APPENDIX D – CONSTRUCTION STANDARDS

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TABLES

D.1 GENERALLY

D.1.1 Scope

This appendix contains the standards, specifications and details for the construction of public infrastructure improvements within private development projects including subdivisions and site plans. The standards contained in this appendix represent the minimum that will be approved by the city for construction and apply to all improvements that may be deeded to and accepted by the city for ownership and maintenance. The standards also apply to many improvements that will be retained in private ownership. This appendix also specifies the content of construction plans and details required to be submitted with an application for development and an adequate review of a construction design. The specification of documents to be submitted is based on the type of application for development approval, the system being designed and the particular stage of development for which the application is submitted.

D.1.2 Modifications

The City Engineer may approve additional or alternative standards, specifications and details when necessary and appropriate and may modify or delete standards, specifications, and details from this appendix when appropriate and for valid reasons. The City Engineer may add to, delete or modify required documents and information contained in this appendix when appropriate and for valid reasons. Any such addition, deletion or alternate shall be documented and forwarded to the Planning Commission as information. In specific cases and for documented reasons, the City Engineer may waive compliance with a specific standard or the submission of a particular document. The reasons for any waiver shall be recorded in the project application file.

D.2 SITE WORK

a. **Scope:** Furnish all material, equipment and labor required for clearing, grubbing, excavation, filling, and grading the site as specified, as shown on the plans, and as directed by the Engineer.

b. **Existing Improvements:** Streets, sidewalks, driveways, power/cable/telephone lines, gas lines, water lines, sewers, storm drains and other existing improvements shall be maintained and protected from damage. Any aerial, surface or subsurface improvements damaged during the course of the work shall be repaired to the satisfaction of the Engineer. Satisfactory provisions shall be made for the maintenance of traffic on streets, driveways and walkways.
   1. Prior to any excavation, the Contractor shall notify all utilities and utility locating services to provide locations for buried utilities. The Contractor shall obtain all necessary permits (grading, building, water, sewer, encroachment, etc.) prior to beginning work.

c. **Clearing:** Clearing shall consist of the felling and cutting up, or the trimming of trees, and the satisfactory disposal of the trees and other vegetation together with the timber, snags, brush and rubbish occurring within the construction area. Individual trees and groups of trees designated to be left standing within cleared areas shall be trimmed of all branches to such heights and in such manner as may be necessary to prevent interference with the construction operations. All limbs and branches required to be trimmed shall be neatly cut close to the trunk of the tree or to main branches, and the cuts thus made shall be painted with an approved tree-wound paint. Individual trees, groups of trees and other vegetation to be left standing, shall be protected from damage as necessary. Clearing operations shall be carefully conducted to prevent damage to trees left standing, existing structures and improvements, and to provide for the safety of employees the public and adjoining properties.

d. **Grubbing:** Grubbing shall consist of the removal and disposal of all stumps and roots from the site as indicated on the drawings. In foundation and sub-base areas, stumps, roots, logs, timber and other debris not suitable for foundation or sub-base purposes shall be excavated to a depth not less than 18 inches below any subgrade, shoulder or slope. All depressions excavated below the original ground surface for the removal of stumps and roots shall be refilled with suitable material and compacted to make the surface conform to the surrounding ground.
   1. All timber, logs, stumps, roots, brush, rotten wood and other refuse from the clearing and grubbing operation shall be removed from the site and disposed of as approved by the Engineer.

e. **Site Grading:** Site grading shall consist of excavating, backfilling, and compacting soils to the final elevations and contours as shown on the drawings, including subgrade preparation for roads and parking areas.

1. Fill material shall be as specified on the drawings or elsewhere in these specifications and shall be free of roots, trash and any other deleterious material.
2. Topsoil shall be stripped from all areas prior to grading and shall be stored for use during restoration. Topsoil shall consist of a natural material that occurs in surface deposits of limited depth and shall be free of stones larger than 2 inches in diameter, roots, excessive vegetation, rubbish or other deleterious matter. Topsoil shall be approved by the Engineer before use.

f. **Fill Placement:** Suitable material removed from excavation shall be used, where feasible, in the formation of embankments, fills, subgrades, shoulders, backfills, and site grading. Excess material from excavations, not suitable for such uses, shall be wasted on site or removed from the site as required. If a waste area is not designated, the material shall be hauled from the site and disposed of in a manner acceptable to the Engineer. Wetting, drying, hauling, scarifying, mixing, shaping, rolling, tamping, de-watering or other operation shall be performed by the Contractor as approved by the Engineer. Such operations shall be considered incidental to the sitework and shall be performed at no additional expense to the Owner.
   1. Embankments, fills and excavations shall be properly shaped and drained to prevent water from running into the excavations. Any water which accumulates in excavations shall be removed promptly and the saturated soil shall be removed and replaced with approved fill material.

g. **Compaction:** All backfill and embankments shall be constructed with approved fill material consisting of sand, clay, gravel, or a combination thereof. No organic or silty materials shall be utilized. Approved material shall be placed in horizontal layers of loose material not to exceed 8 inches in depth. Each layer shall then be compacted utilizing sheepsfoot, vibrator, or mechanical rollers. Compaction shall be made to the percent of maximum dry density as shown in the table below.
   1. The Engineer, at his discretion, may order tests and inspections to be performed during the progress of the work, or at the completion of any individual unit of work, or at the time of final inspection of the entire project. Maximum dry density shall be as determined by ASTM D698 or AASHTO T-99 Method, Standard Proctor, for the material being utilized.

TABLE D-1 COMPACTION REQUIREMENTS

Location	Percent Compaction
Structure footings and foundations	100%
Road subgrade - Top 8”	100%
Road subgrade - Below top 8”	95%
Roadway Shoulders	95%
Utility trench within roadway - top 8”	100%
Utility trench within roadway- Below top 8”	95%
Utility trench outside roadway	95%

2. Density of embankment, fill, backfill or subgrade shall be measured utilizing the sand-cone method or nuclear moisture/density gauge. These tests will be performed by an approved independent soil testing laboratory. The costs of these tests shall be borne by the Contractor. All fills not meeting the compaction requirements shall be removed and re-compacted until the desired compaction is achieved.

h. **Finish Grading:** Except as otherwise specified herein, all disturbed areas on the site shall be finished off to a uniformly smooth surface, free from abrupt, irregular surface changes. The finished surface shall be not more than 0.10 feet above or below the established grade. There shall be no roots, waste building materials, trash or other unsightly matter projecting through or visible at the surface.
   1. After all embankments and fills have been completed to grade, and after all structures and pipe lines requiring the use of heavy equipment have been completed, excavation necessary for the construction of walkways and steps may be performed. Excavation shall be accurately cut to line and grade; sufficient width for the accurate placement and adequate support of the forms shall be allowed. After the forms are removed, the backfill shall be replaced and re-compacted around the walks and steps. Care shall be taken to avoid damage to the walks and steps.
   2. Topsoil shall be evenly spread over the entire area to receive vegetation cover. The compacted subgrade shall be scarified to a depth of 2 inches for the bonding of topsoil with the subsoil. Topsoil shall then be evenly spread, compacted and graded to a uniform thickness of not less than 3 inches, and the surface shall conform to the requirements of site grading, ditches, embankments, or other features, as applicable.
   3. Ditches shall be cut accurately to line, grade, and cross-section. Any excessive ditch excavation shall be backfilled to grade with material approved by the Engineer. The degree of smoothness shall be that usually obtainable with string line or hand raking methods; the finished surface of ditch slopes shall not be more than 0.10 feet above or below the appropriate elevations. Random spot checks of elevations and slopes shall be conducted by ordinary differential level and profile methods

i. **Rock:** Rock will not be classified as such for additional payment. The Contractor shall make appropriate site investigations to satisfy himself as to rock and other materials which may be encountered on the project.

j. **Erosion and Sedimentation Control:** Siltation and soil erosion shall be controlled by the Contractor using the appropriate erosion control devices including but not limited to silt fence, hay bales, stone check dams, temporary sediment basins, temporary ground cover, etc. Erosion control structures shall be maintained until permanent grassing has been established and shall be removed when directed by the Engineer.

D.3 TRENCH EXCAVATION AND BACKFILL

a. **Scope:** Furnish all material, equipment, and labor required to excavate and backfill the trench for the installation of water, sanitary sewer, and storm drainage pipelines as specified, as shown on the Plans, and as directed by the Engineer.

b. **Existing Improvements:** Streets, sidewalks, driveways, power/ cable/telephone lines, gas lines, water lines, sewers, storm drains and other existing improvements shall be maintained and protected from damage. Any aerial, surface or subsurface improvements damaged during the course of the work shall be repaired to the satisfaction of the Engineer. Satisfactory provisions shall be made for the maintenance of traffic on streets, driveways, and walkways.
   1. Prior to any excavation, the Contractor shall notify all utilities and utility locating services to provide locations for buried utilities. The Contractor shall obtain all necessary permits (grading, building, water, sewer, encroachment, etc.) prior to beginning work.

c. **Tree Protection:** Care shall be exercised to protect trees to be left standing. Within the branch spread of such trees, all trenching shall be performed with extra care. The trench shall be opened when the work can be installed immediately. Injured roots shall be pruned cleanly and backfill placed as soon as possible.

d. **Excavation:** Trench excavations shall be made by the open cut method to the depths indicated on the drawings or as otherwise specified. All excavated materials not suitable for backfill shall be wasted on site or removed from the site as directed.
   1. The excavated trench shall be at least 12 inches wider but not more than 16 inches wider than the outside diameter of the pipe being installed. The trench shall be excavated true to line to provide 6 inches to 8 inches clearance on each side of the pipe. The bottom of the trench shall be accurately graded to provide uniform bearing and support along the pipe barrel. Bell holes shall be excavated to allow sufficient space to make the joint and to insure that the pipe will rest evenly on the bottom of the trench. Bell hole dimensions shall be as recommended by the pipe manufacturer. Excavations for structures and other accessories shall be sufficient to provide at least 12 inches clearance between the structure and the trench wall.
   2. If rock is encountered, the trench shall be excavated to a minimum depth 6 inches below the pipe. The trench shall then be backfilled with select material, compacted in place, to the depth required for pipe installation. Wet or other unsuitable material encountered in the trench bottom shall be removed to a depth required to gain sufficient bearing strength as directed by the Engineer. The trench shall then be backfilled with select material, compacted in place, to the depth required for pipe installation. If rock or other unsuitable material is encountered in the excavation for structures, the excavated area below the structure shall be backfilled with stone or concrete as directed by the Engineer

e. **Stockpiling Excavated Material:** Material excavated from the trench that is suitable for backfill shall be stockpiled a safe distance away from the excavation to allow room for adequate angle of repose and to protect the excavation. No material may be placed within three feet of the nearest edge of the trench. Material unsuitable for backfilling, as determined by the Engineer, shall be wasted on site or removed from the site and disposed of by the Contractor, as approved by the Engineer.

f. **Shoring and Sheeting:** All shoring, sheeting, and bracing required to perform and protect the excavation and to safeguard employees and the public shall be performed. Whenever sheeting is driven to depth below the elevation of the top of the pipe, that portion of the sheeting below the elevation for the top of the pipe shall not be disturbed or removed. Sheeting left in place shall be cut off not less than 1 foot below finished grade. No sheeting shall be removed until the excavation is substantially backfilled as hereinafter specified.

g. **Water Removal:** The Contractor shall be required to control groundwater and prevent the accumulation of water within excavations. Well pointing, pumping, or other methods shall be as approved by the Engineer. The Contractor shall also control surface water runoff to prevent the accumulation of water in excavated trenches. Water shall not be allowed to rise in open excavations after pipe or structures have been placed. No work shall be performed within the trench until the Contractor demonstrates that groundwater and surface water runoff is controlled. If water accumulates within an excavation, the Contractor will be required to remove the water and saturated materials and backfill with approved material. Water removed from excavations shall be discharged at points where it will not damage adjacent property or facilities.

h. **Blasting:** Explosives are to be used only within legal limitations. Before explosives are used, all necessary permits for this work shall be secured and all precautions taken in the blasting operations to prevent damage to property, persons, or facilities. The Contractor shall assume full liability for any damage that may occur during the use of explosives. No blast shall be set off within fifty (50) feet of existing pipe or pipe already installed in the trench.

i. **Backfilling:** Trenches and other excavations shall not be backfilled until all required tests are performed and the work has been approved by the Engineer. The trenches shall then be carefully backfilled with approved excavated materials or other material approved by the Engineer. Backfill shall not contain organic material, blasted rock, broken concrete or pavement, construction debris, frozen earth, etc.
   1. For backfill up to a level 1 foot over the top of pressure pipelines and 2 feet above the top of gravity pipelines, only selected materials shall be used. Select materials shall be finely divided material free from debris, organic material and rock, and may be suitable job excavated material or shall be provided by the Contractor from other sources. The backfill shall be placed in uniform layers not exceeding 6 inches in depth. Each layer shall be moistened and carefully and uniformly tamped with mechanical tampers or other suitable tools to 95% standard proctor compaction. Each layer shall be placed and tamped under the pipe haunches with care and thoroughness so as to eliminate the possibility of voids or lateral displacement.
   2. The remainder of the backfill material shall then be placed and compacted above the level specified above. In areas not subject to traffic, the backfill shall be placed in 12-inch layers, and each layer moistened and compacted to a density approximating that of the surrounding earth. Under roadways, driveways, paved areas, parking lots, along roadway shoulders and other areas subject to traffic, the backfill shall be placed in 6-inch layers and each layer moistened and compacted to 95% standard proctor compaction. Any trenches which are improperly backfilled, or where settlement occurs, shall be reopened to the depth required for proper compaction, then refilled and compacted with the surface restored to the required grade and compaction. Along all portions of the trenches not located in roadways, the ground shall be graded to a reasonable uniformity and the mounding over the trenches left in a neat condition satisfactory to the Engineer. All compaction shall be verified by nuclear density gauge on a random basis as specified by the Engineer in the field. Compaction tests shall be paid for by the Contractor.
   3. Sheeting not specified to be left in place shall be removed as the backfilling progresses. Sheeting shall be removed in such a manner as to avoid caving the trench. Voids left by the removal of sheeting and shoring shall be carefully filled and compacted. Where, in the opinion of the Engineer, damage is liable to result from withdrawing sheeting, the sheeting will be ordered to be left in place.

j. **Pavement Replacement:** The Contractor shall replace or repair all road/street/highway pavement and sidewalks that are damaged by this construction as specified herein and/or as required by the SCDOT Highway Encroachment .

k. Pavement repairs shall be made by saw-cutting the existing pavement outside the damaged area to provide eight inches of bearing on undisturbed soil on each side of the excavation. The existing asphalt and/or concrete and/or base materials shall be removed to the depth required to place the patch. The following requirements are minimum thickness and in all cases the patch shall not be less than the existing pavement thickness.
   1. **Concrete Street Pavement:** Replace with 8 inches thick concrete (3000 psi).

