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SECTION 02400 – STORM DRAINAGE

SECTION 02400

STORM DRAINAGE

PART 1 – PRODUCTS

1.01 PIPE:

A. Round Concrete Pipe – Shall be reinforced Class III and shall conform to ASTM Specification C -76 or AASHTO Specification M 170.

1. Joints – Shall be watertight flexible rubber gasket and shall meet ASTM Specification C-443

2. Filter Fabric – Mirafi 140N or equivalent.

3. Concrete pipes shall be designed with no lifting holes. The lifting holes will jeopardize the structural integrity and hydraulic capacity of the pipe once installed.

4. A minimum depth of 12 inches cover is required for RCP Class III.

B. Reinforced Concrete Elliptical Culvert and Storm Sewer Pipe – Shall be reinforced Class He-III, or VE-III, and shall conform to ASTM Specification C -507 or AASHTO Specification M-207.

1. Joints – Shall be watertight flexible rubber gasket and shall meet ASTM Specification C-443

2. Filter Fabric – Mirafi 140N or equivalent.

3. Concrete pipes shall be designed with no lifting holes. The lifting holes will jeopardize the structural integrity and hydraulic capacity of the pipe once installed.

4. A minimum depth of 12 inches cover is required for RCP Class III.

C. Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe – Shall be reinforced Class A-III, and shall conform to ASTM Specification C -506 or AASHTO Specification M-206.

Joints – Shall be watertight flexible rubber gasket and shall meet ASTM Specification C-443

1. Filter Fabric – Mirafi 140N or equivalent.

2. Concrete pipes shall be designed with no lifting holes. The lifting holes will jeopardize the structural integrity and hydraulic capacity of the pipe once installed.

3. A minimum depth of 12 inches cover is required for RCP Class III.

D. Plastic pipe, also referred to as flexible pipe, is manufactured using a variety of different materials. Currently the only materials used to manufacture plastic pipes that are acceptable for use on department projects for storm sewer and culverts is polyethylene (CPE) High-Density polyethylene (HDPE), polyvinyl chloride (PVC) and polypropylene (PPP). The AASHTO standards covering these types of plastic pipe are M294, M304 and M330, respectively. The pipe is all corrugated and CPE is black, PVC is white, and PPP is gray.

1.02 DRAINAGE STRUCTURES:

A. Details – See Plans.

B. Concrete – Reinforced and non-reinforced.

1. Shall have a compressive strength of 3,000 PSI in 28 days. Concrete shall be ready mixed conforming to ASTM-C-94.

2. Reinforcing steel shall conform to ASTM A-615, Grade 60. Mesh reinforcing shall conform to ASTM – A1064. Reinforcing shall be covered by a minimum 1" of concrete for covers and 1 ½ "for walls and flooring and 3" where concrete is deposited directly against the ground.

3. Preformed Expansion joint filler materials shall conform to ASTM Specification D-1751 or shall be resin impregnated fiberboard conforming to the physical requirements of ASTM Specification D-1752.

C. Mortar:

1. Mortar used at connections of pipe and drainage structures shall be composed of one part by volume of Portland cement and two parts of sand. The Portland cement shall conform to ASTM C-150, Type I or II. The sand shall conform to AASHTO Standard M-45 and shall be of an accepted gradation. Hydrated lime shall conform to ASTM C-141, Type A. The quantity of water in the mixture shall be sufficient

to produce a workable mortar but shall in no case exceed 7 gallons of water per sack of cement. Water shall be clean and free of harmful acids, alkalis and organic impurities. The mortar shall be used within 30 minutes from the time the ingredients are mixed with water.

D. Brick Masonry – Brick shall conform to ASTM Specification C-62, Grade SW or C-55, Grade P-I or P-II. Mortar for jointing and plastering shall consist of one part Portland cement and two parts fine sand. Lime may be added to the mortar in the amount not more than 25% of the volume of cement. The joints shall be completely filled and shall be smooth and free from surplus mortar on the inside of the structure. Brick structures shall be plastered with ½ -inch of mortar over the entire outside surface of the walls. For square or rectangular structures, brick shall be laid in stretcher courses with a header course every sixth course, and for round structures, brick shall be laid radially with every sixth course a stretcher course.

E. Pre-cast – Shall be constructed in accordance with ASTM C-478 and conform to the details on the project drawings.

1. Joints – Shall be tongue and groove sealed with flexible gaskets or mastic sealant. Gaskets shall be O-Ring or Type A or B "Tylox" conforming to ASTM C-443 and mastic shall be "Ram-nek", or equivalent, with primer. The primer shall be applied to all contact surfaces of the manhole joint at the factory in accordance with the manufacturer's instructions.

