

## SECTION 02632

### STORM SEWERS AND CULVERTS

#### PART 1 - Description

This section covers storm sewer and culvert materials, excavation, trenching, and backfilling for storm sewers and appurtenances. Work shall consist of removal of all material of whatever description that may be encountered; removal and disposal of debris; handling and storage of materials; all necessary bracing, shoring, and protection; pumping and dewatering as necessary; all backfill preparation of subgrades; and final grading, dressing, and surface restoration cleanup of the site.

#### PART 2 - Materials

##### 2.01 Submittals

Before the fabrication of the pipe and manholes is started, the contractor shall submit for review, drawings showing the pipe lengths, complete laying schedule, joint details, special sections, and other additional details, such as fittings. All pipe and manholes furnished shall be fabricated in accordance with the reviewed drawings. Manufacturer's certificates of compliance and installation recommendations shall be provided to the City prior to construction.

##### 2.02 Materials

The materials furnished for the storm sewer pipe and culverts shall be equal to or shall exceed the following requirements.

###### A. Storm Sewer Pipe and Culverts

The materials furnished for the storm sewer pipe and culverts shall be equal to or shall exceed the following requirements.

###### 1. Reinforced Concrete Pipe (RCP)

- a. All reinforced concrete pipe shall conform to the requirements of ASTM Standards for the specified diameter and strength class as follows:
  1. Circular Pipe – ASTM C76
  2. Horizontal and Vertical Elliptical Pipe – ASTM C507
  3. Arch Pipe – ASTM C506
- b. Minimum wall thickness shall be "Wall B" in referenced specifications C76 and C14 of ASTM.

- c. Strength class or classes shall be as required by the Plans or Contract Documents but in no case shall pipe of less than strength Class III be used. Portland Cement used in manufacturing reinforced concrete pipe shall be Type II, ASTM C150.
- d. Lifting holes will not be permitted in any of the pipe, except elliptical pipe and box sections.
- e. Joints for the reinforced concrete pipe shall be either tongue and groove or bell and spigot. Except for special pieces, each joint shall be at least seven and one-half feet (7'6") (2.3m) in length. Unless deleted elsewhere in the specifications, joints in reinforced concrete pipe shall conform to one of the following types:

Rubber Trapped "O" Ring Gasket type – ASTM C 443  
Flexible Plastic Rope Gasket type – AASHTO M 198 – Type B  
Flexible Butyl Rope Gasket type – AASHTO M 198 – Type A  
Portland Cement Mortar Joint type

- f. Type D, Portland Cement Mortar Joint, may only be used on radial, elliptical, and arch pipe. The shape, dimensions, and tolerance of the bell and spigot or tongue and groove ends of the pipe shall be compatible with the type of joint used and shall conform to the above referenced specifications.
- g. Reinforced concrete pipe shall be manufactured in a plant that is certified by the American Concrete Pipe Association.
- h. In addition to the certifications and bearing test results, the contractor shall furnish the Owner with mill test reports for all cement used to manufacture proposed pipe. The owner reserves the right to sample and test any pipe after delivery and to reject all pipe represented by any sample which fails to comply with the specified requirements.

## 2. Polyvinyl Chloride Pipe (PVC)

- a. Polyvinyl chloride pipe (PVC) shall conform to ASTM D3034, SDR 26, for four inch (4") (100mm) through fifteen inch (15") (375mm) diameter and ASTM F679 for eighteen inch (18") (450mm) through thirty six inch (36") (914 mm) diameter. The pipe shall have bell and spigot joints with an approved gasketed joint.
- b. When special fittings such as wyes, tees, etc., are required, they shall be manufactured from the same material as the pipe and shall be made for use with PVC pipe. Connections to manholes and catch basins shall be made using O-ring gaskets whenever ground water is present; otherwise, catch basins and manholes may be grouted. Other suitable elastomeric boots may be used.

## 3. Corrugated Steel Pipe (CSP)

- a. Corrugated steel pipe, band couplers, and fittings, shall be manufactured in accordance with AASHTO M-36, latest edition, as revised in these specifications. All seams shall be joined in a manner that develops the full strength of the pipe and shall not affect the shape or nominal diameter of the pipe. The wall thickness of the steel shall be specified in the Special Provisions. Corrugated Steel pipe shall not be used unless shown on the construction drawings.
- b. The materials used to coat the steel sheets shall be specified in the Special Provisions and may be one or more of the following types:
  - i Zinc-coated (galvanized) steel sheets for annular pipe shall be coated in accordance with AASHTO M-218.
  - ii Aluminized coated (Type 2) steel sheets shall be coated by the hot dip process in accordance with AASHTO M-274, M-36, and M-274.
  - iii Precoated (Polymeric) galvanized steel sheets shall be coated in accordance with AASHTO M-246 and M-245. The precoated sheets shall be Type C with a polymeric coating in a thickness of 0.010 inch (3mm) minimum on each side and edge of the sheets.
- c. After the fabrication of the pipe, the manufacturer will coat the cut ends of each section of pipe with the specified coating before shipping. Exposed uncoated metal at the ends of the pipe may be reason for rejection of the pipe.
- d. The CSP shall be joined together with coupling bands manufactured in accordance with AASHTO M-36. If coatings of the CSP are specified, the couplings shall be coated with the same materials. Unless otherwise specified, the couplings shall make a watertight joint.
- e. All pipe shall be inspected when delivered to the job site and prior to the unloading of the pipe. Any pipe damaged during shipping and/or handling will be rejected and will not be installed. If the exterior bituminous coating is damaged during installation, the contractor shall repair the coating using approved methods and materials. If the concrete lining is damaged during installation, the contractor shall remove and replace the damaged pipe at no expense to the owner.
- f. The pipe supplier shall prepare and supply the contractor with a pipe-laying schedule, and the Contractor's supervisor and superintendent and the owner's representative shall have these laying schedules available on the job site.
- g. Connections for the laterals and catch basin leads may be shop fabricated or made in the field. In some instances, field connections shall be required. All field connections shall be saw cut using a saber type saw and templates made for such use. Flame cutting shall not be

allowed. After field cuts have been made, the exposed metal shall be coated with the specified coating. Coating materials shall be supplied by the pipe manufacturer. The connection shall be completed according to the manufacturer's recommendations.

