be operating at the time of final inspection.

B. At the time of Final Acceptance, replace lamps in all lighting fixtures that are observed to be noticeably dimmed after Contractor's use and testing, as judged by Engineer. Furnish stock or replacement lamps amounting to 20% (but not less than one lamp in each case) of each type and size lamp used in each type fixture. Deliver replacement stock as directed to Department's storage space.

END OF SECTION

SECTION 16601
LIGHTNING PROTECTION SYSTEM

PART 1 GENERAL

1.01 WORK INCLUDED

A. Furnish and install a structure lightning protection system. Extent of lightning protection system work is indicated on Drawings.

1.02 QUALITY ASSURANCE

A. Lightning protection system shall be furnished and installed in compliance with the provisions of the following:

1. National Fire Protection Association (NFPA):

   a. NFPA 780 Lightning Protection Code.

2. Underwriters Laboratories, Inc. (UL):

   a. UL 96A Standard for Safety Installation Requirements for Lightning Protection Systems.

B. Each item shall be certified by UL, be labeled with UL Seal of Approval, and provided with marking in accordance with referenced standard.

C. Lightning protection system shall bear the UL Master Label. Locate the Master Label adjacent to the main distribution panels in the Electrical Room. Provide separate Master Label for the Generator Building.

D. Work shall be performed by an accredited lightning protection installer.

1.03 SUBMITTALS

A. Product Data: Submit properly identified manufacturer's specifications and catalog data for review on materials, connections, fastenings, and method of installation.

B. Shop Drawings: Submit a roof plan and a ground floor plan with all equipment properly dimensioned.

C. Submit test reports.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Products: Provide all lightning protection system components by one of the following manufacturers:

1. ERICO, Inc.

2. Harger Lightning Protection, Inc.

3. Heary Bros. Lightning Protection Co.

4. Thompson Lightning Protection Systems, Inc.

2.02 MATERIALS

A. Air Terminals: Nickel tipped copper or solid aluminum as required for compatibility with roof material, 1/2" diameter; 18" minimum length or as required to project minimum 12" above roof parapet.

B. Air Terminals Bases on Concrete Roof: Cast bronze or aluminum (as required) with bolt pressure cable connections and shall be securely mounted with adhesive approved by both lightning protection system manufacturer and tank manufacturer.

C. Air Terminals Bases on Pipe/Rail: Cast bronze or aluminum (as required) with bolt pressure cable connections and shall be securely mounted with stainless steel screws or bolts.

D. Roof Conductors:

1. Class I - Stranded copper, 7/16" diameter, 215 lbs. per 1,000 feet. Roof conductors shall be compatible with roof material.

E. Down conductor shall be Class I - Stranded copper, 7/16" diameter, 215 lbs. per 1,000 feet.

F. Secondary Conductors:

1. Standard copper, 1/4" diameter, 92 lbs. per 1,000 feet.

G. Bonding Devices, Cable Splicers and Miscellaneous Connectors: Cast bronze or aluminum (as required) with bolt pressure connections to cable. Where aluminum-to-copper connection is required, use bi-metallic connectors and fittings.

H. Ground Rods: Copper-clad steel, nominally 20 feet long, 3/4" diameter.

I. Miscellaneous Materials: All bolts, nuts and screws shall be brass, bronze or stainless steel.

PART 3 EXECUTION

3.01 INSTALLATION

A. All connectors and fitting shall be compatible for use with the conductor and the surfaces on which they are installed.

B. Care shall be exercised in maintaining moisture, corrosion and structural integrity of roof and parapet, including roof warranty requirements. Coordinate work with roofing installer.

C. Plastic conduits for down conductors shall be installed in poured concrete columns (if required).

D. Down lead cables shall not be brought through roof.

E. Install conductors avoiding radius bends of less than 8 inches.

F. All major rooftop equipment and isolated metal bodies within 6 feet of system conductors shall be bonded to lightning protection system's main roof conductor with secondary conductors and appropriate bonding devices.

G. Ground rods shall be installed such that top is 3 feet below finished grade, a minimum of two (2) feet away from building. Ground rod resistance shall not exceed 10 Ohms. The resistance of the grounding system shall not exceed 3 Ohms.