2. Leaks – No leaks in the manhole will be acceptable. All repairs made from inside the manhole shall be made with mortar composed of one part Portland cement and two parts clean sand; the mixing liquid shall be straight bonding agent equivalent to "Acryl 60".

F. Frames, Covers & Grates shall conform to the details shown on the project drawings. Grates in pavement and in other flush-mounted type surfaces shall be on a "bicycle-safe" configuration consisting of 45 degrees diagonal bars or slotted grated with a maximum clear opening of 1" and a maximum length of 4". In any case, the long dimension of the openings shall be located transverse to the direction of traffic. The vertical dimension of inlet opening for curb inlet shall be 5 ½" for 6" curb and 7 ½" for 8" curb.

1.03 STONE BACKFILL:

A. Shall be graded crushed granite with the following gradation: (AASTO #57 STONE)

Square Opening Size Weight	**Percent Passing By**
1 1/2"	100%

1″	95% to 100%
1/2″	25% to 60%
No. 4	0% to 10%
No. 8	0% to 5%

1.04 SAND BACKFILL:

A. Shall be clean sand free from clay and organic material as described in Section 02200-1.01-D. Not more than 10% shall pass the No. 100 sieve.

1.05 BORROW:

A. Where it is determined by the Engineer that sufficient suitable material is not available from the site to satisfactorily backfill the pipe to at least 2 feet above the top of the pipe, the Contractor shall furnish suitable sandy borrow material to accomplish the requirements. The material shall not have more than 60% passing the No. 100 sieve, nor more than 20% passing the No. 200 sieve.

1.06 DRAINAGE CASTINGS:

A. General - This specification is applicable for gray and ductile iron construction castings. All castings shall be manufactured in the United States of America by Neenah Foundry Company, U.S. Foundry & Manufacturing Corporation, East Jordan Iron Works, Inc. or approved equal. All manufacturers shall be approved suppliers and be able to demonstrate that there is an acceptable quality control program at the producing foundry, prior to supplying castings.

B. Material - Gray iron castings for heavy duty applications shall be manufactured from iron conforming to ASTM A48, Class 35B of AASHTO M306, or as requested by the purchaser. Gray iron castings for sidewalk or pedestrian applications shall be manufactured from iron conforming to ASTM A48, Class 30B or 35B, or as requested by the purchaser. Ductile iron castings shall conform to ASTM A536.

C. Manufacture - Castings shall be of uniform quality, free from sand holes, gas holes, shrinkage, cracks and other surface defects. The casting shall be

1.07 SAND BACKFILL:

A. Shall be clean sand free from clay and organic material as described in Section 02200-1.01-D. Not more than 10% shall pass the No. 100 sieve.

1.08 BORROW:

A. Where it is determined by the Engineer that sufficient suitable material is not available from the site to satisfactorily backfill the pipe to at least 2 feet above the top of the pipe, the Contractor shall furnish suitable sandy borrow material to accomplish the requirements. The material shall not have more than 60% passing the No. 100 sieve, nor more than 20% passing the No. 200 sieve.

1.09 DRAINAGE CASTINGS:

A. General - This specification is applicable for gray and ductile iron construction castings. All castings shall be manufactured in the United States of America by Neenah Foundry Company, U.S. Foundry &

Manufacturing Corporation, East Jordan Iron Works, Inc. or approved equal. All manufacturers shall be approved suppliers and be able to demonstrate that there is an acceptable quality control program at the producing foundry, prior to supplying castings.

B. Material - Gray iron castings for heavy duty applications shall be manufactured from iron conforming to ASTM A48, Class 35B of AASHTO M306, or as requested by the purchaser. Gray iron castings for sidewalk or pedestrian applications shall be manufactured from iron conforming to ASTM A48, Class 30B or 35B, or as requested by the purchaser. Ductile iron castings shall conform to ASTM A536.

C. Manufacture - Castings shall be of uniform quality, free from sand holes, gas holes, shrinkage, cracks and other surface defects. The casting shall be

0% to 5%

1.10 SAND BACKFILL:

A. Shall be clean sand free from clay and organic material as described in Section 02200-1.01-D. Not more than 10% shall pass the No. 100 sieve.

