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ITEM I - EXCAVATION

1.01 Trenching and Excavation Regulations

- (a) The CONTRACTOR shall comply with OSHA trenching and excavation regulations as revised in "Subpart P" of Part 1926 in the Federal Register. Shoring and/or shielding shall be used as specified in "Subpart P" to prevent caving of trench banks and to provide a safe excavation.
- (b) **The CONTRACTOR will be responsible for excavation safety and shall designate his "competent person" (as defined in Subpart P) for the determination of proper shielding/shoring systems.**

1.02 Site Grading or General Excavation

- (a) Sites for pumping stations and access roads shall be graded by mechanical equipment within the areas and to the elevations shown on the plans. Grading operations shall be conducted so that material shall not be removed or loosened beyond the required limits. The finished surfaces shall be left in reasonably smooth and uniform planes such as are normally obtainable from the use of mechanical equipment; if the CONTRACTOR is not able to obtain the required degree of evenness by means of mechanical equipment, he will be required to use hand labor methods. Slopes and ditches shall be neatly trimmed and finished to conform to the slope lines shown on the plans or as staked by the ENGINEER.
- (b) Topsoil from the surface of the ground to be excavated or occupied by fills, within the general area specified to be planted with grass, shall be "stripped" or removed before site grading or other excavation work is started. Topsoil so removed shall be stockpiled at a suitable location on the site of the work so that it can be reused later for planting grass as specified in these specifications. This "stripping" operation shall remove all leaves, loam, and loose topsoil which are unsuitable for foundations. The depth to which topsoil is removed shall be determined by the ENGINEER, but will be generally between the limits of two and six inches.

1.03 Structural Excavation

- (a) Excavation for structures shall be sufficiently large for the proper placing of forms and concrete and for dewatering purposes, but shall not be excessively large in horizontal area. Banks may be sloped at a safe angle provided that such excavation does not endanger or damage existing or proposed structures, pipelines, etc. The bottom of the excavation shall be true to the required shape and elevations shown on the plans. No earth backfilling will be permitted under structures unless specifically shown on the plans. Should the CONTRACTOR excavate below the elevations shown or specified, he shall fill the void made with thoroughly compacted Class I pipe embedment materials or with Class B concrete

at his own expense.

- (b) When muck, quicksand, soft clay, organic matter, soils with excessive moisture content or other material unsuitable for foundations are encountered within the limits of the excavation or which extend beyond the limits of the excavation, such materials shall be removed as directed by the ENGINEER and replaced with thoroughly compacted crushed stone or with Class B concrete as required by the ENGINEER.
- (c) In all cases where materials are deposited along open excavation, they shall be placed so that in the event of rain, no damage will result to the work or adjacent property.

1.04 Trench Excavation

- (a) Trench excavation or excavation for pipelines shall consist of excavation necessary for the construction of sewers, conduits and other pipelines and all appurtenant facilities thereof, including manholes, inlets, outlets, pipe embedment materials, and pipe protection as called for on the Plans. It shall include site preparation, backfilling and tamping of pipe trenches and around structures and the disposal of waste materials, all of which shall conform to the applicable provisions of these specifications.
- (b) Trench excavation shall be made in open cut and true to the lines and grades shown on the Plans or established by the ENGINEER, unless tunneling or boring is shown or specified. When practical, the banks of the trenches shall be cut in vertical, parallel planes equidistant from the pipe center line. The horizontal distance between such planes, or the overall width of trench, shall not be less than 12 inches on either side of the nominal diameter of the pipe but in no case less than 3 feet, unless shown otherwise on the Plans. When vertical banks for trench excavation are not practical to construct or create dangerous conditions to workmen, the banks may be sloped, provided that such excavation does not endanger or damage adjacent structures or properties. When trench banks are sloped, the portion of the trench that is below the level of 12 inches above the top of the pipeline shall be cut to vertical planes as specified above. The sides of the remaining portion of the trench shall be graded to a slope which is sufficient to produce a stable embankment or stabilized with mechanical reinforcement. The bottom of the trench shall be level in cross section and shall be cut true to the required grade of the pipe except where concrete cradles or pipe embedment materials are shown on the Plans, specified or authorized by the ENGINEER, in which case the excavation shall extend to the bottom of the cradle or pipe embedment materials.
- (c) Bell holes for bell and spigot pipe shall be excavated at proper intervals so that the barrel of the pipe will rest for its entire length upon the bottom of the trench. Bell holes shall be large enough to permit proper installation of joints in the pipe.

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- (d) Excavation for manholes and other pipeline structures shall be as specified for structural excavation.
- (e) When muck, quicksand, soft clay, swampy or other material unsuitable for foundations or subgrade are encountered which extend beyond the limits of the excavation, such material shall be removed and replaced with pipe foundation material as specified elsewhere in these specifications.
- (f) All work shall be performed so as to cause the least possible inconvenience to the public. Temporary bridges or crosswalks shall be constructed where necessary to maintain vehicular or pedestrian traffic. Crosswalks and bridges shall have handrails or other features necessary for safe use by the public, and shall be constructed to comply with all applicable codes.
- (g) In all cases where materials are deposited along open trenches, they shall be placed so that no damage will result to the work or adjacent property.

1.05 Dewatering Excavated Areas

- (a) The CONTRACTOR shall provide and maintain ample equipment with which to remove all water from every source which enters excavations for structures and pipelines. Dewatering operations shall ensure essentially dry excavations and the preservation of the elevations, lines, and grades shown on the Plans. Water pumped from excavations which does not meet NCDENR – DWQ turbidity requirements shall not be discharged directly into a natural stream or drainageway but shall be treated in such a manner as to bring the discharge flows into compliance with NCDENR – DWQ requirements.
- (b) Surface drainage shall not be allowed to enter excavated areas.
- (c) Where the areas to be excavated are located under water surfaces or near the banks of flowing streams or other bodies of water, the CONTRACTOR may adopt and carry out any method of dewatering he may deem feasible for the performance of the excavation work and for protection of the work thereafter; provided that the method and equipment to be used is in compliance with NCDENR regulations, and results in completed work which complies with the specifications and is acceptable to the ENGINEER. In such cases, the excavation area shall be effectively protected from water damage during the excavation period and until all contemplated construction work therein has been completed.
- (d) Prior to beginning excavation for structures which are to be constructed at or below the groundwater table, groundwater levels shall be lowered and maintained at workable levels. For structures other than manholes this level must be at least three (3) feet below the bottom of such structures until construction and backfilling operations have been completed.

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- (e) The CONTRACTOR shall be responsible for damage to structures caused by hydrostatic displacement during construction operations.

1.06 Borrow Excavation

- (a) Wherever the backfill or embankment requires a volume of material that is in excess of the volume of suitable material available from the authorized excavations, such excess volume shall be obtained from other sources. Where borrow pits on the construction site are specifically designated on the Plans, borrow excavation shall be obtained therefrom; otherwise, the CONTRACTOR shall provide suitable borrow material from areas accessible to the work. Before a borrow pit is opened, the quality and suitability of the material to be obtained therefrom shall be approved by the ENGINEER.
- (b) Borrow pits shall be properly cleared and grubbed and all objectionable matter shall be removed from the borrow pit material prior to its placement in the backfills.
- (c) Borrow shall be excavated so that the remaining surfaces and slopes will be reasonably smooth and even and will provide adequate drainage over the entire area. Drainage ditches shall be constructed where necessary to provide outlets of water to the nearest natural channel so that the formation of pools in the borrow pit area will be avoided. Sides of borrow pit cuts shall be left at two to one slope unless otherwise authorized by the ENGINEER.
- (d) The CONTRACTOR shall furnish to the ENGINEER written approval for the use of the borrow pit site and shall meet all NCDENR and all other applicable Federal, State, and Local laws and requirements. Upon completion of work, the borrow pit shall be restored to a condition acceptable to the landowner.

1.07 Rock Excavation

- (a) The removal of sound, solid rock of whatever nature which occurs in its original position in ledges, bedded deposits or stratified and unstratified masses within the excavation limits shown on the plans, and which is of such hardness or texture that it cannot be loosened, or broken down and removed without resort to drilling and blasting methods or percussive hammering, shall be classified as rock excavation.
- (b) The removal of hardpan, chert, clay, soft or disintegrated shale, boulders, and other rock materials not included in Paragraph (a) above, shall not be classified as rock excavation although the CONTRACTOR may elect to excavate same by drilling and blasting methods. The excavation and removal of all such materials shall be classified as common excavation.
- (c) The removal of existing pavements, sidewalks, driveways, manholes and similar structures called for on the Plans shall be performed under these specifications

and shall not be classified as rock excavation.

1.08 Rock in Pipe Trenches

- (a) Rock encountered in trench excavation for sewers and other pipelines shall be removed for the overall width of trench which shall be as shown on the Plans. It shall be removed to a minimum depth of 6 inches below the bottom of the pipe. Where pipelines are constructed on concrete cradles, rock shall be excavated to the bottom of the cradle as shown on the plans.
- (b) After the ENGINEER has examined the completed excavation, and has taken the necessary measurements for volume determination, the space below the ultimate pipe grade shall be filled with pipe embedment materials as required, compacted to proper grade and made ready for pipe laying.

1.09 Drilling and Blasting

- (a) Prior to commencing any blasting operations, the CONTRACTOR shall notify the ENGINEER and the official from the list below (if applicable) and obtain blasting permits as required. The CONTRACTOR must furnish certification of insurance specifically covering any and all obligations assumed pursuant to the use of explosives.

BLASTING PERMITS:

City of Asheville	FIRE MARSHAL (259-5636)
Biltmore Forest	PUBLIC WORKS DIRECTOR (274-3919)
Black Mtn. & Montreat	FIRE DEPT. (669-8074)
Town of Weaverville	FIRE MARSHAL (645-3500)
Buncombe County	FIRE MARSHAL (250-6620)
Town of Woodfin	TOWN MANAGER (253-4887)

- (b) Drilling and blasting methods used in rock excavation shall be optional with the CONTRACTOR but shall be conducted with due regard to the safety of persons and property in the vicinity of the work and in strict conformity with all laws, ordinances or regulations governing blasting and the use of explosives. Rock excavation near existing structures of all types shall be conducted with the utmost care, and every precaution shall be taken to prevent damage to such structures. Any damage or injury of whatever nature to persons or property caused directly or indirectly by blasting operations shall be promptly repaired, replaced or compensated for by the CONTRACTOR at his own expense and to the entire satisfaction of the persons injured or the owners of the property damaged.
- (c) The CONTRACTOR shall not be allowed to blast within any rights-of-way maintained by any public agency without specific approval of the controlling agency and only in accordance with their respective requirements.

1.10 Pre-Blast Survey and Vibration Monitoring

- (a) Prior to conducting any blasting operations, the CONTRACTOR shall conduct a preblast survey of all structures within 300 feet of the proposed sewer line, along the entire route of the proposed sewer. Surveys shall be performed by a third party entity other than the blasting agent, and qualified to perform such surveys.
- (b) The pre-blast survey shall consist of digital color photographs of all observable exterior and interior surfaces. The photographs shall be compiled on a CD or DVD and indexed, describing the location of each photograph to facilitate easy comparison of a given structures condition. Existing defects in structures shall be photographed and appropriately documented. The CONTRACTOR shall furnish a copy of the survey results, including photographs, to the ENGINEER, prior to beginning blasting operations.
- (c) All blasting operations conducted within 300 feet of existing structures shall be monitored. In areas where several structures are located adjacent to blasting, a sufficient number of seismic units equipped to provide a printed readout shall be deployed to allow for comprehensive documentation of blasting operations. The resultant seismic data shall be provided to the blasters to allow for blast design changes based on the location of the next blast and the resultant vibration levels for the previous shot. A copy of all resultant seismic data shall be provided to the ENGINEER, immediately after the shot.
- (d) The pre-blast survey, vibration and over pressure monitoring shall be conducted by a professional seismic consultant, who is licensed and certified for this work.
- (e) No separate payment will be made for the pre-blast survey, vibration and over pressure monitoring, the post-blast survey, nor any other work related to the blasting or excavation of rock. This work shall be considered incidental to, and included in, the unit bid prices for sewer pipe, as listed in the bid schedule.

1.11 Backfilling Trenches

- (a) The backfilling of pipeline trenches shall be started immediately after the pipe work has been installed. The initial backfill material (above pipe embedment materials), shall be placed to a height of 2 feet above the top of the pipe.
- (b) Where the trench extends along or across streets, roadways, usable alleys, or sidewalks, the trench shall be completely backfilled (above pipe embedment materials) with material which is non-plastic nature and shall be sufficiently close to optimum moisture content to achieve specified compaction requirements. Backfill material shall exhibit no tendency to flow or behave in a plastic manner under blows of a mechanical tamp. Such materials shall be free of rock, roots, debris, or vegetable matter. Material which does not meet these requirements shall be removed from the site and replaced with suitable backfill materials. These suitable materials further known as "Select Backfill" may be earthen

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material meeting the above requirements, aggregate base course, or screenings. Unless otherwise specified in the Special Conditions or shown on the Plans, such trenches shall be backfilled in 6 inch layers (before compaction) and thoroughly compacted with power tools to a minimum 95% Standard Proctor.

- (c) Where excavation has been made within the limits of easements across private property, the top 1 foot of backfill material shall consist of fine loose earth free from large clods, vegetative matter, debris, stones, and/or other objectionable materials. Backfill material shall be carefully placed and compacted not less than 85% Standard Proctor.
- (d) Any deficiency in the quantity of materials for backfilling the trenches, or for filling depressions caused by settlement, shall be supplied by the CONTRACTOR.
- (e) The ENGINEER may provide the services of a field technician or a recognized commercial testing laboratory during the compaction of the trench backfill to make density determinations. The field technician shall report the test results to the CONTRACTOR and ENGINEER on the project site as soon as these results are known. The results of all density tests shall be reported in writing and shall include the date of test, test location, depth below finished grade, wet density, moisture content, dry density, percent compaction of test sample, and maximum dry density used for comparison. Should any test fail, the cost of any subsequent test will be at the expense of the CONTRACTOR.
- (f) Where pipe trenches are cut across or along pavement, the CONTRACTOR shall construct a temporary surface over the cut which will not disintegrate under traffic and which shall be maintained in good condition under traffic until the permanent pavement has been restored.
- (g) Backfilling around structures shall be done in the manner specified above for pipe trenches by power tamping for the full depth of cut from the bottom of the finished grade.
- (h) All backfilling shall be done in such a manner as will not disturb or injure the pipe or structure over or against which it is being placed. Any pipe or structure injured, damaged or moved from its proper line or grade during backfilling operations shall be opened up and repaired and then re-backfilled as herein specified.
- (i) The CONTRACTOR shall replace all surface materials and shall restore paving, curbing, sidewalks, gutters, shrubbery, fences, sod, and other surfaces disturbed, to a condition equal to that before the work began, furnishing all labor and materials incidental thereto as provided elsewhere in these Specifications.

1.12 Disposal of Unusable Materials

- (a) All materials removed by excavation which are suitable for backfill shall be used whenever practicable for fills, embankments, backfilling pipe trenches, and for such other purposes as may be shown on the Plans or authorized by the ENGINEER. All materials not suitable for backfill shall be considered as waste materials and disposed of by the CONTRACTOR.
- (b) All trees, limbs, brush, stumps, large roots, rubbish, demolition or construction debris shall be removed from the construction site. Neither the construction site nor the adjacent property shall be used for the disposal of such materials, unless specifically approved by the ENGINEER. The CONTRACTOR shall dispose of these materials off the site at a location chosen and obtained by the CONTRACTOR. Written acknowledgment by the property owner shall be obtained by the CONTRACTOR and a copy submitted to the ENGINEER.
- (c) The CONTRACTOR shall be solely responsible for securing approvals and permits for any site utilized for the disposal of said materials and excess or unusable soils. The CONTRACTOR shall strictly follow local, State and Federal regulations regarding disposal of all materials. The CONTRACTOR is also solely responsible for any violations and subsequent fines for not adhering to regulatory agencies regarding such fill or disposal activity.
- (d) Where appropriate, excess soil may be spread in uniform layers and neatly leveled and shaped. Where "on site" disposal is not practical, the CONTRACTOR shall be responsible for "off site" disposal.
- (e) Clean up and restoration shall be an ongoing process. All surplus or unused materials shall be removed and the surface of the work area left in a neat and orderly condition.

1.13 Maintenance

- (a) All excavated areas, backfills, embankments, trenches, access roads, grading, and ditches shall be maintained by the CONTRACTOR in good condition at all times until final acceptance by the DISTRICT. Where trench backfill has settled, trenches shall be re-excavated and compacted.

1.14 Pipe Embedment Materials

- (a) Pipe embedment materials shall be Class I material. Where pipes are installed below groundwater levels or where the trench is subject to inundation, Class I material shall be placed to the top of the pipe. Class I materials shall be graded crushed limestone, or granite. Materials under ¼ inch shall be limited to no more than 3% by weight. No. 67 stone shall be used for PVC pipe installation. No. 57 or No. 67 may be used for Ductile Iron pipe installation.

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- (b) Pipe embedment materials shall be placed to support the full length of the barrel of the pipe at exact line and grade.
- (c) Pipe embedment materials shall be placed in the pipe trench to the trench width and depth shown on the Plans. Where rock has been removed from the pipe trench, it shall be placed to a minimum depth of 6 inches below the bottom of the pipe.
- (d) All materials shall be mechanically tamped and compacted to the percent required herein, or as shown on the Plans.

1.15 Backfill Material

- (a) Backfill material shall be of a relatively non-plastic nature and shall be sufficiently close to optimum moisture content to achieve specified compaction requirements. Material which does not meet these requirements shall be removed from the site and replaced with suitable backfill materials, as defined in Section 1.11(b).
- (b) Initial backfill material from the pipe crown to 2 feet above the crown, and/or select material shall consist of fine loose earth, free of large clods, stones, vegetable matter, debris, and/or other objectionable material.
- (c) The remainder of the backfill shall be the same type material as the initial backfill except that a broken stone content of not more than 50% by volume will be allowed provided that the stones are thoroughly mixed with earth. Maximum individual stone size shall be 0.75 cubic feet.

1.16 Pipe Foundation Material

- (a) Pipe foundation material shall be quarry run crushed limestone or granite ranging in size from fines to a maximum size of 3 inches. The material shall be power tamped in 6-inch layers.
- (b) Pipe foundation material shall be used in local areas where unsuitable materials such as muck, quicksand, soft clay, vegetative matter, or swampy material make it necessary to provide a satisfactory pipe foundation.
- (c) Pipe foundation material used as described above will be measured for payment only in specific locations where its use is authorized by the ENGINEER before this work is performed.

1.17 Rip-Rap

- (a) Dumped rip-rap shall be Type I or Type II as shown on the Plans. All rip-rap shall be shot rock, field stone, or rough unhewn quarry stone. The stone shall be sound, tough, dense, resistant to the action of air and water, and suitable in all

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other respects for the purpose intended. Where shot rock from blasting is available, it shall be clean and may be used instead of stone, provided that it meets with the approval of the ENGINEER. Rip-rap shall be graded to meet requirements as specified. Shot rock from the job site shall be general graded to prevent concentrated areas of rip-rap that are too large or too small.

- (b) Type I Rip Rap stone shall vary in weight from 5 to 200 pounds. At least 30% of the total weight of the rip rap shall be in individual pieces weighing a minimum of 60 pounds each. Not more than 10% of the total weight of the rip rap may be in individual pieces weighing less than 15 pounds each.
- (c) Type II Rip Rap stone shall vary in weight from 25 to 250 pounds. At least 60% of the total weight of the rip rap shall be in individual pieces weighing a minimum of 100 pounds each. Not more than 5% of the total weight of the rip rap may be in individual pieces weighing less than 50 pounds each.

1.18 Aggregate Base Course

- (a) Aggregate base course shall be either Type A or Type B ABC aggregate base course which meets all requirements of Section 1010 of the NCDOT Standard Specifications for Road and Structures, current edition.

1.19 Crushed Stone (Class I Embedment)

- (a) Crushed stone shall be either No. 57, No. 67 or No. 78 stone, as called for in the Specifications or on the Plans, which meets the requirements of the NCDOT Standard Specifications for Roads and Structures, current edition.

ITEM II - SANITARY SEWER PIPE, FITTINGS, & ACCESSORIES

2.01 General

- (a) All sanitary sewers 15 inches in size and smaller shall be constructed of either vitrified clay, ductile iron or PVC sewer pipe as shown on the Plans. All sanitary sewers 18 inches, 21 inches, and 24 inches in size shall be constructed of either vitrified clay, ductile iron or concrete sewer pipe, or unless otherwise shown on the Plans. All sanitary sewers larger than 24 inches in size shall be constructed of precast concrete sewer pipe, ductile iron pipe or centrifugally cast fiberglass pipe, unless otherwise shown on the Plans.
- (b) All vitrified clay, concrete, PVC, and ductile iron sewer pipe and fittings shall be suitably marked at their places of manufacture to show their class, strength, or thickness, as applicable.
- (c) All materials used in the manufacture of sewer pipe and fittings used on the DISTRICT's systems and projects shall be certified by the manufacturer to meet or exceed ASTM, AWWA, NSF and other nationwide accepted standards for the appropriate type of pipe or fittings. Each joint of pipe delivered to the job site shall be stamped or otherwise marked to indicate the testing laboratory's acceptance or approval. In addition, if required by the ENGINEER, all pipe and materials shall be inspected, tested and certified by an accredited commercial testing laboratory, approved by the ENGINEER, prior to or after delivery of such pipe and/or materials to the job site and shall be certified to meet or exceed the requirements set forth in these specifications. Certified copies of all testing and acceptance reports shall be delivered, in duplicate, to the ENGINEER prior to the use of such materials on the project. The cost of any inspecting and/or testing shall be borne by the CONTRACTOR or pipe manufacturer. Laboratory testing of other materials may be required if deemed necessary by the ENGINEER.
- (d) All materials and products used on projects funded by the DISTRICT and/or projects constructed with non-DISTRICT funds which are to be accepted for maintenance and operation by the DISTRICT shall be **"Made in the U.S.A"** unless otherwise approved by the ENGINEER. This requirement shall include all raw materials, processing, manufacture, and fabrication. To ensure conformance to this requirement, the country of origin shall be legibly and permanently affixed by die stamping, molding or etching in a visible location on the final product. The country of origin marking shall appear on the top surface of all manhole covers, frames, or rings. If the name of any city or locality in the U.S. appears on the product, the name of the country of origin shall be preceded by "Made in" or "Product of" or words to that effect. This phrase must be of comparable size as the name of the city or locality and placed as close as reasonably possible thereto. In addition, on any project funded in part or whole by Federal or State funds, all materials and products used on that project shall comply with the provisions of the

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Federal Intermodal Surface Transportation Act of 1991 and regardless of any DISTRICT approvals of shop drawings and/or materials specifications, the CONTRACTOR shall be fully and completely responsible for conformance to the provisions of this Act.

2.02 Vitrified Clay Pipe

- (a) Vitrified clay sewer pipe and fittings shall be "extra strength" and shall conform to the requirements of ASTM Specification C 700-07. The pipe bedding and loading shall comply with MSD standard details. Bedding shall be as shown on the trench details, Plans or in Special Conditions. Pipe and fittings 18 inches in diameter and smaller shall have plain ends and shall be joined by plastic sleeve couplings or shall have bell and spigot ends joined with rubber ring gaskets. Pipe and fittings 21 inches in diameter and larger shall have bell and spigot ends joined with rubber ring gaskets or factory applied resilient joint material. All jointing material shall comply with the requirements of ASTM Specification C 425. Couplings for clay pipe to clay, PVC, and ductile iron pipe shall be as manufactured by Maxadapt or equal.

2.03 Concrete Pipe

- (a) Concrete sewer pipe shall be centrifugally cast, horizontally cast on a vibrating table, or vertically cast and vibrated. The pipe class, bedding, and loading shall comply with MSD standard details. The pipe shall be as shown on the Plans, or as required by the trench details. Bedding shall be as shown on the trench details. Wall thicknesses shall be "Wall B" in diameters 33 inches in diameter and smaller and "Wall C" in diameters 36 inches and larger. Concrete sewer pipe shall be tested under and shall comply with the requirements of ASTM Specification C 76, except as modified herein. All concrete sewer pipe shall have bell and spigot joints suitable for installation with rubber O-ring gaskets and with a rectangular groove in the spigot end to receive the rubber gasket and contain the deformed gasket on all four sides when the joint is completed. Concrete pipe shall be cast in lengths of not less than 8 feet long for 18-inch and 21-inch diameters and not less than 12 feet long for 24-inch and larger pipe diameters. Bell and spigots shall be formed to true dimensions, with a nominal clearance of not more than 1/16 inch. Concrete used in the manufacture of pipe shall have a 28-day compressive strength of not less than 6,000 pounds per square inch, and the absorption shall not exceed 6 percent. Steel reinforcement shall be circular. Materials used in the manufacture of concrete sewer pipe shall comply with the following ASTM Specifications: Portland Cement C 150, Type II or C 175, Type IIA, or C 205 for Blast Furnace Slag Cement; Aggregates, C 33 except that the fine aggregate shall be natural silica sand. Manufactured sand shall not be used.
- (b) Coarse aggregates shall be crushed limestone. Joints and gaskets shall comply with AWWA Specification C 302. Each joint of pipe shall have stamped thereon the class of reinforcement and the wall thickness designation. Couplings for concrete pipe to concrete pipe or ductile iron pipe shall be submitted to the

ENGINEER for approval, prior to use.