H. Lightning protection system shall be bonded to the Main System Ground.

3.02 TESTING

A. Each new ground rod shall be tested individually to ensure the maximum resistance-to-ground shall not exceed 10 ohms, and every rod that fails the test shall be driven deeper, using additional lengths of ground rod if necessary, until the required resistance is achieved. Upon completion of installation of electrical grounding and bonding systems, test ground resistance-to-ground with ground resistance tester. Complete grounding system resistance-to-ground shall not exceed 3 ohms. Where tests show resistance-to-ground exceeds 3 ohms, take appropriate action to reduce resistance to 3 ohms or less, by driving additional ground rods; then retest to demonstrate compliance. Install rods at least 8 feet apart.

END OF SECTION

DIVISION 17
INSTRUMENTATION

SECTION 17010
INSTRUMENTATION

PART 1 GENERAL

1.01 DESCRIPTION

A. Provide elements of process instrumentation, auxiliary equipment, and supplies.

B. The requirements specified in the Conditions of the Contract, Division 1 apply to this Section.

C. Refer to Electrical sheets for Instrumentation, raceway and wiring. Refer to Mechanical sheets for sensors and control components.

D. The work shall include, but not necessarily be limited to:

1. Furnish and install a differential pressure transmitter with a 4-20 mA output to measure the water level in the new tank.

2. Furnish and install two new strap-on transit time flowmeters with transmitter and 4-20 mA output.

1.02 RELATED WORK

A. Section 02001 – Special Provisions to Division 2

B. Section 02615 – Ductile Iron Pipe and Fittings

C. Section 13200 – Prestressed Concrete Tank

D. Division 16 - Electrical

1.02 SUBMITTALS

A. The submittals shall be in accordance with Division 1, Section 01340, as well as include the following:

1. Manufacturer's data.

2. Shop drawings.

3. Certificates of compliance.

4. Certified test reports.

5. Operation and maintenance manuals.

1.03 QUALITY ASSURANCE

A. Manufacturer. Instrumentation, control and monitoring equipment furnished shall be manufactured by a firm regularly and currently engaged in the design and manufacture of similar equipment. Equipment furnished shall be new and of current design.

B. Maintainability. Equipment shall be designed for ease of maintenance and repair, and access to critical parts shall not require a major disassembly. Internal field adjustments where permitted or required herein shall be easily accessible upon removal of a panel or cover.

C. Materials and Installation shall comply with the requirements of the referenced electrical codes and standards, and the codes and standards referred to shall be used for establishing the minimum quality of the materials and equipment supplied and installed. Equipment of the same type shall be a product of the same manufacturer. Capacities of equipment shall not be less than that indicated on the drawings or specified.

D. All exterior mounted instruments shall be furnished with appropriately sized rain shields.

1.04 TOOLS AND SPARE PARTS

A. Provide one (1) set of all special tools required for normal operation and maintenance shall be provided.

B. Provide one (1) set of factory recommended spare parts. All spare parts shall be properly protected for long term storage and packed in containers which are clearly identified with indelible markings on the outside as to contents.

1.05 SERVICE

A. The Contractor shall arrange for the Instrumentation Manufacturers to provide an authorized factory trained representative as required for the purpose of supervising installation, start-up, final field acceptance testing. Instruction of the Owner's operating personnel in the proper operation and maintenance of the equipment furnished under this section shall also be provided.

PART 2 PRODUCTS

2.01 DIFFERENTIAL PRESSURE TRANSMITTER (i.e, TANK LEVEL)

A. The differential pressure transmitter for tank level shall be Model 3051CD as manufactured by Rosemount or approved equal.

