

SECTION 33 40 00  
STORM DRAINAGE UTILITIES  
02/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

JAPANESE STANDARDS ASSOCIATION (JSA)

JIS A 1210	(2009) Test Method for Soil Compaction Using a Rammer
JIS A 1214	(2013) Test Method for Soil Density by the Sand Replacement Method
JIS A 5001	(2008) Crushed Stone for Road Construction
JIS A 5005	(2009) Crushed Stone and Manufactured Sand for Concrete
JIS A 5308	(2014) Ready-Mixed Concrete
JIS A 5372	(2016) Precast Reinforced Concrete Products
JIS A 5506	(2008) Manhole Covers for Sewerage Works
JIS G 3101	(2020) Rolled Steels for General Structure
JIS H 8641	(2021) Hot Dip Galvanized Coatings
JIS K 6353	(2011) Rubber Goods for Water Works
JIS K 6739	(2016) Unplasticized Poly (Vinyl Chloride) (PVC-U) Pipe Fittings for Drain
JIS K 6741	(2016; R 2021) Unplasticized Poly (Vinyl Chloride) (PVC-U) Pipes
JIS K 6761	(2017) Polyethylene Pipes for General Purposes
JIS L 1908	(2000) Geotextile Test Method

JAPAN SEWAGE WORKS ASSOCIATION (JSWA)

JSWAS K-1	(2010) Rigid PVC Pipe for Sewer
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THE SOCIETY OF HEATING, AIR-CONDITIONING AND SANITARY ENGINEERS OF  
JAPAN (SHASE)

SHASE-S 209	(2009) Manhole Cover
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## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

### SD-07 Certificates

Crushed Stone for Perforated Pipes

Geotextile Filter Fabric for Perforated Pipes

Leakage Test; G

Determination of Density

Post-Installation Inspection Report; G

### SD-08 Manufacturer's Instructions

Placing Pipe

## 1.3 DELIVERY, STORAGE, AND HANDLING

### 1.3.1 Delivery and Storage

Materials delivered to site shall be inspected for damage, unloaded, and stored with a minimum of handling. Materials shall not be stored directly on the ground. The inside of pipes and fittings shall be kept free of dirt and debris. Before, during, and after installation, plastic pipe and fittings shall be protected from any environment that would result in damage or deterioration to the material. Keep a copy of the manufacturer's instructions available at the construction site at all times and follow these instructions unless directed otherwise by the Contracting Officer. Solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install plastic pipe shall be stored in accordance with the manufacturer's recommendations and shall be discarded if the storage period exceeds the recommended shelf life. Solvents in use shall be discarded when the recommended pot life is exceeded.

### 1.3.2 Handling

Materials shall be handled in a manner that ensures delivery to the trench in sound, undamaged condition. Pipe shall be carried to the trench, not dragged.

## PART 2 PRODUCTS

### 2.1 PIPE FOR CULVERTS AND STORM DRAINS

Pipe for culverts and storm drains shall be of the sizes indicated and shall conform to the requirements specified.

### 2.1.1 Concrete Pipe

Provide reinforced concrete pipe conforming to JIS A 5372, external pressure type, Class 1 or 2, Type B. Provide gaskets and pipe ends for rubber gasket joint conforming to JIS K 6353. Use gaskets suitable for use with sewage.

### 2.1.2 Precast Concrete Pipe-Type Gutter

Japanese manufactured precast concrete product that comes in standard length of 2 m. Locally known as DO pipe or acceptable alternative, and to be used along curb lines to function as gutter with water conveyance underneath. Shall be of the cross section shown on drawing and panels are supplied both with grating and without grating. Traffic loading capacity shall be 25 tons. Jointing materials shall be in accordance with manufacturer's standards.

### 2.1.3 Precast Concrete Pipe Culvert Type Ditch

Japanese manufactured precast concrete product that comes in standard length of 2 m. Locally known as DO pipe or acceptable alternative, and to be used for below grade construction in place of PVC pipe whenever the sand fill layer above the PVC pipe is less than 300 mm. Shall be of the cross section shown on drawing and to be installed where specified on drainage plans. Traffic loading capacity shall be 25 tons. Jointing materials shall be in accordance with manufacturer's standards.