2.04 PVC Pipe

- (a) Poly-Vinyl Chloride (PVC) sewer pipe and fittings shall conform to the requirements of ASTM Specification D 3034. Wall thickness shall be SDR 35. Joints shall be integral bell and spigot type with compression type rubber gaskets. Joints shall conform to ASTM Specification D 3212. Couplings for PVC pipe to PVC pipe shall be PVC "Closure" or "Stop" couplings and shall meet ASTM D 3034. Transition Couplings for PVC pipe to ductile iron pipe shall be mechanical joint ductile iron fittings utilizing transition gaskets. No more than one material transition will be allowed in any one reach of pipe.

2.05 Ductile Iron Pipe

- (a) Ductile iron pipe shall conform to the requirements of ANSI Specification A21.51. The pipe class, bedding, and loading shall comply with MSD standard details. When loading conditions are beyond those shown, the ENGINEER will submit design computations to the DISTRICT. The pipe class shall be as shown on the Plans. Bedding shall be as shown on the trench details. Joints shall be "push-on" which conform to the requirements of ANSI Specification A21.11. Ductile iron fittings shall conform to the requirements of ANSI Specification A21.10, Class 350 in sizes 24 inches and smaller and Class 250 in sizes larger than 24 inches, unless otherwise shown on the Plans. All ductile iron pipe shall have a cement mortar lining of standard thickness conforming to the requirements of ANSI Specification A21.4.
- (b) All fittings for ductile iron pipe, including but not limited to wyes, tees, saddles, bends, crosses, sleeves, plugs, caps, reducers, and glands, shall be gasketed push-joint pipe or mechanical joint. Fittings shall conform to the requirements of ANSI/AWWA C110/A21.10 (Standard fittings, 3 inches thru 48 inches) or ANSI/AWWA C153/A21.53 (Compact fittings, 3 inches thru 48 inches) with the joints meeting the requirements of ANSI/AWWA C111/A21.11 (Rubber-gasket joints) and shall be pressure rated at the same rating as the mainline sewer pipe but in no case less than 250 psi. Gasketed push-joint type fittings shall meet or exceed the requirements as set forth in ANSI/AWWA C 111/A 21.11 and may be used only in non-pressurized in-line locations and below ground installations. Mechanical joint fittings shall meet or exceed the requirements as set forth in ANSI/AWWA C111/A21.11. All fittings shall be manufactured from ductile iron grade 70-50-05 (min. tensile strength – 70,000 psi; min. yield strength – 50,000 psi, min. elongation – 5%) as specified in AWWA C110 or C153 and ASTM A536. All ductile iron pipe fittings and materials shall conform to paragraph 2.01 (d) of this section of the Technical Specifications. All ductile iron pipe fittings shall have a cement mortar lining of standard thickness conforming to the requirements of ANSI Specification A21.4. Note: Couplings for ductile iron pipe to ductile iron pipe shall be ductile iron mechanical joint sleeves, only.

- (c) All sanitary sewer cleanout boxes and covers shall be manufactured from gray iron meeting the requirements of ASTM A48 or ductile iron grade meeting the requirements of AWWA C110 and ASTM A536. All sanitary sewer cleanout boxes and covers shall conform to paragraph 2.01 (d) of this section of the Technical Specifications. All sanitary sewer cleanout boxes shall conform to the dimensions and requirements as set forth in MSD's Standard Detail for Cleanout Boxes (MSD-12) and shall be U.S. Foundry Handhole Ring and FC Cover model #7610 or East Jordan Iron Works Heavy Duty Monument Box model #1574 or approved equal. Note: U.S. Foundry Handhole Ring and FC Cover model #7630 may be used where cleanout box is within an asphalt or concrete paved area.

2.06 Centrifugally Cast Fiberglass Pipe

- (a) Centrifugally Cast Fiberglass Reinforced Plastic (FRP) pipe shall meet the requirements of ASTM D3262 - Standard Specification for Reinforced Plastic Mortar Sewer Pipe, ASTM D3681 - Method for Determining Chemical Resistance of Reinforced Thermosetting Resin Pipe in Deflected Condition, and ASTM D4161 - Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin Pipe Joints) using flexible elastomeric seals.
- (b) Submittals shall provide sufficient data for the ENGINEER to properly evaluate the pipe. Product data shall include the following, as a minimum:
 - 1. Details for the proposed pipe.
 - 2. Properties and strengths of the pipe.
 - 3. Details of joint.
 - 4. Pipe design analysis (including trench details).
 - 5. Instructions for storage, handling, transporting and installation.
 - 6. Standard catalog sheets.

Test reports shall be provided, certifying that the pipe has been tested in accordance with, and meets or exceeds minimum requirements of ASTM 3262 and ASTM D3681.

2.07 Wyes, Saddles, and Services

- (a) Wyes and Saddles shall be of the same material and strength as the sewer mains on which they are installed, unless otherwise specified. Saddle type fittings shall not be used on new construction or existing mains for pipes 12 inches in diameter or smaller, unless specifically called for in the Plans and/or Specifications or approved in writing by the ENGINEER. For ductile iron mains greater than 12 inches in diameter, "CB" Romac tapping saddles as manufactured by Romac Industries Inc. or an approved equal may be used. Unless otherwise specified in the Plans and/or Specifications, house services shall be constructed of 4-inch diameter Schedule 40 PVC pipe or Class 350 psi ductile iron pipe.

- (b) For taps and services on an existing MSD maintained PVC or VCP sewer main (6 inches in diameter) that are being repaired by trenchless construction methods, flexible saddles as manufactured by NDS/HPI or an approved equal may be utilized. Flexible Saddles shall be affixed to the Main by bands or straps as provided by the manufacturers and by using a two-part epoxy glue uniformly spread over the contact surface of the saddle.
- (c) A compression coupling by Inserta-Tee or approved equal shall be used to re-connect services to existing 8-inch and larger diameter sewer mains that are being rehabilitated by trenchless construction methods.
- (d) Wyes shall be placed in sanitary sewers so as to properly serve each existing house and each vacant lot facing or butting on the street or alley in which the sewer is being laid, and at such other locations as may be designated by the ENGINEER.
- (e) The CONTRACTOR shall measure the distance to the tap or tee from the downstream manhole and the offset distance to each cleanout assembly to obtain the information required for the "As-Built" records. As-built data shall be marked on the Plans and turned over to the ENGINEER at the end of the project.
- (f) The location of all wyes, cleanouts, and house sewers installed in the work shall be identified on the Plans and in the field.

2.08 Pipe Laying

- (a) Before sewer pipe is placed in position in the trench the bottom and sides of the trench shall be carefully prepared and the necessary bracing and sheeting installed. Each pipe shall be accurately placed to the exact line and grade called for on the Plans.
- (b) Each piece of pipe and special fitting shall be carefully inspected before it is placed and no defective pipe shall be laid in the trench. Pipe laying shall proceed upgrade, starting at the lower end of the grade and with the bells upgrade. Pipe shall be straight when placed in the trench. Curved pipe shall not be laid. Trench bottoms found to be at incorrect grade after pipe laying operations has begun shall be corrected and brought to exact line and grade. Any fill required to bring the trench bottom to grade, shall be pipe foundation material or pipe embedment material as specified herein, as applicable.
- (c) Bell holes shall be of sufficient size to allow ample room for properly making the pipe joints. The bottom of the trench between bell holes shall be carefully graded so that the pipe barrel will rest on a solid foundation for its entire length.
- (d) Each joint shall be laid so that it will form a close concentric joint with adjoining pipe and so as to avoid sudden offsets or inequalities in the flow lines. The inside

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of all bells and the outside of all spigots shall be wiped to remove all dirt, water, or other foreign matter. Joint lubricants shall be compatible with the pipe and gasket materials and shall be as recommended by the pipe manufacturer.

- (e) All jointing of pipe and fittings shall be in accordance with the pipe manufacturer's recommendations.
- (f) Any leaks or defects discovered at any time shall be repaired immediately. All pipe in place shall be carefully protected from damage until the backfilling operations have been completed. Any pipe which has been disturbed shall be taken up, the joint cleaned and remade, and the pipe re-laid at CONTRACTOR's expense.
- (g) Water shall not be allowed to run or stand in the trench while pipe laying is in progress or before the joints are completed or before the trench has been backfilled. The CONTRACTOR shall not open up at any time more trench than his available pumping facilities are able to dewater.
- (h) As the work progresses, the interior of all pipe in place shall be thoroughly cleaned. After each line of pipe has been laid it shall be carefully inspected and all dirt, trash, rags, and other foreign matter removed from the interior. When pipe laying is not in progress, the CONTRACTOR shall place a watertight plug in the last section of pipe which has been laid. The CONTRACTOR shall install temporary watertight plugs in the proposed sewer line at any manhole that is incomplete, at the open end of the pipeline prior to leaving the job site daily and elsewhere as dictated by good engineering and construction practices. All installed pipe shall be backfilled to prevent flotation in the event water enters or rises in the trench. The plugs as installed shall prevent infiltration or the introduction of any foreign material into either the existing or proposed systems. Upon completion of all construction, the CONTRACTOR will be responsible for the complete removal of all watertight plugs.
- (i) Backfilling of trenches shall be started immediately after the pipe is in place and the joints completed.

2.09 Deflection Tests

- (a) After backfilling trenches, all sewer pipes shall be lamped and visually inspected for pipe alignment. Each run of pipe must present a full circle of light when viewed from one of the connected manholes. Any run of pipe which does not present a full circle of light will be removed and reinstalled.
- (b) After backfilling trenches, all PVC sewer pipe shall be tested for initial diametric deflections by the use of a Go-No-Go type mandrel which is acceptable to the ENGINEER. The initial diametric deflection shall not exceed five percent of the base inside diameter as defined in ASTM D-3034. Deflection tests will be

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performed after trench is no longer subject to construction traffic loading and a minimum of 30 days after completion of trench backfill.

<u>Nominal Pipe</u>	<u>Pipe I.D.</u>	<u>Required Mandrel</u>
<u>Size</u>	<u>(SDR 35)</u>	<u>O.D.</u>
8"	7.665"	7.28"
10"	9.563"	9.08"
12"	11.361"	10.79"
15"	13.898"	13.20"

- (c) The mandrel shall be pulled through each section of pipe from manhole to manhole. The mandrel must slide freely through the pipe with only a nominal hand force applied. No mechanical device shall be used in pulling the mandrel. Any pipe which refuses the mandrel shall be removed and replaced. Such sections shall be re-tested for deflection 30 days after completion of trench backfill.
- (d) Mandrel testing may be performed by the DISTRICT at any time prior to the expiration of the one-year warranty. Any pipe which refuses the mandrel shall be replaced by the CONTRACTOR as described above.

2.10 Leakage and Infiltration

- (a) All pipe and manhole joints shall be watertight. Any leaks into the sewer shall be repaired or corrected as directed by the ENGINEER. The DISTRICT reserves the right to TV any section of the sewer system to locate point sources of infiltration, either in the pipe or inside manholes. When directed by the ENGINEER, any desired section shall be isolated and tested separately.
- (b) No sooner than 10 days following completion of backfill, the CONTRACTOR along with the ENGINEER, will be required to determine the level of the ground water table. If the ground water table is above the top of the pipe, the sewer line shall be tested for infiltration. If ground water table is less than 2 feet above the top of the pipe, the sewer line shall be low pressure air tested. Each test shall be performed as follows:

(1) Infiltration

The infiltration into each section of the sewer shall be measured in wet weather by the temporary installation of suitable metal or wooden weirs as authorized by the ENGINEER. These weirs shall be furnished, installed and removed by the CONTRACTOR. Infiltration test limits shall be applied to single reaches of pipe, up to one mile in length, of the same diameter. For pipes 8 inches through 15 inches in diameter, infiltration into the sewer system (including manholes) shall not exceed 50 gallons per mile of sewer per inch of inside diameter of the sewer per 24 hours, and in no case shall it

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exceed 3,000 gallons per mile per 24 hours. For all pipe sizes larger than 15 inches in diameter, infiltration into the sewer system (including manholes) shall not exceed 100 gallons per mile of sewer per inch of inside diameter of the sewer per 24 hours, and in no case shall it exceed 3,000 gallons per mile per 24 hours.

(2) **Air Testing of Gravity Sewers**

The CONTRACTOR shall conduct low pressure air tests on all completed sections of gravity sewer. Air tests for PVC, DIP, and VCP lines will be performed in accordance with ASTM C828. Air tests for concrete pipe 30 inches in diameter and smaller shall be performed in accordance with ASTM C924. Air test results will be used to evaluate materials and construction methods on the sewer line sections, and successful air tests shall be mandatory for the acceptance of the sewers 30 inches in diameter and smaller.

- (a) Air tests will not be required on pipe with diameters exceeding 30 inches. Acceptance of pipes exceeding 30 inches will be based on infiltration tests and/or visual inspection of the joints.
- (b) The CONTRACTOR shall furnish an air compressor of the necessary capacity along with all necessary plugs, valves, pressure gages, air hoses, connections, and other equipment necessary to conduct the air tests. Plugs in sewers 18 inches in size and larger shall be connected by steel cable for thrust reaction.
- (c) Compressor capacity shall be sufficient to pressurize the sewer main to 4 psig within a time equal to or less than the required test time. The following equation may be used to ensure compliance with this requirement:

$$C = \frac{0.17 \times D^2 \times L}{T} + Q$$

Where: C = Required Compressor Capacity (cfm)

T = Required Test Time (min)

L = Length of Test Section (feet)

D = Pipe Internal Diameter (feet)

Q = Allowable Air Loss Rate (cfm)

- (d) The following allowable air loss rates will be used for all pipe tests:

<u>Pipe Size</u>	<u>Q (cfm)</u>	<u>Pipe Size</u>	<u>Q (cfm)</u>
4"	2.0	15"	4.0
6"	2.0	18"	5.0
8"	2.0	21"	5.5
10"	2.5	24"	6.0
12"	3.0		

- (e) The sewer section shall be plugged at both ends and air pressure shall be applied until the pressure inside the pipe reaches 4 psig. When a stable condition has been reached, the pressure shall be bled back to 3.5 psig. At 3.5 psig, the time and pressure shall be observed and recorded. If groundwater is present at the sewer, the height of groundwater above the top of the pipe shall be added to the above air pressure readings (height of water in feet X 0.433 = air pressure in psig). A minimum of 5 readings will be required for each test.
- (f) If the time for the air pressure to decrease from 3.5 psig to 2.5 psig is equal to or greater than that shown in the following table, the pipe shall be presumed to be free from defects. When these times are not attained, pipe breakage, joint leakage, or leaking plugs are indicated and the cause must be determined and corrected. After repairs have been made, the sewer sections shall be retested. This process shall be repeated until all sewer sections pass the air test.

(SEE NEXT PAGE FOR PIPE TEST TIMES)

<u>Minimum Test Times for Pipe</u>										
Pipe-Size →		4"	6"	8"	10"	12"	15"	18"	21"	24"
↑	25	0:04	0:10	0:17	0:22	0:26	0:31	0:36	0:44	0:53
	50	0:09	0:20	0:35	0:44	0:53	1:02	1:12	1:29	1:47
	75	0:13	0:30	0:53	1:06	1:20	1:34	1:48	2:14	2:40
	100	0:17	0:40	1:11	1:29	1:47	2:05	2:24	2:58	3:33
L E N G T H	125	0:22	0:50	1:29	1:51	2:13	2:36	3:00	3:43	4:27
	150	0:26	1:00	1:47	2:13	2:40	3:07	3:36	4:27	5:20
	175	0:31	1:10	2:04	2:35	3:07	3:39	4:12	5:12	6:14
	200	0:35	1:20	2:22	2:58	3:33	4:10	4:48	5:57	7:07
O F	225	0:40	1:30	2:40	3:20	4:00	4:41	5:24	6:41	8:00
	250	0:44	1:40	2:58	3:42	4:27	5:13	6:00	7:26	8:54
	275	0:49	1:50	3:16	4:05	4:53	5:44	6:36	8:10	9:47
	300	0:53	2:00	3:33	4:27	5:20	6:15	7:12	8:55	10:41
P I P E	325	0:58	2:10	3:51	4:49	5:47	6:47	7:48	9:40	11:34
	350	1:02	2:20	4:09	4:11	6:14	7:18	8:25	10:24	12:28
	375	1:06	2:30	4:27	5:34	6:40	7:49	9:01	11:09	13:21
	400	1:11	2:40	4:45	5:56	7:07	8:21	9:37	11:54	14:14
T E S T E D	425	1:15	2:50	5:02	6:18	7:34	8:52	10:13	12:38	15:08
	450	1:20	3:00	5:20	6:40	8:00	9:23	10:49	13:23	16:01
	475	1:24	3:10	5:38	7:03	8:27	9:54	11:25	14:07	16:55
	500	1:29	3:20	5:56	7:25	8:54	10:26	12:01	14:52	17:48
↓	525	1:33	3:30	6:14	7:47	9:21	10:57	12:37	15:37	18:42
	550	1:38	3:40	6:31	8:09	9:47	11:28	13:13	16:21	19:35
	575	1:42	3:50	6:49	8:32	10:14	11:60	13:49	17:06	20:28
	600	1:47	4:00	7:07	8:54	10:41	12:31	14:25	17:51	21:22

- (g) For testing a sewer system with one or more installed service lateral pipes, an effective pipe length shall be added to the total sewer main pipe length. The equation used to calculate Effective Pipe Length is as follows:

$$L_e = \frac{d^2 \times l}{D^2}$$

Where: L_e = Effective Pipe Length (added to Total Test Length)
 d = Diameter of Service Lateral Pipe (inches)
 l = Length of Sewer Lateral (feet)
 D = Diameter of Sewer Main Pipe being tested (inches)

2.11 Manholes

(a) General

- (1) Manholes shall be constructed to the sizes, shapes and dimensions and at the locations shown on the plans. Unless otherwise shown on the Plans, manholes shall be as follows:

8" to 18" pipe 4' diameter 5" thick walls
21" to 36" pipe 5' diameter 5" thick walls
39" to 54" pipe 6' diameter 6" thick walls
54" and larger 8' diameter 8" thick walls

- (2) The height or depth of each manhole will vary with its location, but it shall be such as will place the top at the finished grade of the pavement or ground surface or to the elevations shown on the Plans and the invert at the elevation shown on the Plans. The number of joints shall be minimized. No more than one riser section for manholes up to six feet tall and no more than one riser for each additional 4 feet in height. One additional section will be allowed for transition manholes.

(b) Drop Manholes

Drop manholes shall be similar in construction to the standard manhole except that a drop connection of pipe and fittings of the proper size and material shall be constructed outside the manhole and supported as indicated on the Plans.

(c) Manhole Construction

- (1) Manholes shall be composed of precast reinforced components with tongue and groove joints. Manholes shall conform to the requirements of ASTM Specification C478, except as modified herein.
- (2) Concrete: Concrete shall conform to ASTM C478 and as follows:

Compressive strength: 5,000 psi minimum at 28 days.
Air Content: 5 - 7 %
Alkalinity: Adequate to provide a Life Factor, Az = Calcium Carbonate Equivalent times Cover over Reinforcement, no less than 0.35 for bases, risers and cones.
Cementitious Materials: Minimum of 564 pounds per cubic yard

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Coarse Aggregates: ASTM C33. Sound, crushed, angular granitic stone only. Smooth or rounded stone shall not be used. Free from organic impurities.

Chemical Admixtures: ASTM C494. Calcium Chloride or admixtures
(if used) containing calcium chloride shall not be used.

Air Entraining Admixtures (if used): ASTM C260.

Absorption shall not exceed 6 percent.

- (3) Reinforcing: Reinforcing steel shall be ASTM A615 grade 60 deformed bar, ASTM A82 wire or ASTM A185 welded wire fabric.
- (4) Lifting Loops: Lift loops shall be ASTM A416 steel strand. Lifting loops made from deformed bars shall not be used.
- (5) Wall Thickness: The minimum wall thickness of the manhole riser sections shall be as shown in the table above. Cone sections shall have a minimum wall thickness of 8 inches at their top. The minimum thickness of the bottom shall be 6 inches for manholes 4 feet in diameter and 8 inches for all sizes greater than 4 feet in diameter. Suitable openings for inlet and outlet sewer pipe shall be cast or cored into the base sections and into riser sections for drop connections. These openings shall be circular, accurately made, and located as required for each manhole.

(d) Manhole Components

- (1) Precast Manufacturing: Precast components shall be manufactured in conformance with ASTM C478. Wall and inside slab finishes resulting from casting against forms standard for the industry shall be acceptable. Exterior slab surfaces shall have a float finish. Small surface holes, normal color variations, normal form joint marks, and minor depressions, chips and spalls will be tolerated. Dimensional tolerances shall be those set forth in the appropriate references and specified below.
- (2) Certification: Precast manufacturer shall manufacture all precast components with one or more of the following testing methods.

Plant shall be certified by the National Precast Concrete Association (NPCA) Plant certification program.

Plant shall be certified by the Prestressed Concrete Institutes (PCI) Plant certification program.

Manufacturing process of components delivered shall have been randomly tested by a DISTRICT-approved outside agency (such as a State Department

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of Transportation) no less than 5 weeks prior to manufacture. Test results covering no less than one component in 100 and certification from cement manufacturer and aggregate supplier certifying chemical content will be furnished to the DISTRICT upon request. Minimum test shall cover concrete strength and absorption.

Components delivered shall be tested by a certified outside testing agency. Test results covering no less than one component in 25 and certification from cement manufacturer and aggregate supplier certifying chemical content will be furnished to the DISTRICT upon request. Minimum test shall cover concrete strength and absorption.

Precast concrete manholes shall not be shipped to the job site prior to 15 days after the date of manufacture.

Joints: Neither rubber gaskets nor O-Ring seals shall be used. The maximum slope of the vertical surface shall be 2 degrees. The maximum annular space at the base of the joint shall be 0.10 inch. The manhole sections shall be joined as specified herein.

Lift Inserts and Holes: If used for handling Precast Components, lift holes and inserts shall be sized for a precision fit with the lift devices, and shall comply with OSHA Standard 1926.704.

Step Holes: Step holes shall be cast or drilled in the bases, risers and cones to provide a uniform step spacing of 12 inches or 16 inches. Cast step holes shall be tapered to match the taper of the steps.

- (3) Precast Base Sections: Base sections shall have the base slab cast monolithically with the walls, or have an approved PVC waterstop cast in the cold joint between the base slab and the walls. Where extended base manholes are required, the width of the base extensions shall be no less than the base slab thickness. The bottom step in the base section shall be a maximum of 16 inches from the top of the invert bench and shall be located directly over the outlet pipe.
- (4) Precast Riser Sections: The minimum lay length of Precast Riser Sections shall be equal to the step spacing used by that manufacturer.
- (5) Precast Concentric and Eccentric Cone Sections: Precast Cone Sections shall have an inside diameter at the top of no less than 24 inches and no more than 26 inches. The width of the top ledge shall be no less than 8 inches and no less than the wall thickness required for the cone section. Concentric cones shall be used only for shallow manholes.
- (6) Precast Transition Cone Sections: Transition Cone Sections shall provide an

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eccentric transition from 60 inch and larger manholes to 48-inch diameter risers, cones and flat slab top sections. The minimum slope angle for the cone wall shall be 45 degrees. A minimum of 6 feet height is required between the bench and the bottom of the transition cone.

- (7) Precast Transition Top Sections: Transition Top Section shall provide an eccentric transition from 60 inch and larger manholes to 48-inch diameter risers, cones, and flat slab top sections. Transition Top sections shall be furnished with vents as shown on the manhole details. The maximum amount of fill over the transition top section shall be 20 feet. Transition tops shall not be used in areas subject to vehicle traffic. A minimum of 6 feet height is required between the bench and top of transition cone.
- (8) Precast Flat Slab Top Sections: Standard Flat Slab Top Sections shall have an access opening with an inside diameter at the top of no less than 24 inches and no more than 26 inches and shall be designed for HS-20 traffic loadings as defined in ASTM C890. Items to be cast into Special Flat Slab Tops shall be sized to fit within the manhole ID and the top and bottom surfaces. Flat Slab Top Sections shall not be used without prior authorization from ENGINEER.
- (9) Precast Grade Rings and Brick: Precast Grade Rings or Brick shall be used to adjust ring and covers to finished grade. No more than 12 vertical inches of grade rings or brick will be allowed per manhole. Grade Rings shall conform to ASTM C478 and shall be no less than 4 inches in height. All brick used shall be solid and shall be made from Concrete, Clay, or Shale, and shall be of standard building size.
- (10) Steps: Provide steps in bases, risers, cones, transition cones, and transition top sections aligned vertically on 12-inch or 16-inch centers. All steps shall be aligned vertically over the outlet pipe. Secure steps to the wall with a compression fit in tapered holes. Steps shall not be vibrated or driven into freshly cast concrete. Steps shall not be grouted in place. The steps shall be a Copolymer Polypropylene Plastic reinforced with a ½ inch diameter grade 60 bar and have serrated tread and tall end lugs. Step pullout strength shall be a minimum of 2000 lbs. when tested according to ASTM C497. The minimum width shall be 12 inches. Rubber or plastic covered steel steps shall be as manufactured by Delta Pipe Products Co., M. A. Industries, Inc., or equal. All manhole steps shall comply with the requirements of OSHA.
- (11) Lifting Devices: Lifting devices complying with OSHA Standard 1926.704 for handling the Precast Components shall be provided by the Precast Manufacturer.