B. Performance

1. Reference accuracy of ± 0.065% of span for spans greater than 10:1 of upper range limits (URL)
2. Five year stability of ± 0.125% of URL

C. Function

1. Pressure Range: 1000 in H_20
2. Output: Smart, 4-20 mA dc, user selectable for linear or square root output. Digital process variable superimposed on 4-20 mA signal available to any host that conforms to the HART protocol.
3. Power Supply: 10.5 to 55 V dc with no load

D. Physical

1. Electrical Connections: ¼-14 NPT, PG 13.5, g ½, and M20 x 1.5 (CM20) conduit. The Hart interface connections fixed to the terminal block.
2. Wetted Materials:
   a. Isolating Diaphragm: 316L stainless steel
   b. Drain/Vent Valves: 316 stainless steel
   c. Process Flanges and Adapters: 316 stainless steel
   d. Wetted O-Ring: Glass-Filled PTFE
3. Housing Material: Polyurethane covered aluminum
4. Process Connections:
   a. ½-14 NPT (flange adapter)
   b. Side drain/vent valve
5. Fill Fluid: Silicone
6. Meter: LCD display
7. Mounting Bracket: Stainless steel w/ stainless steel anchor bolts for mounting to boss on new tank.

2.02 TRANSIT TIME FLOWMETER

A. Flowmeter shall be a transit time flowmeter, model Vantage 4400-AS1 by Eastech Badger, model DCT6088 by Thermo Scientific (formerly Polysonics), or approved equal.

B. Performance

1. Rangeability of 40 to 0.1 ft/sec
2. Turndown of 400:1
3. Repeatability of 0.25%
4. Accuracy of ±1% of actual flow

C. Sensors

1. Sensors shall be strap-on and shall not penetrate the pipe. Sensors shall be rated for buried and submerged.
2. A V-Shot style sensor mounting (i.e., mounting on only one side of pipe) shall be utilized. Flowmeter with sensors mounted on both sides of the pipe will not be accepted.

D. Transmitter

1. Transmitter shall be NEMA 4X.
2. Transmitter shall have one 4-20 mA output, one relay, and a RS232 serial interface.
3. Display shall be backlit LCD.
4. Data logging capability with non-volatile flash memory and storage up to 30,000 records.

E. Flowmeter shall be appropriate for 24" effluent ductile iron pipe, reclaimed water, 100 psi max pressure, and unidirectional flow.

2.03 TRANSIENT PROTECTION/SURGE SUPPRESSION DEVICES

A. Surge and transient protection devices shall be provided for 4-20 mA loops where not provided by panel originating loop. They shall be two-stage units incorporating gas tube and electronic clamping. Either polarity in surges shall be equally protected. The protection devices shall provide long life, reliability and easy mounting. Surge protection devices for 4-20 mA loops shall add no more than 50 ohms to the circuit and provide impulse clamping levels of 100V maximum for line-to-line and 50V maximum for line-to-ground. Surge protection devices for instrument loops of 4-20 mA shall be Model 1669-02 as manufactured by Joslyn Electronic Systems Corporation.

PART 3 EXECUTION

3. 01 GENERAL

A. Install all system components in accordance with the Drawings, manufacturers' recommendations, and approved Shop Drawings. Provide all necessary

interconnection, services, and adjustments necessary for a complete, operational and fully functional system.

B. All electrical work shall be accordance with NEC and Division 16 of these Specifications. Install all control wiring / cabling, without splices between terminal points. Group, bundle, train and route wires and cables, as required for a neat and professional looking wiring / cabling system in accordance with the best practice known to the industry.

C. All wires entering / exiting control enclosures shall be terminated on terminal blocks. All terminal blocks shall be permanently, legibly labeled with the unique identification number of the wire terminated thereon.

D. Maintain a minimum 6-inch separation between descrete I/O wiring and analog cabling / wiring. Provide separate plastic wireways to segregate discrete I/O wiring from analog I/O cabling / wiring.

E. Provide surge protection on all control and control power circuits routed outside of the control cabinet. Surge protection shall be per data transmission equipment manufacturer's requirements. Surge protection shall consist of surge suppressors, transient protectors and optical isolated relays as applicable.

F. All field-mounted instruments shall be protected and isolated from vibration, temperature extremes, radiant heat, rain, sleet or falling water, and similar adverse conditions.

G. Field mounted elements shall be marked with data required for calibration such as location of adjustments, span, offset, zero suppression, and test voltages. If such data are not provided in permanent markings or on the manufacturer's nameplate, a durable tag or label shall be affixed in a protected location that will become readily visible in the normal course of servicing the instrument.