### 2.1.4 Polyvinyl Chloride (PVC) Pipe

- a. PVC plastic pipe shall be in conformance with JIS K 6741, Type VP or VU.
- b. Fitting for PVC plastic pipe shall be in conformance with JIS K 6739.
- c. Jointing material for PVC plastic pipe shall be in conformance with PVC pipe manufacturer's recommendation.
- d. PVC branch pipe connectors shall be standard product compatible with the PVC plastic pipe and conforming to JSWAS K-1 and JIS K 6739. Adhesive materials shall be per branch pipe manufacturer's recommendation.

### 2.1.5 Polyethylene (PE) Pipe

- a. Polyethylene pipe shall be in conformance with JIS K 6761.
- b. Jointing material shall conform with polyethylene pipe manufacturer's recommendation.

## 2.2 PERFORATED PIPING

### 2.2.1 Polyvinyl Chloride (PVC) Pipe

- a. Perforated PVC plastic pipe shall be in conformance with JIS K 6741, Type VP or VU.
- b. Fitting for perforated PVC plastic pipe shall be in conformance with JIS K 6739.

- c. Jointing material for perforated PVC plastic pipe shall be in conformance with PVC pipe manufacturer's recommendation.

#### 2.2.2 Polyethylene (PE) Pipe

- a. Flexible perforated polyethylene pipe shall be in conformance with JIS K 6761.
- b. Jointing material shall conform with polyethylene pipe manufacturer's recommendation.

### 2.3 OTHER DRAINAGE CONVEYANCE MATERIALS

#### 2.3.1 Precast Concrete Free Gradient Ditch

Manufactured precast concrete product that comes in standard length of 2 m, and to be used as an interceptor trench along curb lines. Typically of inverted U shaped with the flat top functioning as gutter surface with grated inlets while the bottom is open and filled with plain concrete to obtain the desired gradient of the water conveyance underneath. Shall be of the varying cross sections as shown on drawing. Traffic loading capacity shall be 25 tons. Jointing materials shall be in accordance with manufacturer's standards.

#### 2.3.2 Precast Concrete U-Ditch

Manufactured precast concrete product conforming to JIS A 5372. Comes in 600 mm panel length and shall be of the cross section shown on drawing. Ditch shall be non-traffic type and with or without cover where specified on drawing.

#### 2.3.3 Cast-in-Place Concrete Trench

A reinforced concrete trench of varying cross sections as shown on drawing. Concrete in conformance with JIS A 5308 shall be 24 MPa and shall have frame and grating.

### 2.4 MISCELLANEOUS MATERIALS

#### 2.4.1 Concrete

Reinforced concrete drainage structures shall use concrete with compressive strength of 24 MPa.

#### 2.4.2 Leveling Mortar

Mortar for setting precast concrete pipe type gutter and culvert pipe ditch (both locally known as DO pipe) shall composed of cement, sand and water mixed in proportion of 1 part cement to 3 parts of sand, sufficient water to produce a workable mixture. Mortar shall be used in the work within one hour after mixing.

#### 2.4.3 Leveling Concrete and Concrete Fill

Plain concrete to be used where specified on drainage drawing details shall have a compressive strength of 18 MPa.

#### 2.4.4 Precast Reinforced Concrete Manholes

Approved commercial products as shown on drawings and conforming to JIS A 5372. Joints between precast concrete manhole sections shall be made

with flexible watertight, rubber-type gaskets per manhole manufacturer's standards.

#### 2.4.5 Frames, Covers And Grating

##### 2.4.5.1 Manhole Frames and Covers

Shall be manufacturer's standard product conforming to SHASE-S 209, and shall be of cast iron per JIS A 5506. Size, configuration and loading capacity shall be as indicated on drawings. A letter "D" shall be stamped or cast into covers.

##### 2.4.5.2 Ditch and Inlet Frame and Grating

Shall be manufacturer's standard product of steel materials and of the size, shape, grating pattern, and loading capacity as indicated on drawings. Grating shall be finished with factory-zinc-coated in accordance with JIS H 8641, and frame shall be finished with factory-bake coated.

#### 2.4.6 Sand Fill And Leveling Sand

Fill around PVC drainage pipes and for setting non-traffic type precast U-ditch shall be cleaned sand conforming to JIS A 5005.

#### 2.4.7 Crushed Stone For Perforated Pipes

Granular aggregates for use in perforated pipes shall be single-sized crushed stone S-20 (#5) of size 13 mm to 20 mm and conforming to JIS A 5001.

#### 2.4.8 Gravel Base Course

Crushed stone for base course at concrete structures shall be crusher run conforming to JIS A 5001, RC-40.