2. **Asphalt Pavement:** Replace with 2" asphalt concrete (Type III) surface over:
   1. 8" thick concrete (3000 psi).
   2. Controlled Density Fill ("Flowable Fill") poured the entire depth of the trench. OR
   3. Compacted fill subgrade 95% Modified Proctor compaction entire depth of the trench.
3. **Asphalt Pavement Edge, Parking Lots, and Driveways:** Replace with 2" of asphalt concrete (Type III).
4. **Concrete Driveways and Sidewalks:** Replace with 5" thick concrete (3000 psi) for sidewalks and 6" thick concrete for driveways.

l. **Property Restoration:** The Contractor shall restore all property and facilities to a condition equal to or better than the condition found prior to beginning construction. Such restoration shall include but not be limited to re-grassing with seed or sod, replacing trees/shrubs/flowers, replacing pavement, replacing sidewalks/driveways, and replacing fences.

D.4 RESTORATION

a. **Scope:** Furnish all material, equipment, and labor required to properly restore areas disturbed by this construction as specified, as shown on the Plans, and as directed by the Engineer.

b. **General:** Restoration shall include replacing fences, driveways, sidewalks, mailboxes, landscaping, and other surface features in addition to cultivating the soil, fertilizing, seeding, and mulching grass on all disturbed areas. The specified procedures may be adjusted as approved by the Engineer to meet varying weather and soil conditions. All eroded areas shall be filled and grassed. A stand of grass with complete coverage shall be established prior to acceptance by the Engineer.

c. **Fertilizing and Grassing:**
   1. Material shall be approved by the Engineer prior to use.
      a. Fertilizer shall be an acceptable commercial fertilizer known as 4-12-12, or equivalent.
      b. Limestone shall be agricultural limestone containing at least 34% magnesium carbonate, and crushed especially for agricultural purposes.
      c. Seed shall have at least 90% purity and 80% germination. In residential areas the type of grass seed shall match grass in adjacent areas and shall be determined by the Engineer. In highway right of ways, drainage ditches or other non-residential areas, the type of seed and application rates shall be in accordance with Table D-2.

TABLE D-2 GRASSING SCHEDULE FOR NON-RESIDENTIAL AREAS

	Common Name of Seed	Lbs Per AC Rate	Planting Date
1.	**Common Bermuda (Hulled)**	60	Mar 1 - Aug 14
	Love Grass	50	
2.	**Common Bermuda (Un-hulled)**	90	Aug 15- Feb 28
	Love Grass	80	
	Annual Rye Grass	15	

d. Sod shall be installed as required by the Engineer. The type of sod shall match grass in adjacent areas and shall be determined by the Engineer.

2. **Planting:** All preparation, fertilizing, planting and watering shall be done in an acceptable manner by competent personnel.
   a. Area to be seeded or sodded shall be loosened or pulverized to a depth 3 to 4 inches by disc harrowing, with all clods broken up and all sticks and other debris removed. Fertilizer shall be distributed over the area at a minimum rate of 1000 pounds per acre, and limestone at a minimum rate of 2000 pounds per acre.
   b. Seed shall be distributed on the prepared area by the use of a commercial applicator that will provide even distribution. For grassing in residential areas, minimum application rates shall be as specified below; heavier applications shall be made where necessary to provide an acceptable cover.
      Fescue 200 pounds per acre
      Bermuda, Centipede, Zoysia 50 pounds per acre
   c. Seed shall then be raked into the ground and lightly covered. After the seed is covered, the area shall be rolled and dressed smooth by a culti-packer or other means acceptable to the Engineer. Immediately after seeding, the area shall be covered with a mulch of ripe native hay or other acceptable material.
   d. Sod shall be rolled out or placed in straight rows. The ends of rolls or squares shall be staggered at least 1 foot. All edges shall be pulled tightly together. After sodding is complete, the sod shall be set in place using a hand-pushed drum roller.
   e. After planting is completed, the planted areas shall be sufficiently watered. Watering shall be continued as necessary until an acceptable grass cover is obtained.
3. **Temporary Cover:** If grading is completed and ready for seeding at a time inappropriate for establishing the permanent grass cover, temporary coverage shall be provided for erosion control as specified below. Contractor shall return to the site and provide the permanent cover, in the manner specified above, at such time as may be suitable.
   a. Surface area to be seeded shall be prepared as for permanent cover except that fertilizer shall be applied at one half (1/2) the rate specified therefor.
   b. Area to be grassed shall be planted according to Table D-3. Seed shall be applied in the manner specified above.

TABLE D-3 GRASSING SCHEDULE FOR TEMPORARY COVER

Schedule Number	Common Name of Seed	Lbs Per AC Rate	Planting Date
1.	Annual Sudan Grass (Sweet or Tift)	40	Apr 1 - Aug 15
2.	Brown Top Millet	50	Apr 1 - Aug 15
3.	Rye Grain	55	Aug 16 - Mar 31
4.	Annual Rye Grass	15	

   c. After temporary planting is completed, the planted areas shall be watered as specified above.

d. **Maintenance:** During the one year guarantee period, the Contractor shall maintain all grassed areas and repair all damage due to erosion, drought, etc. A stand of grass having complete coverage shall be in place at the end of the guarantee period.

D.5 WATER DISTRIBUTION SYSTEM

a. **Scope:** Furnish all material, equipment, and labor required to install water piping, fittings, valves and appurtenances as specified, as shown on the Plans, and as directed by the Engineer.

b. **General:** The Contractor shall construct the water lines, valves, fire hydrants, and appurtenances as shown on the Plans and as specified below. Clearing, grubbing, trench excavation, shoring, backfill, restoration and other related items shall be as specified elsewhere herein. Pipe and accessories shall be new and unused materials as specified herein or as specifically approved by the Engineer. All pipes, fittings, packing, jointing materials, valves and fire hydrants shall conform to Section C of the American Water Works Association (AWWA) Standards. All materials/products that contact potable water must be third party certified as meeting the specifications of ANSI/NSF Standard 61, Drinking Water System Components – Health Effects. The certifying party shall be accredited by the American National Standards Institute. There shall be no connection between the distribution system and any pipes, pumps, hydrants, or tanks whereby unsafe water or other contamination materials may be discharged or drawn into the system.

c. **Pipe Materials:** The following pipe materials are approved for use within the City of North Augusta, however all water mains 12-inches in diameter and larger shall be ductile iron. All pipe material shall be as shown on the Plans or as directed by the Engineer. The pressure rating, pressure class, pipe weight, length of pipe, specification reference, and name of manufacturer shall be clearly marked on each length of pipe. All pipe material, solder and flux shall be lead free (less than 0.2% lead in solder and flux and less than 8.0% lead in pipes and fittings).

   1. Ductile Iron Pipe shall conform to the requirements of AWWA C150 & C151. Unless otherwise shown on the Plans or directed by the Engineer, 12-inch diameter and smaller pipe shall be Pressure Class 350 and 16-inch diameter and larger pipe shall be Pressure Class 250. Ductile iron pipe shall be coated and lined as specified in AWWA C-104.
   2. PVC Pipe shall comply with AWWA Standard C900, SDR 14, Pressure Class 200. 2-inch PVC pipe shall comply with ASTM D-2241, SDR 13.5, Pressure Class 200. All water pipe shall bear the National Sanitation Foundation seal of approval. Solvent-weld PVC pipe and fittings shall not be used in water mains four (4) inches and larger. PVC water mains shall be installed with a locating wire as described elsewhere in this specification, for its entire length.
   3. **Fittings:**
      a. Cast Iron and Ductile Iron Fittings shall conform to AWWA C-110 (Pressure Class 250) or AWWA C153 (Pressure Class 350) and shall be lined and coated in accordance with AWWA C-104. All fittings shall be manufactured in domestic foundries.
      b. PVC Pipe Fittings shall be mechanical joint, and shall be of cast iron or ductile construction as specified above.
      c. All underground piping shall have mechanical or push-on joints. Above ground and interior piping shall have flanged joints.
      d. Mechanical Joints shall conform to AWWA C-111 and shall have gaskets smooth and free form any porosity or imperfections. Gaskets shall be made of vulcanized synthetic rubber. Bolts for mechanical joints shall be standard, high-strength, heat-treated cast iron tee-head bolts and hexagon nuts meeting the requirements of AWWA C-111.
      e. **Push-On Joints:** Ductile iron pipe and PVC pipe push on joints shall utilize gaskets made of synthetic rubber compound. Natural rubber or other

material which will support microbiological growth may not be used for any gaskets, O-rings, and other products used for jointing pipes, setting meters or valves, or other appurtenances which will expose the material to the water. Lubricant for push-on joints shall be non-toxic, shall not support bacteria growth (no vegetable shortening allowed), and shall have no deteriorating effect on the gasket material. Ductile iron push on joints shall conform to AWWA C-111. PVC push on joints shall conform to AWWA C-900 for 6, 8, and 12-inch pipe and to ASTM D-3139 for 2-inch PVC.

d. **Pipe Installation:**
   1. Pipe and accessories shall be handled with care to insure delivery and installation in a sound, undamaged condition. Particular care shall be taken to protect the linings and coatings from damage. Pipe and accessories shall be examined for defects and tapped with a light hammer to detect cracks prior to installation. All damaged, defective or unsound materials as determined by the Engineer shall be removed from the job site.
      a. Natural rubber or other material which will support microbiological growth may not used for any gaskets, O-rings, and other appurtenances which will expose the material to the water.
      b. Lubricants that will support microbiological growth shall not be used for slip-on joints. Vegetable shortening shall not be used to lubricate joints.
   2. Cutting of pipe shall be done in a neat and workmanlike manner without damage to the pipe or coating. After cutting, all burrs and sharp edges shall be removed and the exterior of the spigot end suitably beveled to facilitate assembly.
   3. Pipe shall be laid with the bell facing in the direction of laying. No blocking of the pipe barrel above the trench bottom will be permitted.
   4. All mains shall be detectable within three (3) feet with electronic locating equipment.
      a. Nonmetallic pipes shall be installed with locating wire placed prior to the backfill operations.
      b. Locating wire shall be 12 gauge copper wire.
      c. Wire shall be installed longitudinally along the top of the water main pipe.
      d. Wire shall be wrapped around the pipe at every 100 LF of main and the wire brought to within a minimum of 24-inches from the finished grade.
   5. If alignment requires deflections in excess of the manufacturer's recommended limitations, the Contractor shall provide fittings or a sufficient number of shorter lengths of pipe to provide angular deflections within the limits set forth.
   6. Water Mains and Sewers shall be separated in accordance with South Carolina Department of Health and Environmental Control’s State Primary Drinking Water Regulation R.61-58.4.D.(12)(a)-(f).
      a. Parallel Installation: Water mains shall be laid at least 10 feet horizontally from any existing or proposed sewer. The distance shall be measured edge to edge. In cases where it is not practical to maintain a ten-foot separation, the Engineer may allow deviation on a case-by-case basis, if supported by data from the design Engineer. Such deviation may allow installation of the water main closer to a sewer, provided that the water main is laid in a separate trench or on an undisturbed earth self located on one side of the sewer at such an elevation that the bottom of the water main is at least 18 inches above the top of the sewer.
      b. **Crossings:** Water mains crossing sewers shall be laid to provide a minimum vertical separation of 18 inches between the outside of the water main and the outside of the sewer. This shall be the case whether the water main is

either above or below the sewer line. Whenever possible, the water main shall be located above the sewer line. Where a new water main crosses a new sewer line, a full length of pipe shall be used for both the water main and sewer line and the crossing shall be arranged so that the joints of each line will be as far as possible from the point of crossing and each other. Where a new water main crosses an existing sewer line, one full length of water pipe shall be located so both joints will be as far from the sewer line as possible. Where a water main crosses under a sewer, adequate structural support shall be provided for the sewer line to prevent damage to the water main.

c. **Special Conditions:** When it is impossible to obtain the distances specified above, the Engineer may allow an alternative design. Any alternative design shall:
   1. Maximize the distances between the water main and sewer line and the joints of each:
   2. Use materials which meet the requirements R.61-58.4 (D)(1) for the sewer line; and,
   3. Allow enough distance to make repairs to one of the lines without damaging the other.

7. Where the minimum cover of forty-two (42) inches cannot be provided, pipe shall be steel, concrete, ductile iron, or other approved material and method approved by SCDHEC, and, when necessary, insulated to prevent freezing.
8. Continuous and uniform bedding shall be provided in the trench for all buried pipes. Back-fill material shall be tamped in layers around the pipe and to a sufficient height above the pipe to adequately support and protect the pipe. Stones, other than crushed bedding, shall not come into contact with the pipe and shall not be within six (6) inches of the pipe.

e. **Jointing:**
   1. **Push-On Joints**: Push-on type joints shall be assembled by inserting a continuous, molded, rubber ring gasket in an annular recess in the pipe socket and forcing the spigot end of the entering pipe into the socket, thereby compressing the gasket radically to the pipe to form a positive seal. The design and shape of the gasket and the annular recess shall be such that the gasket is locked in place against displacement as the joint is assembled. Details of the joint design shall be in accordance with the manufacturer's standard practice. The size and shape of the gasket shall be suitable to provide adequate compressive force between the spigot and the socket after assembly to effect a positive seal under all combinations of joints and gasket tolerances.
   2. **Mechanical Joints:** The last 8 inches of the spigot and inside of the bell of mechanical joint pipe shall be thoroughly cleaned and approved lubricant applied. The cast-iron gland shall then be slipped on the spigot end of the pipe. The rubber gasket shall be placed on the spigot end with the thick edge toward the gland. The entire section of the pipe shall be pushed forward to seat the spigot end in the bell. The gasket shall then be pressed into place within the bell, being careful to have the gasket evenly positioned around the entire joint. The cast-iron gland shall be moved into position for bolting, all bolts inserted, with the nuts finger tight. Bolts shall be tightened alternately to produce an equal pressure on all parts of the gland. A suitable torque-limiting wrench shall be used with maximum torque as recommended by the manufacturer.

f. **Cleanliness:** The interior of all pipe shall be thoroughly cleaned of all foreign matter before being lowered into the trench, and shall be kept clean during laying operations. The pipe shall not be laid in water or when trench or weather conditions

are unsuitable for work. When the work is not in progress, open ends of pipe and fittings shall be securely closed so that no trench water, earth, or other foreign substance can enter the line. A pipe swab shall be kept in the pipe at all times to prevent debris from entering the newly laid pipe.