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- (12) Coatings: Where shown on the Plans, the interior/exterior of the manhole walls shall be coated with 21 mils of Coal Tar Epoxy, Koppers 300M or equal. The coating shall be spray applied according to the manufacturer's recommendations by an applicator with a minimum of 5 year's experience. The joints between precast sections shall not be coated. Use butyl rubber rope as specified below to seal the interior horizontal joint surface.
- (13) Joint Sealing Materials: Joints shall be sealed by **TWO** Butyl Rubber Seals. Each seal shall be as described below:
 - (a) Butyl Seals shall consist of a plastic or paper-backed butyl rubber rope no less than 1 inch cross section. When manholes are larger than 4 feet diameter or have a larger than normal space between the joints, the length and or diameter of the rope shall be increased as required to achieve a seal. Butyl Rubber Material shall conform to Federal Specification SS-S210A, AASHTO M-198, Type B - Butyl Rubber and as follows: maximum of 1% volatile matter and suitable for application temperatures between 10 and 100 degrees F. Butyl Rubber shall be applied to clean, dry surfaces only. Use of 2 independent wraps of Butyl Rubber qualifies for the requirement of two seals.
 - (b) Internal O-Ring Gaskets and Internal Rubber Gaskets shall not be used.
- (e) Manhole Sleeves and Entrance Joints

Flexible manhole sleeves or flexible manhole entrance joints shall be installed on all pipe entering and leaving precast manholes. Manhole openings shall be accurately core drilled or cast in place. Sleeve and Joint material shall be of high quality synthetic rubber which complies with the requirements of ASTM Specification C 923. Sleeve hardware (clamps, bands, straps, draw bolts, nuts, etc.) shall be stainless steel and make a watertight union. Sleeves shall be Kor-N-Seal I, Kor-N-Seal II, flexible connectors models 72, 73, 74, 107, 117, 126, 127, 128, 1610, or 1612 as manufactured by EPCO, or shall be as manufactured by Lock Joint a subsidiary of Gifford-Hill-American, Inc. or comparable sleeves as manufactured by the Press Seal Gasket Corporation, or equal. Flexible manhole entrance joints may be cast into the wall of the manhole base or may be installed by coring the manhole wall and installing the flexible connector to form a tight waterstop. Joints shall be watertight under a 30 foot head of water. Flexible manhole entrance joints shall be A-LOK Joints as manufactured by the A-LOK Products Corp., Press Wedge II as manufactured by the Press Seal Gasket Corp., or equal. Flexible manhole sleeves and flexible manhole entrance joints shall be installed in accordance with instructions of their manufacturer. Alternative entrance joint connections must be approved by ENGINEER prior to construction.

(f) Placing Manhole Sections

The CONTRACTOR shall excavate to the required depth and remove materials that are unstable or unsuitable for a good foundation. Prepare a level, compacted foundation extending 6 inches or more beyond the manhole base.

The base shall be set plumb and level, aligning manhole invert with pipe invert.

Thoroughly clean bells and spigots to remove dirt and other foreign materials that may prevent sealing. Unroll the Butyl Sealant rope directly against base of spigot. Leave protective wrapper attached until sealant is entirely unrolled against spigot. Do not stretch. Overlap from side to side - not top to bottom.

Risers and cones shall be set so that steps align, taking particular care to clean, prepare and seal joints.

(g) Manhole Final Finishing

After placement of manhole frame and vacuum testing, perform the final finishing to the manhole interior by filling all chips or fractures greater than 1/2 inch in length, width or depth (1/8 inch deep in inverts) with non-shrink grout. Grout the interior joints between the precast concrete sections with non-shrink grout. Sharp edges or rough finishes shall be removed providing a smooth surface throughout the manhole. Clean the interior of the manhole, removing all dirt, spills, or other foreign matter.

(h) Connection to Existing Manholes

Any connection with 18 inches and smaller pipe at an existing precast or cast-in place manhole will require the CONTRACTOR to core the necessary opening through the manhole wall and install a flexible manhole to pipe connector. Connector shall be as specified elsewhere. Connections to existing brick manholes do not require coring and an opening may be carefully hammered or sawed. Connections to existing manholes with pipe larger than 18 inches may be cored or sawed as approved by the ENGINEER. Connection to an existing manhole may be made without using flexible pipe connectors only if approved by ENGINEER.

Whenever a connection is made without a flexible pipe connector, a concrete collar shall be poured in accordance with MSD standard details. The existing manhole bench and invert shall be repaired as specified under manhole materials and installation.

(i) Manhole Inverts

- (1) Manhole inverts shall be constructed of brick and cement grout or precast concrete and shall have a "U" shaped cross section of the same diameter as

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the invert of the sewers which they connect. "U" shaped inverts shall be constructed to a minimum depth of 6 inches for 8 inch sewers (unless full depth is required in Specifications or on the Plans) and to full pipe diameter depth of the outlet sewer main for larger mains. The manhole invert shall be carefully formed to the required size and grade by gradual and even changes in sections. Changes in direction of flow through the sewer, whether horizontal or vertical, shall be made with true tangent curve(s) with as large a radius as the size of the manhole will permit. Manhole benches shall slope a minimum of 2 inches to the lip of the "U" shaped invert. Provide a ½ inch radius at the intersection of 2 or more channels. The minimum concrete thickness in the invert of the channel shall be 2 inches, not including the manhole base thickness.

- (2) When the invert is not constructed at the precast company, the CONTRACTOR shall construct the invert using 4000 psi concrete or non shrink grout. Non-shrink grout (minimum 2-inch thickness on invert channel and on bench) may be plastered over layered brick and mortar in lieu of solid non shrink grout invert.

- (3) Inverts shall meet the following additional requirements:

Pipe Openings: Pipe openings shall provide clearance for pipe projecting a minimum of 2 inches inside the manhole. The crown of small I.D. pipe shall be no lower than the crown of the outlet pipe.

Trough: The fall across the manhole invert shall be as noted on the plans.

Bench: Finish benches to provide a uniform slope from the high point at the manhole wall to the low point at invert trough. Provide a radius (1/8 inch to 1 inch range is acceptable) at the edge of the bench and trough.

Gradual smooth sided depressions and high spots may be allowed so long as diameter of invert channel ranges from 1/4 inch less than, or 1/2 inch more than the nominal pipe diameter are maintained. Voids, chips, or fractures over 1/8 inch in diameter or depth shall be filled with a non-shrink grout and finished to a texture reasonably consistent with the bench surface. All work from collar down shall have a steel trowel finish.

(j) Manhole Frame and Cover Construction

- (1) Manhole frames and covers shall be made of cast iron conforming to the minimum requirements of ASTM Specification A48, Class 35B. All castings shall be made accurately to the required dimensions and shall be sound, smooth, clean and free from blisters and other defects. Defective castings which have been plugged or otherwise treated shall be rejected. The contact surfaces between the cover and its corresponding supporting ring in

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the frame shall be machined so that the cover will rest on the ring for the full perimeter of the contact surfaces.

- (2) All frames and covers shall comply with AASHTO HS20 loading requirements. All manhole frames shall be standard height (7" for EJIW's 1045Z frame or 8" for USF 577 frame) unless a reduced height frame is specified in the project plans or specifically approved or required by the ENGINEER. All manhole frames shall be equipped to accept a cam-lock cover. However, only those frame and covers designated on the plans as "watertight" and/or "lock-down" shall have covers equipped with cam-locks. All manholes designated as "watertight" shall be "lock-down" and those designated "lock-down" shall be "watertight". When "lock-down" manholes are required, covers shall be furnished with two stainless steel, pentagon headed cam-locks, located and constructed as per the MSD details cited below. Frames and covers designated as "watertight" shall have a cover equipped with a one-piece gasket permanently attached in a groove in the bottom of the manhole cover. (See MSD Details 2.11-08.1 and 2.11-08.2). An ORS gasket shall be placed in a dove tailed groove in the bottom of the cover and the cam-lock feature shall provide sufficient pressure to prevent cover movement and subsequent wear of gasket.
- (3) All covers shall have two 5/8-inch diameter lifting bars set into the cover to allow for lifting by a chain hoist. There shall be no holes or perforations in covers. Manhole covers shall be either standard covers or watertight / lock-down covers and shall meet the additional requirements set forth in paragraphs 6 or 7 below. Watertight /lock-down covers shall be required and used when specified in the project plans; when the diameter of the sewer main equals or exceeds 18 inches in diameter, where the manhole is subject to flooding, or when required by the ENGINEER. Shop drawings shall be sent to the ENGINEER for review and acceptance prior to manufacturing and shipping of castings to the job site.
- (4) Pre-approved Heavy Duty Standard Frames include:

USF 577 Ring (with tooling for Bi-Loc Cover) as manufactured by U.S. Foundry & Mfg. Corp.

1045Z-1040AGS (with cam-lock ramp) as manufactured by East Jordan Iron Works, Inc.
- (5) Pre-approved Reduced Height Frames include Model 1046Z1 (with cam-lock ramp) as manufactured by East Jordan Iron Works, Inc.
- (6) Pre-approved Standard Logo Manhole Covers shall be:

USF IB-ORS as manufactured by U.S. Foundry and MFG. Corp as approved

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by MSD on November 25, 2009 or EJIW NPR 10-508D as manufactured by East Jordan Iron Works and approved by MSD on March 17, 2010, or approved equal.

- (7) Pre-approved Water-Tight Lock-Down Manhole Covers shall be:

USF IB-ORS-LOC manhole cover as manufactured by U.S. Foundry Corp. or EJIW NPR10-508B as manufactured by East Jordan Iron Work, Inc. or approved equal.

- (8) Manhole Frame Placement

After the manhole has been set in its final position, set the manhole frames to the required elevation using no more than 12 inches of precast concrete grade rings, or bricks sealing all joints between cone, adjusting rings, and manhole frame. When grade rings or bricks are used, grout with cement mortar. Where manholes are constructed in paved areas, the top surface of the frame and cover shall be tilted so as to conform to the exact slope, crown and grade of the existing surrounding pavement. Manhole frames which are placed above final grade will have frames attached to manhole cone section by means of 5/8-inch diameter steel anchors and steel washers. One anchor bolt shall be provided per hole.

- (k) Manhole Submittal Data

Drawings and descriptive data on manholes (including wall thicknesses, vertical dimensions, and deflection angles), concrete used in manufacture of manholes and precast inverts, rubber gaskets, joint sealant, flexible manhole sleeves and joints, frames and covers, inverts, and manhole steps shall be submitted to the ENGINEER for review prior to their manufacture.

- (l) Manhole Delivery, Storage, and Handling

The CONTRACTOR shall coordinate delivery with the manufacturer, and shall handle and store the manhole components in accordance with the ASTM C891 and the manufacturer's recommendations using methods that will prevent damage to the components and their joint surfaces.

- (m) Grouts

All grouts used on manhole interiors shall be "non-shrink" grouts, and grout used on manhole exteriors shall be either "non-shrink" or standard cement mortar grouts, as specified in Item III, Concrete Construction, of the Specifications.

2.12 Vacuum Testing of Manholes

- (a) Vacuum testing of manholes shall be required on no less than 10 percent of the manholes installed. In addition, no less than 5 manholes will be tested. The DISTRICT will select which manholes shall be tested after construction. Vacuum testing each manhole prior to backfilling is recommended as most repairs must be made on the manhole exterior. Vacuum testing is not required on manholes with pipe connections in excess of 30 inches diameter. Vacuum testing shall be made at the CONTRACTOR'S expense. For extensions constructed by Developers and/or projects under the responsible charge and supervision of an Engineer other than DISTRICT's ENGINEER, the Engineer shall certify that the tests were done in accordance with the required testing procedures and that the test reports accurately depict the results of those tests.
- (b) Vacuum test the assembled manhole after completing pipe connections, sealing and allowing mortar or cement proper curing time. The vacuum test shall be as follows:
- (1) Plug pipes with suitably sized and rated pneumatic or mechanical pipeline plugs. Place plugs a minimum of 6 inches beyond the manhole wall and brace to prevent displacement of the plugs or pipes during testing.
 - (2) Position the vacuum tester head assembly according to the manufacturer's recommendations.
 - (3) Draw a vacuum of 10 inches of mercury, close the valve on the vacuum line and shut off the vacuum pump.
 - (4) Measure the time for the vacuum to drop to 9 inches of mercury. The manhole shall pass when the time to drop to 9 inches of mercury meets or exceeds the following:

Manhole I.D. (inches)	48	60	72	84	96	120
Time (seconds)	60	75	90	105	120	150
 - (5) If the manhole fails the test, remove the head assembly and coat the manhole interior with a soap and water solution and repeat the vacuum test for approximately 30 seconds. Leaking areas will have soapy bubbles. Make the necessary repairs and repeat the test until the manhole passes.

2.13 Existing Utilities and Separation Requirements

- (a) The CONTRACTOR will be required to excavate to determine the precise location of utilities, or other underground obstructions, which are shown on the Plans and/or marked by the utility owners. Such location and excavation shall be at least 500 feet ahead of construction, unless otherwise noted.

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- (b) All utility owners shall be notified prior to excavation as required by the 1985 Underground Damage Prevention Act. Utility owners who are members of NC OneCall may be notified by calling 811(toll free) before any excavation or drilling. The CONTRACTOR will be fully responsible for damage to any utilities if the owners have not been properly notified as required by the Underground Damage Prevention Act. All damage to such structures and pipelines and all damage to property or persons resulting from damage to such structures and pipelines shall be borne by the CONTRACTOR and shall be completely repaired within a reasonable time. No claim shall be made against the DISTRICT for damage or delay of the work on account of the proximity of, or the leakage from, such structures and pipelines. Where high pressure gas lines are to be crossed, they shall be uncovered by hand excavation methods before other excavation near them is started.
- (c) Utility owners may, at their option, have representatives present to supervise excavation in the vicinity of their utilities. The cost of such supervision, if any, shall be borne by the CONTRACTOR.
- (d) Conflicts with underground utilities may necessitate changes in alignment and/or grade of this construction. All such changes will be approved by the ENGINEER before construction proceeds.
- (e) When underground obstructions not shown on the Plans are encountered, the CONTRACTOR shall promptly report the conflict to the ENGINEER and shall not proceed with construction until the conflict is resolved.
- (f) When a sewer main or lateral crosses an existing water main or other utility, the CONTRACTOR shall make the installation in accordance with the minimum specifications of the Controlling Agency and in accordance with the following minimum requirements. When a sewer main or lateral crosses or parallels an existing utility, the following clearance requirements are to be met or ferrous sewer pipe with watertight joints shall be used for a distance of 10 feet outside said point of crossing or until horizontal separation requirements are achieved.

(1) Min. Vertical Separation for Sewer Crossings:

Storm Sewers -	18" Vertical	
Under Water -	18" Vertical	
Over Water -	18" Vertical	* Sewer over water requires that both pipes shall be ferrous pipe with a 20 foot jointless span centered at crossing. *
Cable -	18" Vertical	
Power -	18" Vertical	
Gas -	18" Vertical	

(2) Horizontal Separations:

Storm Sewers -	5'
Water Mains -	10'
Water Supply -	100' (AS-I Waters, Class I or Class II impounded reservoirs)
Water Supply -	50' (WS-I, WS-II, WS-III, B, SA, or SB Waters – Natural High Water)
Designated Trout Streams -	25'
Other Stream, Lake or Impoundment -	10'
Building Foundation -	5'
Basement -	10'
Ground Water Lowering and Surface Drainage Ditch	10'
Swimming Pool -	10'
Private Wells -	25'
Public Wells -	50'

2.14 Boring and Jacking

- (a) Steel Encasement pipe for Boring and Jacking shall be welded or seamless, consisting of Grade B steel as specified in ASTM A139. Encasement pipe and joints shall be leak proof construction, capable of withstanding dead loads and live loads specific to the site. Steel pipe shall have a minimum yield strength of 35,000 psi. The encasement pipe and method of boring shall meet the requirements of American Association of State Highway Transportation Officials (AASHTO) or the American Railway Engineering Association (AREA), as applicable.
- (b) Spiral Weld or Smooth Wall Steel Encasement Pipe, may be jacked through dry bores slightly larger than the pipe, bored progressively ahead of the leading edge of the advancing pipe as spoil is mucked by the auger back through the pipe. As the dry boring operation progresses, each new section of encasement pipe shall be butt-welded to the section previously jacked into place. Continuous checks shall be made as to the elevation, grade and alignment of each successive section of encasement as well as the tracks (rails) upon which the boring rig travels.
- (c) Bore Pits (or Tunnel Pits) shall be shored, as described under shoring and shielding herein, well marked, securely fenced, lighted, and not left unattended except as approved by the ENGINEER. Requirements for stabilization and dewatering of bore pits shall be as previously specified. The angle of repose method (sloping pit walls) for creating a safe working area shall not be used unless specifically approved by the ENGINEER.
- (d) If voids are encountered or occur outside of encasement pipes, grout holes shall be installed in the top section of the encasement pipe at 10-foot centers and the voids filled with 1:3 Portland cement grout at sufficient pressure to prevent settlement in

the roadway/railway.

- (e) Boring operations shall be continuous to their completion, and unnecessary or prolonged stoppages shall not be allowed.
- (f) In the event an obstruction is encountered during the boring or jacking operations, the auger is to be withdrawn and the excess pipe is to be cut off, capped, and filled with 1:3 Portland Cement Grout at sufficient pressure to fill all voids before reapplying to the Controlling Agency for a new bore site or permission to tunnel.
- (g) Completed casing installations shall be such as to prevent the formation of a waterway under the road or railbed.
- (h) The Controlling Agency shall have full authority to require remedial measures and/or to stop all work if, in its opinion, said work will cause any damage to the roadway/railway section or endanger traffic.
- (i) The CONTRACTOR shall notify the Controlling Agency and the DISTRICT such that acknowledgement shall be received a minimum of 5 working days prior to beginning any work within roadway or railway rights-of-way. If required, 24-hours notice will be given prior to completion.
- (j) Carrier pipes inside steel encasements shall be constructed of ductile iron pipe as specified on the Plans. The carrier pipe shall be centered in the encasement and be supported by spacers and runners (“spiders”).

For encasement pipes 24 inches in diameter and less, the spacers and runners shall be at 10 feet on center and not more than 5 feet from each end of encasement pipe. Bore and jack applications having an encasement larger in diameter than 24 inches shall be specified by the ENGINEER on a case by case basis.

For all encasement pipe diameter sizes, Model # CCS 14-guage stainless steel casing spacers as manufactured by Cascade Waterworks Mfg. Company or approved equal shall be used. See the MSD standard bore & encasement details 2.14-01 and 2.14-02 for further information.

- (k) Casing ends shall be closed with an 8-inch thick brick and mortar bulkhead.

2.15 Tunneling

- (a) Tunnel work shall consist of the construction of a tunnel lined with structural steel liner plates, installation of the ductile iron carrier (sewer) pipe, and all materials and labor necessary to prevent flotation as directed by ENGINEER.
- (b) Site preparation, excavation, sheeting and shoring, drilling and blasting, backfilling, and the disposal of materials shall be as specified under Item I -

Excavation.

- (c) The CONTRACTOR shall furnish to the DISTRICT 10 copies of drawings, specifications, and computations for the pit shoring, sealed and signed by a Registered Professional Engineer licensed to practice in the State of North Carolina, and a written description (with shop drawings and detail drawings) of the proposed method of tunnel construction including proposed method of handling groundwater, grouting, handling various soil conditions, carrier pipe installation, and sequence of construction. The method of shoring the pits and method of construction for tunneling operations must be approved by the State Design Services Engineer of the NC Department of Transportation, Division of Highways, or the Norfolk Southern Corporation Engineering Department, as applicable, prior to beginning any work at the site.
- (d) The Structural Steel Tunnel Liner Plates shall be of the diameter and gauge shown on the Plans or specified hereafter and shall be galvanized, and bituminous coated. Liner Plates shall be four flange panel type, or two flange type. All Liner Plates for Highway Crossings shall be galvanized, in accordance with the requirements of AASHTO M111-94. Bituminous coating shall meet the requirements of AASHTO M 190. Coatings shall cover the entire surface of the liner plates. The Tunnel Liner Base Metal shall conform to ASTM Specifications A569 and shall be designed in accordance with the requirements of Section 16, Division I, and constructed in accordance with Section 26, Division II of the current or interim Standard Specifications for Highway Bridges, as adopted by the American Association of State Highway and Transportation Officials.
- (e) Liner Plates for Railroad Crossings shall be galvanized and bituminous coated and meet the requirements of Norfolk Southern and the manual for Railway Engineering as published by the American Railway Engineering Association (AREA). The minimum mechanical properties of the flat steel plate before cold forming into liner plates shall be:
- | | | |
|---------------------------|---|------------|
| Tensile Strength of Steel | = | 42,000 psi |
| Yield Strength of Steel | = | 28,000 psi |
| Elongation, 2 inches | = | 30 percent |
- (f) The section properties of the liner plates shall be as specified by the most recent edition of the Standard Specifications for Highway Bridges, adopted by the AASHTO or AREA, as applicable.
- (g) Liner Plates shall be handled in such a manner as to prevent bruising, scaling, or breaking of the coating. Any plates that are damaged during handling or placing shall be replaced by the CONTRACTOR at his expense, except that small areas with minor damage may be repaired by the CONTRACTOR as approved by the ENGINEER. Bolts, nuts washers and other accessory hardware shall meet the

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requirements of ASTM Specification A-307, Grade A and shall be hot-dip galvanized in accordance with the requirements of AASHTO M232 or AREA, as applicable. Bolts spacing in circumferential flanges shall be in accordance with the manufacturer's standard spacing and shall be a multiple of the plate length so that plates shall be interchangeable and will permit staggering of the longitudinal seams.

- (h) All excavation for the entire length of the tunnel shown on the Plans shall be done by tunneling. The periphery of the tunnel shall be trimmed smooth as practical to fit the outside of the liner plates. The tunneling operations shall proceed only a distance sufficient for placing one ring of liner plates. The liner plates shall be installed immediately after the excavated material has been removed. At no time will jetting be allowed.
- (i) Where blasting is allowed, only small controlled charges of 40% dynamite or plastic explosives are to be used. The depth of the holes for these charges shall not exceed the depth necessary for clearing an area sufficient for placing one section of tunnel liner. The charges for the initial series of blasting shall be placed in the triangle method. The second series shall be placed in a radial method a minimum distance from the desired diameter of the tunnel. The triangular pattern of charges shall be set to go off first, with the radial charges to go off following a short interval or using the time lag method. Where rock is encountered before approaching the shoulder or pavement, the first four series of charges will be used in determining the amount of controlled blasting to be used before beginning any blasting beneath the shoulders or pavement of the highway; however, if rock is encountered after proceeding beneath the pavement, only small charges shall be used until the proper amount of charge is determined. In no case will an overshoot be permitted. If a boulder is encountered and is removed by blasting or by other methods, a bulkhead will be formed immediately after removal of the boulder and the area filled with grout before proceeding with the tunneling operations. If there is any indication of a vertical split in the rock formation, or any indication of settlement of the roadway or railroad, during the tunneling operations, all operations shall be stopped and the Engineer for the Division of Highways or Railroad shall be notified immediately. If the vertical split is not determined to be of too great a magnitude or too close to the pavement, the split shall be filled with grout at the pressure specified by the Division of Highways Engineer, or the Railroad Engineer and allowed to set and tunneling operations may be continued. If it is determined that the vertical split is of too great a magnitude or too close to the surface, the Division of Highways Engineer or Railroad Engineer shall advise as to the proper method to be used to correct the vertical split. If settlement of the roadway occurs, the Engineer for the Division of Highways or Railroad will advise the DISTRICT and the CONTRACTOR as to the proper steps to be taken to correct the settlement. Item I, Subsection 1.10 "Pre-blast Survey and Vibration Monitoring" of the Specifications apply to blasting during tunnel construction as well as all other blasting. The CONTRACTOR shall communicate with the blasting consultant and coordinate blasting activities to have said consultant on-site

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to supervise the loading of explosives and monitor the blasts. The CONTRACTOR or any Sub-Contractor shall not load explosives or pull any shots without the blasting consultant present. If at any time the ENGINEER or the blasting consultant determines that the use of explosives is not permissible, other approved methods of removing the material shall be used. Blasting is not permitted in Railroad Crossings.