1.11 BORROW:

A. Where it is determined by the Engineer that sufficient suitable material is not available from the site to satisfactorily backfill the pipe to at least 2 feet above the top of the pipe, the Contractor shall furnish suitable sandy borrow material to accomplish the requirements. The material shall not have more than 60% passing the No. 100 sieve, nor more than 20% passing the No. 200 sieve.

1.12 DRAINAGE CASTINGS:

A. General - This specification is applicable for gray and ductile iron construction castings. All castings shall be manufactured in the United States of America by Neenah Foundry Company, U.S. Foundry & Manufacturing Corporation, East Jordan Iron Works, Inc. or approved equal. All manufacturers shall be approved suppliers and be able to demonstrate that there is an acceptable quality control program at the producing foundry, prior to supplying castings.

B. Material - Gray iron castings for heavy duty applications shall be manufactured from iron conforming to ASTM A48, Class 35B of AASHTO M306, or as requested by the purchaser. Gray iron castings for sidewalk or pedestrian applications shall be manufactured from iron conforming to ASTM A48, Class 30B or 35B, or as requested by the purchaser. Ductile iron castings shall conform to ASTM A536.

C. Manufacture - Castings shall be of uniform quality, free from sand holes, gas holes, shrinkage, cracks and other surface defects. The casting shall be

ground smooth and well cleaned by shot blasting. Bearing surfaces between manhole rings and covers or grates and frames shall be cast or machined with such precision to prevent rocking. As-cast dimensions may vary within accepted foundry tolerances as outlined in the Iron Castings Handbook published by the American Foundry Society. Nominally, casting dimensional tolerances shall be +/- 1/16" per foot. All published casting weights are average and approximate values and shall vary +/- 5%. Castings shall be furnished, painted or unpainted, as specified by the purchaser.

D. Proof Load Testing - Traffic service castings shall have a first article proof load test conducted and the results of that proof load shall be made available upon request. The proof load shall be conducted in accordance with the method and procedure that is outlined in AASHTO M306. The casting shall be tested on a suitable and calibrated load testing machine and the casting shall hold a 40,000-pound proof load for one minute without experiencing any cracks or detrimental permanent deformation.

E. Inspection - Inspections shall be in accordance with AASHTO M306. Results of these tests shall be furnished to the purchaser upon request. The heat or production date and product numbers shall be cast on the casting. This information shall be used for casting traceability and testing.

F. Marking - All castings shall be identifiable and show, at a minimum, the following: name of the producing foundry, "Made in USA" as country of origin, ASTM material designation, individual part number, cast or heat date. In addition, at a minimum, the top or traffic side of all castings shall be clearly marked "Storm" and "City of Savannah" with ""Dump No Waste Drains to River" or "Waterways"" or "Drains to River" in flush cast letters. This includes all manhole covers, grates, and similar castings.

Refer to casting specifications and details as found in the City of Savannah's ***Standard Details for Drainage***.

Note: Particular attention should be made to the specific "Savannah Coastal" casting image required on Inlet Manhole Covers.

G. Sampling - Random checks on the castings may be conducted. These random checks would be conducted in accordance with AASHTO M306.

H. Records - Test results for each lot of castings shall be maintained by the foundry for a minimum of seven years and shall be made available upon request.

Certification/Standards Compliance ASTM A48 Material

ASTM A536 Material
AASHTO M306 Product Performance/Quality
ISO 9001:2008 Quality Assurance

I. Quality Assurance - System of manufacturing quality assurance must conform to the requirements of ISO 9001:2008 and be certified by a third party.

1.13 PRE-CAST BOX CULVERTS:

A. Pre-cast box culvert sections shall conform to ASTM specification C1577.

B. Details – See Plans.

C. Concrete - Mix design shall have a minimum compressive strength of 5,000 psi. The concrete mix design shall conform to ASTM C150 for cement and ASTM C33 for aggregates.

D. Reinforcing Steel - shall conform to ASTM A185/A or A497/A.

E. Joints and Gaskets - shall be watertight and conform to ASTM C1677-09.

F. Filter Fabric – Mirafi 140N or equivalent.

G. Box culvert sections shall be designed with no lifting holes.

PART 2 – EXECUTION & TESTING

2.01 LOCATION AND GRADE:

A. The vertical and horizontal location of the storm pipes and ditches and the position of all manholes and other structures are shown on the drawings. The grade line as given on the profile or mentioned in these specifications means the invert or bottom of the inside of the pipe or bottom of ditch.