- h. Installation of corrugated steel pipe is considered to be a flexible conduit and, therefore, special care must be taken during the bedding and backfilling operations. Installation and backfilling operations shall be in accordance with the recommended practices set forth in the "Handbook of Steel Drainage and Highway Construction Projects", published by the American Iron and Steel Institute.
  - i All pipe shall be bedded with an approved granular bedding material. The pipe shall be bedded true to line and grade with uniform and continuous support from a firm base. Blocking shall not be used to bring the pipe to grade.
  - ii The bedding material shall be placed evenly on both sides of the pipe to a point twelve inches (12") above the top of the pipe. Special care shall be taken to insure that all voids are filled beneath the pipe haunch and that the bedding material is properly placed and compacted to provide lateral restraint. The trench sidewall shall be adequately braced, shored, or sheeted as necessary to stabilize the trench walls. The trench shall not be any wider than necessary for proper installation, and pipe jointing. The bedding material shall be placed under haunches and around the pipe alternately in 6-inch layers on both sides of the pipe to permit thorough consolidation of the bedding material. This material is placed alternately to keep it at the same elevation on both sides of the pipe at all times.
  - iii Extreme care shall be taken in the removal of cribbing, shoring, sheeting, etc., so as not to disturb previously constructed foundation, bedding and initial backfill. If it was necessary to place or drive sheeting or other trench protection below the top of the pipe, the sheeting, shoring, etc., shall be cut off at a point one foot (1') above the pipe and the remaining material shall be left in place. Removal of this portion could seriously jeopardize the side support necessary for "flexible conduits" and create excessive lateral soils pressures and pipe deflections.
  - iv Excessive concentrated loads or heavy equipment on top of or along side of the pipe shall be avoided. Maximum supporting strength in flexible conduits does not develop until the fill consolidates.

#### 4. Corrugated PVC Drainage Pipe

- a. Corrugated Polyvinyl Chloride (PVC) pipe shall conform to ASTM F794 and F949 for twelve inch (12") through thirty-six inch (36") diameter. Joints shall be an integral bell-gasketed joint. When the joint is assembled, it shall prevent misalignment of adjacent pipes and form either a soil tight joint (2psi) hydrostatic test per AASHTO Standard Specification for Highway Bridges, Section 26.4.2.4 or a watertight joint (10.8) psi test per

ASTM D3212.

- b. When special fittings such as wyes, tees, etc., are required, they shall be manufactured from the same material as the pipe and shall be made for use with Corrugated PVC Drainage pipe. Connections to manholes and catch basins shall be made using O-ring gaskets whenever ground water is present; otherwise, catch basins and manholes may be grouted. Other suitable elastomeric boots may be used.

5. Reinforced Concrete Box Culverts

- a. Reinforced box culverts shall be precast or cast in place
- b. Precast concrete box culverts shall conform to the requirements of ASTM C1433, latest revision. Concrete box culverts shall be manufactured in a plant that is certified by the American Concrete Pipe Association.

B. Manholes

1. All manholes and other precast items shall be manufactured in a plant that is certified by the National Precast Concrete Association. Manufacturer's certificates of compliance and installation recommendations shall be provided to the Engineer and City prior to construction.
  - a. All manholes shall be constructed with concentric precast sections without steps unless otherwise approved. Precast concrete manhole sections shall be manufactured to standards at least equal to or greater than the requirements of the standard specifications for precast reinforced concrete manhole sections, ASTM designation C478. The minimum internal diameter for storm manholes shall be forty-eight inches (48") (1.2m) unless shown otherwise. Manholes shall conform to all requirements as shown on the detail drawings. Precast manhole joints shall be made water-tight with RAM-NEK material, or approved rubber gasket at each joint. The RAM-NEK and primer must be used in accordance with the manufacturer's instructions. Rubber gaskets used for precast manhole joints shall be designed in accordance with ASTM designation C443. All lifting holes must be grouted. All Portland cement for manholes shall be Type II.
  - b. The concrete base shall be cast-in-place or precast concrete of the size and depth shown on the drawings. Concrete used for bases shall have a twenty-eight (28) day compressive strength of at least four thousand pounds per square inch (4,000psi) (27,600 kPa). Approved precast concrete bases will be allowed if provided with an integral groove for barrel placement. Precast concrete bases shall conform to ASTM C478. Manholes with a monolithically poured base with bottom barrel are also acceptable and preferred.
  - c. Precast manhole inverts shall be constructed using a secondary invert forming system designed to provide a finished invert that aligns precisely with the incoming pipelines, incorporating a finished flow depth of 0.8 to 1.0 diameter of the largest pipe. The

completed precast invert shall include an alignment bench for each pipe, and provide for uniform horizontal and vertical transition through the manhole in accordance with drawings. Provide 0.1' (30mm) minimum fall between inlet and outlet. After the installation of the pipelines into the manhole, the interior annular space around the outside of the pipe shall be sealed with grout. The acceptable tolerances for manhole inverts are one-quarter inch (1/4") (6.25mm) in any dimension and within 2 degrees for alignment. The invert forming system shall be "a-lok tru contour", or approved equal.

- d. The manhole ring and cover shall be centered over the connection at the centerline of flow.
- e. For manholes with depths of six feet (6') (1.8m) or less, all of the precast manhole sections shall be of the specified diameter and shall have a flat, precast concrete top.
- f. For sewer manholes four (4) to six (6) feet in diameter and less than twenty (20) feet deep, precast reinforced manhole base sections shall be a minimum of 8 inches thick. For sewer manholes greater than six (6) feet in diameter or more than twenty (20) feet deep, precast reinforced concrete manhole base sections shall be a minimum of 12 inches thick. All precast manhole base sections shall be reinforced with #4 steel reinforcement bars placed 6 inches on center each way and at mid depth of the slab, unless shown otherwise on the plans.

#### C. Catch Basins.

1. All catch basins, inlet boxes, and other precast items shall be manufactured in a plant that is certified by the National Precast Concrete Association. Catch basins (storm inlets) shall be cast-in-place or precast concrete with dimensions as shown on the drawings or standard details.
  - a. Precast concrete catch basins shall comply with all the requirements of ASTM C858 and C857. Cast-in-place concrete basins shall be constructed of materials in accordance with Section 03050, Portland Cement Concrete.
  - b. The Contractor may elect to install pre-cast or cast-in-place catch basins.