g. **Valves:** Valves shall be furnished and installed as shown on the plans, as specified, or as directed by the Engineer. Unless otherwise noted, valves shall be furnished with mechanical joint connections for buried service and flanged joints for non-buried service. All valves shall be opened by turning counterclockwise and shall have an arrow cast into the metal of the operating nut or in the handle to indicate direction of opening. Each valve shall have the manufacturer's name, year made, and pressure-rating cast on the body.
    1. **Gate Valves:** Gate valves shall be of the double disc or resilient seat type in conformance with AWWA C-500 or AWWA C-509 respectively, with a minimum working pressure of 200 psi. Valves shall have mechanical joints, or screwed joints as required for the piping in which they are installed. Gate valves shall have a clear waterway equal to the full nominal diameter of the pipe and shall be opened by turning counterclockwise. Prior to shipment from the factory, each valve shall be tested by hydraulic pressure equal to twice the specified working pressure. All valves shall use O-ring packing. Valves smaller than 16 inches to be installed underground shall be non-rising stem type with 2-inch square operating nut. Valves shall be as manufactured by the Mueller Company, or the M & H Valve and Fitting Company.
    2. **Butterfly Valves:** Butterfly valves shall conform to AWWA Standard C504, latest revision, for Class 150B, unless otherwise specified, and the following:
        a. Suitable for two-way flow.
        b. Valve body to be cast iron ASTM A126, Class B or cast iron ASTM A48, Class 40 or ductile iron per ASTM A536, Grade 65-44-12.
            1. Body ends to be flanged, ANSI B16.1, Class 125, for all exposed locations and all valves larger than 48 inch.
            2. Provide mechanical joint ends, AWWA C-111, for buried valve 48-inch and smaller.
        c. Furnish disc of Ni-Resist (ASTM A436 Type I) or ductile iron (ASTM A536). Disc to be offset design, providing 360° uninterrupted seating, with 90° operation from full closed to full open position.
        d. Resilient seats to be synthetic rubber (BUNA-N).
            1. Seat may be located in the valve body or attached to the disc.
            2. Mating material for resilient seat to be 18-8 Type 304 stainless steel.
            3. Seats to be field adjustable around the full 360° circumference and field replaceable.
        e. Shafts to be turned, ground and polished, constructed of 18-8 Type 304 stainless steel.
            1. Shafts may be of one piece or two piece stub design.
            2. Attach disc to shaft with tapered pins and locking nuts.
        f. Valve bearings shall be of Teflon or other self-lubricating material designed for a bearing pressure not to exceed 1/5 of the compressive strength of the bearing material.
        g. Shaft seals shall consist of non-adjustable self-compensation V-type packing or synthetic O-ring seals.
        h. Spray coat all interior wetted ferrous surfaces with two component epoxy applied to a nominal thickness of 3 to 4 mils. Coating material to be AWWA and US Food and Drug Administration approved for use with potable water.

i. Approved valve manufacturers are DeZurik and Pratt. Other manufacturer's valves, conforming to these specifications, may be provided with the approval of the Engineer.
j. Furnish buried valves with manual worm gear operator units conforming in all respects to AWWA C504 and the following:
    1. Provide operators with not less than maximum operator torque, as determined in accordance with Appendix A of AWWA C504, to operate valves under actual line pressures and velocities.
    2. Valves to open when operating stem is turned in a counter-clockwise direction.
    3. Provide worm and gear, lead screw or traveling nut type, self-locking to prevent the valve disc from creeping or fluttering when it is in any intermediate position between open and closed.
    4. Gear operators to be permanently lubricated, totally enclosed, with adjustable stops for the open and closed position.
    5. Provide 2" AWWA square nut.

3. **Tapping Valves:** Tapping valves and mechanical joint sleeves shall be furnished and installed at the locations shown on the plans. The tapping valve shall conform in all respects to the gate valve specified above. The Contractor shall verify the material and size of the pipeline to be tapped. Valves and sleeves shall be manufactured by the Mueller Company, or approved equal.
4. **Air Relief Valves:** Air relief valves shall be provided in accordance with sound engineering practices at high points in water mains as required. Automatic air relief valves shall not be used in situations where flooding of the manhole or chamber may occur. The open end of an air relief valve from automatic valves or from a manually operated valve shall be extended to the top of the pit and provided with a screened downward facing elbow
5. **Valve Boxes:** All underground valves shall be installed with cast iron valve boxes having a suitable base and shaft extension sections to cover and protect the valve and permit easy access and operation. Box assemblies shall be Clow Fig. F-2450, Grinnell, Mueller, or an approved equal. The word WATER shall be cast on covers for valve boxes on potable waterlines only. A 24" X 24" X 4" concrete pad shall be placed around all valve boxes not located in paved areas. All valves shall be installed with a valve box guard to prevent sand and debris from entering the valve box.
6. **Installation:** Valves and valve boxes shall be installed throughout the water system as shown on the Plans or as directed by the Engineer. Chambers, pits, or manholes containing valves, blow-off, meters, air release valves, or other such appurtenances to a distribution system, shall not be connected directly to any storm drain or sanitary sewer. Valves and valve boxes shall be plumb and valve boxes shall be centered directly over the valve's operating nut. Earth fill shall be carefully tamped around valve box to 3 feet on all sides or to the undisturbed face of the trench, if less than that distance. Valves shall have the interiors cleaned of all foreign matter before installation. Stuffing boxes shall be tightened and the valve shall be inspected in both opened and closed positions to see that all parts are working. All piping and valves shall be properly and adequately supported to prevent movement or undue strain on the piping and equipment.

   All valves located on fire hydrants leads that are not connected directly to the main line tee shall be connected to the main line tee with steel tie-rods or restrained mechanical joints.

h. **Fire Hydrants:** The Contractor shall furnish and install fire hydrants as shown on the plans or as directed by the Engineer.
   1. **Materials:** Fire hydrants shall meet or exceed AWWA C502, latest revision. Rated working pressure shall be 250 p.s.i.g., test pressure shall be 500 p.s.i.g., and hydrants shall include the following specific design criteria:
      a. The main valve closure shall be of the compression type. Traffic feature to be designed for easy 360° rotation of nozzle section during field installation.
      b. The main valve opening shall not be less than 5 1/4" and be designed so that removal of all working parts can be accomplished without excavating. The bronze seat shall be threaded into mating threads of bronze. The draining system of the hydrant shall be bronze and positively activated by the main operating rod. Hydrant drains shall close completely after no more than three turns of the operating nut. There shall be a minimum of (2) internal ports and (4) drain port outlets to the exterior of the hydrant. Drain shutoff to be by direct compression closure.
      c. Lower hydrant barrel shall be made of centrifugally cast ductile iron.
      d. Friction loss not to exceed 3.0 p.s.i.g. at 1000 gpm through 4 1/2" pumper nozzle.
      e. Fire hydrants shall be Mueller Super Centurion 250 series with one 4-1/2" pumper nozzle and two hose nozzles.
   2. **Installation:** Hydrants shall be set plumb with the bury line at the ground surface and at such elevations that the connecting pipe shall have at least 42 inches cover over pipe. The Contractor will be required to furnish and install hydrant extensions as necessary to ensure proper elevation. Earth fill suitable for backfill as previously defined shall be carefully placed in six-inch layers and carefully tamped. Adequate concrete thrust or anchor blocks shall be used. Where conditions are such that the bearing value of the trench wall will not provide satisfactory support, the Contractor will be required to furnish and install mechanical joint restraint or and tie rod harnesses to hold the fittings and pipe line in place. Not less than seven cubic feet of crushed or broken stone shall be placed around the base of the hydrant to insure drainage. The interior of the hydrant shall be thoroughly cleaned of all foreign matter prior to installation. After installation, each hydrant and valve shall be inspected in both opened and closed positions to assure that all parts are in satisfactory working condition. Hydrant drains shall not be connected to or located within ten (10) feet of sanitary sewers.

i. **Service Connections:** A separate tap shall be made for each residence and/or business. The tap to the main shall be made with a tapping saddle of double stainless steel strapping construction Smith Blair 317 Series or approved equal. Unless otherwise noted on drawings, all taps, fittings, and service tubing shall be 3/4" diameter. The service tubing shall be type K copper installed by properly bending and not crimping the tube. Corporation stop shall be 3/4" Ford F1000 with pack joint or approved equal. Curb stops shall be 3/4" Ford angle ball meter valve #KV43332W with pack joint, or approved equal. All curb stops to be angle valves with locking wings. Meter boxes are to be of cast iron or black plastic construction. All meter boxes are to be Ford or approved equal. All services shall be located at the center of the lot or unit unless otherwise noted in drawings. The concrete curb shall be marked with a "W" painted blue to designate the tap location.

j. **Reaction Support:** All plugs, caps, tees, wyes, and bends in water mains shall be securely blocked. Mains are any water lines (not services) part of the public water distribution system that are 2" in diameter or larger. Reaction support shall be of 3000 lb. concrete bearing directly against undisturbed earth of the trench wall.

Sufficient thrust block bearing shall be installed to distribute the thrust onto undisturbed earth at a rate not exceeding the allowable soil bearing value. Where conditions are such that the bearing value of the trench wall will not provide satisfactory support, the Contractor will be required to furnish and install mechanical joint restraint or and tie rod harnesses to hold the fittings and pipe line in place.

k. **Provisions for Future Connections:** Where pipe ends are left for future connections, they shall be valved, plugged, and blocked as shown on the plans or as directed by the Engineer. Temporary blow-offs shall be installed at these temporary dead ends.

l. **Testing:** The Contractor shall conduct hydrostatic and leakage tests on all piping as hereinafter specified and as directed by the Engineer.

1. **Pressure Test:** All water system piping and valves shall successfully meet a pressure test of 150% of its working pressure, but not less than 200 psi, in accordance with AWWA C-600. Each valve shall be tested in the closed position after the water line test. The line shall be slowly filled with water and all air expelled through air valves or other means. A suitable test pump shall be connected to the line by means of a tap in the line or other suitable methods, and the proper test pressure slowly applied to the line. The pressure test shall be maintained for at least (2) two hours at a full test pressure. Leaks, if found, shall be immediately repaired.
2. **Leakage Test:** After the pressure test is completed, a leakage test shall be conducted in accordance with AWWA Standard C600 for ductile iron mains or C605. The leakage test shall be conducted by measuring the amount of water that enters the test section under test pressures for a period of at least (2) two hours. All measuring devices shall be furnished by the Contractor.

   No pressure pipe installation will be accepted until leakage is less than the number of gallons per hour for each section tested, as determined by one of the following formulas:

   P.V.C. Pipe Ductile Iron Pipe

   $$L = \frac{ND \times \sqrt{P}}{7400} \quad \text{or} \quad L = \frac{SD\sqrt{P}}{133.2}$$

   L = Allowable leakage in gallons per hour
   N = Number of joints in the length of line under test
   D = Nominal diameter of pipe, in inches
   P = Average test pressure, in psi
   S = Length (Ft.)

   If any test discloses leakage greater than that allowed above, the Contractor shall locate and repair the defect until leakage is within the specified allowances.
3. **Fire Hydrant Test**:** The Contractor shall paint all new fire hydrants according to the color coding scheme and using paint provided by the City of North Augusta. Bonnets (white) and valve caps (shall be painted with the color designating the level of service it provides as determined by the City.
   **Flow testing is conducted by the City of North Augusta.
4. **Coliform Analysis:** The Contractor shall collect a minimum of two (2) samples from each sampling site for total coliform analysis. The number of sites depends on the amount of new construction but must include all dead-end lines, be

representative of the water in the newly constructed mains, and shall be collected a minimum of every 1,200 linear feet. Prior to sampling, the chlorine residual must be reduced to normal system residual levels or be non-detectable in those systems not chlorinating. These samples must be collected at least twenty-four (24) hours apart and must show the water line to be absent of total coliform bacteria. The chlorine residual must also be measured and reported. If the membrane filter method of analysis is used for the coliform analysis, non-coliform growth must also be reported. If the non-coliform growth is greater than eighty (80) colonies per one hundred (100) milliliters, the sample result is invalid and must be repeated. All samples must be analyzed by a State of South Carolina certified laboratory.

m. **Clean Up and Demobilization:** Upon completion of the installation of the water lines and appurtenances, all equipment and debris remaining as a result of the Contractor's operations shall be removed from the site. Any salvaged material shall be turned over to the Owner for storage as directed.

n. **Sterilization:** Disinfection of new mains must be conducted in accordance with AWWA C651. Before being placed in service, all new mains and repaired portions of existing mains shall be thoroughly flushed and chlorinated with not less than fifty parts per million (50 ppm) of available chlorine. Chlorine gas or seventy percent high-test calcium hypochlorite may be used. Water from the existing distribution system or other source of supply should be controlled to flow slowly into the newly laid pipeline during the application of chlorine. The solution should be retained in the pipeline for not less than twenty-four (24) hours and a chlorine residual of 25 ppm should be available at this time. The system should then be flushed with potable water and the sampling program started.
   1. **Chemicals:** The Contractor shall furnish all chemicals required for sterilizing. The Contractor shall exercise care in the use of water to ensure that highly chlorinated water does not enter the existing water system.
   2. **Sampling:** At least two satisfactory bacteriological samples shall be taken from the water line after sterilization. These samples shall be taken 24 hours apart and tested by a South Carolina state certified private laboratory. The cost of these tests shall be borne by the Contractor. Prior to bacteriological sampling, the chlorine residual must be reduced to normal system levels. During bacteriological sampling, the chlorine residual must also be measured and reported. Non-coliform growth must also be reported. If the non-coliform growth is greater than 80 colonies/100mL, the sample result is invalid and must be repeated.

o. **As-Built Drawing:** As the work progresses, a record shall be made on all changes to and deviations from the Plans. As-Built drawings shall be furnished to the City before acceptance of all water systems.

p. **Material Changes:** Any variation in specified material must be pre-approved prior to installation in the City water system. Submit to the Engineering Department drawings and specifications of any proposed material changes, failure to do so may result in removal and replacement of unapproved material at the Contractor’s cost.

D.6 SANITARY SEWER

a. **Scope:** Furnish all material, equipment, and labor required to install sewer pipe, laterals, manholes, and appurtenances as specified, as shown on the Plans, and as directed by the Engineer.

b. **General:** The Contractor shall construct the sewer lines, sewer service laterals, manholes, and appurtenances as shown on the Plans and as specified below.

Clearing, grubbing, trench excavation, shoring, backfill, restoration and other related items shall be as specified elsewhere herein. Pipe and accessories shall be new and unused materials as specified herein or as specifically approved by the Engineer.

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

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

For work outside the streets and roadways, not more than five hundred (500') feet of trench shall remain open at any one time.

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

The Owner reserves the right to accept and use portions of work when it is considered to be in the public's interest to do so; the Engineer shall have the authority to establish the order in which the lines shall be worked.

d. **Location and Grade:** The line and grade of the sewer and the position of manholes and other structures shall be as shown on the plans or as directed by the Engineer. The price for trenching shall include trench excavation to the depth necessary to lay the sewer to the grade shown, but measurements for payment will be made only to the grade line indicated.