- (j) The space between the outer face of the liner plates and the inside face of the excavation shall be filled with cement grout. Grout shall contain a minimum of one part Type 1 cement and three parts sand. Grout shall be placed using a pump at sufficient pressure to completely fill all voids created by excavation for installation of the liner plates. The grout shall be pumped through 2-inch diameter grout holes located not more than 4 feet 6 inches on center along the top of the tunnel liner and, if necessary, along the sides to achieve complete grouting. Sufficient plates shall be provided with 2-inch holes and screw type galvanized plugs for final watertight closure of the grout holes. Grouting shall not be more than 6 feet behind the last liner plate ring installed. In addition, all the rings shall be grouted at the end of each day or any other time the tunnel is to be left unattended. Grout will be forced into each grout hole. If the grout from one hole should flow along the liner plate so as to plug the next grout hole, the plugged hole will be opened by punching through the grout layer so that each hole may be used for grouting.

The grouting operation will be continued at each hole until all spaces outside the liner plates are filled and no grout will flow.

- (k) The tunnel shall be constructed true to line and grade as shown on the Plans. Variation in alignment and grade is not allowed. The invert elevations of the carrier pipe shall be as specified on the Plans. The actual invert of the tunnel liner shall be proposed by the CONTRACTOR in the submittal of shop drawings. However, sufficient working room, for tie downs and anchoring, shall be provided for, between the top of the carrier pipe and tunnel liner.
- (l) After completion of liner plate installation, and prior to the carrier pipe installation, the tunnel shall be thoroughly cleaned of all construction debris, excavated material, grout droppings, rocks, dirt, mud and any other debris. All areas of coating abrasion, scaling, or breaking shall be repaired as directed by the ENGINEER.
- (m) The completed liner shall consist of a series of steel liner plates assembled with staggered longitudinal joints. Liner Plates shall be fabricated to fit the cross-section of the tunnel.
- (n) Prior to the installation of the carrier (sewer) pipe the CONTRACTOR shall install 2 steel rails, minimum weight of 20 pounds per yard, or steel channel sections, set

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to line and grade. The rails shall be welded to the cross members prior to placing concrete and shall be spaced such that the ductile iron pipe bells will ride on the rails.

- (o) After completion and acceptance of the tunnel, the CONTRACTOR shall install the ductile iron carrier pipe on the steel rails or guide channels to line and grade as shown on the Plans.
- (p) Carrier pipe larger than 16 inches diameter shall be held in place by brick and mortar bulkheads placed at each bell. Carrier pipe 16 inches and less shall be anchored to the cross member, and straps shall be secured to the cross members with hooks or other approved fasteners as shown on the Plans. Straps shall be equipped with turnbuckles or ratchet devices for tightening.
- (q) Tunnel ends shall be closed with an 8-inch thick brick and mortar bulkhead.
- (r) The CONTRACTOR shall make himself familiar with the State and Federal regulations regarding the ventilation and safety for tunneling and mining and the work shall comply with these requirements for protecting the workmen at all times. The CONTRACTOR shall be responsible for the workmen wearing the proper safety attire, obeying safety rules, providing safety equipment including gas detectors, and for providing adequate ventilation at all times.
- (s) All shoring materials shall be removed in such a manner so as to avoid collapse and to allow proper backfill. The backfill shall be placed in accordance with the requirements of NCDOT, or the Railroad, and these Technical Specifications.
- (t) Upon completion of the tunnel liner installation the CONTRACTOR shall notify the NCDOT Division Engineer, in writing by letter, with a copy to the attention of the State Design Services Engineer, NCDOT, Raleigh, NC, or Norfolk Southern Railroad, as applicable.

2.16 Sewer Service Lines

- (a) Where existing sewer mains are being rehabilitated, sewer service lines shall be constructed for each property that is occupied by a business or dwelling if it is currently served by the new construction. For extensions of the existing public system, all buildable lots adjacent to the extension shall have a sewer service line provided.

Additional service lines may be installed by the CONTRACTOR as directed and authorized by the ENGINEER. In general, service lines shall be constructed from the public sewer to a point located at the edge of the public right-of-way or the sewer easement. Service lines shall consist of a 4-inch or 6-inch diameter pipe, as listed in the Bid Schedule and/or shown on the Plans.

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- (b) The CONTRACTOR shall be responsible to locate and connect all existing sewer service lines. In the event a service is missed during construction, the CONTRACTOR shall return to the site and perform all work necessary to reinstate the connection. The CONTRACTOR will be compensated in accordance with the original contract unit pricing; however, re-mobilization to the site will not be paid for.
- (c) Service lines built for vacant lots/future connections shall have a cleanout assembly constructed, which includes a 1 foot capped stub-out on the service line. The vertical cleanout pipe shall also be capped, and shall be a minimum of 3 feet above the finish grade.
- (d) Service lines 4 inches or less shall be tapped into the sewer main, not into a manhole. Service connections 6 inches or greater shall only be made into an existing or proposed manhole, unless otherwise approved by the ENGINEER.
- (e) The DISTRICT-maintained portion of each sewer service line shall have a minimum of 3 feet of cover, unless approved by the ENGINEER.
- (f) Sewer service lines and clean-outs shall be Class 350 DIP (with Class 350 appurtenances) if:
 - 1) The service line is installed underneath gravel or paved areas which will have less than 3 feet of cover and will be subjected to traffic loads; or
 - 2) The service line crosses a creek or drainage ditch (whether aerial or subaqueous).
- (g) The minimum slope on any residential sewer service line shall not be less than 2 percent, unless approved by the ENGINEER.
- (h) Sewer service line connections to sewer mains 12 inches and smaller shall be made with a wye of the same material and joint type as the sewer main. Sewer service connections to sewer mains larger than 12 inches may be made with Romac Saddles, style “CB” as manufactured by Romac Industries, Inc., or approved equal.
- (i) Cleanouts shall be constructed at the edge of the permanent easement or at the edge of the public right of way, whichever applies.

In addition, one cleanout shall be constructed for:

- 1) Every four 45-degree changes located in series (a long sweep is equivalent to two 45-degree bends); and
- 2) At intervals no greater than 100 feet.

2.17 Deep Services and Maximum Service Grade

- (a) When the depth of cut is over 8 feet and the grade of a sanitary sewer is lower than necessary to serve abutting property, and at such other locations as may be designated by the ENGINEER, the CONTRACTOR may install the service line with a 22 ½ or 45 degree bend just upstream of the cleanout assembly to bring the service line up to the necessary elevation.
- (b) Unless required service depth is noted on construction Plans, the CONTRACTOR shall contact the ENGINEER and request confirmation of grade prior to constructing any sewer service line at a depth greater than 8 feet.

2.18 Tie-ins to Existing Public or Private Collection Systems

- (a) Tie-ins to existing public or private collection systems will be allowed when proper precautions are taken to protect the existing MSD public collection system. Tie-ins to existing inactivated sewer lines not installed under the same contract will not be allowed without written approval from all parties involved (DISTRICT, CONTRACTOR, contract holders, etc.).
- (b) If the proposed sewer does not begin at an existing manhole, a new manhole will be "cut in" at the required location and the existing pipe(s) repaired as specified. For extensions of the system, the new "cut in" manhole or the connection to the existing manhole will not be constructed until all other sewer construction has been completed and tested in compliance with the Specifications.
- (c) Pipelines or manholes which contain silt, sedimentation, or other foreign material shall not be connected to any portion of the existing public collection system or any private collection system already connected to the DISTRICT's system. The CONTRACTOR shall at his own expense flush, or otherwise cause the line (and manholes) to be cleaned out without any discharge into the existing system.

2.19 Flow Interruptions and Bypass Pumping

- (a) When the flow of an existing sewer must be interrupted and/or bypassed, the CONTRACTOR shall, before beginning any construction, submit a work schedule which will minimize the interruption and/or bypassing of wastewater flow during construction. This schedule must be approved by the ENGINEER, and the owners of the private system if connection is to a private system, and may require night, holiday, and/or weekend work.
- (b) If pumping is required, an identical standby pump shall be on site in the event of failure of the primary pump. If, at any time during construction, effluent from the existing sewer is not fully contained by the bypass system, gravity service will be restored by a temporary tie to the new construction and work will be suspended until the problem is resolved to the satisfaction of the ENGINEER. The

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CONTRACTOR shall be responsible for any fines levied as a result of effluent reaching surface waters. The CONTRACTOR will be required to verify his method of handling sewer flows during construction by pumping at peak flows for 1 hour as approved by the ENGINEER.

2.20 Repairs on New Construction

- (a) All leaks shall be repaired by identifying and exposing the defective section of pipe and completing repairs. Chemical grouting or internal or external wiping of joints with cement grout are specifically not approved as methods for repairing leaks on new pipelines, regardless of the pipe material approved. Methods of repair are as follows:
 - (1) VCP: Defective or damaged pipe sections, including leaking joints, shall be removed and replaced with sound new pipe. The pipe or pipe ends shall be re-connected with approved couplings.
 - (2) PVC or Ductile Iron: Defective or damaged pipe shall be removed and replaced with sound new pipe. The pipe shall be re-connected with approved couplings. Joint leaks shall be cut out and replaced with pipe with mechanical joint sleeves.
 - (3) RCP: Defective or damaged pipe shall be removed and replaced with sound new pipe. The pipe shall be re-connected with concrete collars or approved couplings. Joint leaks may be repaired with bell clamps specifically approved by the ENGINEER. Concrete collars or repair couplings shall be limited to one every 100 feet not to exceed 3 pipe repairs between manholes. Deficiencies in excess of these limitations shall be corrected by relaying the section of pipe.
 - (4) Manholes: Defective or damaged manhole components shall be removed and replaced with sound new components unless repairs are approved by the ENGINEER.
 - (a) Leaks through the manhole joints or walls or around pipe collars, may be repaired with non-shrink or chemical grout applied.
 - (b) Leaks around boots or gaskets used to join pipe to manholes shall be repaired as recommended by the manufacturer. In the absence of specific recommendations, such leaks shall be repaired by internal grouting with non-shrink or chemical grout.
 - (c) Lift Holes leaving less than 2 inches of wall thickness shall be plugged from the outside using non-shrink or chemical grout. Penetrating lift holes shall be plugged from the inside and outside using non-shrink grout.

2.21 Abandonment of Existing Sewers and Manholes

- (a) Manholes which are to be abandoned shall first have both influent and effluent lines plugged inside the manhole with watertight masonry or concrete. The manhole will then be filled with non-compressible material (crushed stone or as approved by ENGINEER), to a point not less than 3 feet below the finish grade. The remainder of the manhole shall be broken down and removed. Then the excavation shall be backfilled to finish grade as specified under trench backfill.
- (b) Abandoned mains at active manholes shall be completely disconnected from the manhole by cutting the pipe outside the manhole and then plugging the abandoned main and the manhole wall with watertight masonry. The invert shall then be rebuilt to conform to the standard details.
- (c) Exposed sections of abandoned mains shall be removed to a point not less than 5 feet from the adjacent banks or surface waters. The remaining ends of the pipe shall be plugged with watertight masonry. Concrete piers or collars in the creek channel shall be removed completely. Concrete piers or collars not located in the creek channel shall be removed to a point 3 feet below the finish grade. Steel piers shall be cut off 3 feet below finish grade.
- (d) The minimum length of watertight masonry plugs will be the diameter of the abandoned pipe plus 1 foot.

2.22 Abandoned Sewer Grouting

- (a) Existing sewers shall be completely filled with high strength (pressure) grout where indicated on the Plans after the new sewer is placed in service.
- (b) High strength (pressure) grout shall be composed of cement, flyash, and water proportioned and mixed to produce a plastic pumpable mixture. Cement shall be portland cement conforming to ASTM Specification C150, Type I. Flyash shall be Type C. Water shall be fresh, clean and free from injurious amounts of oil, acid, alkali, and organic matter.
- (c) The following ingredients shall be selected, proportioned and mixed to produce a pumpable, high strength (pressure) grout:

Wt. of cement per cu. yd.	940 lb.
Wt. of flyash per cu. yd.	1,925 lb.
Vol. of water per cu. yd.	60 gal.
Amount of air entrainment in fresh mix	2 % of volume
Retarder	Max. Allowed / 100 WT

- (d) Pressure grout shall be pumped into place via a pipe cemented into the sewer line to be grouted full. This pump line shall have vent pipes on each end and the pipe used

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shall be capable of withstanding the pressure it will be subjected to during the pump process.

2.23 Structural Demolition

- (a) Prior to starting construction operations, the CONTRACTOR shall demolish and remove such buildings and other structures as are specifically designated on the plans for removal. Debris shall be removed from project site and disposed of in accordance with federal, state, and local ordinances at permitted sites. All permits required shall be obtained by the CONTRACTOR.

2.24 Handling and Storage of Materials

- (a) The CONTRACTOR shall be responsible for the safe storage of materials furnished by, to, and accepted by him and intended for the work, until the materials have been incorporated in the completed project. The interior of all pipe, manholes and other accessories shall be kept free from dirt and foreign materials at all times.
- (b) The CONTRACTOR is responsible for the delivery and site distribution of all materials.
- (c) Ductile iron pipe and cast iron accessories shall be loaded and unloaded by lifting with hoists or skidding so as to avoid shock or damage. Pipe shall not be loaded, unloaded, or transported by placing lifting forks inside the barrel or the pipe. Concrete pipe, clay pipe, PVC pipe, all pipe accessories, precast concrete manholes, and manhole frame and covers will be unloaded with hoists and/or as recommended by the respective manufacturers. Under no circumstances shall such materials be dropped. Pipe handled on skidways shall not be skidded or rolled against pipe already on the ground.
- (d) In distributing the material at the site of the work, each piece shall be unloaded opposite or near the place where it is to be laid in the trench. Pedestrian or vehicular traffic shall not be unduly inconvenienced in placing of material along the streets or right-of-way, as applicable.
- (e) Except as noted below, the CONTRACTOR will string in advance no more than the amount of pipe and material that can be installed within 4 weeks or less as approved by the ENGINEER. All the materials shall be placed in such a manner as not to hinder access, endanger or impede traffic, or create a public nuisance. For residential areas (or any area with maintained lawns), materials shall be placed in such a manner as not to restrict normal maintenance of established lawns, and must either be installed within 2 weeks or removed to an approved storage yard, as required by the ENGINEER.
- (f) The CONTRACTOR will be responsible for locating and providing storage areas for construction materials and equipment. Unless prior written consent from the

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owner of the proposed storage area is received by the ENGINEER, the CONTRACTOR will be required to store all equipment and materials within the limits of the right-of-way and temporary construction easement provided. The materials and equipment storage shall comply with all local and state ordinances throughout the construction period.

- (g) The CONTRACTOR shall be responsible for the safeguarding of materials and equipment against fire, theft, and vandalism and shall not hold the DISTRICT responsible in any way for the occurrence of same.
- (h) At the direction of the ENGINEER, the CONTRACTOR shall remove materials which have been damaged beyond repair from the site to prevent accidental placement.

2.25 Care of Coatings and Linings

- (a) Precast manholes, pipe and fittings, including rings and covers, steps, straps, etc., shall be so handled that the coating or lining will not be damaged. If, however, any part of the coating or lining is damaged, the repair shall be made by the CONTRACTOR at his expense in a manner satisfactory to the ENGINEER, or the component shall be replaced at the CONTRACTOR's expense.

2.26 Work Progress and Clean Up

- (a) The project site shall be cleaned up in accordance with the requirements of the General Conditions, as the work progresses. Site clean up shall not lag pipe laying more than 500 feet, and site clearing and grubbing shall be limited to 3,000 feet ahead of pipe laying, unless specified or directed otherwise by the ENGINEER.

2.27 Property Owner Notice and Protection of Site

- (a) The DISTRICT will secure rights-of-way or easements where required through private lands. The CONTRACTOR shall be responsible for any damage to buildings, walls, fences, utility poles, bridges, utilities, railroad, or other improvements encountered, whether public or private. All such improvements shall be carefully protected from damage and, in case of damage or removal, shall be completely repaired or restored to its original or better condition. All damage to such improvements and all damage to property or persons resulting from damage to such improvements shall be the responsibility of the CONTRACTOR. Special care shall be taken in trenching near buildings, roads and railroads, to avoid or minimize all delays, damage, or injury thereto.
- (b) Prior to any operation, the CONTRACTOR shall give advance notice to all property owners and/or tenants within the project.

2.28 Use of Easements and Rights-of-Way

- (a) Prior to disturbing any area, the CONTRACTOR shall stake the limits of all easements and/or rights-of-way. The CONTRACTOR shall confine all his operations and personnel within limits of all rights-of-way and easements as shown on the Plans. There shall be no disturbance outside the easement or rights-of-way nor shall the workmen be allowed to travel at will through the surrounding private property, except as provided below. The CONTRACTOR is responsible to note any areas where limits have been reduced from typical limits. Prior to using any areas outside the rights-of-way and easements provided, the CONTRACTOR shall provide written approval of the current property owner and submit to the ENGINEER for his approval. **The CONTRACTOR shall abide by all Special Provisions Detail Sheets provided in the Special Conditions section of the Specifications.**

2.29 Protection of Designated Trees and Shrubs

- (a) Trees, cultivated shrubs, and similar growth which occupy areas outside the limits of public rights-of-way or easements OR are designated in the Special Conditions Detail Sheets to remain undisturbed, shall be carefully preserved and protected by the CONTRACTOR throughout all stages of the construction work. Adherence to the above shall be the responsibility of the Contractor.
- (b) The CONTRACTOR shall protect existing trees and other vegetation indicated to remain in place against unnecessary cutting, breaking or skinning of roots, skinning and bruising of bark, smothering of trees by stockpiling construction materials or excavated materials within drip line, excess foot or vehicular traffic, or parking of vehicles within drip line. Provide temporary fencing to protect trees and vegetation that will be left standing.
- (c) The CONTRACTOR shall provide protection for roots over 1-1/2 inches diameter cut during construction operations. Coat cut faces with an emulsified asphalt, or other acceptable coating, formulated for use on damaged plant tissues. Temporarily cover exposed roots with wet burlap to prevent roots from drying out and cover with earth as soon as possible.
- (d) The CONTRACTOR shall trim trees scheduled to remain but damaged by construction operations in a manner acceptable to the ENGINEER. Trim damaged trees promptly to prevent progressive deterioration caused by damage.
- (e) The CONTRACTOR shall replace trees scheduled to remain and damaged beyond survival or aesthetics, with trees of similar size and species, as approved by ENGINEER. Repair and replacement of trees scheduled to remain and damaged by construction operations or lack of adequate protection during construction operations shall be at the CONTRACTOR's expense. Replacement trees shall be maintained in accordance with project Specifications.

2.30 Clearing Easements and Rights-of-Way

- (a) Unless otherwise specified in the Special Provisions Detail Sheets, the entire permanent easement shall be cleared.
- (b) Temporary construction easements will be selectively cleared with designated landscape items carefully preserved and protected as stipulated in Special Provisions Detail Sheets.
- (c) Public rights-of-way shall be cleared as shown on the Plans and as stipulated in Special Provisions Detail Sheets. The ENGINEER shall provide copies of tree permits, when required by the City of Asheville.
- (d) No clearing or grubbing may be performed on easements obtained by the DISTRICT or in rights-of-way except under supervision of the ENGINEER. Areas to be cleared which are occupied by trees, brush, or other vegetable growth shall be cleared of such growth and suitably grubbed. All large roots or stumps shall be removed to a depth of at least 2 feet below original ground surface. Any pits or cavities thereby created which extend beyond the area to be excavated shall be filled with the materials and in the manner specified for trench backfill in these Specifications. All stumps, limbs and trash shall be removed and disposed of at a location approved for disposal of such materials by the agency having jurisdiction.
- (e) Useable timber and/or firewood may be left on the area adjoining the permanent right-of-way at the request of or with the consent of the property owner. The CONTRACTOR must obtain such requests in writing from the property owner. The request must release the DISTRICT from any claims for improper disposal of timber.
- (f) When the Special Provisions Detail Sheets specifies stacking timber or firewood adjacent to the permanent right-of-way, a written release is not required. The CONTRACTOR shall verify cut lengths of timber/firewood for such placement and location with each respective property owner.
- (g) Fences removed during construction shall be replaced with the same material in the same location and elevation as existed prior to construction, or as provided otherwise in the Special Provisions Detail Sheets. Materials may be re-used if approved by ENGINEER.

2.31 Hubs Set by the CONTRACTOR

- (a) As a minimum, centerline hubs and offset stakes will be set by the CONTRACTOR at each manhole.
- (b) Pipe lasers shall be used to set line and grade. Elevations shall be verified at each manhole. Fans may be used in conjunction with pipe lasers if necessary. The

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CONTRACTOR shall keep close check of his pipe laser for variations in line and grade. No variations in line or grade shall be corrected between manholes without relaying that portion of the line which has deviated from line or grade unless otherwise approved by the ENGINEER.

2.32 Steel Straps and Anchors

- (a) All pipe straps, anchors, and hardware shall conform to the requirements of ASTM A36 Grade A with a minimum yield strength of 36,000 psi.
- (b) Straps, anchors, and hardware (washers, nuts, etc.) shall be hot dipped galvanized in accordance with ASTM A153, unless otherwise approved.

ITEM III - CONCRETE CONSTRUCTION

3.01 Scope

- (a) The work covered by this item shall consist of furnishing, erecting and removing concrete forms; furnishing, proportioning and mixing concrete ingredients; and placing and finishing plain and reinforced concrete and masonry; and all other work incidental thereto as required for the proper construction of the structures shown on the Plans or specified herein.
- (b) Concrete and steel reinforcement for all classes and types of construction of whatever nature or location, shall be furnished and placed in accordance with the applicable provisions of this Item III.

3.02 General Requirements

- (a) Concrete shall be composed of cement, fine aggregate, coarse aggregate and water proportioned and mixed to produce a plastic, workable mixture. Concrete shall be either Class A or Class B, as indicated on the plans. If the Class is not otherwise indicated, the CONTRACTOR shall furnish Class A concrete. In general, Class A concrete shall be reinforced concrete masonry, cast-in-place in forms for foundations, footings, piers, headwalls, tanks, walls, floors, manholes, pits, streets, sidewalks and similar structures; and Class B concrete shall be plain concrete and shall be used for pipe cradles, pipe protection, anchors, collars, massive sections and similar work.
- (b) Concrete construction shall conform to the requirements of the American Concrete Institute (ACI) Standard 304 for measuring, mixing, transporting, and placing concrete; Standard 305 for hot weather concreting; Standard 308 for curing concrete; and Standard 309 for consolidation of concrete.

3.03 Materials

- (a) Cement for Class A and B concrete shall be Portland Cement conforming to ASTM Specification C150, Type I and Section 1000 of the 2002 NCDOT Standard Specifications for Roads and Structures, or latest edition. Type IP and Type IS blended cements, fly ash and/or granulated blast furnace slag may be substituted for a portion of the Portland Cement only upon approval of the ENGINEER.
- (b) Additives introduced to effect air entrainment, slump, set; whether to retard or accelerate (high early), water reduction, and other properties may be used only upon consent and approval of the ENGINEER or when specified in the project Plans and / or Specifications. Addictives shall be placed in the cement at the mixer in accordance with recommendations of their manufacturer or as specified

in the mix formula.

- (c) Other type cements, when required, will be specified in the Special Conditions.
- (d) Fine aggregate shall be of a natural siliceous type and consist of hard, durable, and uncoated particles conforming to ASTM Specification C33. It shall have a fineness modulus ranging from 2.40 to 3.00. Fine aggregate shall be of such quality that when made into a mortar and subjected to a mortar strength test (ASTM C87), it shall develop a compressive strength at 7 and 8 days of not less than 90 percent of that developed by a mortar prepared in the same manner with the same cement and graded standard sand having a fineness modulus of 2.40 ± 0.10 .
- (e) Coarse aggregate shall consist of natural washed gravel, crushed stone or crushed blast furnace slag conforming to ASTM Specification C33. It shall be graded to pass square mesh screens of the following limiting sizes:

	<u>Class A Concrete</u>	<u>Class B Concrete</u>
Minimum Screen Size	No. 4	No. 4
Maximum Screen Size	3/4 inch	2 inches

- (f) Water used in mixing concrete shall be fresh, clean and shall not contain any amounts of oil, acid, alkali, vegetable, sewage and/or organic matter.