#### D. Castings

1. Manhole frames and covers, and catch basins frames and grates shall meet the requirements of this Section unless specified otherwise in the Special Provisions or drawings.
2. Manhole frames and covers shall be heavy duty Neenah R 1643 or approved equal. Heavy-duty manhole ring and cover shall have a minimum depth of seven and half inches 1.5 inch thick cover, and an inside clearance of 24 inches in diameter.
3. Acceptable grates shall be determined by the design, hydraulic efficiency, and placement

required. Additionally, grates must be suitable for use in areas where it is possible for handicap persons and pedestrians to be present. The adoption of the Americans with Disabilities Act (ADA), the prominence of narrow-tired bicycles and concern for pedestrian safety dictates the design considerations of storm water installations.

Grate selection criteria should include a combination of capacity, and functionality for the specific location. Directional and/or vane grates are not recommended at the low points of vertical curves, and shall be used only when approved by the Engineer.

Catch basin frames and curb box shall be Neenah R-3067, D&L Supply I-3517, or equivalent. I-3516 is recommended for use in the lowpoint of vertical curves.

Grates shall be certified by the manufacturer as bicycle friendly, and the certification shall be submitted to the City prior to installation.

4. Cover and frame seat shall be machine finished to prevent any rocking of cover in its associated frame. Cover shall have the word “storm sewer” clearly cast on its surface.

When required, self-sealing, waterproof frames and covers meeting Neenah R-1916-F, or approved equal shall be used.

5. Flared end sections for culverts shall be manufactured of the same material as the culvert. End sections shall be fitted for a trash rack on both upstream and downstream ends, or as directed by the Engineer.

E. Granular Materials

1. Granular materials furnished for foundation, bedding, encasement or other purposes as may be specified, shall consist of any material or synthetic mineral aggregate such as sand, gravel, crushed rock, crushed stone or slag, that shall be so graded as to meet the gradation requirements specified herein for each particular use.
2. Granular materials furnished for use in foundation, bedding, or encasement recommended for use in construction are:

MATERIAL USE DESIGNATION

Sieve Size	Percent Passing	
	Foundation AASHTO M43 (No.57)	Bedding & Encasement AASHTO M43 (No. 67)
1 inch (25mm)	95-100	100
3/4 inch (20mm)	-	90-100
1/2 inch	25-60	-
3/8 inch (9.5mm)	-	20-55

No. 4 (4.75mm)	0-10	0-10
No. 8 (0.075mm)	0-5	0-5

3. Other approved material for bedding and encasement shall consist of sand, sandy gravel, or fine gravel having a maximum size of three-quarter inch (3/4") (20mm), uniformly graded and a maximum plasticity of 6 as determined by AASHO T-89 and T-90. Other gradations may be used if written approved is obtained from the City.
4. Certified copies of all sieve analysis and plasticity analysis for the above materials shall be submitted to the City Engineer and approved before construction starts. Other sieve or plasticity analysis may be required during construction as directed by the City Engineer.
5. Granular materials provided for Foundation, Bedding, or Encasement use, shall be classified as to use in accordance with the following:
  - a. Granular Foundation: placed below and to the midpoint of the pipe as replacement for unsuitable or unstable soils, to achieve better foundation support.
  - b. Granular Bedding: placed from four inches (4") (100mm) to six inches (6")(150mm) below the pipe to the pipe midpoint, to facilitate proper shaping and achieve uniform pipe support. When foundation material is required, the granular bedding shall be of foundation material gradation.
  - c. Granular Encasement: placed below an elevation one foot (1') (300mm) above the top of pipe, after pipe installation, for protection of the pipe and to assure proper filling of voids or thorough consolidation of backfill. Granular encasement shall be provided for all flexible piping.
6. Granular encasement and bedding material shall meet the gradation requirements listed in herein. Other gradations may be used if written approval is obtained from the City Engineer. Gradations should meet the requirements of ASTM 2321. Guidelines for the maximum particle size for encasement material in relation to pipe type and diameter are shown below:

<u>Pipe Type</u>	<u>Nominal Diameter Inches (mm)</u>	<u>Maximum Particle Size Inches (mm)</u>
PVC, Other Plastic	15" and greater	3/4 (20)
PVC, Other Plastic	Less than 15"	1/2 (12.5)
Concrete	6.1 - 12.0 (155 - 300)	1 (25)
Concrete	12.1 (307) and greater	1 (25)
CMP	6.1 - 12.0 (155 - 300)	1 (25)
CMP	12.1 (307) and greater	1 (25)



## 7. Select Backfill

Job excavated and imported select backfill material shall be free from debris, organic material, and stones larger than three inches (3") (75mm) in diameter. Contractor shall be responsible, at his expense, for separating debris, organic material and stones larger than three inches (3") (75mm) in diameter. Select material that the Engineer directs to be used shall be the same gradation as the bedding and encasement material. No asphalt chunks or concrete may be used as select backfill.

## 8. Structural Fill Material

Structural fill shall consist of excavated or imported material, free of organic or deleterious material and particles larger than three inches (3") (75mm) in maximum dimension. Structural fill shall be well graded from coarse gravel to fine sand with less than 10% passing the No. 200 sieve. Structural fill material shall be within +2% of optimum moisture content when placed as determined by Proctor, and shall not exhibit pumping (horizontal or vertical displacement) after completion.

## 9. Groundwater Barriers

Low permeability ground water barriers may be used in areas designated by the City Engineer. Barrier material shall meet soil classification GC, SC, or CL per the Unified Soil Classification System and shall have a liquid limit less than 50. The barrier material shall be compacted to 95 percent of maximum density. Job excavated material meeting one of the above soil classifications and free from stones, organic matter and debris may be used.

10. Portland Cement Concrete shall be of the class and dimensions as shown on the Plans or as directed by the Owner. The classes of concrete for drainage facility construction are referred to as Class AS and Class C. Class AS concrete is intended principally for concrete structures designed for high strength. Class C concrete is intended principally for low strength concrete used primarily for foundation stabilization, pipe cradles and encasement and other general purposes. All Portland Cement Concrete shall meet the requirements of Division 3 of these specifications.

### **Part 3 - Execution.**

#### **3.01 Excavation for Pipe and Related Structures (General)**

1. Complete all excavation regardless of the material encountered. If structures, utilities, or other objects are encountered that may be necessary for continued facility operation or may need preservation, immediately notify the Engineer and protect said object.
2. When cutting into existing roads, streets, alleys, or other public rights-of-way, the Contractor,

shall obtain the proper licenses, cut permits, etc., from the appropriate authority.