3. 02 SEQUENCE OF OPERATIONS

A. This Sequence of Operations is for informational purposes only. Refer to Sheet I-1 for a schematic. Refer to electrical drawings for conduit and wire to be furnished and installed by Contractor. All programming to be performed by Manatee County.

B. The 10 MG tank controls are to provide automatic storage of excess effluent reuse water during low demand periods and release stored reuse water during periods of high demand. An existing analog level indicator in the existing High Service Pump Station (HSPS) Wet Well provides level to the existing SCADA system and will be used to trigger the following procedures.

1. Filling 10 MG Tank
When the water level in the HSPS wetwell reaches the "High-High" mark, the Pressure Sustaining and Pressure Reducing (PS/PR) valve and fill Flow Control Valve (FCV) will be activated. The fill FCV will modulate based on a level sign received from the wetwell through the PLC in an attempt to maintain the water level at "Normal" level. Should the water level reach the "Low" level, the PS/PR and fill FCV valves will be deactivated.

2. Returning Effluent from the 10 MG Tank
When the water level in the HSPS reaches the "Low-Low" mark, the return FCV will be activated. The return FCV will modulate based on a level sign received from the wetwell through the PLC in an attempt to maintain the water level in the wetwell at "Normal" level. Should the water level reach the "high" level, the return FCV will be de-activated.

3. Over-rides
If the water level in the 10 MG Tank is at a "high-high" level, any signal to activate the PS/PR and fill FCV will be overridden. This override will stay in effect until the water level in the Tank is reduced to the "High" level or lower.

If the water level in the 10 MG Tank is at "low-low", any signal to activate the return FCV will be over-ridden. This over-ride will stay in effect until the water level in the Tank reaches "low" level or higher.

4. In the case that the 10MG tank is "full" and the WWTP production exceeds the reuse demand, the excess reuse water will overflow into the Existing North Storage Pond.

3. 03 EXAMINATION

A. Verify that systems are ready to receive work.

3. 04 INSPECTION

A. Inspect work in progress for compliance with manufacturer specified tolerances.

3. 05 DELIVERY, STORAGE AND HANDLING

A. Provide factory shipping cartons for each piece of equipment and control device. Provide factory applied plastic end caps on each length of pipe and tube. Maintain cartons and end caps through shipping, storage and handling as required to prevent equipment and pipe-end damage, and to eliminate dirt and moisture from equipment and inside of pipe and tube. Store equipment and materials inside and protected from weather.

3. 06 IDENTIFICATION

A. Piping and Cabling / Wiring: Tag control piping and cabling / wiring at each end and at accessible junction points as specified herein, in accordance with Division 16. Develop and apply a logical alphanumeric identification scheme uniquely identify each wire / cable. The unique identification should relate the wire to the programmable logic controller, the I/O card and the type of device to which the wire is connected.

3.07 EQUIPMENT TESTING AND CALIBRATION

A. General: Provide Construction Manager-approved operation and acceptance testing of the complete system. The Resident Engineer's representative will witness all tests.

B. Factory Tests and Calibration. All field-mounted elements shall be factory-tested by the manufacturer to assure satisfactory performance prior to shipment to the job site. Whenever possible, this shall include calibration to the actual range and conditions of use. Calibration shall be traceable to the National Bureau of Standards with an uncertainty not more than 1/2 of the specified or claimed accuracy of the instruments.

C. Field Calibration. Field mounted elements which were not calibrated to final working values of range, span, and zero suppression at the factory shall be so calibrated prior to or at the time of installation. This calibration shall meet the same requirements of accuracy and traceability required for factory testing above. The engineer shall be given 48 hours notice and the opportunity to witness this calibration.

D. Field Test: When installation and field calibration is complete, verify transmission media operation before the system is placed on-line. Provide a detailed crosscheck of each sensor within the system by making a comparison between the reading at the sensor and a standard traceable to the National Bureau of Standards. Provide a crosscheck of each control point within the system by making a comparison between the control command and the field-controlled device. Submit the results of functional and diagnostic tests and calibrations to the Engineer for final system acceptance.