#### 2.4.9 Flap Gates

Flap Gates shall be medium or heavy-duty with circular or rectangular opening and double-hinged. Top pivot points shall be adjustable. The seat shall be one-piece cast iron with a raised section around the perimeter of the waterway opening to provide the seating face. The seating face of the seat shall be cast iron or stainless steel. The cover shall be one-piece cast iron with necessary reinforcing rib, lifting eye for manual operation, and bosses to provide a pivot point connection with the links. The seating face of the cover shall be cast iron or stainless steel. Links or hinge arms shall be cast or ductile iron. Holes of pivot points shall be bronze bushed. All fasteners shall be either galvanized steel, bronze or stainless steel.

#### 2.5 STEEL LADDER

Steel ladder conforming to JIS G 3101 shall be provided where the depth of the storm drainage structure exceeds 3.66 m. These ladders shall be not less than 406 mm in width, with 19 mm diameter rungs spaced 305 mm apart. The two stringers shall be a minimum 10 mm thick and 63 mm wide. Ladders and inserts shall be galvanized after fabrication in conformance with JIS H 8641.

#### 2.5.1 Manhole Steps

Materials shall conform to JIS G 3101, Type SS 400, galvanized, and of the size and configuration as shown on drawing. Manhole steps are not required in manholes and inlets less than 1.2 m deep.

#### 2.6 RESILIENT CONNECTORS

Flexible, watertight connectors used for connecting pipe to manholes and inlets shall conform to pipe manufacturer's standards.

#### 2.7 GEOTEXTILE FILTER FABRIC FOR PERFORATED PIPES

Submit certification from the manufacturers attesting that the filter fabric meets specification requirements. Provide geotextile that is a nonwoven pervious sheet of polymeric material conforming to JIS L 1908.

#### 2.8 Warning Tape

Provide in accordance with requirements as specified in Section 31 00 00 EARTHWORK.

#### 2.9 Cleanouts

Cleanouts installed at vertical PVC downspouts shall use the standard Y-fitting with the compatible PVC cleanout cover conforming to JIS K 6739. Surface cleanout at paved and turfed areas shall be cast iron cover and fitting adaptable for connection to the lower PVC pipe. Traffic loading capacity for surface cleanout shall be as required for manhole covers located within the same ground surface condition.

#### 2.10 EROSION CONTROL RIP RAP

Provide non-erodible rock not exceeding 375 mm in its greatest dimension and choked with sufficient small rocks to provide a dense mass with a minimum thickness of [200 mm] [as indicated].

### PART 3 EXECUTION

#### 3.1 INSTALLATION OF PIPE CULVERTS, STORM DRAINS, AND DRAINAGE STRUCTURES

Excavation of trenches, and for appurtenances and backfilling for culverts and storm drains, shall be in accordance with the applicable portions of Section 31 00 00 EARTHWORK, 31 23 00.00 20 EXCAVATION AND FILL and the requirements specified below.

##### 3.1.1 Trenching

The width of trenches at any point below the top of the pipe shall be not greater than the outside diameter of the pipe plus 500 mm to permit satisfactory jointing and thorough tamping of the bedding material under and around the pipe. Sheet piling and bracing, where required, shall be placed within the trench width as specified, without any overexcavation. Where trench widths are exceeded, redesign with a resultant increase in cost of stronger pipe or special installation procedures will be necessary. Cost of this redesign and increased cost of pipe or installation shall be borne by the Contractor without additional cost to the Government.

### 3.1.2 Removal of Rock

Rock in either ledge or boulder formation shall be replaced with suitable materials to provide a compacted earth cushion having a thickness between unremoved rock and the pipe of at least 200 mm or 13 mm for each meter of fill over the top of the pipe, whichever is greater, but not more than three-fourths the nominal diameter of the pipe. Where bell-and-spigot pipe is used, the cushion shall be maintained under the bell as well as under the straight portion of the pipe. Rock excavation shall be as specified and defined in Section 31 00 00 EARTHWORK 31 23 00.00 20 EXCAVATION AND FILL .

### 3.1.3 Removal of Unstable Material

Where wet or otherwise unstable soil incapable of properly supporting the pipe, as determined by the Contracting Officer, is unexpectedly encountered in the bottom of a trench, such material shall be removed to the depth required and replaced to the proper grade with select granular material, compacted as provided in paragraph BACKFILLING. When removal of unstable material is due to the fault or neglect of the Contractor while performing shoring and sheeting, water removal, or other specified requirements, such removal and replacement shall be performed at no additional cost to the Government.