- a. Where trench excavation requires the removal of curb and gutter, concrete sidewalks, or asphaltic or concrete pavement, the pavement or concrete shall be cut in a straight line parallel to the edge of the excavation by use of a concrete saw, or similar approved equipment to obtain a straight, square, clean break. Cuts shall be located at standard joint locations, when possible.
3. When crossing existing or prospective cultivated areas, gravel streets or other developed surfaces, the Contractor shall strip the cover material to full depth of the existing surfacing. This surfacing shall be stockpiled and placed back over the trench after backfilling to the extent that it is acceptable and usable for that purpose. New material shall be provided as necessary. Topsoil shall be removed to full depth of the topsoil, or to a maximum depth of twelve inches (12") (300mm), whichever is less.
  4. The disturbed area from construction shall be confined within the construction limits.
    - a. The trench shall be dug only as far in advance of the pipeline as work can be reasonably completed that day. The sides of the trench shall be sloped and/or braced in accordance with the current OSHA Standards and the trench drained so that workers can work safely and efficiently. It is essential that the discharge of pumps when required, be laid to approved natural drainage channels or storm sewers
  5. Pipe crossings under sidewalks or curbs may be made by tunneling only if approved by the Engineer. If the Contractor elects to remove a portion of the sidewalk or curb, he must use a concrete saw for making neat joints corresponding to existing joints, compact the backfill as specified, and pour a new concrete sidewalk or curb section in accordance with the applicable sections of these specifications.
  6. During excavation, materials suitable for backfilling shall be piled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins. All excavated materials shall be stored and retained at least two feet (2') (600mm) or more from the edge of the trench in accordance with Occupational Health and Safety Rules and Regulations for Construction. Excavated material must not be piled over nearby existing parallel trench lines unless adequate precautions are taken by the Contractor to prevent sidewall failure. Ready access to existing fire alarm boxes, fire hydrants, valves, manholes, and other appurtenances must be maintained.
    - a. When making excavations, the various materials excavated shall be piled separately. All concrete and bituminous materials, any soils, which cannot be properly compacted, and all other deleterious materials shall be immediately removed from the construction site and properly disposed of in accordance with applicable laws.
    - b. All excavated material shall be piled within the construction limits or in a location obtained

by the Contractor and accepted by the Engineer in a manner that will not endanger the work and that will avoid obstructing sidewalks, driveways, and fire hydrants.

7. Surface drainage of adjoining areas shall be unobstructed. Grading shall be done as may be necessary to prevent surface water from flowing into excavations, and any other water accumulating therein shall be promptly removed. Under no circumstances shall water be permitted to rise in unbackfilled trenches until after the pipe has been placed, tested, and covered with backfill. Any pipe having its alignment or grade changed as a result of a flooded trench shall be reinstalled.
  - a. Gutters shall be kept clear or other satisfactory provisions made for street drainage at all times.
8. The bottom of the trenches shall be accurately graded to the line and grade shown on the drawings. Bedding material shall be added (four inches (4") (100mm) minimum) to provide uniform bearing and support for each section of pipe at every point along its length. Care must be taken to avoid over excavation. Unauthorized over-depths shall be backfilled with approved bedding material at the Contractor's expense. All bedding material added shall be moistened and compacted to the satisfaction of the City Engineer. The finished trench bedding beneath the pipe shall be prepared accurately by means of hand tools.
  - a. The bottom of all excavations shall be neat and clean, containing no abrupt changes in grade except as shown and shall be free from all slough. Suitable methods shall be used to produce an excavated surface without disturbance to the underlying material by compacting soil material to at least 95% Standard Proctor, ASTM D698.
  - b. If in its natural state the material at the bottom of the trench is soft and, in the opinion of the City Engineer, cannot support the pipe, a further depth and/or width shall be excavated as directed by the City Engineer and refilled with foundation material to the midpoint of the pipe. Other approved methods may be used to assure a firm foundation.
  - c. Foundation material used to dewater the trench or to replace a wet material shall be considered incidental to construction.
9. Blasting the excavation to remove rock, clay, or hardpan will not proceed until the Contractor has notified the City Engineer of the necessity to do so and obtained written approval. This notification shall in no manner relieve the Contractor of the hazard and liability contingent on blasting operations. The City Engineer shall fix the hours of blasting. The Contractor at his expense shall repair any damage caused by blasting. The Contractor's methods of procedure relative to blasting shall conform to local and state laws and municipal ordinances, and the necessary permits shall be obtained.
10. The width of the trench shall be such to provide adequate working room for workers to install the pipe in the specified manner. The trench in the pipe zone and to one foot (1') (300mm)

above the pipe zone shall be adequate in width to allow for proper compaction but shall in no case be less than one and half times the outside pipe diameter plus one foot (1') (300mm).

11. Where the trench is not located near existing utilities, buildings, or other structures, and where water and other conditions permit, the Contractor may omit sheeting and bracing of the excavation. In this event, sides of the trench shall be sloped to protect the workers working within them in accordance with Occupational Health and Safety Rules and Regulations for Construction. However, the trench must stay within the construction limits.
12. The Contractor shall provide safety boxes or sheeting and bracing necessary to confine his work within the construction limits, to provide safe working conditions, to prevent damage and delay to the work, and to prevent the disturbing or settlement of adjacent road surfaces, foundations, structures, utility lines or railroad tracks. The Contractor shall be responsible for the strength and sufficiency of all sheeting and bracing.
13. Any damage to the work under this contract or to adjacent structures or property caused by settlement, water or earth pressures, slides, cave-ins, or other reasons due to failure or lack of sheeting and bracing, or improper bracing, or through negligence or fault of the Contractor in any manner, shall be repaired by the Contractor without delay and at his expense.
14. Bracing shall be so arranged as to provide ample working space, so as not to interfere with the work, and so as not to place any strain on the structures being constructed, until such structures are of sufficient strength to withstand such strain. No sheeting and bracing shall be removed until the construction has proceeded far enough to provide ample strength for its safe removal.
  - a. Sheeting or bracing may be left in place in the trench at the discretion of the City Engineer. Any sheeting or bracing left in place shall be cut off approximately three feet (3') (900mm) above the top of the pipe or two feet (2') (.6m) below finish grade, whichever is lower, and the cut-off portion removed. All sheeting or bracing left in place shall be accurately located and shown on the "Record Drawings"
15. The Contractor shall be responsible for enforcing safety and maintaining safe working conditions in all trenching, shoring, and blasting operations to conform to OSHA regulations.
16. Trenching and tunneling standards near and around trees.
  - a. Trenches should be routed outside the tree protection zone or critical root zone (CRZ). For trees less than 6" diameter at breast height (DBH), defined as 4.5 feet about average ground level, that are to be retained, no trenching should occur within the dripline or tree protection/critical root zone as defined by the City of Lakeland Tree Management Ordinance. For trees 6" DBH and less than 20" DBH no trenching should occur within an area equal to 1' radius for every inch of DBH or within the tree protection/critical root zone as defined by the City of Lakeland Tree Management Ordinance. For trees 20" DBH and greater, no trenching should occur within an area equal to 1.5' of radius for