END OF SECTION

SUPPLEMENTAL INFORMATION
GEOTECHNICAL REPORT

TEST LAB INC.
GEOTECHNICAL & MATERIALS
ENGINEERING, TESTING & INSPECTION

May 26, 2009
(Revised 08/10/2009)

URS Corporation Southern
7650 Courtney Campbell Causeway
Tampa, Florida 33607

Attention: Mr. David Wilcox, P.E.

Reference: Report of Subsurface Exploration
Southwest Water Reclamation Facility
New 10 MGD Storage Tank
Manatee County, Florida
URS Job Number 12008554.00005
Test Lab Project No: 09-3479

Dear Mr. Wilcox:

As authorized, a subsurface exploration was performed for the proposed 10 MGD storage tank structure planned for construction at the referenced site located in Manatee County, Florida. The proposed field exploration consisted of performing five (5) exploratory borings in the proposed tank footprint. The following report briefly describes the field test procedures used for this study and presents the findings, an engineering evaluation of the subsurface conditions and geotechnical recommendations for the proposed structure.

The subsurface test data revealed inconsistent old fill conditions that will require special attention during the construction phase, to provide proper foundation support for the proposed structure. These recommendations are by no means the only possible solutions. However, in our professional opinion it appears to be the most practical.

The upper 5 feet of old fill and possible fill will need to be undercut and replaced. The excavated soils can be reused as structural fill material for backfill operations. The slightly clayey materials encountered may require moisture conditioning to obtain proper compaction. Upon completion of the excavation the exposed subgrade soils will need to be compacted to 98% of Modified Proctor (ASTM D-1557) maximum dry density prior to the placement of fill materials. The proposed construction area will require dewatering prior to excavation of the old fill and all fill material placement will be performed in the dry. Dewatering should extend to a minimum depth of 3 feet, below proposed depth of excavation and verified through the placement of piezometers.

It is anticipated that the structure will settle approximately 1.25 inches and reference points will need to be established at the start of construction and monitored through the completion of construction, during the first water loading cycle and one (1) year there-after in one month increments.

The above recommendations are provided as an overview and should not be implemented without a complete review and understanding of the following report.

Test Lab, Inc. appreciates the opportunity to have been of service. If there are any questions concerning this investigation, or if we may be of any further assistance, please do not hesitate to contact us.

Respectfully submitted,

Test Lab, Inc.

Gilberto Ramos, P.E. 08/10/09
Florida Registration No. 48574

Copies Submitted: (3) Client

Appendix A: Site Plan
Appendix B: Boring Logs (B-1 thru B-5)
Soil Legend
Appendix C: Sieve Analysis
Appendix D Double Ring Infiltrometer Test

1. EXPLORATION PROGRAM

Five (5) exploratory borings were performed with a truck-mounted CME-45B drilling rig at the locations shown on the accompanying Boring Location Plan, Appendix A. Conventional rotary drilling procedures were utilized along with a bentonite drilling fluid to stabilize the boreholes. Standard penetration tests were performed and split-barrel soil samples obtained at intervals of 2 feet to a depth of 10 feet and intervals of 5 feet thereafter. The following is a brief description of this field test procedure.

The exploratory borings were performed in accordance with ASTM Specification D-1586, entitled "Standard Method for Penetration Test and Split-Barrel Sampling of Soils." After drilling to the required depth and cleaning the bore hole, the sampler (2" O.D.) was driven 18 or 24 inches into the undisturbed soil by a 140-pound drop-hammer falling 30 inches. The number of blows required to drive the sampler the second and third 6-inch increments is known as the "Standard Penetration Resistance" (N). The numerals in parentheses below the 'N' values are the blow counts for each of the 6-inch increments that the split-barrel sampler was driven. The various soils encountered in the borings were visually classified in the field and representative soil samples obtained for further examination by a geotechnical engineer and laboratory testing. The soils encountered in the borings were classified utilizing the "Unified Soil Classification System." At the completion of the drilling operations, the boreholes were sealed and grouted in accordance with Southwest Florida Water Management District regulations.