All lines and grades shall be laid out by the Contractor from the controlling lines and bench marks established by the Engineer, or from measurements shown. All line and grades shall be subject to checking by the Engineer, but that checking shall in no way relieve the Contractor from responsibility for their correctness. The Contractor shall provide such stakes, materials, labor and assistance as the Engineer may require in laying-out work, establishing bench marks and checking and measuring the work.

e. **Inspection:** All work done and materials furnished shall be subject to inspection by the Engineer or his authorized representative. Improper work shall be reconstructed and materials which do not conform to the requirements of this section shall be removed from the work upon notice being received from the Engineer of the rejection of those materials. The Engineer shall have the right to mark rejected materials and/or the Contractor shall segregate said materials to distinguish them as such.

f. **Unloading, Handling and Storing Materials:** Equipment and facilities for unloading, hauling, and distributing and storing materials shall be furnished by the Contractor. Delays and/or charges for unloading materials shall be at the expense of the Contractor.

Pipe, fittings and other materials shall be carefully handled so as to prevent breakage and/or damage. Pipe may not be unloaded by rolling or dropping off of trucks or cars. Preferred unloading is in units using mechanical equipment, such as fork lifts, cherry pickers, or front end loaders with forks. If fork lift equipment is not

available units may be unloaded with use of spreader bar on top and nylon strips or cables (cushioned with rubber hose sleeve) looped under the unit.

Materials shall be distributed and placed where they will not interfere with traffic. No street or roadway may be closed without first obtaining permission of the proper authorities. The Contractor shall furnish and maintain proper warning signs and lights for the protection of traffic along highways, streets and roadways upon which material is distributed. No distributed materials shall be placed in drainage ditches.

1. **Storage:** All pipe, fittings, and other materials which cannot be distributed along the route of the work shall be stored for subsequent use when needed. The Contractor shall make his own arrangements for the use of storage areas; except that, with permission, he may make reasonable use of the Owner's storage yards.
   a. **Concrete and Ductile Iron Pipe:** Concrete and ductile iron pipe must be stockpiled on level ground. Timbers must be placed under the pipe for a base and to prevent dirt and debris from washing into the pipe.
   b. **PVC Pipe:** PVC pipe must be stockpiled on level ground. If pipe is unloaded individually by hand the same as factory load, with stop blocks nailed at either end. Stockpile must be built up the same manner as it was stocked for shipment. Individual lengths of pipe shall not be stacked in piles any higher than five feet (5').

      If pipe is unloaded in units, the units must be place on level ground and shall not be stacked more than two (2) units high. Units must be protected while loaded on the truck or car. Supports shall be sufficient to carry the weight of all units loaded above.

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

g. **Pipe Materials:** The following pipe materials are approved for use within the City of North Augusta. All pipe material shall be as shown on the Plans or as directed by the Engineer. The specification reference, and name of manufacturer shall be clearly marked on each length of pipe.
   1. **Quality and Inspection:** Latitudes in workmanship and finish allowed by ASTM notwithstanding, all pipe shall have smooth exterior and interior surfaces; be first quality, be free from cracks, blisters, and other imperfections, and be true to theoretical shapes and forms throughout each length. Pipe shall be subject to inspection by the Engineer at the pipe plant, trench, and other points of delivery for the purpose of culling and rejecting pipe, independent to laboratory tests, which does not conform to the requirements of this Section. Pipe which does not conform will be so marked by the Engineer, and shall not be used in the work. On-the-job repairing of rejected pipe will not be permitted.
   2. **Experience of Manufacturers:** The pipe manufacturer shall submit evidence, if requested by the Engineer, of having consistently produced pipe and joints of the quality specified herein, and which have exhibited satisfactory performance results in service over a period of not fewer than two years. The pipe manufacturer and the pipe manufacturing process shall be subject to approval by the Engineer.

3. **Concrete Pipe:** Concrete sewer pipe shall be bell and spigot and shall conform to the applicable ASTM Specification, as amended to date.
   a. **Reinforced Pipe:** ASTM C 76, Table 3, 4, or 5, (Class III, IV or V).
   b. **Size 18-Inch and Larger:** All pipe shall be reinforced. Pipe shall be of the class dictated by the depth of bury and bedding shown in "Trench Widths" Tables and Detail Drawings. Pipe shall be furnished in lengths of at least eight feet (8').
   c. **Cement and Coarse Aggregate:** Cement shall be Type II, or approved equal. Coarse aggregate shall be crushed limestone.
   d. **Wire Reinforcement:** Wire reinforcement used in the pipe shall conform tot he standard specifications, with the following exceptions:
      1. Elliptical steel reinforcement will not be permitted.
      2. Longitudinal wires for pipe made on packer head type machines shall be at least seven (7) gauge and in no case shall spacing thereof be in excess of four inches (4").
   e. **Steam Curing:** Steam curing, of concrete pipe, shall conform to the standard specifications, with the following exceptions:
      1. When temperatures fall below an average of 40°F. Curing shall be continuous for a 24 hour period, except for the interval when forms and/or rings are removed.
   f. **Minimum Crushing Strength:** All pipe when tested by the 3-edge bearing method in accordance with ASTM C 497, shall have minimum strength (defined as the load to produce a 0.01 inch crack for reinforced pipe) of not less than the following values.

TABLE D-4 MINIMUM STRENGTHS FOR REINFORCED CONCRETE PIPE

Pipe Size	Class III	Class IV	Class V
18"	2025 p.l.f	3000 p.l.f.	4500 p.l.f.
21"	2360 p.l.f.	3500 p.l.f.	5250 p.l.f.
24"	2700 p.l.f.	4000 p.l.f.	6000 p.l.f.
30"	3375 p.l.f.	5000 p.l.f.	7500 p.l.f.

   g. **Absorption:** Absorption shall not exceed 6 percent when determined in accordance with ASTM C 497.
   h. **Joints:** All pipe shall have O-ring rubber gasket type joints conforming with he applicable provisions of ASTM C 443. A rectangular groove shall be provided in the spigot end of the pipe to receive the circular rubber gasket and it shall be so formed that when the joint is complete the gasket will be deformed to the shape of the groove and confined on all four sides. Bell and spigot surfaces shall be accurately formed and smooth to provide a close sliding fit with a nominal clearance not to exceed 1/16-inch between the outside surface of the spigot and the inside surface of the bell.
   i. **Repaired Pipe:** Repaired and patched pipe will not be acceptable unless each individual pipe so repaired or patched shall have first been inspected and approved by the Engineer, for repair and patching at the pipe plant. Repairs to, and patching of gasket groves and shoulders will not be permitted if damage is of a nature which, in the opinion of the Engineer, would impair the water tightness of the completed joint.

j. **Shear Loading Test:** Made-up gasketed joints shall be tested for shear loading at a total load of 100 pounds per inch of diameter, including the weight of the pipe, water, and test apparatus. The load shall be uniformly applied to the spigot and over an arc of not less than 120 degrees for a longitudinal distance of 12 inches immediately adjacent to the bell, with the pipe supported on blocks behind the bells during the test procedure. There shall be no visible leakage when tested with an internal water pressure of 100 psi for a period of 10 minutes. At least one shear loading test shall be conducted for each size of pipe to be delivered to the jobsite.

4. **Polyvinyl Chloride (PVC) Sewer Pipe and Fittings:** Polyvinyl Chloride (PVC) Sewer Pipe shall be bell and spigot in lengths not exceeding 20 feet laying lengths and shall have minimum wall thickness conforming to ASTM D 3034 under the classification for SDR 35 pipe, as amended to date, or ASTM 789-85.

   Polyvinyl Chloride (PVC) sewer pipe fittings shall be bell and spigot or bell and plain end and shall conform to ASTM D 3034, as amended to date.

   a. **Markings:** PVC pipe shall be marked at intervals of 5 feet or less with the following information: Manufacturer's Name or trade Mark, Plant code, Date of manufacture, Nominal Pipe Size, PVC Cell Classification, the legend "Type PSM DR 35 PVC Sewer Pipe", and ASTM designation D 3034.

      Fittings shall be marked with the following information, Manufacturer's Name or Trade Mark, Nominal Size, Designation PVC and PSM and ASTM designation D 3034.

      All markings shall remain legible during normal handling, storage and installation.

   b. **Certification:** The Contractor ;shall furnish the Engineer with a written statement from the manufacturer that all pipe and fittings furnished have been sampled, tested and inspected in accordance with ASTM D 3034, as amended to date. Each certification so furnished shall be signed by an authorized agent of manufacturer.

   c. **Joints:** All pipe shall have elastomeric joints with an integral bell gasket coupler. Rubber gaskets shall comply with the physical requirements specified in the latest revision of ASTM F 477, as amended to date. Joints shall meet the requirements specified in ASTM D 321, as amended to date.

5. **Ductile Iron Pipe:** Pipe shall be centrifugally cast and shall conform to ANSI Specifications A21.10, A21.50 and A21.51, as amended to date, with mechanical or push-on joints and laying lengths of at least 18 feet with Class 51 wall thickness for size 3-inch and 4-inch pipe and Class 50 wall thickness for pipe 6-inch in size and above unless indicated otherwise herein and/or on the drawings.

   a. **Fittings:** Fittings shall be cast from gray or ductile iron and shall conform to ANSI Specifications A21.10 (C 110), as amended to date. All fittings shall have standard mechanical joints. Fittings for size 3-inch through 12-inch shall be Class 250 for Gray Iron and Class 350 for Ductile Iron. Fittings for size 14-inch through 48-inch shall be Class 150 for Gray Iron and Class 250 for Ductile Iron. Either Gray Iron or Ductile Iron fittings will be permissible unless otherwise specified or shown on the Drawings.

   b. **Lining and Coating:** Pipe and Fittings shall be cement-lined (standard thickness) inside and bituminous coated outside, in accordance with the applicable provisions of ANSI Specification A 21.4 (AWWA C 104) and, ANSI

A 21.51 (AWWA C 151), as amended to date. The inside cement lining shall be treated with a bituminous seal coat.

c. **Weights and Marking:** Weights of pipe and fittings shall conform strictly to the requirements of ANSI Specifications. The class designations for the various classes of pipe and fittings shall be cast onto fittings in raised numerals, and cast or stamped on the outside of each joint of pipe. Weights shall be plainly and conspicuously painted in white on the outside of each joint of pipe and each fitting after the exterior coating has hardened.

d. **Certification:** The manufacturer of iron pipe and fittings shall furnish both the Engineer and the Owner with a certified letter stating that inspection and specified tests have been made and that the results thereof comply with the applicable ANSI Specifications for each.

h. **Trench Width:** Trench widths and depths (where applicable) for concrete and PVC pipe.

1. **Concrete Pipe:** The maximum trench widths and depths for the respective pipe sizes with the various classes of bedding shall be as given in Table D-5:

TABLE D-5 MAXIMUM TRENCH WIDTHS AND DEPTHS FOR CONCRETE PIPE

Size Pipe	Maximum Trench Width	Class of Pipe	Class C Bedding		Class B Bedding		Class A Bedding	
			(1)	(2)	(1)	(2)	(1)	(2)
18"	3' - 4"	III	8	8	11	9	24	15
18"	3' - 4"	IV	15	12	24	15	*	22
18"	3' - 4"	V	*	18	*	22	*	*
21"	3' - 8"	III	8	8	11	9	24	16
21"	3' - 8"	IV	15	12	24	16	*	22
21"	3' - 8"	V	*	18	*	23	*	*
24"	4' - 0"	III	9	9	13	11	24	16
24"	4' - 0"	IV	16	12	24	16	*	22
24"	4' - 0"	V	*	19	*	24	*	*
30"	4' - 8"	III	10	10	14	12	25	17
30"	4' - 8"	IV	17	14	25	17	*	24
30"	4' - 8"	V	*	20	*	24	*	*

(1) Maximum Trench Depth for Maximum Trench Width
(2) Limit of Trench Depth if Maximum Trench Width is Exceeded
* Up to and including 30 foot depth.
Note: If trenches are excavated to widths in excess of the maximum trench width or if trench wall collapses, sewers shall be laid with the class of bedding required for the trench depth shown in column (2) above at the expense of the Contractor.

2. **PVC Pipe:** The maximum trench widths and depths with the various classes of bedding and required conditions shall be as follows:

a. **Trench Width:** The maximum clear trench width at the top of the pipe shall not exceed a width equal to the normal pipe diameter plus eighteen inches (18"). If this width is exceeded or the pipe is installed in a compacted embankment, pipe embedment shall be compacted to a point at least 2½

pipe diameters from the pipe on both sides of the pipe or to the trench walls, whichever is less.

b. **Trench Depths:**

TABLE D-6 PIPE SIZES 6-INCH TO 21-INCH, INCLUSIVE

Class of Bedding	% of Proctor Density Range	Maximum Height of Cover
I	95	30”

c. **Compaction:** If the proper compaction cannot be obtained with materials from trench excavation, the Contractor will be required to obtain them elsewhere.

3. **Payment:** The cost of special bedding and tamping shall be included in the prices bid for sewers at various depths, except that the Engineer may authorize payment for concrete bedding or the use of crushed stone bedding where poor soil conditions are encountered, each in accordance with unit prices bid. The cost of furnishing extra strength sewer pipe shall be included in the prices bid for sewers at various depths.

i. **Pipe Bedding:** All pipe shall be laid on foundations prepared in accordance with the following specifications.

1. **Concrete Pipe:** Concrete pipe shall be laid as specified using the following classes of bedding required by the trench width and trench depth for the various sizes of pipe to be installed.

a. **Class A Bedding:** Class A bedding shall be either a concrete cradle (Type 1) or a concrete arch (Type 2).

Where the concrete cradle (Type 1) method is used, the trench shall be excavated not less than six inches (6") below the barrel of the pipe or a minimum of two inches (2") below the pipe bell (whichever is greater) and the pipe laid to line and grade on concrete blocking or equal. Class "B" concrete shall then be placed to the full width of the trench, but in no case less than four inches (4") from the pipe bell on either side of the trench, and to a height of at least one-fourth the outside diameter of the pipe. No backfill shall be placed in the trench for a period of at least 24 hours after the concrete has been placed. The backfill shall then be completed with selected backfill, had placed and tamped, to the limits shown on Detail Drawings.