every inch of DBH or within the tree protection/critical root zone as defined by the City of Lakeland Tree Management Ordinance.

- b. Soil removed from the trenches should be placed on the side away from the trees and replaced as soon as possible. The width of the trench should be minimized. The use of trench walls should be considered rather than sloping sides when working around trees.
  - c. Trenches should be backfilled with quality or native soil when inside of a tree protection zone or critical root zone. Gravel, slurry, stone, and concrete are not appropriate fill material within a tree protection zone, unless used as bedding material.
  - d. If placement of utilities or other infrastructure is unavoidable within the tree protection zone or critical root zone then specific measures should be applied to minimize root damage. Tunneling is recommended as soon as roots 1 inch diameter and greater are encountered. Minimum tunnel depth should be 24 inches. Launch and recovery pits should be located outside of tree protection zones and critical root zones. If tunneling is impossible due to specific soil restrictions, the trenching should be done by hand within the tree protection zone or critical root zone. If this required trenching will sever more than 25% of the tree protection/critical root zone then the trench should be re-directed at the center of the tree with the final section dug under the base of the tree.
  - e. Changes to the approved construction plans or methods for trenching and tunneling must be submitted to and receive approval by the City's Representative before proceeding.
17. Dewatering, if required by site conditions, shall be provided by the Contractor. The contractor shall provide and maintain adequate dewatering equipment to remove and dispose of all surface water and groundwater entering the excavations, trenches, or other parts of the work.
18. All trench excavations which extend down to or below groundwater shall be dewatered by lowering and keeping the groundwater level beneath such excavations twelve inches (12") (300mm) or more below the bottom of the excavation.
19. Surface water shall be diverted or otherwise prevented from entering excavated areas or trenches to the greatest extent practicable without causing damage to adjacent property.
20. The Contractor shall be responsible for the conditions of any pipe or conduit which he may use for drainage purposes, and all such pipes or conduits shall be left clean and free of sediment.
21. In areas where dewatering is required, the Contractor will comply with the following requirements.
- a. All discharges from dewatering systems, including well points, dewatering wells, pumps

in the bottoms of the trenches, etc. will require a permit from the Tennessee Department of Environment and Conservation (TDEC). Before starting any construction, the Contractor shall submit an application to discharge to the TDEC along with this proposed dewatering plan for review.

- b. One copy of the initial application, dewatering plan, and of the permit authorizing the discharge must be provided to the City Engineering office with the application for an excavation permit. Copies of any revisions to the dewatering plan shall be immediately provided to the City Engineering office.

### **3.02 Disposal of Excess Material**

1. Except as otherwise permitted, dispose of excess excavated materials in a legal manner.
2. When making excavations, the various materials excavated shall be piled separately. All concrete and bituminous materials, any soils which cannot be properly compacted, and all other deleterious materials shall be immediately removed from the construction site and properly disposed of in accordance with applicable laws.

### **3.03 Pipe and Structure Installation**

1. The Contractor shall use laser beam equipment, surveying instruments, or other proven techniques to maintain accurate alignment and grade. Reasonable care shall be exercised in handling and laying the pipe and fittings. The interior of all pipe and fitting shall be kept free from dirt and foreign matter at all times, and cleaned out thoroughly before being lowered into the trench. Under no circumstances shall materials be dropped or thrown into the trench.
2. Materials shall be placed where they will not be subject to injury from vehicles or equipment. The contractor's facilities for lowering the pipe into the trench shall be such that neither the pipe nor trench will be damaged or disturbed. Pipe shall be lowered into the trench with rope slings, gin poles, dragline, or trench in such manner as to lay the pipe carefully into place and shall be lowered and laid with the bell end up grade. Holes shall be dug under the bells so that pipe is unsupported at the pipe connection. The laying of pipe in the finished trench shall be started at the lowest point and laid up grade. The Contractor shall clean and remove all sand, gravel, concrete, and cement grout that has entered the lines in the process of construction.
3. Any pipe which is broken, cracked, or otherwise unsuitable, as determined by the Engineer, shall be removed and replaced by the contractor at no additional cost to the owner. Any damage to pipe coatings shall be repaired with the same materials used for the original coating before laying the pipe.
4. The Contractor shall keep the pipe, manholes, catch basins, and other structures free from deposits of mud, sand, gravel, or other foreign matter, and in good working condition until the construction is completed and accepted. Upon completion of each line between manholes, a

clear and unobstructed view of the whole bore of a pipe shall be obtained between manholes by use of a light or subreflector. If such view is not apparent an air-filled rubber ball, approved by the Engineer, having a diameter one-inch (1") (25mm) less than the tile to be tested, shall be flushed through the line between manholes. Any obstruction found in any line shall be removed by the contractor without cost to the owner. Any methods used by the contractor to remove deposits of mud, sand, gravel, or other foreign matter from the line shall be approved by the Engineer. Unless specified in the Special Provisions, a leakage test will not be required. However, this does not preclude the fact that obvious and concentrated leaks (such as open joints, pinched gaskets, cracked barrels or bells, etc.) will not be allowed.