One (1) hand auger boring was performed at boring location B-2 to probe for utilities prior to commencing mechanical drilling operations. The hand auger boring was performed by advancing a 3¼ inch diameter bucket auger in small increments into the ground. As each type of soil was encountered its depth interval was recorded. Representative samples of the soils found in the auger boring were obtained and sealed in glass jars. At the completion of the field operations, the soil samples were transported to our laboratory and examined by a geotechnical engineer. The soils revealed by the borings were classified using the "Unified Soil Classification System."

The data obtained from the borings are presented on the accompanying logs, Appendix B. Also attached is a legend explaining the classification terms and symbols used on the logs.

One (1) double-ring infiltrometer test (DRI) was performed. The DRI test was conducted in accordance with ASTM Procedure D-3385. An infiltration rate of 14.75 inches/hour was documented. The data obtained from the DRI test is attached.

2. SITE CONDITIONS

The Southwest Water Reclamation facility is generally located at 5101 65th Street West, Bradenton, Manatee County, Florida 34210, south of the intersection of Cortez Street West and 66th Street West in Bradenton, Manatee County, Florida. The site is located within Section 8, Range 17 E, and Township 35 S in Manatee County, Florida. The existing plant facility structures occupy the west, south, southeast and southwest portion of the property and the area to the north is undeveloped land. Refer to Appendix A for the "Boring Location Plan," Sheet 1 of 1.

3. SUBSURFACE CONDITIONS

The following is a generalization of the subsurface conditions revealed during the field exploration.

Proposed 10 MGD Water Storage Tank (Borings B-1 through B-5)

Borings B-1 through B-5 typically encountered cohesionless fill and/or possible fill soils consisting of loose to very firm dark gray-brown and gray-brown fine SAND and slightly clayey fine SAND from existing subgrade elevation to depths of 4.0 feet to 6 feet, underlain by dense to very firm to loose light gray-brown slightly silty fine SAND with shell from 35 feet to 47 feet. Underlying the cohesionless material stiff to very stiff cohesive green-gray-brown and light gray-brown fine sandy CLAY was encountered from 47 to 67 feet. Beneath the cohesive soils, hard to very hard gray-brown fine sandy calcareous CLAY (Weathered Limestone) was encountered from 67 feet to boring terminal depths of 80 feet. With exception that Boring B-5 was terminated at 50 feet and a weathered limestone layer was encountered from 42 feet to 47 feet in borings B-1 and B-4. Characteristically, the weathered limestone was more like soil than rock. Casing was used up to depths of 50 to avoid losses of drilling fluid in the shell layer.

4. GROUND WATER CONDITIONS

The water table was encountered at depths ranging from 2.8 to 4.3 feet. Fluctuations of the water table should be expected during the year due to local amounts of rainfall, site development, tidal fluctuations and other factors. The United States Department of Agriculture "Soil Survey of Manatee County, Florida" indicates that the shallow soils at the northern end of the site are composed of EauGallie fine sands. According to the soil survey, seasonal high ground water for this type of soil can range between 10 and 40 inches below the existing ground elevation.

Based on the exploration data, our estimate of the normal seasonal high ground water conditions expected in the proposed construction area of the property are summarized in the following table.

Boring	Measured Water Depth Below Existing Grade	Estimated SHWT
B-1	4' 3"	2' 3"
B-2	3' 6"	1' 6"
B-3	3' 0"	1' 0"
B-4	2' 8"	0' 8"
B-5	3' 0"	1' 0"

5. LABORATORY TESTING

Five (5) soil samples obtained from the field testing program were selected for Atterburg Limits (ASTM D-1557) testing, particle size analysis of soils (ASTM D-422-98), natural moisture content and specific gravity. The following table summarizes the laboratory test results for the Atterburg Limits test results:

Boring #	Depth (ft)	W (%)	γ_d (pcf))	G_s	Atterberg Limit			Sand	Silt	<0.005 mm Clay	C_c	C_r
					LL	PL	PI					
B-1	8.0-12.0	16.9	-	2.71	NP	NP	NP	-	-	-	-	-
B-1	42.0-47.0	27.7	-	2.81	41	29	12	-	-	-	-	-
B-1	52.0-57.0	46.4	-	-	66	24	74	-	-	-	-	-
B-2	32.0-37.0	28.6	-	2.67	NP	NP	NP	-	-	-	-	-
B-5	17.0-22.0	27.2	-	2.74	NP	NP	NP	-	-	-	-	-

The data obtained from the laboratory tests are presented in Appendix C.