The Contractor shall be responsible for the proper location and grade of drainage pipe, culverts and other structures. Pipe and box culvert lines shall be straight and show a uniform gradient between manholes. The following descriptions of pipe related work shall also apply to all drainage structures including manholes, inlets, box culverts, junction boxes and other underground features.

2.02 EXCAVATIONS:

A. Excavated material shall be piled a sufficient distance from the trench banks to avoid overloading to prevent slides or cave-ins, following OSHA trench safety techniques and requirements.

B. Remove from site all material not required or suitable for backfill.

C. Grade as necessary to prevent water from flowing intoexcavations.

D. Remove all water accumulating in the excavation from surface flow, seepage or otherwise, by pumping or other accepted method.

E. Provide bracing and shoring as necessary for the protection of the work and safety of personnel.

2.03 TRENCHING:

A. The width of trenches at any point below the top of the pipe shall not be greater than the outside diameter of the pipe, plus 2′ – 0″ for pipes measuring through 30-inches, and 3′ 0″ for pipes greater than 30-inches box culverts and other structures, to permit satisfactory jointing and through tamping of the bedding material under and around the structures. Shoring and bracing where required shall be placed within the trench width as specified. Care shall be taken not to over-excavate. Where trench widths are exceeded, redesign with a resultant increase in cost of stronger pipe or special installation procedures shall be necessary. The cost of this re-design and the increased cost of pipe or installation shall be borne by the Contractor without additional cost to the owner.

B. Removal of Unstable Material – Where wet or otherwise unstable soil, incapable of supporting the pipe, as determined by the Owner, is encountered in the bottom of the trench, such material shall be removed to the depth required and replaced to the proper grade with select material, compacted as provided in Paragraph 2.08, "BACKFILLING", hereinafter.

2.04 BRACING AND SHORING:

A. The sides of all trenches and other excavations shall be securely held by skeleton or solid sheeting and bracing, as required to protect the adjoining property and for safety.

2.05 BEDDING:

A. The bedding surface for pipe and other structures shall provide a firm foundation of uniform density throughout the entire length of pipe or extent of structure. The excavation bottom shall be dewatered by whatever means and methods are necessary before installing pipes or other structures. Depending on the nature of the soil and other conditions, Contractor shall use well points or other means such as sumps and sump pumps to remove all water from the bedding surface. Pipe shall be carefully bedded in a soil foundation that has been accurately shaped and rounded to conform to the lowest one-fourth (1/4) of the outside portion of circular pipe, or to the lower curved portion of arch pipe for the entire length of the pipe. When necessary, the bedding shall be compacted to 95% modified proctor density (ASTM 698). Bell holes and depressions for joints shall be only of such length, depth and width as required for properly making the particular type of joint.

B. Stone Backfill – Where, in the opinion of the Engineer, the subgrade of the pipe trench is composed of unsuitable material, the Contractor shall remove the unsuitable material a minimum of six inches (6") below the specified pipe invert elevation and furnish and replace the excavated material with stone backfill in the trench to stabilize the subgrade. The stone requirement shall be per section 1.03 of the specifications. Variations in the gradation of the stone may be permitted upon approval of the Engineer. Under pavement and other settlement sensitive areas, woven geotextile fabrics shall be placed to wrap and fully encapsulate the backfilled stone bedding. The geotextile fabric must be GDOT QPL-28 approved or equivalent material. The presence of water in the trench does not necessarily indicate that stone backfill is required. If well points or other dewatering methods will remove the water, the Contractor shall be required to completely dewater the trench in lieu of stone backfill. Stone backfill will be limited to areas where well pointing and other conventional methods of dewatering will not produce a dry trench bottom. Pipe shall be carefully bedded in sand placed above the stone as specified above. Crushed concrete or other aggregates cannot be substituted for natural stone.

C. Sand Backfill - Where in the opinion of the Engineer, the character of the soil is such that the material even though dewatered is unsuitable for pipe bedding, an additional foot of excavation shall be made and replaced with clean sand furnished by the Contractor.

2.06 PLACING PIPE AND PRE-CAST BOX CULVERT SECTIONS:

A. Each pipe shall be carefully examined before being laid, and defective or damaged pipe shall not be used. Pipelines shall be laid to the grades and

alignment indicated. Proper equipment shall be provided for lowering sections of pipe into trenches. Under no circumstances shall pipe be laid when trench conditions or weather are unsuitable for such work.