5. Pipe shall not be laid on frozen ground, or when trench conditions are unsuitable for such work.
6. The upgrade end of pipelines not terminating in a structure shall be plugged with a cap or plug approved by the Engineer.
7. Fine grading to the bottom of the barrel shall proceed ahead of the pipe laying and, should any over-excavation exceeding two inches (2") (50mm) be encountered, the material added shall be moistened (95% of Standard Proctor) and compacted to the density of the existing subgrade or foundation material shall be added at the Contractor's expense.
8. Bell holes shall be dug for the pipe bells or couplings and the materials placed along the preceding pipe laid. The pipe shall be supported for the bottom 60 degrees and throughout its length (except for the minimum distance necessary at the bell holes). Bell holes shall be adequate to make the joint, but no larger than necessary so that maximum support on undisturbed ground or pipe zone material will be provided for the pipe. The remainder of the pipe shall be surrounded to at least its midpoint by granular bedding material, compacted in maximum six inch (6") (150mm) layers to completely fill all space under and adjacent to pipe.
9. Pipe laying should proceed upgrade with the spigot ends pointed in the direction of flow. No pipe shall be laid in water or when the trench conditions are unsuitable for such work, except by written permission of the Engineer. The Contractor shall make all connections of pipe to the manholes which have previously been constructed.
10. The Contractor shall connect all existing storm inlets and sewers to the new storm sewer as shown on the drawings. These connections shall be made as the storm sewer construction progresses which will require that each section of the new sewer be fully completed and ready for operation as the construction advances.
11. Open excavation shall be satisfactorily protected at all times. At the end of each day's work, the open ends of all pipes shall be protected against the entrance of animals, children, earth, or debris, by bulkheads or stoppers. The bulkheads or stoppers shall be perforated to allow passage of water into the installed pipeline to prevent flotation of the pipeline. Any earth or other material that may find entrance into the main sewer or into any lateral sewer through any

such open end of unplugged branch must be removed at the Contractor's expense.

12. Curved alignments shall be constructed with precast, beveled end concrete radius pipe which meet the same requirements as for straight pipe. Concrete radius pipe less than or equal to 36 inch diameter shall have a minimum centerline radius of 20 feet and all radius pipe greater than 36 inch diameter and less than 72 inch diameter shall have a minimum centerline radius of 30 feet.

### **3.04 Installation of Manholes**

1. Excavation shall be to a depth and size to provide for construction of the manhole. Concrete bases shall be poured on undisturbed ground. Precast concrete bases shall be carefully lowered onto one of the following:
  - a. Six inches (6") (150mm) minimum layer of well-compacted granular material accurately laid to a smooth level surface using a straight edge and hand level.
  - b. Three inches (3") (75 mm) of concrete poured on undisturbed soil.
2. Walls shall be of precast concrete as shown in the standard drawings and shall be constructed to form a complete watertight structure.
3. The Contractor shall provide a minimum of two inches (2") (50mm) and a maximum of twelve inches (12") (300mm) in two-inch (2") (50mm) layers of precast reinforced concrete adjusting rings between the cast iron frame and the manhole top section. Each ring shall be set on a full bed of mortar and shall be made watertight in accordance to Drawing 602-2. Wood will not be allowed as spacers. Adjusting rings shall conform to the size and shape of the casting frame. Frames and covers shall be set to the designated elevation in a full mortar bed.
  - a. The minimum two-inch (2") (50 mm) concrete ring for grade is not needed if grade can be met with a six-inch (6") (150mm) flange on top of the cone section of the manhole.
  - b. If the number of adjusting rings exceeds the maximum twelve inches (12") (300) mm), the manhole shall be reexcavated and a manhole barrel section installed.
4. Manholes shall be set as shown on drawing details. All lifting holes must be grouted in after placement.
5. When manholes are to be constructed in new streets, manhole rings shall be set to the final grade before the street-wearing course is placed. Riser rings shall not be used to make adjustments for new construction. In gravel or unpaved roads, the manhole ring shall be kept four to six inches (4"-6") (100mm-150mm) below the road surface.



6. The invert of all manholes shall be smoothly shaped so as to allow a free, uninterrupted flow of storm water. The invert forming system shall be "A-Lok Tru Contour", or approved equal. Floor troughs shall be furnished for all storm sewers entering manholes. Inverts shall be U-shaped to the 1.0 diameter point before sloping at a 1 to 12 slope to the manhole walls.

### **3.05 Trench Backfilling.**

#### **A. Trench Backfilling**

1. All excavation in trenches shall be backfilled to the original ground surface or to such grades as specified or as shown on the drawings. The backfill shall begin as soon as practical after the pipe has been placed and shall thereafter be carried on as rapidly as the protection of the balance of the work shall permit.
2. No pipe shall be covered before the Project Representative or the Engineer has observed and approved the pipe. If any piping or appurtenance is covered without the approval of the Engineer or Resident Project Representative, at the discretion of the Engineer, the Contractor shall be required to re-excavate to expose the covered materials. The cost of exposing those materials and then backfilling and recompacting will be at the Contractor's expense regardless of the condition of the pipe and/or the materials under question.
3. The Contractor shall completely backfill all excavations before stopping work at the end each day. Open excavations (fenced or unfenced) shall not be allowed overnight or on weekends at any site after work has stopped for the day unless approved by the City.
4. Complete cleanup shall proceed directly behind the backfilling operation to accommodate the return to normal conditions. Should the Contractor, in the City's opinion, fail to pursue diligently the backfilling and cleanup, the amount of work on which complete cleanup has not been accomplished shall be limited to one thousand lineal feet (1,000') (300m) for the entire job. The Contractor shall have sufficient equipment on the job to assure timely backfill and cleanup at all times.

#### **B. Pipe Bedding.**

1. **Class A - Concrete Cradle**  
Class A bedding for storm sewers and culverts shall consist of a continuous concrete cradle up to springline constructed in conformity with the details shown on the Plans or as directed by the Engineer.
2. **Class B - Granular Encasement Bedding**  
Class B bedding shall consist of a bed of granular material having a thickness of at least 150 mm (6 inches) below the bottom of the conduit. For conduits other than precast reinforced concrete box sections and corrugated aluminum and steel box culverts, the bedding shall extend up around the pipe for a depth of not less than 12 inches above the

top of the pipe.

3. Class C - Granular Bedding

Class C bedding shall be constructed by bedding the drainage pipe on a bed of granular material shaped by a template to fit the lower part of the pipe exterior for at least 10 percent of its overall height (Minimum of 4 inches below the bell of the pipe). After pipe installation granular encasement material shall then be rammed and tamped in layers not over 6 inches in loose thickness around the pipe to the springline.