3.04 Material Sampling and Testing

- (a) Cement and aggregates shall be tested by a recognized testing laboratory which has been selected by the ENGINEER. The testing laboratory shall prepare written reports of such tests which shall certify that the material covered by the report complies in all respects with these Specifications. These tests and reports shall be made on each shipment of cement and on each bin or stockpile of aggregates used in the work. When aggregate is being furnished from the same source, tests subsequent to the initial tests may be suspended when authorized by the ENGINEER. When requested by the ENGINEER, mill test certificates shall be submitted for cement shipments. Certified test reports and certificates shall be submitted to the ENGINEER in duplicate.
- (b) The CONTRACTOR shall determine the source, kind and quality of cement and aggregates to be used in the work well in advance of the scheduled start of the work, in order to permit proper sampling and testing. He shall be fully responsible for delays in the progress of the work due to delays in sampling, testing and reporting on cement or aggregates. No cement or aggregates shall be incorporated in the work prior to receipt and acceptance of certified test reports or certificates by the ENGINEER. The cost of sampling and testing cement aggregates will be borne by the CONTRACTOR.

3.05 Storage of Concrete Materials

- (a) Cement shall be stored off the ground in a dry, ventilated building. Storage facilities shall be provided by and at the expense of the CONTRACTOR and approved by the ENGINEER prior to the arrival of the first shipment. No cement damaged by improper storage or handling shall be used in the Work.
- (b) Sand and coarse aggregates shall be stored in stock piles at selected points to provide maximum drainage and to prevent the inclusion of any foreign material during re-handling. Stock piles shall be built on planking in 2 foot layers to avoid segregation. Sizes shall be kept separate by the use of wooden bulkheads between adjacent piles.

3.06 Proportioning

- (a) Concrete ingredients shall be selected, proportioned and mixed to produce a workable, homogeneous concrete within the following limiting requirements:

MIXTURE	CONCRETE	CONCRETE
	CLASS A	CLASS B
Min. Compressive Strength (28 days) 5 consecutive specimens (lbs. per square inch)	4000	3000
Any one specimen (lbs. per square inch)	3500	1600
Volume of cement per cubic yard of concrete - minimum (bag)	6	4.5
Volume of cement per cubic yard of concrete - maximum (bag)	7	5.5
Volume of water per cubic yard of cement - maximum (gal)	6	7.5
Amount of air entrained in fresh mix - minimum (% of volume)	4	None
Amount of air entrained in fresh mix - maximum (% of volume)	7	None

- (b) The exact volumes and proportions of ingredients to be used in each cubic yard of concrete shall be predetermined by the CONTRACTOR well in advance of the start of mixing operations in order to assure conformity of the resulting concrete with the above specifications. Such predetermination shall be made by mixing and testing a series of trial mixes of the actual ingredients proposed to be used, the trial mixes to be computed and designed in accordance with the Portland Cement Association Bulletin ST-100, Design of Concrete Mixes. Trial mixes shall be repeated with varying proportions of ingredients until the resulting concrete meets the specified limitations. The results of such trial tests shall be reported to and accepted by the ENGINEER prior to the start of concrete mixing operations. Said

test shall be performed by an independent certified testing laboratory.

- (c) The amount of moisture carried on the surface of the aggregate particles shall be included in calculating the water content of each mix. In all cases, however, the amount of water to be used shall be the minimum amount necessary to produce a plastic mixture of the specific strength and of the desired durability, density and workability. The slump shall be between 3 inches and 4 1/2 inches when determined in accordance with ASTM Test C143. Concrete must be workable at these slumps.
- (d) The air content of freshly mixed concrete shall be determined by the appropriate ASTM Test C231. Frequency of this test will be at the discretion of the ENGINEER. Any concrete shown by such measurements to contain more or less air than the specified amount shall be rejected and shall not be used in the work.
- (e) No admixtures of hardening or curative materials shall be used unless previously authorized in writing by the ENGINEER.

3.07 Mixing and Transporting

- (a) Concrete materials shall be measured by weight. Scales suitably designed and constructed for this purpose shall be provided. Each batch of aggregate and cement shall be weighed separately. Cement in standard packages need not be weighed. Mixing water shall be measured by volume or by weight. All measuring devices shall be checked and accepted by the ENGINEER prior to use.
- (b) Concrete shall be mixed in a standard type of batch mixer with a drum speed of 200 to 225 peripheral feet per minute. Mixing time shall be 1 minute for batches of 1 cubic yard or less, and shall be increased 15 seconds for each additional 1/2 cubic yard or fraction thereof. The entire batch shall be discharged before recharging.
- (c) Central mixed and transit mixed concrete may be used, providing that the quality and kind of material used and the proportioning, mixing and transportation to the forms conform to the requirements of ACI Standard 304.

3.08 Concrete Placement

- (a) Before placing concrete, forms shall be clean and thoroughly oiled with a non-staining mineral oil. Concrete shall not be placed until the forms and reinforcement have been checked and accepted by the ENGINEER. Unless otherwise specified, all concrete shall be placed upon clean, damp surfaces, free from water, and never upon soft mud or dry porous earth.
- (b) Chutes shall be used to place concrete only when specifically authorized by the ENGINEER. When permitted, metal or metal lined chutes shall have rounded bottoms, with end baffles and shall be sloped to insure continuous flow of

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concrete without segregation of aggregates. Tremies, bottom dump buckets, or concrete buggies shall be used whenever practical for depositing concrete.

- (c) Concrete shall be deposited as close as possible to its final position in the forms. The depositing of concrete shall be regulated so that the concrete may be effectively compacted with a minimum of lateral movement into horizontal layers approximately 12 inches in thickness. Concrete shall be worked into all corners and angles and around reinforcement and embedded fixtures in such manner as will fill all voids, prevent honeycombing against the forms, and prevent segregation of coarse aggregate. This operation shall be performed by the use of spades or forks, or by other approved methods. Rakes shall not be used.
- (d) During placing operations, concrete shall not be allowed to drop freely a distance greater than 5 feet. When concrete is placed a vertical distance greater than 5 feet in narrow wall forms, metal drop chutes with top hoppers (tremies) or other acceptable placing methods shall be used.
- (e) Concrete shall be compacted with mechanical vibrating equipment supplemented by hand spading and tamping. Vibrators shall not be used to transport concrete inside the forms. Vibrating equipment shall be of the internal type and shall at all times be adequate in number of units and power of each unit to properly consolidate all concrete. Form or surface vibrators shall not be used. Internal vibrators shall maintain a frequency of vibration of not less than 3,600 RPM when submerged in the concrete. Vibrators shall not be left stationary in any position, but shall be moved continuously from point to point in a slow and steady movement. Vibration shall be held to a minimum to avoid loss of air content after concrete has been placed in the forms.
- (f) Water accumulated during placement shall be immediately removed. Under no circumstances shall concrete be placed in such accumulations.
- (g) Before depositing new concrete on or against hardened concrete, the surface of the hardened concrete shall be thoroughly roughened, cleaned, and saturated with water. The surface shall then be coated with grout against which the new concrete shall be placed before the grout has attained its initial set.
- (h) All top surfaces not covered by forms and which are not to be covered by additional concrete or backfill shall be carried slightly above grade and struck off by board finish.
- (i) Freshly placed concrete shall be protected from wash by rain, flowing water, mud deposits and other injurious conditions. Concrete shall not be allowed to dry out from the time it is placed until the expiration of curing period.

3.09 Curing and Protecting Concrete

- (a) All concrete shall be cured by the use of wet burlap or by a liquid membrane

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curing compound. Wet burlap shall be used where concrete is to be painted, topped with grout, and where concrete is to receive tile or a covering which requires an adhesive. Burlap so used shall be kept continuously wet for a period of 7 days, Liquid membrane curing compound shall be Sonneborn-Contech Hydroxide Resin Base Compound with fugitive red tint, Lambert Corporation No. 64-WB Compound with fugitive red tint, or approved equal. Curing compounds shall comply with ASTM Specification C309, Type 1 and AASHTO Specification M148, Type 1 and shall be applied to concrete at a rate recommended by the manufacturer.

- (b) In cold weather concrete shall be mixed and placed only when the temperature is at 40°F, or above, and rising, unless specifically authorized by the ENGINEER, in which event all materials shall be heated in a manner acceptable to the ENGINEER. In freezing weather, suitable means shall be provided for maintaining the concrete at a temperature of at least 50°F for a period of not less than 72 hours after placing, or until the concrete has thoroughly hardened. Salt, chemicals or other foreign materials shall not be mixed with the concrete for the purpose of preventing freezing. Concrete temperature shall not be allowed to exceed 90°F during pouring operations or for 72 hours thereafter.

3.10 Finish

- (a) All permanently exposed concrete surfaces which are above water level, except slabs and precast manholes, shall have a uniform and textured surface. All form marks exposed to view shall be rubbed off with a concrete rubbing stone.

3.11 Forms

- (a) Forms shall be of wood, steel or other authorized material. Where feasible, steel slip forms for continuous concrete placement may be used, subject to prior authorization by the ENGINEER of the materials to be used. Unless otherwise authorized, the form sheeting against permanently exposed concrete surfaces shall be either steel or plywood of the necessary strength.
- (b) Forms shall be built true to line and grade, and shall be mortar tight and sufficiently rigid to prevent displacement, or sagging between supports. Form surfaces shall be smooth and free from irregularities, dents, sags, or holes. Bolts and rods used for internal ties shall be arranged so that when the forms are removed, metal will not be less than 1 inch from any concrete surface.
- (c) Forms shall not be removed without the authorization of the ENGINEER. Removal shall be accomplished in such a manner as will prevent injury to the concrete. Forms shall not be removed before the expiration of the following minimum number of days after placement of concrete:

Slabs	14 days
Monolithic Pipe	7 days

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Columns and Walls	2 days
Other Concrete	2 days

- (d) All exposed concrete edges shall be given a 3/4 inch chamfer unless other size chamfers are shown on the Plans. Chamfers shall be formed by properly sized strips secured to the forms.

3.12 Embedded Items

- (a) Before placing concrete, all embedded items shall be firmly and securely fastened in place. They shall be thoroughly clean and free of any coating, rust, scale, oil or other foreign matter.

3.13 Reinforcement Bars

- (a) Reinforcement bars shall conform to the requirements of ASTM Specification A615 Grade 60. Bars shall be deformed in accordance with the requirements of ASTM Specification A615. Steel mesh reinforcement shall be electrically welded cold drawn mild steel fabric conforming to the requirements of ASTM Specification A185.
- (b) Prior to the placing of any steel reinforcement in the work, written evidence shall be submitted to the ENGINEER to the effect that such steel has been tested under and is in conformity with these Specifications unless testing is specifically waived by the ENGINEER. Certified true copies of test and acceptance reports by a responsible testing laboratory shall be considered as evidence of compliance. Additional tests may be required by the ENGINEER upon the finished bars as furnished if deemed necessary.
- (c) Complete detailed shop drawings, bending diagrams and schedules of the steel to be used in the work shall be submitted by the CONTRACTOR to the ENGINEER for review prior to the fabrication of the steel. All steel which fails to meet these Specifications or which has been improperly cut or bent, or which does not conform to the sizes shown on the Plans shall be rejected.
- (d) On delivery to the site of the work, the steel reinforcement shall be carefully bundled, tagged and stored in such a manner that the bars for any position in the work may be readily identified. Reinforcement bars shall be protected from oil, grease, dirt and any other substance that could prevent proper bonding to the concrete.

3.14 Placing Steel

- (a) Before being placed in position, all steel reinforcement shall be thoroughly cleaned of oil, mill and rust scale and other coatings that would tend to destroy or reduce the bond. Where there has been a delay in depositing concrete after the

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reinforcement has been placed, it shall be re-inspected and re-cleaned, if necessary.

- (b) Reinforcement shall be accurately positioned and secured against displacement by using annealed or similar wire of not less than No. 18 gage, or suitable clips at intersections, and shall be supported by concrete or metal chairs, stays, spacers, hangers or other acceptable supports which shall have sufficient strength and stability to maintain the reinforcement in place throughout concrete operations.
- (c) The minimum distance between parallel bars shall be as shown on the plans. Bars placed parallel to a concrete face shall be embedded in the concrete so as to provide a protective coating around the bars of the following minimum thickness unless otherwise shown on the plans:

Slabs	1	inch
Floors, walkways, driveways	1 1/2	inches
Walls	2	inches
Columns (including Pier Columns)	2	inches
Footings in contact with ground	3	inches

- (d) Where splicing is necessary, the bars shall be lapped not less than 30 diameters, and splices shall be staggered. In all cases, the lapped connection shall be sufficient to transfer the stress between bars by bond and shear, and to develop the full strength of the bars. In slabs, beams and girders, no splices shall be made at points of maximum stress and in no case shall adjacent bars be spliced at the same point.
- (e) All supports and ties shall be placed in such manner that they will not be exposed on the face of the concrete nor discolor the surface of the finished concrete. Reinforcement which has been exposed for bonding with future work shall be protected from corrosion by heavy wrappings of burlap saturated with a bituminous material.
- (f) Movement of steel reinforcement in place during concrete operations shall be prevented. Any rods which were displaced shall be restored to proper position before they are completely covered.

3.15 Joints

- (a) Construction joints and expansion and contraction joints shall be constructed only at locations shown on the Plans, unless otherwise authorized by the ENGINEER. Concrete at all joints shall have been in place not less than 12 hours before concrete is placed on or adjacent to it. The joints shall be straight and exactly horizontal or vertical as shown on the Plans. When shown on the Plans, molded water stops shall be used in construction joints and expansion and contraction joints. Molded water stops shall be of rubber or polyvinyl chloride composition.

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- (b) Molded rubber water stops for construction joints shall be the flat type, 6 inches in length, with a 3/4-inch bulb at each end. Molded rubber water stops for expansion and contraction joints shall be the flat type, 9 inches in length, with a 1-inch bulb at each end and a 1 1/2 inch hollow bulb in the center. Splices in rubber water stops shall be made by vulcanizing or by the use of a rubber union and rubber cement. Molded rubber water stops shall be as manufactured by A.C. Horn, W. R. Meadows, Inc., Rubber & Plastics Compound Company, or equal.
- (c) Molded polyvinyl chloride water stops for construction joints shall be the flat type, 6 inches in length and 3/8 inch thick, with a 3/4-inch bulb at each end, as manufactured by A.C. Horn, or the flat type 6 inches in length and 3/8 inch thick with end and intermediate ribs, as manufactured by Vulcan Metal Products, Inc., A-H Products, Viveflex Corporation, or equal. Molded polyvinyl chloride water stops for expansion and contraction joints shall be the flat type, 9 inches in length and 3/8 inch thick, with a 1-inch bulb at each end and a 1 1/2-inch hollow bulb in the center, as manufactured by A.C. Horn, Vulcan Metal Products, Inc., A-H Products, Viveflex Corporation, or equal; or the flat type 9 inches in length and 3/8 inch thick, with intermediate ribs and center hollow bulb as manufactured by Vulcan Metal Products, Inc., A-H Products, Viveflex Corporation, or equal. Splices in polyvinyl chloride water stops shall be made by the heat-softening process in strict accordance with the manufacturer's recommendations.
- (d) In expansion and contraction joints, pre-molded joint filler and cold applied joint sealing compound shall be applied in the opening on both sides of the molded water stop. Cold applied joint sealing compound shall be applied to the opening at the top of the molded water stop. Pre-molded joint filler shall be Self-Expanding Cork, Code 4324, and cold applied joint sealing compound shall be Vertiseal (light gray), a polysulfide polymer, both as manufactured by A.C. Horn, or shall be comparable products as manufactured by W.A. Meadows, Inc., Rubber & Plastics Compound Co., or equal.

3.16 Waterproofing

- (a) Waterproofing materials of the paint and/or membrane types shall be applied to concrete structures at the locations shown on the Plans.
- (b) Waterproofing paint and its application shall be as shown on the Plans or as specified in the Special Conditions.
- (c) Membrane type waterproofing shall consist of 4 coats of hot applied waterproofing pitch and 3 layers of No. 15 tarred felt, or 1 coat of cold applied setting cement and one layer of synthetic sheeting. Pitch and felt shall be as manufactured by the Barrett Division, Allied Chemical Corporation; the Flintkote Company; Johns-Manville, or equal. Cold applied cement shall be Nerva-Plast and synthetic sheeting shall be Nervastrol Seal-Pruf H-D, as manufactured by Rubber & Plastics Compound Co.; comparable materials as manufactured by Carlisle Tire & Rubber Division, Carlisle Corporation; Building Products

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Division, American Cyanamid Company, or equal. Membrane waterproofing shall be applied in accordance with the manufacturer's recommendations and as authorized by the ENGINEER.

3.17 Test Cylinders

- (a) During concrete placement operations, the DISTRICT shall make test cylinders. Generally 4 cylinders for each major pour or day's operations, or on large pours every 50 cubic yards of concrete poured unless additional testing is required by the ENGINEER on-site. The test cylinders shall be placed in a protected spot immediately after molding and kept under moist curing conditions for 24 hours, and then removed to the testing laboratory. The cost of providing cylinder molds, storing, transportation, handling, and testing the cylinders will be borne by the DISTRICT. Samples shall be taken and test specimens prepared in accordance with the requirements of ASTM Specification C31, and shall be tested in accordance with the requirements of ASTM Test C39. One cylinder shall be tested at 7 days and 2 cylinders shall be tested at 28 days for each major pour or day's operation unless otherwise authorized by the ENGINEER. In addition, one cylinder shall be tested at 56 days in the event that the 28-day test fails to meet the requirements of the specifications. Slump and air content tests shall be made at the time samples are taken for each set of cylinders. Test results shall be reported to the ENGINEER in writing and shall include the date and location of the pour from which the samples were taken.

3.18 Hydrostatic Testing

- (a) Concrete structures that are to contain water, sludge, or other liquids, such as settling or digestion tanks, coagulation basins, reservoirs, filter basins and similar structures shall be hydrostatically tested for leakage before backfilling, where applicable. Testing shall consist of filling each structure with water so that the ENGINEER can inspect and observe any leaks when the structure has been full of water for 24 hours or as directed by ENGINEER. When practical, such tests shall be made before backfill is placed around the structure. All leaks in the structure are to be repaired in an approved manner. Patching or caulking or any other method of repair on the outside or dry side of walls will not be permitted. Damp areas or spots on permanently exposed walls, such as in filter galleries, will be considered leaks. For structures below finished grade, hydrostatic testing may be omitted when specifically authorized by the Special Conditions.

3.19 Grout

- (a) All grouts used on manhole interiors shall be "non-shrink" grouts. Grout used on manhole exteriors shall be either "non-shrink" or standard cement mortar grouts.
- (b) Non-Shrink grouts shall be either Gilco pre-mixed Supreme nonmetallic grout as manufactured by Cormix Construction Chemicals, Dry Pack Grout "Willco Brand" by A. W. Cook Cement Products, Inc., or equal.

- (c) Acceptable range of testing requirements:

Compressive Strength (7 days)....7,000 to 9,000 psi
Compressive Strength (28 days)....8,250 to 11,000 psi
% Expansion.....+0.025% to +0.75%

- (d) Expansion grouts shall be used only as directed by the ENGINEER.
- (e) Grouts shall be mixed (if applicable) and placed in accordance with the manufacturer's current recommendations, for each specific application.
- (f) Cement mortar grouts shall be mixed and proportioned depending upon application range from plastic to flowable cement water paste.

3.20 Unapproved and Damaged Work

- (a) On concrete work where samples failed to show proper strength or where the quality of the concrete is otherwise questionable, the CONTRACTOR may be directed to obtain cores for further testing. Such cores and tests shall be at the CONTRACTOR's expense.
- (b) Concrete which develops less strength than specified will be reviewed on a case by case base. If ENGINEER determines that it can remain in place, payment will be made at a reduced amount as determined by the ENGINEER.
- (c) Unapproved or damaged work shall be satisfactorily replaced by the CONTRACTOR in accordance with the requirements of the Plans and Specifications. Removal and/or replacement of concrete work shall be done in the manner that will not impair the strength of the structure.

ITEM IV - SIDEWALKS, PAVEMENT AND SURFACING

4.01 Scope

- (a) The work covered by this item shall consist of the construction of new streets, roads, driveways, pavement, and surfacing, or the replacement of streets, roads, concrete sidewalks, driveways, curbs and gutters, and surfacing of whatever nature which have been removed to permit the construction of pipelines or other work, all at the locations and to the lines and grades shown on the Plans or designated by the ENGINEER. All replacements shall be of the same materials of construction as was removed, unless directed otherwise by the ENGINEER. All permits for cutting pavement shall be the responsibility of the CONTRACTOR, and no extra payment will be made for this requirement.
- (b) Where sidewalks, driveways, curbs and gutters, or surfacing of whatever nature have been removed by the CONTRACTOR beyond the limits called for in the Plans and Specifications or as set by the ENGINEER, or have been damaged through negligence or carelessness of the CONTRACTOR's forces, they shall be replaced in accordance with these Specifications at the CONTRACTOR's expense.
- (c) Unless otherwise approved or required, concrete pavement shall be removed to the nearest expansion or control joint. The CONTRACTOR will contact the Superintendent of Streets and/or NCDOT's District Engineer for a determination of the limits of concrete replacement and location of joints. Where sawed joints are allowed, the depth of the sawed cut shall be at least 1/5 of the depth of the concrete.
- (d) Bituminous pavement to be removed shall be saw-cut in a smooth and straight line. The width of pavement left between the edge of the ditch and the existing edge of the pavement or the front line of the gutter, shall be at least 3 feet. Residual strips of pavement less than 3 feet in width must be removed and replaced. Existing pavement shall be removed on each side of the trench for at least 12 inches beyond top of trench.

4.02 Materials

- (a) Materials for the construction or replacement of bituminous pavements shall be furnished in accordance with the current applicable NCDOT Standard Specifications for Roads and Structures and the NCDOT Superpave, HMA/QMS, Manual (latest edition), hereinafter referred to as the Superpave Manual. All references to the Superpave Manual shall mean the latest edition.
- (b) Concrete work in the construction or replacement of sidewalks, driveways, curbs and gutters, and road pavement shall be constructed of Class A concrete, meeting all of the applicable requirements of these Specifications. Concrete forms shall be

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of wood or metal, shall be straight and free from warp, and shall be of sufficient strength, when in place, to hold the concrete true to line and grade without springing or distortion, and shall conform to all applicable requirements of these Specifications. The quality and suitability of steel forms shall be approved by the ENGINEER prior to their use in the work. Bituminous pre-formed joints 1/2 inch thick shall be furnished and installed at points herein specified or shown on the Plans. Pre-formed expansion joints shall conform to the requirements of AASHTO Specification Designation M33 and M153.

- (c) Surfacing of graveled or similarly unpaved driveways or roads for construction or replacement shall consist of hard, durable pit run gravel or crushed stone of suitable gradation for road surfacing, meeting NCDOT specifications and shall be approved by the ENGINEER prior to being delivered to the site of the work.
- (d) Aggregate base course (ABC) shall be either type "A" or "B" which meets all requirements of Section 1010 of the NCDOT Standard Specifications for Roads and Structures.
- (e) Asphalt Intermediate Course shall be Type I 19.0B, meeting the requirements of the NCDOT Superpave Manual, latest edition.
- (f) Asphalt Surface Course shall be S4.75A or SF 9.5B, as specified, meeting the requirements of the NCDOT Superpave Manual, latest edition.
- (g) Bituminous tack coat shall be applied to all existing asphalt or concrete surfaces in accordance with DISTRICT's standard Details and Specifications and shall be of a material as set forth in Section 205-2 of the NCDOT Standard Specifications for Roads and Structures (latest edition). Bituminous tack coat shall comply with Section 605 and paragraphs 1020-2, 1020-6, and 1020-7 of Section 1020 of the above referenced NCDOT Standards.
- (h) The CONTRACTOR shall submit an asphalt mix design, for each mix type specified in the Schedule of Estimated Quantities and/or the Plans and Specifications, to the ENGINEER for review. The mix design shall be submitted as a part of the shop drawing submittal process. In lieu of performing a mix design specifically for a particular pavement repair project, the CONTRACTOR may submit a mix design, for each mix type specified, that has been reviewed and approved by NCDOT within the last six months, and will be produced at the same asphalt plant.

4.03 NCDOT Roadways

- (a) Where it is necessary to cross, cut, destroy or replace sections across or along roadways owned or maintained by the North Carolina Department of Transportation, the CONTRACTOR shall provide all bonds or deposits. The CONTRACTOR shall comply with all rules and regulations of NCDOT, including the Encroachment Agreement, and shall furnish materials and perform

all work in accordance with NCDOT Specifications.