6. STRUCTURE DESIGN DATA

The foundation conditions were evaluated by comparing the subsurface characteristics of this site with previously made correlations of such data and foundation stabilities that have been developed for similar conditions. The following presents discussion regarding the expected structural characteristics of the proposed tank.

Proposed 10 MGD Storage Tank

The new 10 MGD storage tank will be constructed on the southwest end of the property. The 10 MGD storage tank will have an approximate diameter of 200 feet. The new storage tank will bear approximately at existing ground surface elevation. The tank will have a total depth of approximately 45.0 feet. The tank will transmit a stress of approximately 3.0 ksf to the subgrade.

7. EVALUATION

A. General

The exploratory borings revealed variable subsurface conditions. The following sections will provide evaluations for the proposed 10 MGD storage tank.

Proposed 10 MGD Storage Tank

The field exploration revealed one subsurface condition of concern. That is, the very loose old fill soils encountered form existing subgrade elevation to a depth of 5 feet at all the borings. Based on these conditions the footprint area of the storage tank, needs to be undercut to a minimum depth of 5 feet and to a minimum distance of seven (7) feet beyond the exterior foundation and compacted with a heavy drum-type vibratory compactor to 98% of Modified Proctor maximum dry density and back fill the excavation with the fill materials compacted to 98% of Modified Proctor maximum dry density. The undercut soils can be used as structural fill. A settlement monitoring program will need to be established prior to commencing construction and measurements reported on a regular basis. Dewatering will be required to a minimum depth of 3 feet below the excavation bottom.

8. RECOMMENDATIONS

A. General

The proposed construction area should be cleared of all construction debris. Any buried utility lines not needed for the new additions should be removed and the excavations backfilled with suitable, compacted soil as outlined in the "Fill Requirements" section of this report.

B. Site Preparation

Proposed 10 MGD Storage Tank

The cleared tank area should be excavated to a minimum depth of 5 feet below existing subgrade elevation and to a minimum distance of seven (7) feet beyond the exterior foundation, a heavy drum-type compactor having a minimum static weight of 20,000 pounds. Proof-rolling of the tank area, to seven (7) feet beyond construction lines, should consist of at least 10 complete passes by the compaction equipment. It is recommended that the proof-rolling operation be observed under the supervision of the geotechnical engineer or his representative to provide assurance that the minimum recommended number of passes be applied. The compactor should be operated at a speed less than 1 mph. Compaction should continue until the soil 1 foot below the compaction surface attains a density of at least 98 percent of the maximum dry density as indicated by the Modified Proctor compaction test (ASTM D- 1557). Backfill the excavation in 12 inch loose lifts compacted to 98% of the maximum dry density as indicated by the Modified Proctor Compaction (ASTM D-1557).

9. Ground Water Control

Dewatering will be required during site preparation based on the ground water levels encountered during field operations. A well-point dewatering system is usually the most effective method to control ground water levels. Well point dewatering, should extend to a minimum of 3 feet below the bottom of the excavation and the water elevation verified with piezometers.

10. Fill Requirements

Fill required for the project should be suitable material, which is placed in thin, properly compacted lifts. Material to be used for fill should be an inorganic soil of low plasticity, preferably clean sand containing less than 10 percent of the material passing a No. 200 sieve. Fill beneath foundations and floor slabs should be compacted to at least 98 percent of the maximum Modified Proctor dry density.