4. Class B bedding shall be provided for all piping unless otherwise shown on the drawings and authorized by the City Engineer.

5. Bedding material shall be placed as shown on the typical trench detail and described above. Spread bedding material to provide continuous and uniform support beneath pipe at all points between bell holes or pipe joints. Particular attention shall be given to the area from the base of the pipe or culvert to the centerline to ensure firm, uniform, and continuous support is obtained and to prevent any lateral movement upon subsequent backfilling or under service conditions. Bedding material shall be placed, prepared, and compacted simultaneously on both sides and lateral movement shall be prevented. Bedding material shall be moisture conditioned to +2% to -4% of optimum and compacted to 90% maximum density, as determined by ASTM D698. Class C bedding material shall be placed manually with shovels, and tamped in maximum 6" lifts and evenly placing the material on both sides of the pipe. Bedding material shall not exhibit pumping (horizontal or vertical displacement) after compaction. Encasement material will then be placed around and over the top of the pipe, but need not be hand placed. During conditions where flexible piping shall be buried in excess of 20 feet in depth, all bedding material shall be moisture conditioned to +2% to -4% of optimum and compacted to 95% maximum density, as determined by ASTM D698.

6. Trench Backfill above the Encasement Zone. Trench backfill above the encasement zone may consist of excavated material or select backfill material. Excavated material shall be used unless the minimum density requirements cannot be met. Select backfill material such as pit run shall be substituted for excavated material to meet compaction requirements. Backfill material shall be pushed onto the slope of the excavated trench and allowed to slide down into the trench. Backfill material shall not be permitted to free fall into the trench until at least one foot (1') (254mm) of cover is over the pipe or culvert. Moisture conditioning may be provided by water trucks or hoses. Excavated or select backfill material shall not exhibit pumping (horizontal or vertical displacement) after compaction.

7. Backfilling shall be done in lifts of uniform layers which will produce the required compaction. Each lift shall be completely compacted over the full width of the excavated area. Compacting shall continue until the specified relative compaction has been attained or until no more settlement occurs. Water jetting of backfill shall not be permitted.

8. In-place densities of compacted backfill material shall be determined by the Engineer using

either ASTM standard test method D1556-82 (Sandcone) or ASTM standard test method D2922-81 (nuclear). The minimum and maximum dry density for non-cohesive materials such as clean sands and gravel shall be determined by ASTM D4253 and D4254. The maximum dry density for cohesive backfill materials, such as clays, silts, etc., shall be determined by ASTM D698.

- a. Backfill above the encasement zone shall be compacted to the minimum densities and moisture conditions listed below. The densities listed below may only be modified through a geotechnical report.

<u>Area</u>	<u>Cohesive</u>
Streets, highway, alleys	95%, $\pm 2\%$
Sidewalks, curbs, and driveway	95%, $\pm 2\%$
Lawns and cultivated areas	90%, $\pm 2\%$

9. Care of Utilities

- a. In excavating and backfilling for pipelines or structures, extreme care must be taken so as to not mar or injure any gas, telephone, sewer, water, power, or television lines. The utility owner shall be notified that the relocation is necessary and shall be given adequate time to provide for the relocation.

10. When the trench excavation for the sewer main and appurtenances is within the rights-of way of state or county highways, the backfilling of the trench, compaction of materials, subgrade preparation and surfacing shall be done in strict accordance with the requirements and specifications of the authority having jurisdiction or as required by these specifications, whichever is more stringent.

11. In all cases, the Contractor shall blade and compact the roadway after the trench has been backfilled, so that it shall be passable to traffic at all times. The Contractor shall maintain the roadway in a condition acceptable to the City at all times until final acceptance of the entire work by the City.

12. The Contractor shall also blade and maintain all detours and bypasses. All maintenance work shall be done at no additional compensation. In addition to the blading and maintenance requirements specified, the Contractor shall provide at least one tank truck with pressurized spray bars for spraying water on the streets to control the dust. Dust control shall be required as necessary on all streets after compacting and grading and on all detours and bypasses.

13. The Contractor is responsible for the complete maintenance of his work at all times. If he fails to provide proper maintenance, and safety or nuisance conditions arise, it is expressly understood that City crews may be directed by the City to provide essential maintenance, and that such work will be done at the expense of the Contractor.

14. The Contractor shall remedy at his own expense any defects that appear in the backfill following completion and during the warranty period.

C. Storm Sewers and Culverts Placed on Fill

1. Fill material placed in areas over which storm sewer or culverts will be constructed shall be select earth material from the elevation of suitable subgrade to the bottom elevation for bedding or foundation of the drainage facility.
2. Placement and Compaction. If storm sewer or culverts are constructed on filled areas, the fill material shall be placed in 6 inch loose layers and compacted to 95 percent of maximum density at plus or minus 2 percent of optimum moisture content as determined by Laboratory Standard Proctor Test (ASTM D 698) up to a point at least 2 feet above the outside top of the pipe or to the foundation of manholes, inlets, special structures, box culverts, concrete channel lining and concrete ditch paving. If compaction standards for storm sewer pipe exceed that of the adjoining fill, the width of compaction for the storm drain shall be not less than the outside diameter of pipe plus 10 feet. If compaction standards for the manhole, inlets, special structure, box culverts, concrete channel lining and concrete ditch paving exceed that of adjoining fill, the limits of compaction for the facility shall be not less than 5 feet outside of the facility base slab.

**3.06 Installation of Structures.**

1. Structures shall be set on a six-inch (6") (150mm) layer of foundation material when directed by the Engineer. The surface shall be accurately graded to provide uniform bearing for the structure.
2. Catch basins shall be constructed at the locations shown on the drawings and approved by the Engineer. The size and type of catch basins shall be shown on the drawings or in the Standard Details of the Specifications. Catch basin frames shall be set accurately to grade. Concrete grout shall then be placed around and beneath the frame to hold the grate securely in place.
3. Manhole castings shall be installed one-fourth inch (1/4") (6.25mm) to one-half inch (1/2") (12.5mm) below the surface of the existing pavement. Where the structure is in unpaved streets, the manhole casting shall be set to the future street elevation. The casting shall be constructed as shown in the Standard Details. The contractor shall provide a minimum of two inches (2") (50mm) and a maximum of twelve inches (12") (300mm) in two inch (2") (50mm) layers of precast reinforced concrete adjusting rings between the cast iron frame and the manhole top section. Each ring shall be set on a full bed of mortar and shall be made watertight. The bearing surface around the perimeter of the frame shall be grouted to a height within two inches (2") (50mm) from the existing street surface, and to a width of twelve inches (12") (300mm) greater than the manhole ring, and a depth of six inches (6") (150mm) below the bottom adjusting rings or one foot (1') (300MM), whichever is greater. The manhole frame

shall then be tacked and asphaltic concrete pavement shall be placed for the final two inches (2") (50mm).