Diversion of drainage or dewatering of trenches during construction shall be provided as necessary. All pipes in place shall have been checked before backfilling. When storm drainpipe terminates in a new ditch, the headwall or end section together with ditch pavement, if specified, shall be constructed immediately as called for on the plans. Ditch slopes and disturbed earth areas shall be grassed and mulched as required.

The Contractor will be responsible for maintaining these newly constructed ditches and take immediate action subject to acceptance to keep erosion of the ditch bottom and slopes to a minimum during the life of the contract. No additional compensation will be given to the Contractor for the required diversion of drainage and/or dewatering of trenches. Grassing of the completed earth surface of the trench backfill shall conform to the technical specification for Grassing.

B. Concrete Pipe – Laying shall proceed upgradient with the bell upstream and spigot downstream in the direction of the flow.

C. Each box culvert section shall be carefully examined before being laid, and defective or damaged sections shall not be used. Box culvert lines shall be laid to the grades and alignment indicated. Proper equipment shall be provided for lowering sections of box culvert into trenches. Under no circumstances shall box culverts be laid when trench conditions or weather are unsuitable for such work. Diversion of drainage or dewatering of trenches during construction shall be provided as necessary.

D. Pre-cast Box Culverts – Installation shall proceed upgradient with the groove upstream and tongue downstream in the direction of the flow.

E. Pipe shall be laid a minimum vertical distance of 10’ and a minimum horizontal distance of 24” from adjacent utilities. The maximum pipe length between manholes shall be 300’.

2.07 JOINTS IN PIPES AND BOX CULVERTS:

A. Concrete Pipe – Flexible watertight joint shall be made with rubber-type gaskets for concrete pipe. The design of joints and the physical requirements for rubber-type gaskets shall conform to ASTM Specification C-443.

1. Installation of Filter Fabric at Joint – After each joint is joined together, the Contractor shall place two layers of Mirafi 140N or equivalent filter fabric around the joint a minimum width of four feet, centered on the joint.

B. Pre-cast Box Culverts – Flexible watertight joint shall be made with rubber-type gaskets for concrete box culverts. The design of joints and

the physical requirements for rubber-type gaskets shall conform to ASTM Specification C1677-09.

1. Installation of Filter Fabric at Joint – After each joint is joined together, the Contractor shall place two layers of Mirafi 140N or equivalent filter fabric around the joint a minimum width of four feet, center on the joint. The two layers of fabric shall wrap around all four sides of the box culvert joint.

C. Plastic Pipe- When using watertight pipe, requiring some degree of watertight performance, it is necessary to provide additional measures to insure a watertight connection between the pipe and structure. ASTM F2510/F 2510M, "Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures and Corrugated High Density Polyethylene Drainage Pipes," is the governing standard for corrugated HDPE pipe-manhole connections, but specific performance/installation requirements should be verified for each specific project.

D. Soil-Tight Performance When using soil-tight pipe in non-watertight applications, it may be acceptable to grout the void space between the pipe and drainage structure. Watertight Performance When using watertight pipe for testable systems, requiring some degree of watertight performance, it is necessary to provide additional measures to ensure a watertight connection between the pipe and structure. ASTM F2510/F 2510M, "Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures and Corrugated High Density Polyethylene Drainage Pipes," is the governing standard for corrugated HDPE pipe-manhole connections, but specific performance/installation requirements should be verified for each specific project. Along with a full line of adapter fittings available, including the Waterstop® Gasket, are flexible boot fittings provided by other manufacturers.

Fitting dimensions should be supplied to the manufacturer to ensure the proper fitting size and manhole boot connector are supplied.

2.08 BACKFILLING:

A. After the bedding has been prepared and the pipe installed, select material from excavation or borrow, at a moisture content that will facilitate compaction, shall be placed along both sides of the pipe in layers not exceeding six inches (6") in compacted depth. The backfill shall be brought up evenly on both sides of the pipe for the full length of the pipe. Care shall be taken to ensure thorough compaction of the fill under the haunches of the pipe. Each layer shall be thoroughly compacted with mechanical tampers or rammers. This method of filling and compaction shall continue until the fill has reached an elevation of at least 12-inches above the top of the pipe. The remainder of the trench shall be backfilled and compacted by spreading and rolling or compacted by mechanical tampers or rammers in layers not exceeding 8-inches. Soil density relations tests and moisture density relations tests may be performed by a testing firm or laboratory and shall be taken as directed in conformance with the compaction requirements specified in subparagraph "COMPACTION" hereinafter. Deficiencies shall be corrected by the Contractor without additional cost to the owner, any sheeting and/or portions of bracing used shall be left in place. Untreated sheeting shall not be left in place beneath structures or pavements.