4.04 Street Crossings

- (a) When pipe trenches are cut across or along existing streets or alleys, they shall be backfilled and resurfaced in accordance with the requirements of the regulatory agency but as a minimum to the requirements of these Specifications.
- (b) Where pipe trenches are cut across or along existing street or alley pavement or surfacing, backfill and resurfacing operations shall be of the manner specified in these Specifications and traffic restored as quickly as possible. The CONTRACTOR shall maintain such surfaces under traffic until the permanent surfacing has been placed. Replacement bituminous pavement shall have a thickness equal to that removed but shall in no case be less than 4 inches in thickness. Replacement concrete pavement shall have a thickness equal to that removed but shall in no case be less than 8 inches in thickness. A minimum of two 4-inch lifts of aggregate base course compacted to 100% standard proctor are required under the replacement pavement.
- (c) Where pipelines cut across or along existing unimproved or graveled streets or alleys, they shall be backfilled in a manner, conforming with applicable sections of these Specifications and traffic restored as quickly as possible by placing at least 8 inches of aggregate base course on the surface. A minimum of two 4-inch lifts of aggregate base course compacted to 100% standard proctor are required for final repair to the surface. The CONTRACTOR shall maintain the surfacing in good condition until acceptance of the work.
- (d) All excess materials and debris shall be removed from the site of the work and the areas left in a neat workmanlike condition.

4.05 New Unpaved Access Roads and Driveways

- (a) New unpaved access roads and driveways shall be constructed with a surfacing of aggregate base course compacted to 100% proctor, minimum thickness of 8 inches, unless otherwise shown on the Plans. It shall be spread, leveled, compacted, and maintained in good condition until final acceptance of the work.

4.06 Pavement Line Striping

- (a) When pavement replacement destroys existing line striping, new line striping of the same kind shall be provided in accordance with the requirements of the controlling agency. Pavement striping shall be incidental, and no extra payment will be made therefore.

4.07 Bituminous Pavement Removal, Replacement and Resurfacing

- (a) Pavement to be removed shall be marked with chalk lines parallel to the proposed

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sewer line and the pavement shall be saw-cut neatly along these lines prior to excavating. No pavement shall be pulled or removed by the excavation equipment until after the pavement has been completely cut along the lines. The CONTRACTOR shall establish appropriate horizontal and vertical controls so that the replacement pavement will be to the same width, crown, and elevation as the original pavement.

- (b) The trench in open-cut highways shall be backfilled in accordance with Item I of the Technical Specifications except as modified in the Special Conditions or on the Trench Details. Crushed stone, bituminous materials, and construction methods used on highways shall conform to the requirements of Standard Specifications for Roads and Structures of the North Carolina Department of Transportation (NCDOT) and the Superpave Manual.
- (c) All types of bituminous pavement replacement and resurfacing shall be performed in two phases as described below.
 - (1) Bituminous Pavement Replacement shall consist of the following items:
 - (a) Removal and disposal of existing pavement, including saw cutting of edges. The width of pavement cuts shall be the minimum required to accomplish the work. However, the maximum allowable width shall be 4 feet, unless additional width is specifically authorized, by the ENGINEER, due to circumstances beyond the control of the CONTRACTOR.
 - (b) Crushed aggregate base course, compacted to 100% Standard Proctor Density, placed to the depth specified on the pavement replacement and resurfacing details.
 - (c) A thorough application of tack coat applied to the edges of the existing pavement.
 - (d) Bituminous concrete intermediate or base course, placed flush with the existing roadway pavement surface and rolled smooth so as to conform to the lines and grades on the adjacent pavement surfaces.
 - (e) The CONTRACTOR may place the aggregate base course all the way flush with the existing pavement surface to provide a temporary safe surface but shall place the Asphalt 19.0B Intermediate Course within 3 days of completing the trench backfill unless specified or instructed otherwise by the ENGINEER.
 - (f) The Asphalt 19.0B Intermediate Course shall be left open to traffic for a period of at least 30 days to allow for settlement before pavement resurfacing can be started. The CONTRACTOR shall maintain a safe travel way at all times.

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(g) In the event poor soil conditions cause undermining of sawed pavement cuts, extra trench width will be allowed in computing pavement repair quantities, on a case by case basis, when specifically authorized by the ENGINEER.

(2) Bituminous Pavement Resurfacing shall consist of the following items:

(a) Thoroughly clean the surface of the intermediate or base course previously applied.

(b) Repair all areas in which settlement or damage of the pavement have occurred with intermediate or base course, as applicable. Settled areas may require removal of asphalt and stone, and replacement or stabilization of the subgrade. Cracked and pumping areas shall be repaired by removing the binder, stone and stabilizing the subgrade.

(c) Apply a tack coat to the entire width of paving surface.

(d) Apply bituminous concrete surface course to the width and thickness specified herein, or shown on the pavement replacement details in the plans, or as instructed by the ENGINEER.

(e) Generally, in longitudinal pavement cuts, resurfacing shall extend from edge of pavement to center line of roadway if the allowed edge of pavement cut is 3 feet or more from the roadway centerline. Where the allowed edge of pavement cut is closer than 3 feet to the roadway centerline, the pavement resurfacing shall extend from the edge to edge of the existing roadway. The resurfacing width (one lane or full width) for each street is specified on the detail drawings in the Plans. Streets specified to receive one lane resurfacing may require full width resurfacing, at the ENGINEER's discretion, if it is determined that the crown cannot be maintained.

(f) In transverse cuts, pavement resurfacing shall not be tapered as shown on the Details. One lane and full width resurfacing shall not be tapered at the edges. The full specified thickness shall extend to the road edges.

(g) Pavement requiring replacement and/or resurfacing as a result of scarring or damage by equipment movement or travel, material or equipment storage, over excavation, or other actions by the CONTRACTOR, other than specifically cutting pavement for sewer installation, shall not be included in the pavement replacement or pavement resurfacing pay items, and shall be paid for at the CONTRACTOR's expense.

(h) Private drives and parking lots shall be repaired and resurfaced in

ITEM IV - SIDEWALKS, PAVEMENT AND SURFACING

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accordance with the Specifications and the Details.

(i) Total pavement resurfacing is not required for pavement cuts in private parking lots and drives, unless specifically directed by the ENGINEER.

(j) Centerline and Edgeline Pavement Striping shall be in accordance with current NCDOT Specifications, Standard Specifications for Roads and Structures. No extra payment will be made for centerline or edgeline striping.

(k) Shoulder treatment with same materials as existing shoulder, i.e., ABC Stone, or grass surface, to bring the shoulder flush with new pavement surface and prevent a low shoulder. All shoulder treatments shall be considered incidental to pavement resurfacing and no extra payment will be made therefore.

4.08 Bituminous Curb Replacement

(a) The shape of the bituminous curb profile shall be field-verified, and matched to the existing curb section, or shall be as shown on the Plans. Curb shall be saw-cut before removing any section. Asphalt used shall be Type SF or RSF conforming to NCDOT Standards and Specifications and with all requirements of DISTRICT's Technical Specifications.

4.09 Bonds

(a) If required by NCDOT or other controlling agency, the CONTRACTOR shall be required to post a bond guaranteeing completion of pavement repair and resurfacing, to the satisfaction of the NCDOT or other controlling agency.

4.10 Concrete Drives and Walks

(a) Concrete driveways, walks and parking areas shall be replaced to match the existing concrete pavement thickness, (but not less than 6 inches thick), and existing concrete surface texture. Removal shall be made to the nearest expansion or control joint within 10 feet of the sewerline. The CONTRACTOR shall saw new control joints at intervals as approved by the ENGINEER when total replacement widths exceed 10 feet. Expansion joints shall be in lieu of construction joints as required by the ENGINEER. All work shall be performed in accordance with Item III Concrete Construction of the Specifications and to the Standard Detail shown on the Plans. Concrete shall be Class A.

(b) New concrete sidewalks and curb and gutter shall be Class A unreinforced concrete as specified in Item III of these Specifications and constructed to the width, thickness and length shown on the Plans. New sidewalks shall be 4 feet in width and 4 inches in thickness unless otherwise shown on the Plans.

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- (c) Replacement concrete sidewalks, driveways, curb and gutter shall be Class A unreinforced concrete as specified in Item III of these Specifications with a minimum thickness of 6 inches and of the same width, length, shape and grade as the section removed. Concrete pavement in streets and roads shall be replaced to the original size, shape and grade with Class A concrete 8 inches thick.
- (d) The shape of the curb and gutter profile shall be field-verified, and matched to the existing curb section, or shall be as shown on the Plans. Curb shall be saw-cut before removing any section and replaced to the nearest expansion joint. Concrete used shall be a minimum of 4000 psi Class A and shall comply with all requirements of the Technical Specifications.
- (e) Concrete side forms shall be carefully set with their top true to line and grade of the finished work and shall be rigidly held in place by stakes or braces. Forms shall be cleaned and oiled before they are set in place. Subgrade and forms shall be approved by the ENGINEER just prior to concrete placement, after which the subgrade shall be dampened, if necessary, and the freshly mixed concrete placed in the amount required to fill the area within the forms to the proper finished grade in one course. The concrete shall be thoroughly tamped or vibrated, struck off with an approved straightedge and floated with a wooden float true to the required grade and slope. The finished surface shall match existing surface and shall have a surface deviation of not more than 1/8 inch. Curb and gutter shall have control joints every 10 feet or match existing. Pre-formed bituminous expansion joints shall be placed in curb and gutter and sidewalk construction at intervals specified herein, but no greater than 40 feet. Sidewalks shall have control joints at 4 foot intervals or match existing patterns.
- (f) All completed concrete surfaces shall be immediately covered with a pre-approved material or curing agent. The concrete shall be kept continuously damp for a period of not less than 5 days, and shall be protected from damage during the curing process and thereafter until finally accepted. Any section that is damaged during construction or before final acceptance shall be replaced in a satisfactory manner by the CONTRACTOR at his own expense. No pedestrian or vehicular traffic shall be allowed on concrete walks or paving during the curing period and in no case less than 5 days after placement.
- (g) Unless otherwise specified by the Controlling Agency, all concrete work required by this section of the Specifications shall be in strict accordance with all applicable sections of the latest edition of the North Carolina Department of Transportation's Standard Specifications for Roads and Structures and NCDOT Standard Roadway Drawings.

ITEM V - GRASSING , PLANTING AND EROSION CONTROL

5.01 Scope

- (a) Grassing, planting and surface restoration consists of performing all labor and furnishing all materials to do the grassing and planting work complete as shown on the Plans and specified herein, including ground preparation and fertilizing, seeding, hydro-seeding, mulching, erosion control netting, and tree root protection, vines, shrubs and tree planting and transplanting. This work shall also include the maintenance and watering and any necessary replanting.
- (b) All materials and methods for repairing disturbed areas shall be completed in accordance with the NCDENR rules, regulations and requirements. This may require that a temporary seeding mixture be used during given dates of the year when permanent seeding would not be allowed. Temporary seeding for compliance shall be replaced by permanent seeding during allowed seeding dates.
- (c) Slopes steeper than 3:1 shall require hydroseeding unless otherwise approved by the ENGINEER.
- (d) The area within the limits shown on the Plans (and upon the direction of the ENGINEER, all areas disturbed as a result of the construction of the sanitary sewers) shall be planted with a mixture of grassing seeds and mulched as herein specified.
- (e) Vines, shrubs and trees shall be placed as shown on the planting plan or as directed by the ENGINEER, or as listed in the Special Conditions.
- (f) Grassing shall be seeding and mulching or hydroseeding. Mulching shall be straw as specified herein.

5.02 Materials

- (a) Fertilizer
 - (1) The quality of all fertilizer and all operations in connection with the furnishing of this material shall comply with the requirements of the North Carolina Fertilizer Law and with the rules and regulations, adopted by the North Carolina Board of Agriculture, in effect at the time of sampling. All fertilizer will be subject to sampling and testing by the ENGINEER, or by an authorized representative of the North Carolina Department of Agriculture, or both.
 - (2) Dry fertilizer shall have been manufactured from cured stock. During handling and storing the fertilizer shall be cared for in such a manner that it will be protected against hardening, caking, or loss of plant food values.

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Any hardened or caked fertilizer shall be pulverized to its original condition before being used.

- (3) Liquid fertilizer shall be stored and cared for after manufacture in a manner that will prevent loss of plant food values, and a homogeneous blend of plant food elements shall be maintained or re-blended to the original condition immediately before use.

(b) Limestone

- (1) The quality of all limestone and all operations in connection with the furnishing of this material shall comply with the requirements of the North Carolina Lime Law and with the rules and regulations adopted by the North Carolina Board of Agriculture, in effect at time of sampling. All limestone will be subject to sampling and testing by the ENGINEER, or by an authorized representative of the North Carolina Department of Agriculture, or both.
- (2) Limestone shall be agricultural grade ground limestone. Either dolomitic or calcitic limestone may be used. All limestone shall contain not less than 90 percent calcium carbonate equivalents. Dolomitic limestone shall contain not less than 10 percent of magnesium. Dolomitic limestone shall be so graded that at least 90 percent will pass through a U.S. Standard 20 mesh screen, and at least 35 percent will pass through a U.S. Standard 100 mesh screen. Calcitic limestone shall be so graded that at least 90 percent will pass through a U.S. Standard 20 mesh screen, and at least 25 percent will pass through a U.S. Standard 100 mesh screen. Where current grading requirements of the North Carolina Board of Agriculture are different from the above, the requirements of the Board of Agriculture shall apply.
- (3) During handling and storing, the limestone shall be cared for in such manner that it will be protected against hardening or caking. Any hardened or caked limestone shall be pulverized to its original condition before being used.

(c) Nutri-Lime

- (1) Nutri-Lime, produced at the MSD Water Reclamation Facility, is an acceptable substitution for commercially produced limestone, if it is available. This product may be picked up at the MSD Water Reclamation Facility, if available. The CONTRACTOR shall contact the DISTRICT's construction office to verify availability. Application shall be increased at a rate of 30 percent greater than conventional lime.
- (2) The use of Nutri-Lime is subject to property owner approval.

ITEM V - GRASSING, PLANTING AND EROSION CONTROL

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(d) Seed

- (1) The quality of all seed and all operations in connection with the furnishing of this material shall comply with the requirements of the North Carolina Seed Law and with the rules and regulations, adopted by the North Carolina Board of Agriculture, in effect at time of sampling. All seed will be subject to sampling by the ENGINEER, or by an authorized representative of the North Carolina Department of Agriculture, or both; and will be tested by the North Carolina Department of Agriculture. Supplementary testing for seed germination may be performed by the ENGINEER.
- (2) The quality of all seed will be based on the percentage of pure live seed, which will be computed by multiplying the percentage of purity by the percentage of germination and dividing the result by 100.
- (3) Seed shall have been approved by the North Carolina Department of Agriculture before being sown. No seed will be accepted with a date of test more than 8 months prior to the date of sowing, excluding the month in which the test was completed. Such testing, however, will not relieve the CONTRACTOR from the responsibility for furnishing and sowing seed that meets these Specifications at the time of sowing. The ENGINEER may retest seed for germination after a 5 month storing period; at the beginning of each normal seeding season for the particular kind of seed involved; or at any time that the condition of the seed appears to have deteriorated.
- (4) When a low percentage of germination causes the quality of the seed to fall below the minimum pure live seed specified, the CONTRACTOR may elect, subject to the approval of the ENGINEER, to increase the rate of application sufficiently to obtain the minimum pure live seed content specified, provided that such an increase in the rate of application does not cause the quantity of noxious weed seed per acre or square yard, as the case may be to exceed the quantity that would be allowable at the regular rate of application.
- (5) Each of the species or varieties of seed shall be furnished and delivered in separate bags. If seed is to be mixed before sowing, such mixing shall be done in a commercial seed mixing machine or by equally thorough means after sampling and testing have been completed.
- (6) During handling and storing, the seed shall be cared for in such a manner that it will be protected from damage by heat, moisture, rodents, or other causes.

(e) Straw Mulch

- (1) Straw mulch shall be threshed straw of oats, rye, or wheat and shall be free of mature seed, and free of any weed or grass species which would germinate and be detrimental to the specified grass.

(f) Erosion Control Matting

- (1) Erosion Control Matting shall be jute, cotton, excelsior, plastic, or other material permitted by NCDENR. Matting shall not be dyed, bleached or otherwise treated in a manner that will result in toxicity to vegetation. When used within NCDOT Rights-of-Way, matting shall be in accordance with all applicable sections of the NCDOT Standard Specifications.

- (2) Jute matting shall be woven from plain single jute yarn, averaging 130 pounds per spindle of 14,400 yards. The yarn shall be loosely twisted and shall not vary in thickness by more than 1/2 its normal diameter. The finished mesh shall be of uniform, open (nominal one inch) plain weave, furnished in rolls as follows:

Width: 48 inches minimum, plus or minus one inch, with 78 warp ends, plus or minus 2 ends, per width of matting.

Length: Convenient lengths, 50 yards minimum, with 41 weft ends, plus or minus 1 end, per linear yard.

Weight: Average 1.22 pounds per linear yard, plus or minus 5 percent.

- (3) Cotton netting shall be woven from undyed and unbleached cotton yard. The finished netting shall be of uniform open weave forming an open rectangular or square mesh of 1/4 to 1/2 inch, and furnished in rolls with the following characteristics:

Width: 48 inches minimum

Length: Convenient lengths, 50 yards minimum

Weight: Minimum average 0.12 pounds per linear yard of 48 inch wide material

- (4) Excelsior matting shall consist of a machine produced mat of curled wood Excelsior at least 47 inches in width. The mat shall be 0.975 pounds per square yard with a tolerance of plus or minus 10 percent. At least 80 percent of the individual excelsior fibers shall be 6 inches or more in length. The Excelsior fibers shall be evenly distributed over the entire area of the blanket. One side of the Excelsior matting shall be covered with a woven fabric of twisted paper cord or cotton cord, or with an

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extruded plastic mesh. The mesh size of either the fabric or plastic mesh shall be a minimum of 1 inch x 1 inch and a maximum of 1 ½ inches x 3 inches.

- (5) Plastic netting shall be an extruded polypropylene or other acceptable plastic material, extruded in such a manner as to form a net with 1/4 to 1/2 inch rectangular or square openings with strands of approximately 9 millimeters thickness. The netting shall be furnished in rolls meeting the following characteristics:

Width: 48 inches minimum

Length: Convenient lengths, 50 yards minimum

Weight: Minimum average 5 pounds per 1,000 square feet

- (6) Staples to hold erosion control netting in place shall be "U" shaped and shall be approximately 6 inches long and 1 inch wide. Machine made staples shall be of No. 11 gauge or heavier steel wire. Hand made staples shall be made from 13-inch lengths of No. 9 gauge or heavier steel wire.

(g) Shrubs and Trees

- (1) Materials to be furnished hereunder shall be approved by ENGINEER prior to delivery of materials. All materials delivered hereafter shall conform to approved samples. All stored materials on the site shall be protected until installation of materials has been completed.
- (2) Shrubs and plants shall be inspected for quality, size and variety, either at the place of growth or after delivery at the site of the work; as directed by the ENGINEER. No shrubs or plants rejected at place of growth or at the site of the work shall be used or paid for under the pay item. Certificates of inspection as required by federal, state or other authorities shall accompany each shipment.
- (3) Plants shall be freshly dug, vigorous, of normal habit of growth, free of disease, insects, insect eggs and larvae. Plants shall be nursery grown under climatic conditions similar to those in the locality of the project. The height of plants and branching shall be measured when branches are in normal positions. The caliper shall be the diameter of trunk measured 1 foot above the surface of ground and shall be the determining measurement on a primary stem which starts from or close to the ground or at a point not higher than 1/4th of the height of the plant. Plants shall conform to measurements of plant list in the Plans, except that oversize plants may be used at no increase in contract price. Plants shall not be pruned prior to delivery except upon special approval. The variety of any shrub or plant shown on the Plans may be changed prior to delivery to

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another variety of equal cost, at the option of the ENGINEER.

- (4) Stakes for supporting trees shall be of sound wood of uniform size, capable of standing in ground at least 2 years. They shall be at least 1.5 inches in diameter and not less than 9 feet in length, except that for trees under 6 feet in height stakes shall be not less than 8 feet in length. Ties shall be strips of canvas not less than 3 inches in width and 10 ounces in weight or equal fabric. Wrapping materials shall be of first quality burlap or waterproof crepe paper not less than 6 or more than 10 inches in width and of suitable strength.
- (5) Scientific and common plant names used on the Plans conform to Standardized Plant Names prepared for the American Joint Committee of Horticulture Nomenclature. Names of varieties not included therein conform generally with names accepted in the nursery trade. Substitutions will not be permitted, except that if proof is submitted that any plant specified is not obtainable a proposal will be considered for use of nearest equivalent size or variety with an equitable adjustment of contract price. The plants to be furnished and planted are shown on the Plans or listed in the Specifications.

5.03 Seedbed Preparation

- (a) After all other construction work is completed and the surface of the ground finished to subgrade, the topsoil that was removed and stockpiled as specified in Item I of the Specifications shall be spread over the area to be planted. This topsoil shall be uniformly spread in a layer not less than 4 inches thick. Additional topsoil from other sources shall be furnished by the CONTRACTOR if necessary, to cover the area to be planted to the specified depth. The entire area to be planted shall be carefully finished to exact line and grade before planting. Care shall be used to shape the surface of the ground properly around structures. Topsoil to be furnished shall be fertile, friable, natural topsoil typical of topsoil of locality. It shall be without admixture of subsoil and shall be reasonably free of stones, lumps, plants, roots, sticks, and other extraneous matter, and shall not be used for planting operations while in a frozen or muddy condition.
- (b) The CONTRACTOR shall cut and satisfactorily dispose of weeds or other unacceptable growth on the areas to be seeded. Uneven and rough areas, such as crop rows, farm contours, ditches and ditch spoil banks, fence line and hedgerow soil accumulations, and other minor irregularities which cannot be obliterated by normal seedbed preparation operations, shall be shaped and smoothed as directed by the ENGINEER to provide for more effective seeding and for ease of subsequent mowing operations.
- (c) The soil shall then be scarified or otherwise loosened to a depth of not less than 4 inches except as otherwise provided below or otherwise directed by the ENGINEER. Clods shall be broken and the top 2 to 3 inches of soil shall be

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worked into an acceptable seedbed by the use of soil pulverizers, drags, or harrows, or by other methods approved by the ENGINEER. All rock and debris shall be removed prior to the application of seed and fertilizer.

- (d) Prior to distribution of topsoil, the sub-grade shall be scarified as described above. After the topsoil is spread, the surface of all areas to be planted shall be prepared by plowing and disking in both directions, when feasible, to a depth of not less than four (4) inches. After removal of all large particles which cannot be broken, the surface shall then be harrowed and cultivated. Plowing and harrowing shall be performed with proper equipment and in such a manner as to break up all clods, lumps, or earth balls, and to remove all rocks, stumps, large roots, or other particles so as to provide a suitable planting bed. Hand tools shall be used in inaccessible small areas.
- (e) The preparation of seedbeds shall not be done when the soil is frozen, extremely wet, or when the ENGINEER determines that it is an otherwise unfavorable working condition.
- (f) All soil to be used in a tree, shrub and vine pit for planting operations shall be conditioned by thoroughly mixing one part by volume of peat, one part by volume of composted manure and four parts by volume of topsoil.

5.04 Applying and Covering Limestone, Fertilizer, and Seed

(a) General

- (1) Seasonal limitation for seeding operations; the kinds of grades of fertilizers; the kinds of seed; and the rates of application of limestone, fertilizer, and seed shall be as stated in the Special Provisions.
- (2) Equipment to be used for the application, covering, or compaction of limestone, fertilizer, and seed shall have been approved by the ENGINEER before being used on the project. Approval may be revoked at any time if equipment is not maintained in satisfactory working condition, or if the equipment operation damages the seed.
- (3) Limestone, fertilizer, and seed shall be applied within 24 hours after completion of seedbed preparation unless otherwise permitted by the ENGINEER, but no limestone or fertilizer shall be distributed and no seed shall be sown when the ENGINEER determines that weather and soil conditions are unfavorable for such operations.
- (4) During the application of fertilizer, adequate precautions shall be taken to prevent damage to traffic, structures, houses, vehicles, or any other appurtenances. The CONTRACTOR shall either provide adequate covering or change methods of application as required to avoid such damage. When such damage occurs the CONTRACTOR shall repair it,

including any cleaning that may be necessary.

(b) Limestone and Fertilizer

- (1) Limestone may be applied as a part of the seedbed preparation, provided it is immediately worked into the soil. If not so applied, limestone and fertilizer shall be distributed uniformly over the prepared seedbed at the specified rate of application and then harrowed, raked, or otherwise thoroughly worked or mixed into the seedbed.
- (2) If liquid fertilizer is used, storage containers for the liquid fertilizer shall be located on the project and shall be equipped for agitation of the liquid prior to its use. The storage containers shall be equipped with approved measuring or metering devices which will enable the ENGINEER to record at any time the amount of liquid stored in the containers.
- (3) Fertilizers shall be applied uniformly into the areas to be planted or improved in such amount and to such depth and according to the methods indicated in the Specifications for the various ground covers. The fertilizer shall be well pulverized and free of lumps when applied. In no case shall full strength fertilizer be permitted in direct contact with roots. When fertilizers are applied hydraulically they must be diluted sufficiently as directed so that no damage is done to either seed or established grasses and legumes. Agricultural limestone and basic slag shall be applied in a separate operation but may be incorporated in soil with fertilizers in one operation.