The permissible thickness of fill lifts will depend upon both nature of the fill material and the type of compaction equipment used. When clean sand is used for fill, lifts up to 12 inches in thickness may be placed if heavy drum-type vibratory compaction equipment can be used, since vibratory compaction can not be used within 20 feet of existing structures, whereas lifts should be limited to a maximum of 8 inches in thickness if either the fill is slightly cohesive or medium-weight drum-type vibratory compaction equipment is used. In restricted working areas, such as when backfilling around foundations or in service

line trenches beneath slabs-on-grade or pavement, light-weight manually-guided compaction equipment may be used. But when such light equipment is used, lifts of fill should be limited to a maximum of 4 inches in thickness.

11. Foundation Design

When the proposed construction areas have been prepared as recommended, a shallow foundation system may be used to support the structures. The buildings and/or tank foundations may be designed utilizing a maximum allowable net soil bearing pressure of 3,500 psf. Prior to the placement of foundation steel and concrete, the bottom of foundation excavations should be compacted to redensify the soil loosened by the excavation process.

Field density tests should be taken to verify that the subgrade is adequately proof-rolled and that all fill and backfill are properly placed and compacted. We would be pleased to provide the necessary engineering inspection and quality control testing of the subgrade preparation, backfill and fill densification, concrete and other construction materials, should you so desire.

12. Settlement Considerations

Settlement analyses and consolidation settlement were calculated for the proposed structure. Based on the site preparation and foundation design recommendations made in this report, it is estimated that the differential settlements within the structures should be less than 0.75 inch within 100 feet.

13. Field Settlement Observation Program

A field settlement observation program is necessary to ensure that the methods and equipment used are adequate and compatible and that mat foundations perform satisfactorily with the settlement calculations and are capable of safely and adequately supporting the design load. It is recommended that at least two locations for each proposed structure be marked to performed field settlement observations. It is recommended that the field settlement program be performed under the supervision of the geotechnical engineer or his representative. The field measurements need to be obtained by a licensed Registered Land Surveyor in the State of Florida and/or the surveyor's designee.

LIMITATIONS

This foundation study was undertaken for design purposes only. Generally accepted geotechnical engineering practices were utilized in the preparation of this report; and no other warranty, either expressed or implied, is made as to the professional advice provided. The report is based upon the design information provided as discussed in this report. Consequently, we can assume no responsibility for misinterpretation or misapplication of these recommendations unless given an opportunity to review any changes in either the design or location of the structure, which may affect their validity. This report has been prepared solely for the use of our client and may not contain sufficient information for other uses or for the purposes of other parties. Therefore, conclusions or recommendations based upon these data, but made by others are not our responsibility. The following are other limitations that are applicable to this report.

The borings were not located by a survey crew, but rather a representative of Test Lab, Inc. We made use of identifiable landmarks, and structures and used ninety-degree angles to make directional turns. The boring locations are accurate only to the degree implied by the method used.

The lines on the logs designating the interface between the various strata may only be approximate boundaries when the transition is gradual or could not be detected by the drilling operations.

The depth to the groundwater table measured at the site during the investigation is only indicative of the conditions at that time. The groundwater table may fluctuate significantly due to seasonal changes, variations in rainfall, and other factors not evident at the time of the investigation nor reported herein.

The engineering evaluation, opinions, conclusions and recommendations presented in this report are based upon the data obtained from the borings made at the locations indicated on the plan; and are only valid so long as the site and subsurface conditions remain unchanged. This report does not reflect any variations that may occur between these borings, except as may be discussed in the report. The nature and extent of subsurface variations at the site may not become evident until during construction. Such variations should be observed to note their nature and re-evaluate and modify, if necessary, the recommendations presented herein.

The site is underlain by limestone bedrock that is susceptible to dissolution and the subsequent development of karst features such as voids and sinkholes in the natural soil overburden. Construction in a sinkhole prone area is therefore accompanied by some risk that internal erosion and ground subsidence could affect new

structures in the future. It is not possible to investigate or design to completely eliminate the possibility of future sinkhole related problems. In any event, the owner must understand and accept this risk.

In view of the possibility of variations in subsurface conditions being encountered during construction, it is suggested that we be retained to perform on-site review of the site preparation and foundation phases of the construction. Otherwise, we can assume no responsibility for construction compliance with our site preparation recommendations.