B. For pipe placed in fill sections, the backfill material and the placement and compaction procedures shall be as specified above and in subparagraph "COMPACTION" hereinafter. The fill material shall be uniformly spread in layers longitudinal on both sides of the pipe, not exceeding six inches (6") in compacted depth and shall be compacted by rolling parallel with pipe or by mechanical tamping or ramming. Prior to commencing normal filling operations, the crown width of the fill at a height of 12-inches above the top of the pipe shall extend not less than twice the outside diameter on each side of the pipe or 12 feet, whichever is less. After the backfill has reached at least 12-inches above the top pipe, the remainder of the fill shall be placed and thoroughly compacted in layers not exceeding 8-inches.

E. In compacting by rolling or operating heavy equipment parallel with the pipe, displacement of or injury to the pipe shall be avoided. Movement of construction machinery over a culvert at any stage of construction shall be at the Contractor's risk. Any pipe damaged thereby shall be repaired or replaced at the expense of the Contractor.

operations, the crown width of the fill at a height of 12-inches above the top of the pipe shall extend not less than twice the outside diameter on each side of the pipe or 12 feet, whichever is less. After the backfill has

reached at least 12-inches above the top pipe, the remainder of the fill shall be placed and thoroughly compacted in layers not exceeding 8-inches.

F. In compacting by rolling or operating heavy equipment parallel with the pipe, displacement of or injury to the pipe shall be avoided. Movement of construction machinery over a culvert at any stage of construction shall be at the Contractor's risk. Any pipe damaged thereby shall be repaired or replaced at the expense of the Contractor.

2.09 COMPACTION:

A. Soil and compaction tests shall be made by a testing laboratory accepted by the Owner and shall be made at the Owner's direction and expense. Failed tests shall be rescheduled at the Owner's direction, and retesting shall be paid for by the Contractor. Laboratory compaction characteristics of the soil shall be made in accordance with ASTM D-698. In-place density tests shall be made in accordance with ASTM D-1556, D-2922 or D-5195. Results of the tests shall be furnished to the Owner by the testing laboratory.

The minimum number of tests required shall be:

Backfill in traffic areas ..... 1 per 100 lf or less for each 2'of depth or portion thereof. (Minimum of 2 for any line segment.)

Backfill in non-traffic areas ..... 1 per 200 lf or less for each 6 feet of depth or portion thereof.

The minimum percentage of compaction of the backfill material (in accordance with ASTM D-698) shall be the following:

In traffic areas ..... 100% modified proctor density for the top 12" below pavement base; 95% modified proctor density below the 12" line.

In non-traffic areas . . . . . 95% modified proctor density.

2.10 DRAINAGE STRUCTURES:

A. Drainage structures shall be constructed of the materials specified for each type and in accordance with the details shown on the drawings

2.11 MANHOLES:

A. Manholes shall be constructed where shown on the drawings or directed by the Owner. The raised invert in the bottom of the manholes shall be smooth and properly shaped. Special care must be exercised in laying the channel in adjacent pipes to grade. The tops of manholes shall be built to grades designed by the Owner. Manhole sections with either honeycomb defects; exposed reinforcing; broken/fractured tongue or groove; or cracked walls will be subject to rejection by the Engineer for use on the project. When mastic sealant is used, improperly applied primer will also be cause for rejection.

B. Lifting rings shall be cut off, ground down below surface and grouted.

2.12 LEAKAGE:

A. All visible leaks shall be repaired, regardless of the amount of leakage.

2.13 CONNECT PIPE TO EXISTING STRUCTURES:

A. The Contractor shall connect the system to the existing structure where indicated. A hole not more than 4-inches larger than the outside diameter of the new pipe shall be cut neatly in the structure and the new pipe laid so that it is preferably flushed, but no more than 2" max. intrusion with the inside face of the structure. The annular space around the pipe shall be filled with a damp, expanding mortar or grout, combined with bricks and/or brick fragments, as necessary to make a watertight seal. If not flush, seal with angled grout so as not to catch debris.

B. Where the plastic pipe connects to a structure, such as a manhole, connection to be cored. The integrity of the pipe-to-manhole connection should be based on the site conditions. For most site conditions, a soil tight pipe-to-structure connection is sufficient for long term performance and the integrity of the pipe-to-structure connection. Certain site conditions require a watertight connection, and these include high ground water with fine native soils; and storm sewer systems subjected to prolonged surcharge

conditions. Certain types of connections also allow for differential settlement, or alternatively, a transition segment can be used to manage the movement.