Where concrete arch (Type 2) method is used, the trench shall first be excavated not less than six inches (6") below the barrel of the pipe bell (whichever is greater). The trench shall then be brought to grade with compacted crushed stone, placed the full width of the trench, as excavated, up to one-half the outside diameter of the pipe. the backfill shall then be complete with Class "B" concrete placed for the full width of the trench, as excavated, and to a point at least four inches (4") above the barrel of the pipe or one-fourth the inside diameter of the pipe (whichever is greater).

b. **Class B Bedding:** Class B bedding shall be performed by first undercutting the trench not less than six inches (6") below the barrel of the pipe or a minimum of two inches (2") below the pipe bell (which is greater). The trench shall then be brought to grade with compacted crushed stone, the pipe laid to line and grade and backfilled with compacted crushed stone placed the full

width of the trench, as excavated, up to one-half the outside diameter of the pipe. The backfill shall then be completed with selected backfill, hand placed and tamped, to the limits shown on the Detail Drawings.

c. **Class C Bedding:** Class C bedding shall be performed by first undercutting the trench not less than six inches (6") below the barrel of the pipe or a minimum of two inches (2") below the pipe bell (whichever is greater). The trench shall then be brought to grade with compacted crushed stone, the pipe laid out to line and grade and backfill of compacted crushed stone placed and grade and backfill of compacted crushed stone placed the full width of the trench, as excavated, up to one-fourth the outside diameter of the pipe. The backfill shall then be completed with selected backfill, hand placed and tamped, to the limits shown on the Detail Drawings.

d. **Bell Holes:** Bell Holes shall be provided in all classes of bedding so as to relieve pipe bells of all load, but small enough to insure that support is provided throughout the length of pipe barrel.

e. **Crushed Stone Bedding Material:** Crushed stone bedding material shall conform to the latest revision of ASTM C 33, as amended to date, gradation of #57 (ASTM #57), varying in sizes ¼" through 1". Bedding material shall be placed in the trench and thoroughly compacted to grade by tamping. Compacted bedding materials shall be carried up the sides of the pipe to the heights shown for the various classes of bedding.

f. **Excess Trench Widths:** If trenches are excavated to widths in excess of those specified in Table D-5 or if trench walls collapse, pipe shall be laid down with the class of bedding required for the trench depth shown in column (2) of Table D-5, at the expense of the Contractor.

2. **PVC Pipe:** PVC pipe shall be laid as specified using the following classes of bedding required for the various type soils and conditions encountered. Bedding for PVC pipe shall be in accordance with ASTM D 2321, as amended to date, the manufacturers recommendations and these specifications.

   a. **Bedding Material:** Class IA or IB Materials shall be used for bedding and haunching in all conditions. Class II, Class III, Class IVA, Class IVB and Class V materials will not be permitted for bedding and haunching under any condition.

   b. **Depth of Bedding:** Trench shall be undercut to allow for a minimum of six inches (6") of bedding material. Bell holes shall be excavated in the bedding material to allow for unobstructed assembly of the joint but care shall be taken to assure that bell hole is no larger than necessary to accomplish proper joint assembly. After joint assembly, material shall be placed under and around the entire length of pipe and compacted. Compaction up to one-half the outside diameter of the pipe and the full width of the ditch shall be of the same material used in the bedding. Backfilling shall then be carried to a point six inches (6") above the top of pipe, using hand tools for tamping. If the remaining backfill material contains large particles which could damage the pipe from impact during placement the initial backfill shall be increased to twelve inches (12") above the top of the pipe. Puddling will not be allowed as a method of compaction. The remaining backfill shall be as specified in "General Backfill" paragraph of these specifications. Pipe shall have at least thirty six inches (36") inches of cover before wheel loading and at least forty eight inches (48") of cover before using heavy duty tamping equipment such as a hydrohammer.

c. **Definitions and Uses of Bedding Material**: Class IA, IB, II, III, IVA, IVB, and V materials are defined in Table D-7. Their recommended uses are given in Table D-8.

TABLE D-7 CLASSES OF EMBEDMENT AND BACKFILL MATERIALS

Class	Type	Soil Group Symbol D 2487	Description	Percentage Passing Sieve Sizes			Atterberg Limits		Coefficients	
				1 1/2 in. (40mm)	No. 4 (4.77 mm)	No. 200 (0.075 mm)	LL	PL	Cu	Cc
IA	Manufactured Aggregates: open-graded, clean	None	Angular, crushed stone or rock, crushed gravel, broken coral, crushed slag, cinders or shells; large void content, contain little or no fines.	100%	</=10%	<5%	Non Plastic			
IB	Manufactured, Processed Aggregates; dense-Graded, clean	None	Angular, crushed stone (or other Class IA materials) and stone/sand mixtures with gradations selected to minimize migration of adjacent soils; contain little or no fines.	100%	</=50%	<5%	Non Plastic			
II	Coarse-Grained Soils	GW	Well-graded gravels and gravel-sand mixtures; little or no fines.	100%	<50% of "Coarse Fraction "	<5%	Non Plastic		>4	1 to 3
		GP	Poorly-graded gravels and gravel-sand mixtures; little or no fines.						<4	<1 or >3
		SW	Well-graded sands and gravelly sands; little or no fines.		>50% of "Coarse Fraction "				>6	1 to 3
		SP	Poorly-graded sands and gravelly sands; little or no fines.						<6	<1 or >3
II.	Coarse-Grained Soils, borderline clean to with fines	e.g. GW-GC, SP-SM	Sands and gravels which are borderline between clean and with fines.	100%	Varies	5% to 12%	Non Plastic		Same as for GW, GP, SW and SP	

Class	Type	Soil Group Symbol D 2487	Description	Percentage Passing Sieve Sizes			Atterberg Limits		Coefficients	
				1 1/2 in. (40mm)	No. 4 (4.77 mm)	No. 200 (0.075 mm)	LL	PL	Cu	Cc
III	Coarse-Grained Soils with fines	GM	Silty gravels, gravel-sand-silt mixtures.	100%	<50% of "Coarse Fraction "	12% to 50%		<“A” Line <7 and		
		GC	Clayey gravels, gravel-sand-clay mixtures.					>“A” Line		
		SM	Silty sands, sand-silt mixtures.		>50% of "Coarse Fraction "			>4 or <"A" Line		
		SC	Clayey sands, sand-clay mixtures.					>7 and >"A" Line		
IVA	Fine-Grained Soils (inorganic)	ML	Inorganic silts and very fine ands, rock flour, silty or clayey fine sands, silts with light plasticity.	100%	100%	>50%	<50	<4 or <"A" Line		
		CL	Inorganic clays of low to medium plasticity, gravely clays, sandy clays, silty clays, lean clays.					>7 and >"A" Line		
IVB	Fine-Grained Soils (inorganic)	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.	100%	100%	>50%	>50	<"A" Line		
		CH	Inorganic clays of high plasticity, fat clays.					>"A" Line		
V	Organic Soils	OL	Organic silts and organic silty clays of low plasticity.	100%	100%	>50%	<50	<"A" Line		
		OH	Organic clays of medium to high plasticity, organic silts.				>50	<"A" Line		
	Highly Organic	PT	Peat and other high organic soils.							

TABLE D-8 RECOMMENDATIONS FOR INSTALLATION AND USE OF SOILS AND AGREGATES FOR FOUNDATION, EMBEDMENT AND BACKFILL

	Soil Class (see Table D-7)*				
	Class IA	**Class IB**	**Class II**	**Class III**	**Class IV-A**
General Recommendations and Restrictions	Do not use where conditions may cause migration of fines from adjacent soil and loss of pipe support. Suitable for use as a drainage blanket and underdrain in rock cuts where adjacent material is suitably graded.	Process materials as required to obtain gradation which will minimize migration of adjacent materials. Suitable for use as a drainage blanket and underdrain.	Where hydraulic gradient exists check gradation to minimize migration. “Clean" groups suitable for use as drainage blanket and underdrain.	Do not use where water conditions in trench may cause instability.	Obtain geotechnical evaluation of proposed material. May not be suitable under high earth fills, surface applied wheel loads, and under heavy vibratory compactors and tampers. Do not use where water conditions in trench may cause instability.
Foundation	Suitable as foundation and for replacing over-excavated and unstable trench bottom as restricted above. Install and compact in 6” maximum layers.	Suitable as foundation and for replacing over-excavated and unstable trench bottom. Install and compact in 6 in. maximum layers.	Suitable as foundation and for replacing over-excavated and unstable trench bottom as restricted above. Install and compact in 6 in. maximum layers.	Suitable as foundation and for replacing over-excavated trench bottom as restricted above. Do not use in thicknesses greater than 12” total. Install and compact in 6” maximum layers.	Suitable only in undisturbed condition and where trench is dry. terial and provide firm, uniform trench bottom before bedding is placed.
Bedding	Suitable as restricted above. Install in 6 in. maximum layers. Level final grade by hand. Minimum depth 4 in. (6 in. in rock cuts).	Install and compact in 6 in. maximum layers. Level final grade by hand. Minimum depth 4 in. (6 in. in rock cuts).	Suitable as restricted above. Install and compact in 6 in. maximum layers. Level final grade by hand. Minimum depth 4 in. (6 in. in rock cuts).	Suitable only in dry trench conditions. Install and compact in 6 in. maximum layers. Level final grade by hand. Minimum depth 4 in. (6 in. in rock cuts).	Suitable only in dry trench conditions and when optimum placement and compaction control is maintained. Install and compact in 6 in. maximum layers. Level final grade by hand. Minimum depth 4 in. (6 in. in rock cuts).

Soil Class (see Table D-7)*					
	Class IA	**Class IB**	**Class II**	**Class III**	**Class IV-A**
Haunching	Suitable as restricted above. Install in 6 in. maximum layers. Work in around pipe by hand to provide uniform support.	Install and compact in 6 in. maximum layers. Work in around pipe by hand to provide uniform support.	Suitable as restricted above. Install and compact in 6 in. maximum layers. Work in around pipe by hand to provide uniform support.	Suitable as restricted above. Install and compact in 6 in. maximum layers. Work in around pipe by hand to provide uniform support.	Suitable only in dry trench conditions and when optimum placement and compaction control is maintained. Install and compact in 6 in. maximum layers. Work in around pipe by hand to provide uniform support.
Initial Backfill	Suitable as restricted above. Install to a minimum of 6 in. above pipe crown.	Install and compact to a minimum of 6 in. above pipe crown.	Suitable as restricted above. Install and compact to a minimum of 6 in. above pipe crown.	Suitable as restricted above. Install and compact to a minimum of 6 in. above pipe crown.	Suitable as restricted above. Install and compact to a minimum of 6 in. above pipe crown.
Embedment Compaction**	Place and work by hand to insure all excavated voids and haunch areas are filled. For high densities use vibratory compactors.	Minimum density 85%.*** Use hand tampers or vibratory compactors.	Minimum density 85%.*** Use hand tampers or vibratory compactors.	Minimum density 90% Std.Proctor.*** Use hand tampers or vibratory compactors. Maintain moisture content near optimum to minimize compactive effort.	Minimum density 95% Std. Proctor.*** Use hand tampers or impact tampers. Maintain moisture content near optimum to minimize compactive effort.
Final Backfill	Compact as required by the engineer.	Compact as required By the engineer.	Compact as required by the engineer.	Compact as required by the engineer.	Suitable as restricted above. Compact as required by the engineer.

*Class IV-B (MH-CH) and Class V (OL, OH, PT) materials are unsuitable as embedment. They may be used as final backfill as permitted by the Engineer.
**When using mechanical compactors avoid contact with pipe. When compacting over pipe crown maintain a minimum of 6" cover when using mechanical compactors. When using larger compactors maintain minimum clearances as required by the Engineer.
***The minimum densities given in the table are intended as the compaction requirements for obtaining satisfactory embedment stiffness in most installation conditions.

3. **Ductile Iron Pipe:** Ductile iron pipe for gravity sewer shall be laid as specified using the following type of bedding required for the depth of cover for the various sizes of pipe to be installed.
   a. **Flat bottom trench on undisturbed earth:** Backfill shall be as specified in the "General Backfilling" paragraph of these specifications.

b. **Pipe bedded in 4-inches of select materials (may be excavated material if free from rocks, foreign material and frozen earth):** Backfill shall be as specified in the "General Backfilling" paragraph of these specifications.
c. **Cover:** Maximum depth of cover for ductile iron pipe of the various classes and sizes to be installed are as given in Table D-9:

TABLE D-9 MAXIMUM DEPTHS OF COVER OVER DUCTILE IRON PIPE

Pipe Size (in.)	Thick Class	Normal Thick (in.)	Maximum Depth of Cover (ft.)	
			(1) Flat Bottom Trench	(2) Selected Material
10	50	0.29	38	55
	51	0.32	49	66
	52	0.35	59	79
12	50	0.31	36	52
	51	0.34	43	60
	52	0.37	53	71
16	50	0.34	30	47
	51	0.37	34	51
	52	0.40	40	57
18	50	0.35	29	42
	51	0.38	32	49
	52	0.41	36	53
20	50	0.36	27	38
	51	0.39	30	44
	52	0.42	34	50
24	50	0.38	23	31
	51	0.41	27	36
	52	0.44	30	41
30	50	0.39	18	25
	51	0.43	21	29
	52	0.47	24	33

j. **Laying Gravity Sewer Pipe:** All sewer pipe shall be laid upgrade, spigots shall point downgrade. The pipe shall be laid in the trench so that, after the sewer is completed, the invert fixed or given by the Engineer. The interior of all pipes shall be carefully freed of all dirt and superfluous material of every description, as pipe laying proceeds. Defective joints discovered after laying shall be repaired and made tight. Defective pipe shall be removed and proper replacement made.
1. **Concrete Pipe with Rubber Gasket Joints:** The surfaces of the pipe joints as well as the rubber gaskets, shall be thoroughly cleaned and wiped free of dust,

dirt, and other foreign material. After the surfaces have been thoroughly cleaned, the mating surfaces of the joints and gaskets shall be lubricated with proper type of lubricant supplied by and applied in accordance with the recommendations of the pipe manufacturer. The gasketed spigot end of the pipe shall then be centered on a grade into the bell of the preceding pipe, shoved home, and properly seated by applying a moderate force with a pry or lever device. Pipe joints shall have the ability to joint up with relative ease and shall resist backing out from the seated position so that when the joint is made, it will need no restraint to keep it tight. Immediately after joining the pipes, the last pipe shall be brought to final alignment and grade. After each joint is made, the gasket shall be checked for proper position in its groove. Care shall be taken to prevent pinching and cutting of the gasket during installation. If the gasket during installation. If the gasket is out of position, or has been damaged in any way the pipe shall be removed and re-laid with a new gasket. Every pipe shall be filled around immediately after being properly placed to prevent the moving of joints.