(c) Seed

- (1) The CONTRACTOR shall notify the ENGINEER at least 24 hours in advance of the time he intends to start inoculating and mixing seed or begin sowing seed and shall not proceed with such work until permission to do so has been given.
- (2) Prior to sowing, the seed accepted for use shall be inoculated as provided herein. Each kind of seed shall be inoculated separately with the appropriate commercial culture according to instructions of the manufacturer of the material accepted for use, then allowed to surface dry to a free flowing state before mixing or sowing. In general, no greater quantity of seed shall be inoculated at one time than can be sowed by the end of the following working day. All inoculated seed shall be protected from the sun and direct contact with commercial fertilizers.
- (3) Seed shall be distributed uniformly over the seedbed at the required rate of application, and immediately harrowed, dragged, raked, or otherwise worked so as to cover the seed with a layer of soil. The depth of covering shall be as recommended by the seed company. If two kinds of seed are to

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be used which require different depths of covering, they shall be sown separately.

- (4) Sowing of seed shall follow promptly after incorporation of fertilizer. Sowing shall be done uniformly at the specified rate by approved mechanical seeders. Hand operated cyclone sowers will be considered mechanical seeders. No sowing shall be done during windy weather, when the prepared surface is crusted, or when the ground is frozen, wet or otherwise in a non-tillable condition. When a combination seed and fertilizer drill is used, fertilizer may be drilled in with the seed after limestone has been applied and worked into the soil. If two kinds of seed are being used which require different depth of covering, the seeding requiring the lighter covering may be sown broadcast or with a special attachment to the drill, or drilled lightly following the initial drilling operation.
- (5) When a hydraulic seeder is used for application of seed and fertilizer, the seed shall not remain in water containing fertilizer for more than 30 minutes prior to application unless otherwise permitted by the ENGINEER.
- (6) Immediately after sowing, the seeded area shall be harrowed, dragged, raked or otherwise worked so as to work the seed into the soil. Care shall be exercised during covering operations to preserve the line, grade and cross-section of the seeded areas and to see that areas adjacent to pavement, walks, etc., are not left higher than the paved surface. After the seed has been properly covered the seed bed shall be compacted immediately by means of a cultipacker, light roller or approved drag. Rolling or covering of seed may be omitted when seeding is done hydraulically and mulched.
- (7) The CONTRACTOR shall water, fill washes, and otherwise protect and maintain the seeded areas until permanent grass is established. Damage by either pedestrian, vehicular traffic, or other causes shall be repaired by the CONTRACTOR. It shall be the responsibility of the CONTRACTOR to establish and maintain a satisfactory stand of grass until final acceptance of the project and for the warranty period. A satisfactory stand of established grass shall be defined as a dense uniform growth 3 inches high with complete cover of living grass (limited to the species of seed that are expected to germinate in the current season). If a satisfactory stand of grass is not established, the area shall be reseeded by the CONTRACTOR until permanent grass is established. Seeded areas shall be mowed as required and when weeds or other undesirable vegetation threaten to smother the planted species.
- (8) Existing privately maintained lawns shall be matched with a permanent seeding mixture. Said mixture rates and dates of seeding are to be

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documented by the CONTRACTOR and approved by the ENGINEER prior to application. Certain lawns may require sodding or sprigging in order to match existing lawns within the warranty period.

(9) **TEMPORARY SEEDING MIXTURE – WINTER, EARLY SPRING AND FALL**

Seed Application Rates

<u>Species</u>	<u>Rate (lb./acre)</u>
Rye (Grain)	120

The Plans and Special Easement Provisions may specify seed other than above for specific properties or areas.

Suggested Seeding Dates

January through April

During prime growing season Kentucky 31 fescue may be used as temporary seeding. Application shall be as specified under permanent seeding.

Soil Amendments

Apply lime and fertilizer according to soil tests or apply 2,000 lb./acre ground agricultural limestone and 750 lb./acre 10-10-10 fertilizer.

Mulch

Apply 3,000 - 4,000 lb./acre grain straw or equivalent cover of another suitable mulching material. Anchor mulch by tacking with asphalt, roving or netting, if specified on the Plans, or if directed by the ENGINEER.

Jute, Excelsior or other specified erosion control material shall be used in ditches and swales.

Maintenance

In all areas where an adequate stand of grass is not established and where erosion damage has occurred, rework the seed bed, as specified and seed and mulch again.

(10) **TEMPORARY SEEDING MIXTURE – SUMMER**

Seed Application Rates

<u>Species</u>	<u>Rate (lb./acre)</u>
German Millet	40

The Plans or Special Easement Provisions may specify seed other than above for specific properties or areas.

Suggested Seeding Dates

May through August

During prime growing season Kentucky 31 fescue may be used as temporary seeding. Application shall be as specified under permanent seeding.

Soil Amendments

Apply lime and fertilizer according to soil tests or apply 2,000 lb./acre ground agricultural limestone and 750 lb./acre 10-10-10 fertilizer along with 500 lb./acre of 0-20-0 superphosphate.

Mulch

Apply 3,000 - 4,000 lb./acre grain straw or equivalent cover of another suitable mulching material. Anchor mulch by tacking with asphalt, roving or netting, if specified on the Plans, or if directed by the ENGINEER.

Jute, Excelsior or other specified erosion control material shall be used in ditches and swales.

Maintenance

In all areas where an adequate stand of grass is not established and where erosion damage has occurred, rework the seed bed, as specified and seed and mulch again.

(11) **PERMANENT SEEDING MIXTURE - LAWNS**

Seed Application Rates

<u>Species</u>	<u>Rate (lb/acre)</u>
Falcon Fescue	175
Rebel Fescue	175
Jaguar Fescue	175
Biltmore Mix	200

The Plans or Special Easement Provisions may specify seed other than above for specific properties or areas.

Suggested Seeding Dates

Best

August 15 - September 1

March 1 - April 1

Possible

July 25 - September 15

March 1 - May 10

Complete seeding earlier in Fall, and start later in Spring on north and east facing slopes.

Soil Amendments

Apply lime and fertilizer according to soil tests or apply 4,000 lb./acre ground agricultural limestone and 1,000 lb./acre 5-10-10 fertilizer along with 500 lb./acre of 0-20-0 superphosphate.

Mulch

Apply 4,000 - 5,000 lb./acre grain straw or equivalent cover of another suitable mulching material. Anchor mulch by tacking with asphalt, roving or netting, if specified on the Plans, or if directed by the ENGINEER.

Jute, Excelsior or other specified erosion control material shall be used in ditches and swales.

Maintenance

In all areas where an adequate stand of grass is not established, rework the seed bed, as specified and seed and mulch again.

(12) **PERMANENT SEEDING MIXTURE –
OPEN FIELDS AND PASTURES**

Seed Application Rates

<u>Species</u>	<u>Rate (lb./acre)</u>
Kentucky 31 Fescue	175 – 200

The Plans or Special Easement Provisions may specify seed other than above for specific properties or areas.

Suggested Seeding Dates

<u>Best</u>	<u>Possible</u>
August 15 – September 1	July 25 – September 15
March 1 – April 1	March 1 – May 10

Complete seeding earlier in fall, and start later in spring on north and east facing slopes.

Soil Amendments

Apply lime and fertilizer according to soil tests or apply 4,000 lb./acre ground agricultural limestone and 1,000 lb./acre 5-10-10 fertilizer along with 500 lb./acre of 0-20-0 superphosphate.

Mulch

Apply 3,000 – 4,000 lb./acre grain straw or equivalent cover of another suitable mulching material. Anchor mulch by tacking with asphalt, roving or netting, if specified on the Plans, or if directed by the ENGINEER.

Jute, Excelsior or other specified erosion control material shall be used in ditches and swales.

Maintenance

In all areas where an adequate stand of grass is not established, rework the seed bed as specified and seed and mulch again.

(13) PERMANENT SEEDING MIXTURE for R-O-W CLEARED
THROUGH WOODS

Seed Application Rates

<u>Species</u>	<u>Rate (lb/acre)</u>
Kentucky 31 Fescue	175 - 200

Alternate Wildlife Friendly Seeding Mixture

The following seeding mixtures may be specified when wildlife-friendly vegetation is desired, or for environmentally sensitive areas.

Alternate 1 2 Bushels (120 pounds) of wheat

Small amounts of the following may be added to enhance the composition of the resulting native vegetation : big bluestem, little bluestem, partridge pea, clover, sunflowers, or other desirable plants

Alternate 2 - Wildlife Food Plot	6 pounds ladino clover
	2 pounds white dutch clover
	50 pounds wheat or oats

Alternate 3 - Wildlife Food Plot (ability to last for several years)

5 pounds ladino clover
5 pounds red clover
5 pounds sunflower
50 pounds wheat or oats

Alternate 4 - Wildlife Food Plot (for dove and small game; annual)

50 pounds wheat or oats
5 pounds buckwheat
5 pounds millet (proso or browntop)
5 pounds grain sorghum

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Alternate 5 - Native Prairie mix (perennial)

Plant	Seeding Rate
Blackwell Switchgrass	3 lbs / acre
Indiangrass	3 lbs / acre
Big Bluestem	3 lbs / acre
Little Bluestem	3 lbs / acre
Partridge Pea	1.5 lbs / acre
Virginia Wild Rye	3 lbs / acre
Maxmillian sunflower	1.2 lbs / acre
Winter Wheat or oats(F) or Annual Ryegrass (S)	25 lbs / acre
Fertilize with 400 lbs / acre of 0-25-25	
*Planting date: S = Spring, F = Fall	

The Plans or Special Easement Provisions may specify seed other than above for specific properties or areas.

Suggested Seeding Dates

Best

August 15 - September 1

March 1 - April 1

Possible

July 25 - September 15

March 1 - May 10

Complete seeding earlier in Fall, and start later in Spring on north and east facing slopes.

Soil Amendments

Apply lime and fertilizer according to soil tests or apply 4,000 lb./acre ground agricultural limestone and 1,000 lb./acre 5-10-10 fertilizer along with 500 lb./acre of 0-20-0 superphosphate.

Mulch

Apply 3,000 - 4,000 lb./acre grain straw or equivalent cover of another suitable mulching material. Anchor mulch by tacking with asphalt, roving or netting, if specified on the Plans, or if directed by the ENGINEER.

Jute, Excelsior or other specified erosion control material shall be used in ditches and swales.

Maintenance

In all areas where an adequate stand of grass is not established rework the seed bed, as specified and seed and mulch again.

5.05 Mulching

(a) General

- (1) All seeded areas shall be mulched unless otherwise indicated in the Special Provisions or directed by the ENGINEER.
- (2) Grain straw may be used as mulch at any time of the year. If permission to use material other than grain straw is requested by the CONTRACTOR and the use of such material is approved by the ENGINEER, the seasonal limitations, the methods and rates of application, the type of binding material, or other conditions governing the use of such material will be established by the ENGINEER at the time of approval.

(b) Applying Mulch

- (1) Mulch shall be applied within 24 hours after completion of seeding unless otherwise permitted by the ENGINEER. Care shall be exercised to prevent displacement of soil or seed or other damage to the seeded area during the mulching operations.
- (2) Mulch shall be uniformly spread by hand or by approved mechanical spreaders or blowers which will provide an acceptable application. An acceptable application will be that which will allow some sunlight to penetrate and air to circulate but also partially shade the ground, reduce erosion, and conserve soil moisture.
- (3) Straw mulch shall be applied at the rate of not less than 2 tons per acre.
- (4) Straw mulch may be applied by hand or with a mechanical mulch spreader. The spreader shall be designed to break up balls or clusters of the mulch and apply it evenly and uniformly over the surface so as not to exclude penetration of sunlight.
- (5) Immediately after the area to be mulched has received ground preparation and specified planting, the mulch shall be applied at the rates specified above. Mulch which is too fresh, or excessively brittle, or so decomposed as to retard growth of grass will not be acceptable. The asphalt adhesive shall be applied at a rate of 200 to 250 gallons per acre of undiluted asphalt.
- (6) Mulch shall not be applied during period of high winds or other unfavorable conditions. Care shall be exercised to protect the public, adjacent property, buildings, curbs, sidewalks, and the like from discoloration by the asphalt adhesive. The CONTRACTOR shall be responsible for any such damage to public or private property. Any damage or discoloration to structures shall be repaired without delay at the

CONTRACTOR's expense.

(c) Holding Mulch

- (1) Where directed by the ENGINEER or called for on the Plans, mulch shall be held in place by applying a sufficient amount of asphalt or other approved binding material. The rate and method of application of binding material shall meet the approval of the ENGINEER. Where the binding material is not applied directly with the mulch it shall be applied immediately following the mulch application.
- (2) During the application of asphalt binding material, or other approved binding materials, adequate precautions shall be taken to prevent damage to traffic, structures, sidewalks, houses, or any other appurtenances. The CONTRACTOR shall either provide adequate covering or change methods of application as required to avoid such damage. When such damage occurs, the CONTRACTOR shall immediately repair it, including any cleaning that may be necessary.

5.06 Hydro-Seeding and Mulching

- (a) Hydro-seeding and mulching shall consist of sowing seeds by hydraulic equipment and covering, compacting, mulching, and maintaining seeded areas. Seeds, hydro-seeding and mulching shall comply with applicable portions of these Specifications. Hydro-seeding and mulching shall be performed at the locations and at the time shown on the plans and in conformity with these specifications.
- (b) Hydro-seeding shall be performed by approved equipment designed for the purpose. The equipment shall be designed to pump a water-seed-inoculant uniformly over the areas to be seeded. It shall include a power driven agitator to keep the mixture uniform during application. The equipment shall be of sufficient force and capacity to apply a uniform application to the upper limits of all cut slopes and the lower limits of all fill slopes. For hay or straw mulch, equipment shall be as specified herein.
- (c) Apply legume inoculates at 4 times the manufacturer's recommended rates when adding inoculant to hydro-seeder slurry. The seeds shall be placed in the culture solution and mixed by mechanical agitator in the hydraulic feeder. Seeds shall be applied at the rate specified herein, and shall not remain in contact with the fertilizer for more than one hour prior to application.

5.07 Maintenance of Seed and Mulching

- (a) Areas where seeding and mulching have been performed shall be maintained in a satisfactory condition until final acceptance of the project. Maintenance shall

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include mowing at the location and times directed by the ENGINEER.

- (b) Areas of damage or failure due to any cause shall be corrected by being repaired or by being completely redone as may be directed by the ENGINEER.
- (c) Where correction will require extensive seedbed preparation, or where earthwork repairs or complete reshaping is necessary, the seeding and mulching shall be redone in accordance with this section.
- (d) As an exception to the above, areas of damage or failure resulting either from negligence on the part of the CONTRACTOR in performing subsequent construction operations, or from not taking adequate precautions to control erosion and siltation as required throughout the various sections of the Specifications, shall be repaired by the CONTRACTOR as directed by the ENGINEER at no cost to the DISTRICT.

5.08 Erosion Control Netting (Jute)

- (a) Erosion control netting shall be applied to seeded and mulched ground areas where directed by the ENGINEER, or where called for on the Plans.
- (b) Erosion control netting shall be placed immediately after completion of ground preparation, fertilizing, seeding, and mulching in accordance with these Specifications. The netting strips shall be rolled out flat, parallel to the direction of flow. When 2 or more strips are required to cover an area, they shall overlap 3 inches, minimum. Ends of strips shall overlap 6 inches, minimum, with the upgrade section on top. The upslope end (anchor slot) of each strip shall be buried in 6 inch vertical slots, and soil tamped firmly against it. Any other edge exposed to excessive flow shall be buried similarly, at the direction of the ENGINEER.
- (c) The netting shall be spread evenly and smoothly, and in contact with the mulch at all points. It shall be tamped or stapled to assure close contact with the mulch. Each strip shall be stapled in 3 rows; each edge and the center, spaced at not more than 3 feet longitudinally. Ends of strips shall be stapled at 9 inch intervals across their width.
- (d) Care during construction shall consist of protection and of repairs made necessary by erosion, wind, fire, and/or other causes. Repairs shall be such as to re-establish the condition and grade of the soil as existed prior to application of the netting, restoring damaged ground preparation, re-fertilization and replanting of damaged areas, without additional compensation. The period of care shall continue until final acceptance of the project. This work shall be performed without additional compensation.

5.09 Excelsior Matting

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- (a) Excelsior matting may be used instead of erosion control netting and mulching on ground areas having a slope steeper than 2 to 1 or at other locations as directed by the ENGINEER, or where called for on the Plans.
- (b) The area to be covered by the matting shall be properly prepared, fertilized, and seeded before the matting is applied. When the matting is unrolled, the netting shall be on top and the fibers in contact with the soil over the entire area. In ditches the matting shall be applied in the direction of the flow of water with the edges secured and lapped as per the manufacturer's specifications. On slopes the matting shall be applied vertically with the slope, with the ends, sides and sections being installed and secured as per the manufacturer's specifications.
- (c) Staple spacing and size may vary with soil conditions, placement pattern, flow rates and slope and shall be in accordance with the manufacturer's specifications and requirements. However, in no case shall they be spaced less than 2 linear yards apart, on each side, and one row in the center alternately spaced between each side (60 staples on each blanket); a common row of staples shall be used on adjoining blankets. All staples shall be driven vertically into the ground.

5.10 Planting Shrubs and Trees

- (a) Remove rock or other underground obstructions to the depths necessary to permit proper installation of the planting, unless other locations are selected by the ENGINEER.
- (b) Stake plant locations and secure approval before excavating pits, making any adjustments necessary; locate no plants, except vines, closer than 2 feet to pavement or structure.
- (c) Excavate pits in circular outline, with vertical sides, for all plants except hedge plants.
- (d) Tree pits shall be at least 2 feet greater in diameter than diameter of ball or spread of roots; and at least 2 feet in depth. Shrub pits shall be at least 1 foot greater in diameter than diameter of ball or spread of roots and at least 1 foot in depth.
- (e) Set plants in center of pits, placing ball or roots on a layer of topsoil at least 2 inches in depth, adjusting depth as necessary so that crown of plant will stand at finished grade; set hedge plants, evenly spaced, along center line of trench. Compact soil around balls or roots of plants and water thoroughly. Form ridge of soil around edge of pit to facilitate watering. Use clean soil excavation from plant pits between shrub pits, if arranged in groups, as necessary to bring planted areas to finished grade, and dispose of excess excavated soil as directed; cultivate between pits to a depth of 6 inches, rake smoothly and neatly outline.
- (f) Prune plant in accordance with standard horticultural practice. Mulch plant pits 1 inch deep, using well composted manure lightly incorporated in soil.

- (g) Stake trees as follows: setting each stake vertically and at least 1/3 of its length in ground, approximately 12 inches from trunk; guy trees to upper end of stakes with canvas ties folded to a 1 1/2 inch width. Single stake trees under 2 inches in caliper if indicated by drawings. Double stake each tree 2 or 3 inches in caliper setting each stake vertically at least 1/3 of its length in the ground, approximately 12 inches from trunk. Guy trees to upper end of stake with canvas ties folded to 1 1/2 inches in width.
- (h) Wrap trunk of trees, spirally to height of second branches and tie the wrapping in place with suitable cord.

5.11 Guarantee and Replacements

- (a) The CONTRACTOR will replace during the next planting season all dead trees, shrubs, and grass at no additional cost. Plants used for replacement shall be of the same kind and size removed or as specified elsewhere and shall be furnished, planted and mulched as specified.
- (b) The CONTRACTOR shall maintain planting at his own expense until expiration of the warranty period, and until 1 year after planting. Maintenance shall consist of preserving, protecting, watering, replacing, and such other work as may be necessary to keep the work in a satisfactory condition.

5.12 Erosion Control

- (a) The DISTRICT will obtain the Certificate of Plan approval of the Erosion and Sedimentation Control Plan and a general stormwater NPDES Permit, if required, prior to beginning construction. The Permit is issued by the Land Quality Section, Department of Environment, Health and Natural Resources, 2090 U.S. Hwy. 70, Swannanoa, NC 28778. A copy of the Permit is included in the Special Conditions (if applicable).
- (b) The CONTRACTOR shall be required to perform the items of work shown on the Plans, and/or described in the Special Conditions of the Specifications and listed in the Permit.
- (c) During the construction of the project, the CONTRACTOR shall take the necessary steps to minimize soil erosion and siltation of rivers, streams, lakes and property. The CONTRACTOR shall comply with the applicable regulations of the appropriate governmental agencies in regard to soil erosion control and sedimentation prevention.
- (d) The DISTRICT will limit the area over which clearing and grubbing and excavation operations are performed whenever the CONTRACTOR's operations do not make effective use of proper erosion control measures.

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- (e) Prior to the end of each work day on the project, the CONTRACTOR shall take the necessary measures to protect the construction area from erosion.
- (f) Temporary and permanent erosion control measures shall be accomplished at the earliest practicable time. Temporary erosion control measures shall be coordinated with permanent measures to insure economical effective and continuous erosion control during the life of the project.
- (g) Temporary erosion control measures may include but not be limited to the use of temporary berms, dams, dikes, drainage ditches, silt ditches, silt fences, vegetation, mulches, mats, netting or other methods or devices which are shown or referenced in the NCDENR's "Erosion and Sediment Control Planning and Design Manual" (latest edition) and which are approved by the ENGINEER for use on the project or shown upon the project erosion control plan.
- (h) Erosion control measures installed by the CONTRACTOR shall be suitably maintained by the CONTRACTOR, until the site is fully stabilized.
- (i) Where excavation is adjacent to streams, lakes or other surface waters, the CONTRACTOR shall not place excavated materials between the excavation and the surface waters. Where this practice is impractical, the CONTRACTOR shall provide temporary erosion control measures as authorized by the ENGINEER, shown on the Plans, described in the Special Conditions of the Specifications, or listed in the Permit.
- (j) Where live streams are crossed by the project, the CONTRACTOR shall exercise particular care to prevent siltation of the stream. Disturbance shall be limited to the width allowed by the US Army Corps of Engineer's Permit. Temporary erosion control measures shall be constructed as authorized by the ENGINEER. These may include but not be limited to use of coffer dams in the stream, dikes, diversion ditches and/or temporary sediment traps at the top of the banks, and silt fences on all creek banks. All temporary erosion control measures shall be acceptably maintained until permanent erosion control measures at stream crossings shall include but not be limited to filter fabric and dumped rip-rap on the creek banks and the establishment of permanent grass cover on all disturbed and exposed soil.
- (k) Where runoff on natural ground may cause erosion of the trench or erosion of the backfill in the trench, the CONTRACTOR shall construct temporary erosion control measures. These may include but not be limited to diversion ditches, check dams and silt basins or other suitable erosion control measures as authorized by the ENGINEER.
- (l) Clearing and grubbing operations shall be limited to a maximum of 3,000 feet ahead of pipe installation crews. Temporary erosion control measures shall be constructed by the CONTRACTOR on cleared areas of the project as authorized

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by the ENGINEER. These shall include but not be limited to dikes, diversion ditches, silt basins, check dams and silt fences.

- (m) Permanent seeding of disturbed areas shall be accomplished at the earliest practicable time. Temporary seeding may be permitted and/or required in some areas where permanent seeding cannot be immediately installed. In no case shall the time between the completion of the pipe laying/backfill phase of the operation and the establishment of permanent and/or temporary ground cover exceed that specified by NCDENR.
- (n) The CONTRACTOR may install temporary seeding or ground cover, in lieu of permanent seeding on disturbed areas where he deems it necessary and desirable and when authorized and approved by the ENGINEER. The CONTRACTOR shall not place more than 500 feet of sewer line ahead of temporary or permanent seeding of disturbed areas, except where the CONTRACTOR is using such areas for access for pipe laying operations. A single lane travel corridor may be maintained within the easement with the remainder of the easement being seeded and mulched. Between March 1 and September 30, permanent seeding and mulching shall be completed within 300 feet of pipe construction.
- (o) Gravel construction entrances shall be installed at all locations used regularly as ingress and egress to the project site.
- (p) Stream and River Crossings
 - (1) Stream and River Crossings shall be constructed as shown on the Plans or listed in the Special Conditions and should be in accordance with all rules, regulations and requirements of the US Army Corps of Engineers, US Fish and Wildlife Service, or any other Federal, State, or Local Agency having jurisdiction in the area of work.
 - (2) Diversion ditches shall be constructed at or near the top of each river bank at river crossings. Localized stormwater runoff shall be diverted by way of the diversion ditches away from the disturbed stream bank. Water coming into contact with uncured concrete shall be pumped to a separate holding tank or basin and shall not be returned to the river until proper settlement of solids and adjustment of pH to between 7 and 9. Temporary sediment traps may be required if determined necessary by the ENGINEER.
 - (3) The CONTRACTOR shall submit a plan for each stream and river crossing showing his methods and materials. The plan shall be approved by the ENGINEER prior to construction.
- (q) Dumped Rip Rap for River and Stream Bank Protection
 - (1) Rip Rap, where specified on the Plans, shall be placed to provide a depth

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of 1.5 feet minimum and shall conform to the existing river bank slope and alignment. Where rip rap is to be placed on river banks, the banks shall be excavated to accommodate the proposed rip rap, leaving the riprap surface flush with the adjoining existing surfaces, such that the finished stream bank is restored to pre-construction contours.