### **3.07 Structure Backfilling.**

- A. Structure backfilling shall cover manholes, catch basins, junction boxes, and any other structure encountered during the course of the work. Fill around structures shall consist of trench backfill meeting the requirements of structural fill material or select backfill material. Fill material shall be spread and compacted to provide continuous and uniform support around the structure. Special attention shall be given to the compaction operation around structures to ensure uniform compaction.
- B.. Do not place fill when the surface to be filled is frozen. Do not place frozen fill.
- C.. Fill around concrete structures shall commence only after concrete has attained 80% of the ultimate compressive strength specified. Remove all form materials, concrete spills, and trash from around the structures before placing fill. Where backfilling on both sides or around the perimeter of a structure is required, place the backfill and compact simultaneously at the same elevation on opposite sides or around the perimeter in lifts.
- D. Place fill material in eight inch (8") (200mm) maximum lifts and compact to at least 95% density for cohesive soils. The moisture content shall be +2% to -2% of optimum.

### **3.08 Cleanup**

- A. Construction cleanup and all backfill operations shall directly follow the storm sewer installation. Cleanup shall be completed to allow local traffic on the street and access to driveways, parking lots, etc.
- B. During construction, all existing gutters, storm drains, runoff channels, etc., shall be kept clean of dirt, rubble, or debris which would impede the flow of storm sewer.

### **3.09 Quality Control**

- 1. Light Test
  - a. After the trench has been backfilled, a light test shall be made between manholes to check alignment and grade for displacement of pipe. Except for curved alignments shown on the plans, the completed pipeline shall be such that a true circle of light can be seen from one manhole to the next. If alignment or grade is other than specified and displacement of pipe is found, the Contractor shall remedy such defects at his own expense.
- 2. Leakage Test

- a. Unless specified in the Special Provisions, a leakage test will not be required. However, this does not preclude the fact that obvious and concentrated leaks (such as open joints, pinched gaskets, cracked barrels, or bells, etc.) will not be allowed.

### 3. Gradation Test

- a. Bedding Material

- i One initial gradation test for each type of material plus one additional test for each one thousand cubic yards (1000 yd<sup>3</sup>) (750m<sup>3</sup>) placed of each material.

- b. Foundation Material

- i One initial gradation test for each type of material plus one additional test for each one thousand cubic yards (1000 yd<sup>3</sup>) (750m<sup>3</sup>) placed of each material.

- c. Structural Fill Material

- i One initial gradation test for each type of material plus one additional test for each one thousand cubic yards (1000 yd<sup>3</sup>) (750m<sup>3</sup>) placed of each material.

- d. Select Backfill Material

- i One initial gradation test for each type of material plus one additional test for each one thousand cubic yards (1000 yd<sup>3</sup>) (750m<sup>3</sup>) placed of each material.

- e. Encasement Backfill Material

- i One initial gradation test for each type of material plus one additional test for each one thousand cubic yards (1000 yd<sup>3</sup>) (750m<sup>3</sup>) placed of each material.

- f. All gradation tests shall be the responsibility of the Contractor using a certified approved testing laboratory acceptable to the Owner and Engineer. The Contractor shall be responsible for all costs associated with gradation testing.

### 4. Density Test

- a. Encasement Zone Material

- i One test for each five hundred lineal feet (500') (150m) pipe installed.

- b. Bedding Zone Material

- i One test for each five hundred lineal feet (500') (150m) pipe installed.

- c. Trench, Select Backfill Material, and/or Structural Fill Material
  - i One standard proctor test ASTM D698 or one relative density test, (ASTM D4253 and D4254) for each type of material for every two foot (2') (600mm) of trench depth above the pipe zone per every three hundred lineal feet (300') (30m) pipe installed. The Engineer may elect to take one test for each one thousand cubic yards (1000yd<sup>3</sup>) (750m<sup>3</sup>) or a portion thereof.
- d. Unless otherwise indicated in the Contract Documents, density and moisture tests shall be the responsibility of the Owner/Engineer. The Contractor shall cooperate with the Engineer or testing agency. If the initial moisture/density tests fail, the Contractor will be responsible for all costs associated with retests, until a passing moisture/density test is completed.

## 5. Deflection Test

- a. Mandrel or deflection testing for flexible conduit shall be conducted as directed by the City Engineer. Testing shall be conducted using a mandrel with a diameter equal to 95 percent of the inside diameter of the pipe. The test shall be performed without mechanical pulling devices. The mandrel go/no-go, device shall be cylindrical in shape and constructed with either 9 or 16 evenly spaced arms or prongs. Mandrels with few arms will be rejected. Contact length of mandrel's arms shall equal or exceed nominal inside diameter of pipe to be inspected. Critical mandrel dimensions shall carry tolerance of 0.01 inch maximum. Contractor shall provide mandrel and necessary equipment for mandrel test. Mandrel shall be hand-pulled through flexible pipe lines prior to end of warranty period. Sections of pipe not passing mandrel shall be uncovered and rebedded, rerounded, or replaced to the satisfaction of the owner. Repaired section shall be retested. It is also recommended that the contractor perform a mandrel test prior to placing paving surfaces.

### **3.10 Final Acceptance and Record Drawings**

- A. "Record Drawings" shall be submitted to the City prior to preliminary acceptance of the construction project. "Record Drawings" shall include, in addition to construction drawings and details, "as built" information where it differs from construction drawings and locate information including horizontal and vertical coordinates in the datum established by the City for the Geographical Information System.
- B. Final Acceptance
  - 1. Final acceptance will not take place until preliminary acceptance is obtained and all paving and curbwalk is completed.
  - 2. Before final acceptance of any storm sewer, the following inspections shall be made:

- a. All lines clean and flushed
  - b. Manholes up to proper grade in a proper condition
3. All punch list items must be completed prior to final acceptance.

**END OF SECTION**