2. **PVC Pipe With Elastomeric Joints:** Proper implements, tool and equipment shall be used for placement of the pipe in the trench to prevent damage. Under no circumstances may the pipe be dropped into the trench. In subfreezing temperatures, caution shall be exercised in handling pipe to prevent impact damage. All pipe shall be carefully examined for cracks, blisters, nicks, gouges, severe scratches, voids inclusions, and other defects before laying. If any pipe is discovered to be defective after having being laid, it shall be removed and replaced with sound material at the expense of the Contractor.
   a. **Assembly of Gasketed Joint:** The assembly of the gasketed joint shall be performed as recommended by the pipe manufacturer. The elastomeric gaskets may be supplied separately in cartons or pre-positioned in the bell joint or coupling at the factory. When gaskets are color-coded, the Contractor shall consult the pipe manufacturer or his literature for the significance. In all cases, the gasket, the bell or coupling interior, especially the groove area (except when the gasket is permanently installed) and the spigot area shall be cleaned with a rag, brush, or paper towel to remove any dirt or foreign material before the assembling. The gasket pipe spigot bevel, gasket groove, and sealing surfaces shall be inspected for damage of deformation. When gaskets are separate, only gaskets which are designed for and supplied with the pipe shall be used. They shall be inserted as recommended by the manufacturer.

      Lubricant used shall be supplied by the pipe manufacturer and shall be applied as specified by the pipe manufacturer.
   b. **Lubrication:** After lubrication, the pipe is ready to be joined. Good alignment of the pipe is essential for ease of assembly. Align the spigot to the bell and insert the spigot into the bell until it contacts the gasket uniformly. Do not swing or "stab" the joint, that is, do not suspend the pipe and swing it into the bell. The spigot end of the pipe is marked by the manufacturer to indicate the proper depth of insertion.

      If undue resistance to insertion of the pipe end is encountered, or the reference mark does not position properly, the joint shall be assembled and the position of the gasket checked. If it is twisted or pushed out of its seat ("fish mouthed"), the Contractor shall inspect components, and repeat the assembly steps. Both pipe lengths concentric alignments. If the gasket was

not out of position, the Contractor shall verify proper location of the reference mark. The reference mark shall be relocated if it is out of position.

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

d. **Deflection Testing:** The maximum deflection in the installed PVC pipeline shall not exceed 5% of the pipe original internal diameter. Deflection testing will be required using either a deflect meter or a "GO-NO-GO" mandrel. The Engineer shall randomly select portions of the project to be deflection tested. Such portions shall consist of not less than 5% of the total reaches. (Reach being lengths of pipe between two manholes in the project excluding house leads).

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

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

3. **Ductile Iron Pipe With Mechanical or Push-On Joints:** Proper and suitable tools and equipment shall be used for the safe and convenient handling and laying of ductile iron pipe. Care shall be taken to prevent damage to the exterior coating and interior cement lining. All pipe shall be carefully examined for crack and other defects before laying. If any pipe or fitting is discovered to be defective after having being laid, it shall be removed and replaced with sound material at the expense of the Contractor. Whenever pipe is required to be cut, the cutting shall be done by skilled workmen using an abrasive wheel cutter. Use of a cold chisel or oxyacetylene torch will not be permitted.

a. **Mechanical Joints:** Mechanical joints shall be made only by experience mechanics. sockets and spigots shall be washed with soapy water before slipping the gland and gasket over the spigot end of the pipe.

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

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

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

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

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

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

c. **Mechanical joint or Push-On Joint Pipe on Piers:** Mechanical or Push-on Joint pipe may be used on piers in gravity sewer lines. Pipes shall be laid with ¼ inch clearance in each joint to provide for expansion. Jointing of pipe shall be as described above. On mechanical joint pipe the bolts shall be tightened alternately 180 degrees apart, but be left "finger-tight" until the sewage is diverted into the sewers; then the bolts shall be further tightened a sufficient amount which will prevent slippage which may occur because of temperature stress.

k. **Precast Concrete Manholes:** Precast concrete manholes shall consist of precast reinforced concrete riser sections, concentric top section and a base section conforming to Typical Details shown on Detail Drawings. Precast manhole sections shall be manufactured in accordance with ASTM C 478, as amended to date, and these specifications. Concrete shall have a minimum compressive strength of 4,000 psi when tested in accordance with ASTM C 39, as amended to date. Steel reinforcement shall be as specified in ASTM C 478, as amended to date. Wall and bottom section shall have a minimum thickness of five inches (5"). Absorption shall not exceed 9 percent when determined in accordance with ASTM C 497, as amended to date.

1. **Base Section:** Base sections for precast concrete manholes shall have a bottom poured monolithically with the walls. Base sections shall be furnished with inside diameters of 4, 5, or 6 feet as required. Base sections shall be furnished with a minimum height of 24 inches for pipes having a diameter of 8, 10, or 12 inches and a minimum height of 36 inches for pipes having a diameter of 15 or 18 inches. Minimum height for 5 or 6 feet diameter base sections shall be 48 inches regardless of pipe size. Base sections with 5 or 6 foot inside diameter shall be reduced to 4 foot inside diameter by means of an adapter ring or transition top.

The openings in the base section for the accommodation of the pipe shall be cast to closely conform to job conditions and shall provide a minimum clearance of

three inches (3") between the inside bottom of the base and outside bottom of the pipe barrel.

2. **Riser Section:** The riser sections shall be furnished in a minimum of six (6) inch increments and shall be four feet (4') in diameter with, (a) tongue and groove joint to be sealed with approved butyl rubber or bitumastic material, similar to "Ram Nek" as manufactured by K. T. Snyder Co., Inc. or (b) O-ring gasket type joint conforming to ASTM C 443, as amended to date. The gasket joint shall be thoroughly cleaned of all loose materials and brushed with an approved Epoxy to give a smooth surface free of any honeycomb.
3. **Alteration to Manholes:** In the event that the manhole has to be altered after delivery to job site the Contractor may, with permission of the Engineer, connect the pipe to the manhole with a collar of mortar and brick. The opening between the pipe and manhole shall have a minimum clearance of one (1) inch and shall be filled from the inside of the manhole with a non-shrink grout.
4. **Repaired and Patched Sections:** Repaired and Patched sections will not be acceptable unless each individual section so repaired and patched shall have first been inspected and approved by the Engineer, for repair and patching at the manhole plant. Repairs to the patching of O-Ring grooves and shoulders will not be permitted.
5. Manhole brick for grade adjustment shall be whole hard burned common brick conforming to ASTM C 32 Grade MS, as amended to date. A maximum of 3 courses shall be used.

l. **Placing Precast Concrete Manholes:** Precast concrete manholes shall be placed or constructed where shown and/or directed by the Engineer. Manholes shall be 4, 5, and 6 feet in diameter as determined from the schedule of pipe sizes and line deflections or as shown.

The top of manholes outside of roads, streets, and highways shall be built to grades twelve inches (12") above ground surface unless otherwise shown on the Drawings. Manholes in roads, etc. shall be built to grade designated by the Engineer. Vented manholes shall be constructed to elevations as shown on the Drawings.

Manholes shall be placed and/or constructed as follows:

1. **Precast Concrete Manholes:** Precast concrete manholes shall be bedded on not less than six inches (6") of compacted crushed stone at Contractor's expense. The crushed stone shall extend to not less than six inches (6") outside the walls of the manhole, and shall be compacted under entire length of pipe within manhole excavation.
    a. **Connection of Pipe to Manholes:** Connections of pipe to manholes shall be made with a flexible joint system. The joint system shall be a neoprene or synthetic rubber boot or sleeve, either cast or core drilled into the wall of manhole. The boot or sleeve shall be clamped and seated to the pipe with a stainless steel band. The boot or sleeve, system shall be "LOCK JOINT FLEXIBLE MANHOLE SLEEVES" as manufactured by Interpace Corporation, Parsippany, New Jersey or "KOR-N-SEAL" as manufactured by National Pollution Control System, Inc., Nashua, New Hampshire or equal. connections of pipe to manhole shall have a minimum clearance of one inch (1") and shall be filled from the inside of the manhole with a Non-shrink grout.
    b. **Adjustment:** The top of the concentric top section shall have a minimum wall thickness of eight inches (8") to accommodate brick courses for height

adjustment. A maximum of three (3) brick courses will be allowed for adjustment of manhole to required grade.

2. **Drop Connections:** Drop connections will be required, wherever there is a difference in elevation between the inlet and outlet inverts of 2 feet or more or wherever called for on the Drawings. Drop pipe shall be the same size as the sewer which they serve. Openings in the walls of precast concrete manholes for drop connections shall not be made at joints. Drop connection fittings and riser pipe shall be encased in formed Class "C" concrete. Drop connections shall conform with typical details as shown on the Drawings. Drop connections shall be carefully backfilled to prevent dangerous side pressure.
3. **Manhole Inverts:** Manhole inverts shall be carefully constructed with cement grout, Class "B" concrete, or cement mortar brickwork; special care shall be taken to lay the channel and adjacent pipes to grade. Cement mortar shall be made of one (1) part cement and two (2) parts clean sharp sand. Channels shall be properly formed, rounded, and troweled smooth. The connections of the sewer with the wall and channel of the manhole shall be tight and smooth.
4. **Manhole Steps:** Manhole steps shall conform to the details shown. Steps for precast concrete manholes shall be installed along a vertical centerline, on approximately 14" to 16" centers.
5. **Future Sewer Connections:** Where shown, a twelve inch (12") long pipe stub for future sewers, of such size as any be designated, shall be laid to proper grade and alignment and plugged with a factory plug with same type joint as used on the sewer pipe.
6. **Manhole Frames and Covers:** Manhole frames and covers shall be as detailed and shown on the Drawings and as called for in the proposal and shall include setting to finished grade as required, and grouting in place.
7. **Manhole Inflow Seal:** A manhole inflow seal made of High Density Polyethylene Copolymers shall be installed on all sanitary sewer manholes.
8. **Frame and Chimney Seal:** An internal frame and manhole chimney seal shall be installed on all manholes installed in areas that have potential for water infiltration through the frame and chimney section. The seal shall be removable and flexible see FlexRib by NPT, Inc for typical.

m. **Connections to Existing Sewers:** At location where new sewers are shown to be connected to existing sewers at a new manhole, the Contractor shall first expose the existing sewer and install a supporting timber beam with suitable straps around the pipe so a to bridge the excavation for the new manhole. The manhole shall then be constructed complete with invert and frame and cover. Under special conditions the Contractor may temporarily block and/or divert sewer flows to facilitate the construction operations. Actual physical connection of the sewer will be made at a later date, as directed.

n. **Iron Castings:** Castings shall be of gray-iron conforming to ASTM A 48, as amended to date. Manhole and step castings shall be as shown on the Detail Drawings unless otherwise specified. Castings shall be tough, close-grained and smooth, free from blow holes, blisters, shrinkage stains, cracks, cold shots and like defects. No plugging of defective castings will be permitted. Castings shall be made accurately to dimensions shown on the Drawings or ordered and shall be planned or ground where necessary, whether marked or not, to secure perfectly flat bearing surfaces. Allowance shall be made in the patterns so that the specified thickness or metal will not be reduced. No casting will be accepted, the weight of which is less than the theoretical weight, based on required dimensions, by more than five percent (5%).

o. **Highway Crossing:** The Contractor shall install pipe lines across highways in accordance with the applicable regulations of the State Highway Department and as shown on the Drawings. All work shall conform to the "Construction Along Highways, Streets and Roadways" section of these specifications. Permits for highway crossings will be obtained by the Owner.

p. **Steel Pipe Casing:** Steel pipe casing shall be manufactured from Steel conforming to ASTM A 252 Grade 2, as amended to date, with a minimum yield strength of 35,000 psi before cold forming. Pipe may be straight seam or spiral weld. A protective coating will not be required. The diameter and wall thickness of steel pipe casing shall be as shown on the Drawings.

q. **Installation of Steel Pipe Casing by the Boring Method:** Installation of steel pipe casing shall be by the dry boring method at locations shown on the Drawings. Installations of steel pipe casing shall be in accordance with the applicable regulations of the State Highway Department; the Detail Drawings and these Specifications. All excavation for pit and bore shall be unclassified.
    1. **Boring Pit:** The boring pit shall be solid sheeted, braced and shored as necessary to provide a safe operation. The Contractor shall take all precautions, and shall comply with all requirements as may be necessary to protect private or public property.
    2. **Line and Grade:** The Contractor shall set the boring rig so that, after the casing is completed and the sewer carrier pipe installed, the invert surface of the sewer shall conform accurately to the grades and alignment fixed or given by the Engineer.
    3. **Boring:** The hole shall be bored and cased through the soil by a cutting head on a continuous auger mounted inside the casing pipe. The boring of the howl and installation of the casing pipe; shall be simultaneous. Lengths of casing pipe shall be fully welded to the prodding section in accordance with AWS recommended procedures.
    4. **Installation of Sewer Carrier Pipe:** After installation of the casing pipe is complete, the sewer carrier pipe shall be installed through the casing pipe as shown on the Detail Drawings.

r. **Concrete Piers:** Concrete piers for ductile iron pipe shall be constructed of Class "A" concrete, and shall be constructed as shown on the Standard Detail Drawing. If rock is encountered, piers supporting pipe lines across streams shall be anchored into the rock, as shown on the Detail Drawings, so as not to resist overturning during periods of flood stages in the stream. Holes not smaller than two and one-half inches (2½") in diameter by two feet (2') deep shall be drilled into the rock after excavation for the footing is complete; No. 6 reinforcing bars shall be embedded in grout made with high-early strength cement poured into the holes. In wet holes, grout shall be deposited with a tremie. Straight bars shall be used, and shall be bent over for anchorage after the concrete has attained its full strength. Where unusually poor soil conditions are encountered, the Engineer may direct that spread footings of concrete be constructed, or that pin piles be driven for support for piers.

s. **Closing Pipe:** When the work of pipe-laying is suspended for the night, and at other times, the end of the sewer shall be closed with a tight cover. The Contractor shall be responsible for keeping the sewer free from obstruction.

t. **Testing and Cleaning:** Before acceptance of any sewer or systems of sewers, lines shall be cleaned and tested in accordance with these Specifications. Where any obstruction is met, the Contractor will be required to clean the sewers by means of rods, swabs, or other instruments. Lines and manholes shall be clean before final

inspection. Pipe lines shall be straight and show a uniform grade between manholes. The Contractor shall be required to correct any variations therefrom which may be disclosed during the inspection.

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

1. **Infiltration Test:** Where natural ground water levels stand a minimum of two feet (2') above the top of the pipe, the amount of leakage may be determined form measurements made at the lower end of the sewer section under test. Sewers above the test section shall be closed before testing by the installation of suitable watertight bulkheads. The length of the test section shall be determined by the Engineer. The average of six reading at five minute intervals will be used to determine the rate of infiltration for any one test section.

   The rate if infiltration of ground water into any test section of sewer, including manholes, shall not exceed the following:

TABLE D-10 MAXIMUM RATE OF GROUND WATER INFILTRATION

Size of Sewer	Gallons Per 24 Hours Per Foot of Sewer
8"	0.30
10"	0.38
12"	0.45
15"	0.57
18"	0.68
21"	0.80
24"	0.91
30"	1.14

2. **Exfiltration Test:** Where natural ground water levels do not stand two feet (2') above the top of the pipe, an exfiltration test shall be conducted on each section of sewer. The test shall be performed up to an average maximum hydrostatic head of ten feet (10'). The test shall be conducted in the following manner.