## 3.2 BEDDING

The bedding surface for the pipe shall provide a firm foundation of uniform density throughout the entire length of the pipe.

### 3.2.1 Concrete Pipe Requirements

Concrete pipe shall be bedded with sand material minimum 200 mm in depth in trenches with soil foundation. Depth of sand bedding in trenches with rock foundation shall be 13 mm in depth per 300 mm of depth of fill, minimum depth of bedding shall be 200 mm up to maximum depth of 600 mm. Where concrete pipes are laid in deep trenches or where traffic loads are expected, the entire pipe line length shall be supported uniformly by concrete foundation or cradle.

### 3.2.2 Precast, Concrete Pipe Type Gutter/Ditch and Free-Gradient Ditch

These type of Precast drainage materials shall be laid using leveling mortar over a concrete foundation base.

### 3.2.3 Precast Concrete U-Ditch

Use leveling sand for non-traffic areas and leveling mortar over concrete foundation for traffic areas.

### 3.2.4 Plastic Pipe

Use clean sand for bedding, haunching and initial backfill for PVC and PE pipes. Minimum depth of bedding shall be 200 mm

## 3.3 PLACING PIPE

Each pipe shall be thoroughly examined before being laid; defective or damaged pipe shall not be used. Plastic pipe shall be protected from exposure to direct sunlight prior to laying, if necessary to maintain

adequate pipe stiffness and meet installation deflection requirements. Pipelines shall be laid to the grades and alignment indicated. Proper facilities shall be provided for lowering sections of pipe into trenches. Lifting lugs in vertically elongated pipe shall be placed in the same vertical plane as the major axis of the pipe. Pipe shall not be laid in water, and pipe shall not 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. Deflection of installed flexible pipe shall not exceed 4.5 percent of the average inside diameter of pipe.

#### 3.3.1 Concrete and Plastic Pipes

Laying shall proceed upgrade with spigot ends of bell-and-spigot pipe pointing in the direction of the flow.

#### 3.3.2 Precast Concrete Pipe Type Gutter/Ditch, Free Gradient Ditch and U-Ditch

Lay the drainage materials in conformance with product manufacturer's instructions.

#### 3.3.3 Multiple Culverts

Where multiple lines of pipe are installed, adjacent sides of pipe shall be at least half the nominal pipe diameter or 1 meter apart, whichever is less.

### 3.4 JOINTING

#### 3.4.1 Concrete Pipes and Other Precast Concrete Drainage Conveyance Materials.

##### 3.4.1.1 Flexible Watertight Joints

Gaskets and jointing materials shall be as recommended by the particular manufacturer. Cements, or adhesives shall be clean and dry. Gaskets and jointing materials shall be protected from the sun, blowing dust, and other deleterious agents at all times. Gaskets and jointing materials shall be inspected before installing the pipe; any loose or improperly affixed gaskets and jointing materials shall be removed and replaced. The pipe shall be aligned with the previously installed pipe, and the joint pushed home. If, while the joint is being made the gasket becomes visibly dislocated the pipe shall be removed and the joint remade.

##### 3.4.2 Plastic Piping

Install pipes and fittings per pipe manufacturer's installation manual.

### 3.5 DRAINAGE STRUCTURES

#### 3.5.1 Manholes and Inlets

Construction shall be of reinforced concrete, precast reinforced concrete, precast concrete segmental blocks complete with frames and covers or gratings; and with fixed galvanized steel ladders or manhole steps where indicated. Pipe connections to concrete manholes and inlets shall be made with flexible, watertight connectors in conformance with pipe manufacturer.



### 3.5.2 Walls and Headwalls

Construction shall be as indicated.

### 3.6 Metal Steps

Individual metal steps shall be adequately anchored to precast manhole walls per manhole or metal step manufacturer's installation standards.

### 3.7 STEEL LADDER INSTALLATION

Ladder shall be adequately anchored to the wall by means of steel inserts spaced not more than 1.83 m vertically, and shall be installed to provide at least 152 mm of space between the wall and the rungs. The wall along the line of the ladder shall be vertical for its entire length.