2.14 CLOSING PIPE:

A. When the work or pipe laying is suspended, either for night or at other times, the end of the storm must be closed to keep debris, sand, and soil from entering the pipe. The Contractor will be held responsible for keeping the storm system free from obstructions.

2.15 REGRADE EXISTING DITCH:

A. Designated existing ditches shall be re-graded and shaped to provide a bottom with a uniform slope, without depressions that hold water, and that conforms to the plan grades. The side slopes shall be smooth and uniform, dressed by hand if necessary, conforming to the indicated slopes

2.16 CONSTRUCT NEW DITCHES:

A. New ditches as shown on the construction drawings shall be graded and shaped to provide a bottom with a uniform slope, without depressions that hold water, and that conforms to the plan grades. The side slopes shall be smooth and uniform, dressed by hand if necessary, conforming to the indicated slopes. Ditches with side slopes greater than 3:1 (Horizontal: Vertical) shall be stabilized by means of woven jute fabric engineered for erosion control and soil stabilization or approved equal.

2.17 CLEANING:

A. Prior to televising and before acceptance of the storm systems, all storm lines shall be cleaned to the satisfaction of the Engineer. Where any obstruction occurs, the Contractor will be required to clean the lines by means of flushing and rods and swabs or other instruments.

2.18 TELEVISING:

A. TELEVISING - All Public and Private storm line segments constructed for the project shall be televised. No storm lines shall be televised within 30 days of installation. Construction activity that may cause damage to pipes must be completed. Roadway base material (GAB) compaction shall be performed, and proof roll tests passed, before televising of pipes located below the road boundary. Televising may be scheduled only after the construction of and installation of permanent stabilization of stormwater features, including but not limited to stormwater ponds, ditches, swales, green infrastructure and properly installed and maintained BMPs, per the stamped approved plans. All observed deficiencies must be corrected prior to site acceptance.

B. The Stormwater Management Division reserves the right to delay pipe television inspections due to special site conditions which have the potential to damage drainage infrastructure prior to final acceptance. If televising is performed by City personnel, contractors will be charged a standard fee and will be responsible for preparing the lines to ensure that they are clean and free of debris prior to televising. The Engineer of Record must verify the lines are clean and free of debris. The City of Savannah will NOT clean any lines. A private NASSCO-PACP Certified Company may be utilized in lieu of the City CCTV. All televising videos shall conform to Current NASSCO-PACP standards and be transmitted to the City of Savannah Stormwater Division acceptable for review. No costs shall be incurred by the City of Savannah for this work. All Televising requirements shall be satisfied and acknowledged by the Engineer of Record, be limited to all storm lines that are installed, as well as the upstream and downstream line segments for any connections to the City's existing drainage system. Pipeline televising contractors shall use the approved plan stormwater structure identifiers as labeled on the approved plans during completion of pipeline televising. The Stormwater Management Division video review is official and final. Details and procedures of the City of Savannah's CCTV program are included in the "Televising Procedures Manual" developed by the City's Water Quality Control Department.

2.19 RECORD DATA:

A. As required under Section 1500, Paragraph 54, of the General Conditions, the Contractor is required to keep accurate, legible records of the vertical and horizontal location of all new storm lines and structures during construction. These records shall be made available to the Engineer before his final review for incorporation into Record Drawings. Final payment to the Contractor will be withheld until all such information is received and accepted.

B. As built drawings shall contain accurate information including length, size, slope of storm pipe, and type of construction material; manholes/catch basin location coordinates, top and invert elevations, all vertical elevations shall be based on NAVD88 datum. Benchmark shall include elevation and coordinates (up to minimum accuracy of two decimal points based on Georgia State Plane Coordinate System, East Zone, North American Datum of 1983 /NAD 83). The final as-built plans must be stamped" Field Verified" and signed, sealed, and dated by the developer's registered State of Georgia professional engineer or land surveyor.

2.20 PRE-INSTALLATION STORAGE AND HANDLING PLASTIC PIPE

A. Thermoplastic pipes such as polyethylene and polypropylene are lightweight and easy to use. While no special care is needed in handling and installation a few precautions should be set forth.