   The ends of the pipe in the test section shall be closed with suitable watertight bulkheads. Inserted into each bulkhead at the top of the sewer pipe shall be a 2-inch pipe nipple with an elbow. At the upper end of the test section a riser pipe shall be installed. The test section of the pipe shall be filled through the pipe connection in the lower bulkhead which shall be fitted with a tight valve, until all air is exhausted and until water overflows the riser pipe at the upper end. Water may be introduced into the pipe twenty four (24) hours prior to the test period to allow complete saturation. House service line, if installed, shall also be fitted with suitable bulkheads having provisions for the release of air while the test section is being filled with water.

   During the test period, which shall extend over a period of thirty (30) minutes, water shall be introduced into the riser pipe from measured containers at such intervals as are necessary to maintain the water at the top of the riser pipe. The

total volume of water added during the thirty (30) minute test period shall not exceed that shown for infiltration in (a) above.

3. **Low-Pressure Air Test:** Where sewer grades are such that preclude performance of the exfiltration test or at the Contractor's option, a low-pressure air test shall be conducted on each section of sewer after completion and before acceptance.

   Prior to air testing, the section of sewer between manholes shall be thoroughly cleaned and wetted. Immediately after cleaning or while the pipe is water soaked, the sewer shall be tested with low-pressure air. At the Contractor's option sewers may be tested in lengths between manholes or in short sections (25 feet or less) using Air-Lock balls pulled through the line from manhole to manhole. Air shall be slowly supplied to the plugged sewer sections until internal air pressure reaches approximately 4.0 psi. After this pressure reached and the pressure allowed to stabilize approximately 2 to 5 minutes), the pressure may be reduced to 3.5 psi before starting the tests. If a 1.0 psi during the test time the line is presumed to have failed the test, and the Contractor will be required to locate the failure, make necessary repairs and re-test the line. Minimum test time for various pipe sizes, in accordance with ASTM C 828, as amended to date, is as follows:

TABLE D-11 MINIMUM TEST TIME FOR PIPE SIZES

Nominal Pipe Size (Inches)	T(time) Min/100 Feet
8	1.2
10	1.5
12	1.8
15	2.1
18	2.4
24	3.6
30	4.8

   Required test equipment includes Air-Lock balls, braces, air hose, air source, timer, rotometer as applicable, cut-off valves, pressure reducing valve, 0-15 pressure gauge, 0-5 pressure gauge with gradations in 0.1 psi and accuracy of $\pm$ 2%.

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

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

4. **Repairs:** All visible leaks shall be repaired regardless of whether infiltration, exfiltration or air test is within allowable limits. No sewer will be accepted until leakage tests demonstrate compliance with one of the above leakage test methods.

v. **Manhole Vacuum Test:** All new wastewater manholes shall be vacuum tested according to the following procedure prior to acceptance:

All manholes shall be vacuum tested according to ASTM C1244-93 "Standard Test Methods for Concrete Sewer Manholes by the Negative Pressure (Vacuum) Test" after backfilling operations. The general procedure shall be as follows:

1. Manholes shall be prepared by plugging all lift holes and pipes entering the manhole. Care should be taken to securely brace all pipes and plugs to prevent being pulled into the manhole during the test.
2. The test head shall be placed on top of the manhole according to manufacture specifications and 10 inches of mercury be drawn down on the manhole.
3. The valve on the vacuum line shall be closed and valve pump shut off.
4. The time shall be measure for the vacuum to drop to 9 inches of mercury.

The manhole shall pass if the time required to drop from 10 inches to 9 inches of mercury exceeds the time listed in the table below. If the drop occurs faster than the time below the manhole shall be repaired using approved methods and retested until a passing time is obtained.

TABLE D-12 MANHOLE VACUUM TEST TIMES

Depth of Manhole (Feet)	Diameter of Manhole (Feet)			
	4	**5**	**6**	Time (Seconds)
4	17	21	27	
6	17	21	27	
8	20	26	33	
10	25	33	41	
12	30	39	49	
14	35	46	57	
16	40	52	67	
18	45	59	73	
20	50	65	81	
22	55	72	89	
24	59	78	97	
26	64	85	105	
28	69	91	121	
30	74	98	121	

w. **Cleaning Up:** Before the work is considered complete, all material not used, and rubbish of every character must be removed from the project. All streets, sidewalks, curbs, fences and other private or public facilities and structures disturbed must be in essentially as good condition as existed before the work was done. Any subsequent settlement of backfill or payment over trenches shall be replaced by the Contractor and the surfaces brought to grade.

x. **Acceptance of Work:** Sewer lines and appurtenances will not be considered ready for acceptance until all provisions of the Specifications have been complied with, until all tests have been satisfactorily completed, and until inspection of the lines has been made by the Engineer, and permission granted therefor.

D.7 STORM DRAINAGE

a. **Scope:** Furnish all material, equipment, and labor required to install storm drainage facilities as specified, as shown on the Plans, and as directed by the Engineer.

b. **General:** The Contractor shall construct the storm drainage pipelines true to line and grade including all manholes, drainage structures, and other appurtenances shown on the Plans and specified below. Clearing, grubbing, trench excavating, sheeting, shoring, backfilling, restoration, and related items shall be as specified elsewhere herein. All materials shall be furnished new and shall be as shown on the Plans and as specified below.

c. **Pipe Materials:** The following pipe materials are approved for use within the City of North Augusta. All pipeline materials shall comply with SCDOT Standard Specifications for Highway Construction (latest edition). Specific Exceptions area as follows:

   1. The minimum pipe diameter for storm drainage pipelines to be maintained by the City shall be eighteen (18) inches.
   2. No metal pipe (CMP, DIP, BCMP, aluminized or galvanized CMP) shall be installed or approved for use in construction.
   3. All storm drainage pipelines installed within road rights-of-way shall be reinforced concrete pipe (RCP).

   Pipeline materials shall be as shown on the Plans and as directed by the Engineer.

   1. **Reinforced Concrete:** Pipe shall conform to requirements of AASHTO M170. Circular, Class III RCP shall be used unless otherwise specified or shown on the Plans. Elliptical RCP may only be used on a case by case basis as approved by the Engineer.
   2. **Corrugated Plastic Pipe:** Pipe shall be in conformance with the appropriate AASHTO or ASTM standard and pipe stiffness shall be as specified by the Engineer. Pipe may only be used on a case by case basis as approved by the Engineer.

d. **Pipe Installation:** All pipe shall be inspected and approved by the Engineer prior to installation. The pipe shall be free from functional defects (cracks, broken ends, spalls, etc.) as determined by visual inspection. The Contractor shall remove all defective pipe from the site.

   The pipe trench shall be prepared as previously specified and pipe installation shall proceed upgrade with the bell end upgrade. Pipe shall be carefully lowered into the trench using pipe slings or cable. Pipe shall not be rolled or dropped into the trench. Each pipe shall be laid true to the line and grade as shown on the Plans to form a close concentric joint to ensure a uniform flow line. A minimum grade of one (1%) percent is required for all storm drainage pipelines unless otherwise shown on the Plans or directed by the Engineer. Pipe shall be installed in a straight alignment to allow visual inspection by looking from both ends of the completed installation. Unless specifically approved by the Engineer, pipe shall not be laid on a curve.

   Concrete pipe joints shall be made with flexible water-tight gaskets in conformance with AASHTO M198. The pipe ends shall be thoroughly cleaned and dry prior to applying the gasket. In lieu of gasket joints, the Contractor may make concrete pipe joints with cement mortar fully packed in the annular space finished smooth and flush inside and an excess mortar bead outside the pipe joint.

e. **Structure Materials:** All drainage boxes, wingtraps, head walls, junction boxes, weir inlets, manholes, outlet structures, and energy dissipation structures shall be built as shown on the Plans and standard detail drawings. Structures shall be precast

concrete or constructed in place with brick, block, or concrete as specified herein and as shown on the standard details.

1. **Concrete Materials:** Precast concrete manholes and drainage structures shall conform to ASTM C-478. Cast in place concrete shall be SCDOT Class A (3000 psi) unless otherwise specified. The concrete mix design must be approved by the Engineer.
2. **Masonry Materials:** Clay or shale brick used in the construction of manholes, catch basins and other drainage structures shall conform to the requirements of AASHTO M 91, Grade MM. Concrete brick shall conform to ASTM C-55, Grade S-II. Concrete block shall be Grade A, Hollow Load Bearing Concrete Masonry Units in conformance with ASTM C-90. Mortar materials shall meet SCDOT requirements.
3. **Frame and Covers:** Trap weir inlet frame must be U.S. Foundry USF 1258, cover type "BD". Manhole frame and must be U.S. Foundry USF 668, cover type KL.
4. **Rip-Rap:** Stones shall be hard quarry or field stone and shall be of such quality that they will not disintegrate on exposure to water or weathering. Stone for hand placing to thickness of 12 inches shall vary in size with no pieces weighing more than 150 lbs. At least 20 percent of the stone pieces, excluding spalls, shall weigh more than 60 pounds, and no more than 20 percent of the stone pieces, excluding spalls shall weigh less than 25 pounds. Stone for hand placing to a thickness of 6 inches must be no less than 3 inches in one dimension and 6 inches in another dimension.

f. **Structure Installation:** Drainage structures shall be installed where shown on the Plans and as directed by the Engineer. Excavation shall proceed as previously specified to prepare a firm foundation on native material capable of supporting the weight of the structure. Water shall not be present in the foundation area. If native materials are not capable of providing a firm foundation, the foundation area shall be excavated and suitable material placed and compacted to provide the necessary bearing strength.

1. **Masonry Construction:** All masonry structures shall be installed on reinforced concrete footings or foundations as shown on the Plans and Standard Details. Brick and block shall be laid to line in courses in full and close joints of mortar which shall be not less than 1/4 inch and not more than 1/2 inch in thickness, and the thickness shall be uniform throughout. Adjoining courses shall break joints 1/2 a brick (block) as nearly as practicable. Courses shall be level except where otherwise necessary. All joints shall be finished properly as the work progresses and, on exposed faces, they shall be neatly struck. Broken or chipped brick (block) will not be allowed in the faces of the structure. In making closures, no piece of the brick (block) less than the width of a whole shall be used and wherever practicable in making such closures, whole brick (block) shall be laid with the long side at right angles to the face of the structure. The exposed surface of the masonry structure shall be thoroughly cleaned of mortar stains, and pointed satisfactorily. When Reinforced Masonry is specified, care shall be taken to insure the proper placement of the reinforcing steel as specified in the plans.
2. **Precast Concrete Construction:** Precast concrete structures shall be set plumb and to the elevations shown on the plans. Pipe connections shall be made by stubbing the pipe end inside the structure and rebuilding the structure wall around the pipe with brick and mortar. In lieu of brick and mortar, concrete

collars may be poured around the pipe on the outside structure wall, overlapping the structure wall a minimum of six (6") inches in all directions.

3. **Cast-in-Place Concrete:** All concrete structures shall be constructed in accordance with the design requirements and details shown on the Plans and as specified elsewhere herein. Concrete shall be placed and compacted to form a structure of maximum density and impermeability and of uniform texture exhibiting a smooth surface when the forms are removed. Concrete shall not be placed until the foundation, steel placement, and formwork has been approved by the Engineer. Defective concrete, as determined by the Engineer, shall be removed and/or repaired by the Contractor.
4. **Rip-Rap:** The Contractor shall place rip-rap as shown on the plans, or a minimum of 10 square yards at all discharge points of ditches and pipe outlets/inlets. Rip-rap shall be placed by machine and/or by hand to the designated slope, thickness, length, and depth, taking care to avoid damage to pipes and structures. The Contractor shall grout loose rip-rap as indicated on the Plans and as directed by the Engineer.

g. **Inspection and Testing:** Upon completion of pipe installation, the pipeline shall be cleaned to remove all construction debris, dirt, mud, mortar, etc. Existing downstream piping shall be inspected by the Engineer and cleaned by the Contractor if necessary. All new storm drainage piping and appurtenances will be subject to final inspection by the Engineer. All deficiencies noted shall be corrected to the satisfaction of the Engineer prior to acceptance. All required testing such as concrete strength, soil compaction, etc., as specified herein and as directed by the Engineer shall be conducted by an approved independent laboratory hired by the Contractor. Test results shall be submitted directly to the Engineer.

h. **As-Built Drawing:** As the work progresses, a record shall be made on all changes to and deviations from the Plans. As-Built drawings shall be furnished to the City before acceptance of all water systems.

D.8 ROADS

a. **Scope:** Furnish all material, equipment, and labor required for road construction, including subgrade, base, asphalt surface, sidewalk, curb and gutter, and shoulders as specified, as shown on the Plans, and as directed by the Engineer. All work shall be in accordance with SCDOT, Standard Specifications for Highway Construction, except as modified below. This specification shall also be applied to parking lots, driveways, and other paved areas as applicable.

b. **Pavement Design:** These specifications are based on minimum subgrade, base course, and surface course requirements. Road designs may vary from these minimum requirements based on site conditions, road type, traffic volume, etc. The design for each road will specify additional subgrade, base and surface course requirements if necessary. These material and thickness requirements will be shown on the Plans.

c. **Subgrade:** The subgrade shall be prepared for the subsequent installation of base course, pavement, sidewalk, curb and gutter, and shoulders. Prior to the completion of the subgrade, all cuts/fills, sewers, drains, water lines, and structures shall be substantially complete. The compacted subgrade shall conform to the lines, grades and cross sections as specified, as shown on the Plans, and as directed by the Engineer.

1. **Preparation:** The entire surface of the in-place subgrade shall be plowed, harrowed and thoroughly mixed to a depth of at least 12". After the material is mixed, the subgrade shall be compacted as previously specified to final line and

grade (100% of maximum density for the top 8” and 95% of maximum density below the top 8”). Maximum densities will be determined by either AASHTO T99, SC T-25, or SC T-29.