### 3.8 BACKFILLING

#### 3.8.1 Backfilling Pipe in Trenches

After the pipe has been properly bedded clean sand shall be placed along both sides of pipe in layers not exceeding 150 mm in compacted depth. The backfill shall be brought up evenly on both sides of pipe for the full length of pipe. The fill shall be thoroughly compacted under the haunches of the pipe. Each layer shall be thoroughly compacted with mechanical tampers or rammers. This method of filling and compacting shall continue until the fill has reached an elevation of at least 300 mm above the top of the pipe. The remainder of the trench shall be backfilled with select material from excavation or borrow and compacted by spreading and rolling or compacted by mechanical rammers or tampers in layers not exceeding 150 mm. Tests for density shall be made as necessary to ensure conformance to the compaction requirements specified below. Where it is necessary, in the opinion of the Contracting Officer, that sheeting or portions of bracing used be left in place, the contract will be adjusted accordingly. Untreated sheeting shall not be left in place beneath structures or pavements.

#### 3.8.2 Backfilling Pipe in Fill Sections

For pipe placed in fill sections, backfill material and the placement and compaction procedures shall be as specified below. The fill material shall be uniformly spread in layers longitudinally on both sides of the pipe, not exceeding 150 mm 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 300 mm above the top of the pipe shall extend a distance of not less than twice the outside pipe diameter on each side of the pipe or 4 m, whichever is less. After the backfill has reached at least 300 mm above the top of the pipe, the remainder of the fill shall be placed and thoroughly compacted in layers not exceeding 150 mm. Use sand material for this entire region of backfill for flexible and concrete pipe installations.

#### 3.8.3 Movement of Construction Machinery

When 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 or storm drain at any stage of

construction shall be at the Contractor's risk. Any damaged pipe shall be repaired or replaced.

#### 3.8.4 Compaction

##### 3.8.4.1 General Requirements

Cohesionless materials include gravels, gravel-sand mixtures, sands, and gravelly sands. Cohesive materials include clayey and silty gravels, gravel-silt mixtures, clayey and silty sands, sand-clay mixtures, clays, silts, and very fine sands. When results of compaction tests for moisture-density relations are recorded on graphs, cohesionless soils will show straight lines or reverse-shaped moisture-density curves, and cohesive soils will show normal moisture-density curves.

##### 3.8.4.2 Minimum Density

Backfill over and around the pipe and backfill around and adjacent to drainage structures shall be compacted at the approved moisture content to the following applicable minimum density, which will be determined as specified below.

- a. Under airfield and heliport pavements, paved roads, streets, parking areas, and similar-use pavements including adjacent shoulder areas, the density shall be not less than 90 percent of maximum density for cohesive material and 95 percent of maximum density for cohesionless material, up to the elevation where requirements for pavement subgrade materials and compaction shall control.
- b. Under unpaved or turfed traffic areas, density shall not be less than 90 percent of maximum density for cohesive material and 95 percent of maximum density for cohesionless material.
- c. Under nontraffic areas, density shall be not less than that of the surrounding material.

#### 3.9 FIELD PAINTING

##### 3.9.1 Cast-Iron Covers and Frames

After installation, clean cast-iron, not buried in masonry or concrete, of mortar, rust, grease, dirt, and other deleterious materials to bare metal and apply a coat of bituminous paint.

#### 3.10 FIELD QUALITY CONTROL

##### 3.10.1 Tests

Testing is the responsibility of the Contractor. Perform all testing and retesting at no additional cost to the Government.

##### 3.10.1.1 Leakage Test

Lines shall be tested for leakage by exfiltration tests prior to completing backfill. Prior to exfiltration tests, the trench shall be backfilled up to at least the lower half of the pipe. If required, sufficient additional backfill shall be placed to prevent pipe movement during testing, leaving the joints uncovered to permit inspection. Visible leaks encountered shall be corrected regardless of leakage test

results. When the water table is 600 mm or more above the top of the pipe at the upper end of the pipeline section to be tested, infiltration shall be measured using a suitable weir or other device acceptable to the Contracting Officer. An exfiltration test shall be made by filling the line to be tested with water so that a head of at least 600 mm is provided above both the water table and the top of the pipe at the upper end of the pipeline to be tested. The filled line shall be allowed to stand until the pipe has reached its maximum absorption, but not less than 4 hours. After absorption, the head shall be reestablished. The amount of water required to maintain this water level during a 2-hour test period shall be measured. Leakage as measured by the exfiltration test shall not exceed 9 mL per mm in diameter per 100 meters of pipeline per hour.