- Follow all applicable safety regulations when handling pipes.
- The pipe shall not be dropped from the delivery truck into an open trench, or onto uneven surfaces.
- Avoid dragging or striking the pipe against another pipe or object.
- Avoid dragging the pipe across the ground.
- Avoid any impact on the bell or spigot.
- Do not drive over the pipe prior to installation.
- Inspect the pipe and joining systems before installation

2.21 Deflection Testing

Mandrel Testing for Plastic Storm Sewer Pipes

A. Plastic pipe, also referred to as flexible pipe, is manufactured using a variety different materials. Currently the only materials used to manufacture plastic pipes that are acceptable for use on department projects for storm sewer and culverts is polyethylene (CPE), High-Density polyethylene (HDPE), polyvinyl chloride (PVC) and polypropylene (PPP). The AASHTO standards covering

these types of plastic pipe are M294, M304 and M330, respectively. The pipe is all corrugated and CPE is black, CPV is white, and PPP is gray.
When plastic pipe, manufactured using any of the above materials, is installed on a project for a storm sewer or culvert application it may be subject to mandrel testing. In accordance with the standard specifications, each size of plastic pipe must be tested for deformation using a nine-point mandrel. The effective diameter of the mandrel must be 95 percent of the nominal pipe diameter and verified using a proving ring. The mandrel is sized to allow for up to 5% deformation of the installed pipe. Nominal pipe diameters are defined in the respective AASHTO standards. The Contractor is required to provide the appropriately sized mandrel and proving ring. The proving ring is used by the inspector to verify that the diameter of the mandrel is appropriate for the diameter of pipe being tested before it is used.

The Contractor must perform the mandrel testing after the required backfilling and compaction of the trench is completed. All Public and Private storm line segments constructed for the project shall be tested. No storm lines shall be tested within 30 days of installation. Construction activity that may cause damage to pipes must be completed. Roadway base material (GAB) compaction shall be performed, and proof roll tests passed, before mandrel testing of pipes located below the road or vehicular travel boundaries. When testing storm sewer, the Contractor will access the pipe from one drainage structure and pull the mandrel through to the next drainage structure. For pipe with a diameter larger than the access to the drainage structure the contractor must provide a mandrel that can be disassembled on the ground surface and reassembled in the drainage structure to facilitate testing. The mandrel must be pulled through the pipe by hand without any mechanical advantage. If the mandrel can be pulled through the entire run of pipe the test passes, and the pipe can be accepted for deformation testing.

If the mandrel cannot be pulled through a pipe run by hand the deformation testing has failed. The Contractor should attempt to pull the mandrel through the pipe from the opposite direction to better identify the length of pipe in the run impacted by excessive deformation. All plastic pipes that does not have successful mandrel test results (5% or less deformation) are not acceptable and must be removed and reinstalled or replaced. If the Contractor elects to reinstall removed plastic pipe they must first obtain approval by the Engineer to ensure the pipe is not damaged. All reinstalled or replaced plastic pipes are subject to mandrel testing. The use of a vibratory pipe re-rounder is not an acceptable means to rectify failed mandrel test results.

B. All mandrel test results for plastic pipe must be recorded by the inspector on one of two forms:

Culvert Mandrel Pull Test Report
Storm Sewer Mandrel Pull Test Report

2.22 LASER PROFILING

A. NASSCO certified CCTV with the capability to perform laser profiling must be utilized.

B. For new pipe installations, profile the pipe prior to final inspection but no earlier than 30 days after completion and all construction activities above the pipe have that may cause damage to have ended of backfilling unless approved by the City Stormwater Department.

C. Laser profiled pipe video may be required to demonstrate that vertical deflection is within the allowable deflection of the Specifications.

Table 1
Base Inside Diameters for HDPE Pipe

Nominal Pipe Diameter (in.)	Base Inside Diameter (in.)	Base Inside Diameter with 5% Deflection (in.)	Base Inside Diameter with 7.5% Deflection (in).
4	3.88	3.68	3.59
6	5.82	5.53	5.38
8	7.76	7.37	7.17
10	9.69	9.21	8.97
12	11.63	11.05	10.76
15	14.54	13.82	13.45
18	17.45	16.58	16.14
24	23.27	22.10	21.52
30	29.08	27.63	26.90
36	34.90	33.16	32.28
42	40.72	38.68	37.66
48	46.54	44.21	43.05
54	52.35	49.73	48.43
60	58.17	55.26	53.81

*Value is per AASHTO M252[1] (4"-10" dia.) and AASHTO M294[2] (12" – 60" dia.).
If designing to a specific standard, please review allowable minimum diameter.

END OF SECTION