2. **Finish Grading:**
   a. **Surface:** The surface of the complete subgrade shall be bladed to a smooth and uniform texture. The center line profile shall conform to the established elevations with an acceptable tolerance of 0.10 feet.
   b. **Shoulder:** The full width between the back of the curb and right-of-way shall be finished, graded to a uniformly smooth surface, free from any abrupt irregularities, and sloping at a ratio not to exceed 1/2" per foot nor less than 1/4" per foot. The finished grade shall not exceed 0.25 feet from the plan cross-section.
   c. **Approval:** No base or curb and gutter shall be placed before the subgrade is inspected, tested, and approved by the Engineer.
3. **Testing:** Testing shall be done on all portions of the subgrade underlying the base and curb and gutter, plus an 18-inch width behind each curb.
   a. **Test Rolling:** The Contractor will provide the roller with a minimum axle load of 15,000 lbs (7-1/2 tons) per rear axle; generally a fully loaded water distributor, asphalt distributor, loaded 20 yard truck, or similar approved equipment.
      1. Test rolling shall be done parallel to the center line, with the forward speed of the roller between 2 and 3 miles per hour.
      2. Test rolling under the curb and gutter shall be done prior to placement of curb and gutter. The surface shall be in a finished condition ready for the placement of curb and gutter,
      3. Test rolling under the base material shall be done prior to placement of the base material. The surface shall be in a finished condition ready for the placement of base material. Test rolling of the area under the base material shall be done over the quarter parts of the road, with additional passes at the discretion of the Engineer.
   b. **Compaction Test:** Compaction testing shall be as previously specified.
      1. The Contractor shall arrange for an approved testing laboratory to conduct the necessary compaction tests at his own expense. Test results shall be submitted directly from the lab to the Engineer.
      2. Test locations will be determined by the Engineer and in no case, will be less than one test per 450 feet of road bed.
4. **Repair of Failed Areas:** Areas that exhibit pumping, soft spots, and low compaction shall be repaired or replaced and re-tested as directed by the Engineer. The repairs may consist of re-mixing in-place material, additional compaction effort, removal of unsatisfactory material and replacement with satisfactory material, or by the strengthening or stabilizing of the material in place.
5. **Approval:** Upon submission of passing compaction test results and satisfactory test roll, the Engineer will approve the subgrade for the installation of road base and curb and gutter. However, subgrade approval may be rescinded if significant time passes or inclement weather deteriorates the subgrade. The Contractor will be required to repair and/or replace any subgrade deterioration and seek re-approval from the Engineer.

d. **Base Course:** Upon approval of the subgrade, the base course shall be installed to the lines, grades and cross sections as specified, as shown on the Plans, and as directed by the Engineer.

1. **Material:** The following materials may be used for road base. Alternate materials may be submitted to the Engineer for review.
   a. **Aggregate Base Course:** The material for aggregate base course shall consist of a mixture of crushed stone, gravel, sand, soil, or approved similar material. The mixture shall be in conformance with SCDOT Type 1 or Type 2 Stabilized Aggregate Base Course.
      1. Aggregate base course shall consist of a 6" minimum compacted thickness, as shown on the Plans, or as directed by the Engineer.
      2. The material shall be free from lumps or balls of clay, weeds, roots, or other objectionable matter.
      3. No in-place mixing will be permitted.
   b. **Asphalt Base Course:** The material shall be in conformance with SCDOT Hot Laid Asphalt Aggregate Base Course or other asphalt mix approved by the Engineer.
      1. Asphalt base course shall consist of a 4" minimum compacted thickness, as shown on the Plans, or as directed by the Engineer.

2. Installation:
   a. **Aggregate Base:** The base material shall be spread evenly on the approved subgrade and brought to line, grade, and cross-section as shown on the Plans or as directed by the Engineer. The material shall then be bladed, wetted and rolled to achieve a dense, smooth, unyielding, well bonded base course compacted to 100% maximum density. **Asphalt Base:** The base material shall be spread by a mechanical spreader on the approved subgrade, struck to the line, grade, and cross-section as shown on the Plans or as directed by the Engineer, then compacted by rolling to achieve a dense, smooth, uniform surface. A tack coat shall be applied to the asphalt base prior to laying the asphalt surface course.

3. **Finish Grading:** The Contractor shall finish the base course to a smooth and uniform surface, free from abrupt changes, and sloping to the edges at a rate of 1/4" per foot. The surface shall vary from profile and cross section at any given point by no more than 1/4". The edges of the road at the curb and gutter shall be uniformly graded to a depth of at least 1-1/2 inches. There shall be no roots, organic matter, trash or any other deleterious material on or protruding from the surface.
4. **Testing:** Testing shall be as previously specified for subgrade.
5. **Maintenance:** The base course shall be maintained by repeated machining throughout its entire length for such length of time as necessary to provide an adequate base course conforming to the required cross section, grade, thickness and proper compaction. Maintenance shall also include the correction of any defects which may develop due to traffic, erosion, or other cause; and shall include watering, machining, rolling, and other operations necessary to condition and preserve the base course. Any lack of uniformity in the base course mixture, unevenness in the surface, or other irregularities shall be corrected by adding or replacing base materials and re-mixing, reshaping, and re-compacting as necessary and as required. The base shall be properly drained at all times.

e. **Bituminous Pavement:** The prime coat and hot laid asphalt concrete surface course shall be installed on the approved base course to the lines, grades, and cross-sections as specified, as shown on the Plans, and as directed by the Engineer.
   1. **Weather Limitations:** Bituminous mixtures shall not be produced or placed during rainy weather, when the subgrade or base course is frozen or shows any evidence of excess moisture, when the moisture on the surface to be paved

would prevent proper bond, or when the air temperature is less than 40°F in the shade away from artificial heat. In addition, hot laid asphalt concrete surface courses, which are to be placed at a rate of 100 pounds per square yard or less, shall not be placed when the air temperature measured in the shade, away form artificial heat, is less than 50ºF.

2. **Prime Coat:** A prime coat shall be uniformly applied to the base course by use of the distributor spray bars at the rate of 0.25 to 0.28 gallons per square yard. The prime coat shall be applied when the atmospheric temperature is above 55°F. The material for the prime coat shall be one of the following:
   a. **Cut-Back Asphalt (Rapid Curing Type):** This material shall be grade RC-30 and shall conform to the requirements of the SCDOT Standard Specifications. RC-30 shall be sprayed between 50° and 120°F.
   b. **Cut-Back Asphalt (Medium Curing Type):** This material shall be Grade MC-30 and shall conform to the requirements of AASHTO M 82, except that the penetration of the residue shall be 80-250. The Saybolt-Furol viscosity shall apply. MC-30 shall be sprayed between 50° and 120°F.
   c. **Emulsified Asphalt (Anionic):** Anionic emulsified asphalt shall be Grade EA-P and shall meet the requirements of AASHTO M 140. EA-P shall be sprayed between 50° and 160°F.
3. **Surface Course:**
   a. **Asphalt Concrete:** The asphalt concrete mixture shall be composed of mineral aggregate and asphalt cement, mixed in an approved plant and shall conform to SCDOT Standard Specifications for Highway Construction for Type 3 asphalt concrete surface course. The job mix shall be approved by the Engineer prior to installation.
   b. **Transportation and Delivery:** The mixture shall be transported from the mixing plant to the point of use in approved vehicles. Loads shall not be of such size or weight as to interfere with the efficient operation of the spreader. Loads shall not be sent out so late in the day as to prevent the completion of spreading and completion of the mixture during daylight, unless artificial light is provided. The mixture shall be delivered at a temperature between 250° and 325°F. and within 20°F of the temperature set at the mixing plant.
   c. **Spreading:** Upon arrival at the point of dumping, the mixture shall be dumped into the spreader and immediately spread true to line, grade and cross section specified and to the loose depth that will secure a minimum compacted thickness of 2 inches. The hot mixture shall be free from lumps and shall be spread while it is in a workable condition.

      After the mixture has been spread and before roller compaction is started, the surface shall be checked, all fat spots and irregular areas removed and replaced with satisfactory material. All irregularities in alignment and grade along the outside edge shall also be corrected by the addition or removal of mixture before the edge is rolled.
   d. **Compaction:** While the mixture is hot, it shall be compacted thoroughly and uniformly by rolling. The surface of the compacted mixture shall be smooth, and true to crown and grade. Any mixture that becomes loose or broken, mixed with dirt or is in any way defective, shall be removed and replaced with fresh hot mixture which shall be immediately compacted to conform to the surrounding area. Any area showing an excess of bituminous materials shall be removed and replaced, and the edges shall be kept to a reasonable straight line and trimmed.

e. **Protection of Pavement:** The newly finished pavement shall be protected from vehicular traffic of any kind until the pavement has cooled and hardened and in no case less than 6 hours.
f. **Tolerances:** The finished surface shall not vary more than 1/8 inch in 10 feet from the true profile and cross section.

4. **Tests:** The above work will be subject to thickness and compaction tests as deemed necessary by the Engineer. Such tests will be at the expense of the Contractor.

f. **Protection of Existing Improvements:** Streets, sidewalks, driveways, power/ cable/telephone lines, gas lines, water lines, sewers, storm drains and other existing improvements shall be maintained and protected from damage. Any aerial, surface or subsurface improvements damaged during the course of the work shall be repaired to the satisfaction of the Engineer. Satisfactory provisions shall be made for the maintenance of traffic on streets, driveways, and walkways.

Prior to any excavation, the Contractor shall notify all utilities and utility locating services to provide locations for buried utilities. The Contractor shall obtain all necessary permits (grading, building, water, sewer, encroachment, etc.) prior to beginning work.

g. **Restoration of Property:** The Contractor shall restore all property and facilities disturbed by this construction as specified elsewhere herein.
h. **Adjustment of Existing Facilities:** All manholes, valve boxes, catch basins, traps, fire hydrants, etc. shall be adjusted flush to the finished pavement surface or grade along the road shoulder. The Contractor will be required to raise, lower, and/or reconstruct such facilities at his expense. Adjustments may be made as specified elsewhere herein with brick/mortar, concrete, manhole riser sections, or other materials as required. Manhole adjustment rings shall be submitted for approval to the Engineer prior to use.
i. **Maintenance:** Unless otherwise specifically noted, the Contractor shall maintain the roadway throughout the warranty period.

D.9 CONCRETE CONSTRUCTION

a. **Scope:** Furnish all material, equipment, and labor required for concrete construction, including manholes, headwalls, footings, foundations, piers, drainage structures, curb and gutter, sidewalk, etc. as specified, as shown on the Plans and as directed by the Engineer.
b. **General:** Concrete strength and mix design shall be as specified for each type of facility, as shown on the Plans, and as directed by the Engineer. Concrete shall conform to SCDOT requirements for Class A concrete (3,000 psi 28-day compressive strength) or Class B concrete (2,500 psi 28-day compressive strength) as indicated. Mixing shall be accomplished at an approved central mix plant in accordance with ASTM C94. Unless specifically approved by the Engineer, job site mixing will not be allowed. Mix designs shall be submitted to the Engineer for approval prior to placement.
c. **Concrete Cylinders:** Concrete Cylinders for testing purposes shall be made in accordance with ASTM C 31. Testing shall be done by a laboratory approved by the Engineer. Each test shall consist of at least four (4) specimens; two (2) for field control and (2) two for laboratory control. One (1) initial test will be required and then on (1) test for each one hundred (100) yards thereafter. All testing will be performed at the discretion of the Engineer at the Contractors expense.

d. **Placing of Concrete:** Placing of concrete shall be in daylight hours and no concrete shall be placed when the atmospheric temperature is below 35 degrees. Concrete mixed at a central plant shall be transported to the job site as per ASTM C94. Concrete shall be compacted with mechanical, internal-vibrating equipment and/or with hand spading with a slicing rod. Earth fill shall not be placed on fresh concrete until it has been allowed to set 24 hours.
   1. **Form Work:** Form work shall be built to conform to the shape, lines and dimensions of the concrete work as shown. Forms shall be set to line and grade, and shall be braced, tied, and secured in a manner which will withstand placing of the concrete and which will maintain shape and position. Forms shall be tight and be substantially assembled to prevent bulging and the leaking of concrete. Joints may be arranged vertically or horizontally as required. Temporary openings shall be arranged, where required, at the bottoms of wall forms and elsewhere, to facilitate cleaning and inspecting. Used formwork shall have nails removed and surfaces in contact with concrete thoroughly cleaned before reuse. Wall sleeves, inserts, and openings required in concrete work shall be securely set to alignment and elevation. Chamfer strips shall be placed in forms for all exterior corners.
   2. **Removing Forms:** Under normal conditions the time elapsing before the forms may be stripped shall not be less than the following:
      Slabs - 14 days; Piers - 7 days; and Walls - 2 days
   3. **Finishing:** All exposed concrete surfaces shall be kept wetted with water, and shall be rubbed with a carborundum stone of medium fineness, or other equal abrasive, to bring the surface to a smooth texture and to remove all form and other marks. The paste formed by the rubbing may be rubbed down by floating with a canvass, carpet-faced, or cork float, or may be rubbed down with dry burlap.

e. **Reinforcing Steel:** Reinforcing steel, structural steel, miscellaneous iron, and steel and iron castings shall be as specified, as shown on the Plans, and as called for in the work to which they pertain.
   1. **Drawings:** The Contractor shall furnish to the Engineer for review six (6) copies of bending and placing details for steel bar reinforcing which show bar size, spacing, bending, and tagging identification.
   2. **Reinforcing Steel:** Bar reinforcement and wire mesh shall be furnished by domestic steel mills. Steel bar reinforcement shall conform to the requirements of ASTM A 615, (Grade 60), and shall be of an approved deformed type. Bars shall be cold bent to the dimensions indicated on the drawings. Bending shall be done in the shop unless otherwise specified and shall conform to the requirements of ACI Building Code (ACI - 318). Bars shall be furnished full lengths unless otherwise indicated on the drawings, or approved by the Engineer. Bars shall be placed in the locations shown on the drawings and held securely in place during the placing of concrete. Bars shall be spaced the proper distance from the face of the wall by the use of approved precast concrete mortar blocks and/or steel chairs with plastic coated legs or plastic tips or stainless steel chairs.

      Wire mesh reinforcement shall conform to the requirements of ASTM A 185, and unless otherwise indicated on the Drawings, shall be 4-inch by 4-inch mesh, of 6 gauge wire. Wire mesh shall be secured in position by space bars and chairs or pre-cast concrete mortar blocks.

3. **Miscellaneous Iron and Steel:** Miscellaneous iron and steel for straps, brackets and related items shall conform to ASTM A-36 with a minimum yield strength of 36,000 psi and shall be as shown on the Plans.

   Carbon steel bolts and nuts shall conform to ASTM A-307, unless otherwise shown on Drawings. Bolts and nuts in general shall be United States standard dimension. All anchor bolts exposed to the weather shall be of stainless steel Type 316, unless otherwise specified. Anchor bolts in general shall be placed in forms prior to pouring concrete. When concrete anchors must be used, they shall be Phillips "Red Head", Rawl "Saber Tooth" self drilling anchors, or equal.

   Welding under these Specifications may be done by the MIG, TIG, or "Electrode" method in accordance with AWS-ASTM E 6012, (Electrode Method only).

D.10 GRADING (LAND DISTURBANCE PERMITS)

a. No land disturbing activity shall be performed by the Contractor until a Grading Permit has been obtained from the City of North Augusta.
b. No land disturbing activity shall be performed by the Contractor until a stormwater management plan and sediment reduction plan has been submitted to the City of North Augusta Stormwater Management Department and the required Stormwater Permit has been obtained. See Article 15 and Appendix E.

D.11 STANDARD DETAILS