#### 3.10.1.2 Determination Of Density

Testing shall be performed by an approved commercial testing laboratory or by the Contractor subject to approval. Tests shall be performed in sufficient number to ensure that specified density is being obtained. Laboratory tests for moisture-density relations shall be made in accordance with JIS A 1210 except that mechanical tampers may be used provided the results are correlated with those obtained with the specified hand tamper. Field density tests shall be determined in accordance with JIS A 1214.

#### 3.10.1.3 Deflection Testing

Conduct deflection test no sooner than 30 days after completion of final backfill and compaction testing. Clean or flush all lines prior to testing. Perform a deflection test on entire length of installed flexible pipeline upon completion of work adjacent to and over the pipeline, including backfilling, placement of fill, grading, paving, placement of concrete, and any other superimposed loads. Deflection of pipe in the installed pipeline under external loads shall not exceed limits in paragraph PLACING PIPE above as percent of the average inside diameter of pipe. Use a laser profiler or mandrel to determine if allowable deflection has been exceeded.

##### 3.10.1.3.1 Laser Profiler

Inspect pipe interior with laser profiling equipment. Utilize low barrel distortion video equipment for pipe sizes 1.22 m or less. Use a camera with suitable lighting to allow a clear picture of the entire periphery of the pipe interior. Center the camera in the pipe both vertically and horizontally. The camera must be able to pan and tilt to a 90 degree angle with the axis of the pipe rotating 360 degrees. Use equipment to move the camera through the pipe that will not obstruct the camera's view or interfere with proper documentation of the pipe's condition. The video image shall be clear, focused, and relatively free from roll static or other image distortion qualities that would prevent the reviewer from evaluating the condition of the pipe. For initial post installation inspections for pipe sizes larger than 1.22 m, a visual inspection shall be completed of the pipe interior.

##### 3.10.1.3.2 Mandrel

Pass the mandrel through each run of pipe by pulling it by hand. If deflection readings in excess of the allowable deflection of average inside diameter of pipe are obtained, stop and begin test from the opposite direction. The mandrel must meet the Pipe Manufacturer's

recommendations and the following requirements. Provide a Mandrel that is rigid, nonadjustable, has a minimum of 9 fins, pulling rings at each end, and is engraved with the nominal pipe size and mandrel outside diameter. The mandrel must be 4.5 percent less than the certified-actual pipe diameter for Plastic Pipe. The Government will verify the outside diameter(OD)of the Contractor provided mandrel through the use of Contractor provided proving rings.

### 3.10.2 Inspection

#### 3.10.2.1 Post-Installation Inspection

Visually inspect each segment of concrete pipe for alignment, settlement, joint separations, soil migration through the joint, cracks, buckling, bulging and deflection. An engineer must evaluate all defects to determine if any remediation or repair is required.

##### 3.10.2.1.1 Concrete

Cracks with a width greater than 0.25 mm. An engineer must evaluate all pipes with cracks with a width greater than 0.25 mm but less than 2.5 mm to determine if any remediation or repair is required.

##### 3.10.2.1.2 Flexible Pipe

Check each flexible pipe (PE, PVC)for rips, tears, joint separations, soil migration through the joint, cracks, localized bucking, bulges, settlement and alignment.

##### 3.10.2.1.3 Post-Installation Inspection Report

The deflection results and final post installation inspection report must include: a copy of all video taken, pipe location identification, equipment used for inspection, inspector name, deviation from design, grade, deviation from line, deflection and deformation of flexible pipe, inspector notes, condition of joints, condition of pipe wall (e.g. distress, cracking, wall damage dents, bulges, creases, tears, holes, etc.).

### 3.10.3 Repair Of Defects

#### 3.10.3.1 Leakage Test

When leakage exceeds the maximum amount specified, correct source of excess leakage by replacing damaged pipe and gaskets and retest.

#### 3.10.3.2 Deflection Testing

When deflection readings are in excess of the allowable deflection of average inside diameter of pipe are obtained, remove pipe which has excessive deflection and replace with new pipe. Retest 30 days after completing backfill, leakage testing and compaction testing.

#### 3.10.3.3 Inspection

Replace pipe or repair defects indicated in the Post-Installation Inspection Report.

3.10.3.3.1 Concrete

Replace pipes having cracks with a width greater than 2.5 mm.

3.10.3.3.2 Flexible Pipe

Replace pipes having cracks or splits.

3.11 PROTECTION

Protect storm drainage piping and adjacent areas from superimposed and external loads during construction.

3.12 WARRANTY PERIOD

Pipe segments found to have defects during the warranty period must be replaced with new pipe and retested.

-- End of Section --