- (2) Geotextile fabric shall be placed on stream banks prior to placing rip rap as shown on Plans and shall meet the following requirements: Grab tensile strength shall be a minimum of 200 lbs. in accordance with ASTM-D4632. Elongation at failure shall be 50% minimum in accordance with ASTM D4632. Burst strength shall be minimum 360 psi in accordance with ASTM D3786. Coefficient of normal permeability shall not be less than 0.1 CM/SEC. Vertical water flow shall be a minimum of 80 GPM/F² in accordance with ASTM D4491. Apparent opening size shall be 70 (US Std. Sieve Number).
- (3) Puncture strength shall be a minimum of 90 lbs. in accordance with ASTM D3787. Trapezoid tear strength shall be a minimum of 75 lbs. in accordance with ASTM D4533. The above values shall be taken as minimum average roll value in the weakest principal direction. The geotextile fabric shall be Trevira Spunbond Type 1125 as manufactured by Hoechst Celanese, or approved equal.
- (4) Unless specified otherwise in the Plans, rip rap shall conform to the requirements for Type II rip rap of the Specifications or for Class 2 riprap of the NCDOT Standard Specifications for Road and Structures, latest edition.
- (5) Select excavated trench rock may be used in lieu of quarry stone for dumped rip rap. Stones shall be well graded weighing from 10 to 250 lbs. each. Generally, not more than 10 percent by total weight shall weigh less than 10 lbs. each, and not more than 10 percent by total weight shall weigh more than 250 pounds each. Select excavated trench rock used for dumped rip rap shall be free of excessive fines.

ITEM VI – TRENCHLESS TECHNOLOGY

6.01 Scope

- (a) This Specification consists of the method and process to provide complete rehabilitation of gravity sanitary sewers, including all labor, materials, tools, equipment and incidentals necessary, by one of the following two methods:
 - (1) Fold and Formed Liner - Insertion of fold and formed poly-vinyl chloride (PVC) pipe that is heated, pressurized, and expanded to conform to the wall of the original pipe between manholes forming a new structural pipe-within-a-pipe.
 - (2) Cured-In-Place Pipe (CIPP) - Installation of a flexible polyester tube, vacuum impregnated, with a thermo setting, polyester or epoxy vinyl ester resin, having an impermeable inner surface.
- (b) Sewers to be rehabilitated, tested and sealed under this process are shown on the Plans.
- (c) All necessary bypass pumping, including appurtenances necessary to maintain sewer service is also part of the work specified under this Section.
- (d) **Qualifications required with Bid**

- (1) Contractor

All work shall be performed by a pre-qualified and appropriately licensed CONTRACTOR using one of the chosen trenchless rehabilitation methods listed above. In order to qualify for work on this project, CONTRACTOR shall have:

- (a) Successfully installed a minimum of 150,000 linear feet of similar sized pipe;
- (b) Own, rent, lease or otherwise have access for the duration of this project, all equipment necessary for a satisfactory and successful installation of the pipe;
- (c) Supervisory personnel certified by the manufacturer of the trenchless pipe product as an installer of the product.

The pre-qualification submittal with the bid shall include:

- (a) CONTRACTOR's name, license number and primary contact person;
- (b) Address, telephone number and fax number of the CONTRACTOR's primary place of business and any secondary place of business that the CONTRACTOR will use during the project;
- (c) List and description of previous projects completed by the CONTRACTOR totaling a minimum of 150,000 linear feet of similar sized pipe.
- (d) At least 3 references who are familiar with the trenchless rehabilitation process and the quality of the CONTRACTOR's work. A contact name and telephone number shall be provided for each reference.

(2) Manufacturer

Any manufacturer wishing to qualify shall have successfully installed a minimum 150,000 linear feet of similar sized pipe as manufactured by their company. The manufacturer shall have a minimum of 3 years' experience in the manufacture of the pipe.

The qualification submittal with the bid shall include:

- (a) Manufacturer's name, address, telephone number and fax number;
- (b) List and description of previous projects which the manufacturer has provided the specified pipe of similar size totaling a minimum of 150,000 linear feet;
- (c) The number of years the manufacturer has produced the product;
- (d) Contact information for at least 3 references who are familiar with the process and the quality of the manufacturer's product.

6.02 SYSTEM DESCRIPTION

(a) FOLD AND FORMED

The fold and formed liner pipe shall be made from PVC compound which meets or exceeds all requirements as referenced in ASTM F 1871 – 98.

(b) CURED IN PLACE

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- (1) The CIPP when cured shall, at a minimum, meet or exceed the following values:

<u>Physical Characteristic</u>	<u>Minimum Values</u>	<u>Test Method</u>
Flexural Strength.....	4,500 psi.....	ASTM D790 mod.
Modulus of Elasticity	250,000 psi.....	ASTM D790 mod.
Tensile Strength.....	3,000 psi.....	ASTM D638
Chemical Resistance	Loss not to.....	ASTM D543
	exceed the	
	above values	

- (2) The existing host pipe shall be considered **fully deteriorated** for design calculations.
- (3) CONTRACTOR shall confirm loadings on buried pipe based on depths, soil conditions and water table. The height of water table shall be the same as the depth of soil above the pipe. The design soil unit weight shall be 120 pounds per cubic foot. The pipe shall also be designed for an additional AASHTO HS-20 highway live load condition.
- (4) All pipes shall have a minimum of 2% ovality in the circumference. Any deviation must be approved by the ENGINEER.
- (5) Thickness of CIPP shall be rounded to the next higher multiple of 1.5 mm, after adding an allowance of 5% to the design thickness for resin migration per manufacturer recommendation.
- (6) The minimum CIPP design thickness shall meet the requirements of equations XI.1, XI.2, XI.3, and XI.4 in the appendixes of ASTM F 1216.
- (7) The required structural CIPP wall thickness shall be based, as a minimum, on the physical properties of the cured composite and in accordance with the following design parameters, the design equations contained in ASTM F 1216 and all other applicable ASTM Standards:

Initial Flexural Modulus	=	250,000 psi
Long-Term CIPP Creep	=	50%
Overall Safety Factor	=	2.0
Soil Height	=	maximum project soil height
Modulus of Soil Reaction	=	1000 psi

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Ground Water Height	=	maximum project soil height
Bending Stress Safety Factor	=	2.0
Initial Flexural Strength	=	4500 psi
Pipe Ovality or Deflection (as a %)	=	2.0%
Long-Term Flexural Modulus	=	125,000 psi
Long-Term Flexural Strength	=	2,250 psi
Water Buoyancy Factor	=	0.67 minimum
Poisson's Ratio	=	0.3
Enhancement Factor (K)	=	7

Values not listed in this Specification shall be approved by the ENGINEER prior to submittal of design calculations.

- (8) The final liner thickness shall not include non-structural thickness of calibration tubes.
- (9) The cured CIPP liner shall be rated as resistant, chemically and mechanically, to common municipal sewage.

6.03 Quality Assurance

- (a) The materials and the method of installation shall be in accordance with ASTM standards and in accordance with manufacturer's recommendations.
- (b) The CONTRACTOR shall test all sewers, service line connections and piping reconstructed under this Contract in accordance with the Standard Specifications.
- (c) All testing shall be done by a certified independent testing firm approved by the ENGINEER. Cost of testing shall be borne by the DISTRICT.

6.04 References

- (a) Codes, specifications, and standards, referred to by number or title, shall form a part of this Specification to the extent required by the reference thereto. Latest revision shall apply in all cases.

(1) FOLD AND FORMED PVC

Following is a partial list of American Society of Testing & Materials Standards which are applicable to this Specification for Fold and Formed PVC:

- (a) **ASTM-F 1867-98** Standard Practice for Installation of Folded/Formed Poly Vinyl Chloride (PVC) Pipe Type A for Existing Sewer and Conduit Rehabilitation

(b) **ASTM-F 1871-98** Standard Specification for Folded/Formed PVC Pipe Type A for Existing Sewer and Conduit Rehabilitation

(c) **ASTM-D-1784** Standard Specification for Rigid Poly Vinyl Chloride (PVC) Compounds and Chlorinated PVC (CPVC) Compounds

(2) **CURED IN PLACE PIPE**

Following is a partial list of American Society of Testing & Materials Standards which are applicable to this Specification for Cured in Place.

(a) **ASTM-F1216-93** Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube

(b) **ASTM-F1743-96** Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-In-Place Thermo Setting Resin Pipe (CIPP)

(c) **ASTM-F-2019** Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Pulled in Place Installation of Glass Reinforced Plastic (GRP) Cure-in-Place Thermosetting Resin Pipe (CIPP)

(d) **ASTM-D-5813-95** Standard Specification for Cured-In-Place Thermosetting Resin Sewer Pipe

(e) **ASTM-D-790-00** Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

(f) **ASTM-D-638-01** Standard Test Method for Tensile Properties of Plastics

(g) **ASTM-D-2412** Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading

(h) **ASTM-D-3567** Standard Practice for Determining Dimensions of “Fiberglass” (Glass-Fiber-Reinforced Thermosetting Resin) Pipe and Fittings

(i) **ASTM-D-543** Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents

6.05 Submittals

(a) **Shop Drawings**

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The CONTRACTOR shall submit at least 3 copies of shop drawings to the ENGINEER for approval. CONTRACTOR's dated stamp and signature verifying CONTRACTOR's approval must be on each shop drawing. Shop drawings shall not be approved without a CONTRACTOR's dated stamp and signature. The shop drawings shall include the items listed below:

(1) Fold and Formed PVC

- (a) Liner data showing liner meets all requirements of ASTM F 1871-98 and ASTM D 1784.
- (b) Complete catalog cuts and technical data and the manufacturer's recommendations as to method of installation.
- (c) Liner design calculations.
- (d) Curing process and recommended curing cycle.
- (e) Factory quality control test reports for each liner reel.

(2) Cured In Place Pipe

- (a) Complete shop drawings of CIPP liner which demonstrate compliance with these Specifications, show materials of construction (including resins, catalysts, etc.) and detail installation procedures (including recommended curing cycle). Certified material test results shall be included that confirm that all materials conform to these specifications. Testing procedures and quality control methods shall also be submitted. Materials not complying with these requirements will be rejected.
- (b) Liner thickness calculations for the ENGINEER's review and approval. The CIPP shall be designed in accordance with the applicable provisions of ASTM F1216 and ASTM F2019 for "fully deteriorated gravity pipe conditions." The liner thickness shall be approved by the ENGINEER prior to liner manufacture or installation.
- (c) Wastewater capacity calculations for each size of CIPP liner to be installed.
- (d) Documents certifying that the CIPP liner is manufactured in accordance with these specifications and the appropriate ASTM standards shall be submitted with each shipment. The certifications shall include a signed statement by the wet-out manager/supervisor that no fillers were added to the resin system during manufacture of

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the CIPP liner. In addition, wet-out forms documenting the wet-out shall be submitted for each section of CIPP liner manufactured. The wet-out forms shall be submitted prior to requesting payment and shall be provided without delay or claim to any confidentiality. The wet-out forms shall document the date and time of wet-out, the wet-out supervisor, the wet-out facility address, the location where the CIPP liner will be installed (by manhole numbers), the CIPP liner diameter, the length of wet-tube and dry-tube, the thickness of the CIPP liner, the roller gap setting for establishing the liner thickness, the felt manufacturer, the resin used (by product name and batch/shipment number) and quantity, the catalyst(s) used (by product name) and quantity, any quality control samples taken, and all else pertinent to the wet-out process.

(b) Pre-construction Video

A CD or DVD of the video inspection performed no longer than 24 hours prior to the trenchless rehabilitation shall be provided. Video shall include voice description, as appropriate, with stationing of services indicated. Data and stationing shall be on videos and begin at Station 0.0 Ft.

(c) Post Construction Submittals

- (1) Provide 1 CD or DVD containing MPEG files for each post TV inspection of the liner from manhole to manhole. The CD's or DVD's may be filled to capacity with as many MPEG files that will fit. Each MPEG file will be labeled with corresponding manhole numbers of the line segment inspected. For example, a file containing TV information of a liner inspected from manhole 28000 to manhole 28001 would be labeled "28000-28001.MPEG". MPEG 4 format shall be used and videos shall be scored per NASSCO PACP standards. Video shall include voice description as appropriate with stationing of services indicated and shall begin at Station 0.0 ft.
- (2) For cured in place pipe, submit certified copies of all test reports indicating properties of the selected resin and liner. Test results on field liner samples, performed by an approved independent testing company, shall be submitted to the ENGINEER.

6.06 Product Handling

- (a) The CONTRACTOR shall use all means necessary to protect lining materials before, during, and after installation. The installed work and materials of other trades shall also be properly protected. In the event of damage, the

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CONTRACTOR shall immediately make all repairs or replacements deemed necessary by the ENGINEER, at no additional cost to the DISTRICT.

6.07 Site Conditions

- (a) CONTRACTOR shall be responsible for verifying the size and condition of the existing sewer and his ability to insert the CIPP liner, prior to ordering materials. CONTRACTOR shall not receive compensation for excavations to remove obstructions due to conditions the CONTRACTOR should have seen by visual observation.
- (b) Prior to entering confined spaces such as manholes or inspection hatches to perform inspections or cleaning operations, an evaluation of the atmosphere to determine the presence of toxic gasses, flammable vapors or lack of oxygen must be performed by the CONTRACTOR in accordance with local, state and federal OSHA safety regulations.
- (c) Television Inspection
 - (1) Within 24 hours prior to installation, all sewer sections to be lined shall be inspected by closed circuit television to confirm any changes that may have occurred from the date of the original inspection. All sewers or pipelines are to be cleaned as stated below prior to the television inspection.
 - (2) The television inspection shall be performed in order to provide a visual and audio record of the location of obstructions in the sewer that would interfere with or prohibit lining of the sewer and provide the location of service laterals that are to be reconnected to the new liner. A color television inspection camera with pan and tilt capability is required for all inspections.
 - (3) Any grade or alignment issue observed by CONTRACTOR in video review, which reduces the pipe's flow area by 10% or greater, shall be reported to ENGINEER in a timely manner. The ENGINEER shall review subject pipe video in a timely manner and make a determination as to any point repair or other improvement that is to occur before lining proceeds. CONTRACTOR shall not be compensated for repairs required after lining if this requirement was not followed.
 - (4) CD's or DVD's and hard copy reports shall be made for each line inspected. The quality of the video shall be such that obstructions and service lateral locations are clearly identified and can be located. The CONTRACTOR shall make the CD's or DVD's, and reports available to the ENGINEER for review. Areas in the pipe where camera is underwater

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shall be cleared of debris prior to or during inspection to allow complete survey of pipe. Post construction video with “camera underwater” conditions due to debris will not be accepted.

- (5) If there is an obstruction in the sewer line that will not allow the television camera to pass, then the camera shall be backed out of the line and an attempt shall be made to televise the line from the manhole at the other end. If the entire length of the sewer line cannot be televised because of two or more obstructions, then the ENGINEER shall be notified and a determination of how to proceed shall be made by the ENGINEER.
- (6) The CONTRACTOR shall provide CD's or DVD's of the finished liner including all service reconnections and reinstatements of drops at drop manholes prior to acceptance by the ENGINEER.
- (7) The cost of the television inspection, CD's or DVD's, and reports shall be included in the unit cost of the liner.

6.08 Warranty

- (a) The Manufacturer shall warrant all materials to be free from defects in workmanship and materials for a period of one (1) year after final acceptance.

6.09 Materials

(a) Fold And Formed

(1) Poly Vinyl Chloride Liner

- (a) The liner shall be fabricated to a size that, when installed, will neatly fit the internal circumference of the pipeline to be rehabilitated. Allowance for circumference stretching during insertion shall be made. The liner material shall be made from a poly vinyl chloride (PVC) compound.
- (b) The minimum length shall be the distance from inlet to the outlet of the respective pipe to be lined. The CONTRACTOR shall verify the lengths in the field before forming.
- (c) The minimum thickness shall be SDR 32.5, which is verified by design calculations by a Professional Engineer. The existing host pipe shall be considered **fully deteriorated** for design calculations. CONTRACTOR shall confirm loadings on buried pipe based on depths, soil conditions and water table. The height of water table shall be the same as the depth of soil above the pipe. The design soil unit

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weight shall be 120 pounds per cubic foot. The pipe shall also be designed for an additional AASHTO HS-20 highway live load condition. All pipes shall have a minimum of 2% ovality in the circumference. Any deviation must be approved by the ENGINEER.

- (d) Unless otherwise specified, the CONTRACTOR shall furnish a poly vinyl chloride compound liner pipe meeting all the requirements for cell classification 12111-C, as defined in Specification D 1784, and with minimum physical properties as listed below:

<u>Physical Characteristics</u>	<u>Test Procedure</u>	<u>Rating</u>
Tensile Strength	ASTM D-638	3,600 psi
Tensile Modulus	ASTM D-638	155,000 psi
Flexural Strength	ASTM D-790	4,100 psi
Flexural Modulus	ASTM D-790	145,000 psi

- (e) The CONTRACTOR shall furnish, prior to installation of the materials, satisfactory written certification of compliance with the manufacturer's standards for all materials and conformance with the methods of the manufacturer.

(b) Cured In Place

(1) Liner

- (a) The liner shall consist of one or more layers of flexible needled felt or an equivalent non-woven material capable of: carrying resin, withstanding installation pressure, installation tension (if pulled in place) curing temperatures, and should be compatible with the resin system recommended by the manufacturer.
- (b) The liner shall be specifically fabricated and manufactured to fit the host pipe that is to be lined. It shall be the CONTRACTOR's responsibility to measure each host pipe section and to ensure that the liner shall be of sufficient size and diameter to produce a final product which meets or exceeds all requirements of these specifications. "Prefabricated or "Off-the-shelf" liners will only be permitted if they are an exact fit to the specific host pipe section. Liners which, in the opinion of the ENGINEER, have wrinkles, improperly cured sections or other abnormalities which do not meet or exceed the tolerances permitted in these specifications, will be rejected and it shall be the CONTRACTOR's responsibility to make appropriate corrections, up to and including full replacement of the pipe section by whatever means deemed necessary and appropriate by the DISTRICT.

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- (c) The liner shall be able to stretch to fit irregular pipe sections and negotiate bends.
- (d) The liner shall be fabricated to a size that, when installed, will be water tight and tightly fit the internal circumference and the length of the original sewer pipe.
- (e) Allowance shall be made for circumferential stretching during installation.
- (f) The fabric liner and seam (if applicable) shall be tested in accordance with Test Method D1682. The liner shall have a minimum tensile strength of 750 psi in both the longitudinal and transverse directions.

(2) Resin

- (a) The resin system shall be a corrosion resistant polyester, vinyl ester, or epoxy and catalyst system that meets the requirements of ASTM F1216 and ASTM F2019 and the physical properties herein. No fillers are to be added to resin without prior approval from the ENGINEER.
- (b) The application of resin to the felt liner (wet-out) shall be conducted under factory conditions and the materials shall be fully protected against UV light, excessive heat and contamination at all times.

6.10 Surface Preparation

- (a) All affected sewer sections are to be thoroughly cleaned and all debris, roots and other obstructions removed. All material removed from the existing sewer sections shall be properly transported on a daily basis to an approved disposal site obtained by the CONTRACTOR. Under no circumstances will the CONTRACTOR be allowed to accumulate debris or to create a public nuisance.
- (b) The method used to clean the sewer sections shall be at the option of the CONTRACTOR and may include high pressure water jet cleaning, brushes, balls, swabs, bucket machine or other methods. The CONTRACTOR shall be responsible for damage to the sewer sections due to improper cleaning methods.
- (c) The cost of preparatory cleaning shall be included in the unit price of liner.
- (d) Removal Of Obstructions In Sewer
 - (1) Obstructions in the sewer sections which cannot be dislodged or cleared by cleaning, bucketing, dragging a mandrel, or other internal methods shall be cleared by excavation. The CONTRACTOR shall notify the

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ENGINEER prior to any proposed excavation work that is not indicated on the plans.

- (2) The excavation shall conform to requirements of Section VI-1, “Excavation,” and shall minimize the obstruction of traffic. The size of the excavation shall be kept to a minimum and shall be shored and sheeted as required.
- (3) The existing sewers shall be repaired, after the obstruction is removed, in accordance with DISTRICT Standards.
- (4) If more than two obstructions require excavation in any one sewer section, the CONTRACTOR shall notify the ENGINEER and a determination of how to proceed shall be made by the ENGINEER.

6.11 Field Measurements

- (a) The CONTRACTOR shall make all necessary measurements in the field to ensure precise fit of items in accordance with the Plans. In the event of a discrepancy, the CONTRACTOR shall immediately notify the ENGINEER. The CONTRACTOR shall not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

6.12 Inspection of Pipe Liner

- (a) Each pipe liner shall be subject to inspection by the ENGINEER immediately before it is installed. Defective liner or liner which is less than the minimum required thickness will be subject to rejection for use on the project.

6.13 INSTALLATION

(a) General

- (1) The CONTRACTOR shall make every effort to maintain sewer service throughout the duration of the project. In the event that a service line will be temporarily out of service, the maximum time of disruption of service shall not exceed 8 hours for any property. The CONTRACTOR shall notify DISTRICT and all affected property owners whose service laterals will be disrupted and advise against water usage until the sewer main is back in service. Such notifications to property owners shall be made 48 hours in advance of disruption of service.
- (2) The following installation procedures shall be adhered to unless otherwise approved by ENGINEER.

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- (a) Safety: The CONTRACTOR shall carry out his operations in strict accordance with all OSHA and manufacturer's safety requirements. Particular attention is drawn to, but not limited to, those safety requirements involving working with hazardous/combustible materials, scaffolding, and entering confined spaces.
 - (b) Cleaning of Sewer Line: It shall be the responsibility of the CONTRACTOR to remove all internal debris from the sewer line.
 - (c) Inspection of Pipelines: Inspection of pipelines shall be performed by experienced personnel trained in locating breaks, obstacles and service connections by closed circuit television. The interior of the pipeline shall be carefully inspected to determine the location of any condition which may prevent proper installation of the liner into the pipelines and it shall be noted so that these conditions can be corrected. A video and suitable log shall be kept for later reference by the DISTRICT. Pre-installation video shall be no older than 24 hours.
 - (d) Bypassing Flow: The CONTRACTOR, when required, shall provide for the flow around the section of pipe designated for lining. The bypass shall be made by plugging the line at an existing upstream manhole and pumping the flow into a downstream manhole or adjacent system. The pump and bypass line shall be of adequate capacity and size to handle peak flow.
 - (e) Any costs incurred by overflowing in a home or business shall be the responsibility of the CONTRACTOR.
 - (f) Line Obstructions: It shall be the responsibility of the CONTRACTOR to clear the line of obstructions that cannot be removed by conventional sewer cleaning equipment. The CONTRACTOR shall remove the obstruction or repair the pipe by excavation. Such excavation shall be approved in writing by the ENGINEER prior to the commencement of the work and shall be considered as a separate pay item.
- (b) Installation of Fold and Formed Pipe Liner
- (1) The method of installation shall be compatible with the manufacturer's recommended practices and shall meet ASTM-F 1867-98. For the pipe liner, the installation shall be as follows:
 - (a) The liner pipe shall be inserted into the existing sewer through existing manholes. The existing inverts shall be removed to a point no less than 2 inches below the invert of the pipe. This will

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provide an area of expansion at the point where the liner exits the host pipe and also accommodates the invert rebuilding.

- (b) After insertion of the liner pipe is completed, the CONTRACTOR shall apply steam of sufficient volume and pressure to “cure” the pipe liner. The equipment used shall be capable of delivering steam throughout the liner section to uniformly raise the pressure to form the PVC liner. The temperature shall be determined by the system employed.
 - (c) The heat source shall be fitted with suitable monitors to gauge the pressure of the steam supply. Another such gauge shall be placed at the remote manhole to determine the pressure during forming. Monitoring methods and forming time shall conform to manufacturer’s recommendations.
 - (d) The liner pipe shall be expanded until it is pressed tightly against the existing pipe walls.
 - (e) If the liner fails to form, the CONTRACTOR shall remove the failed liner and replace it with a new liner. This work shall be performed without additional cost to the DISTRICT.
 - (f) After the liner has been formed, the ends of the liner shall be cut away at both manholes, leaving 4 inches inside of manhole. Ponding in the invert shall not be permitted. Existing invert may require chipping prior to pipe installation. See Technical Specification Section VI-II for additional information on manhole inverts.
 - (g) The finished liner pipe shall be continuous over the entire length of run between 2 manholes and shall be free from visual defects such as foreign inclusions and pin holes. It shall also meet the leakage requirements and pressure test as specified.
 - (h) Any defects which will affect the integrity or strength of the liner pipe shall be repaired at the CONTRACTOR’s expense. Allowance shall be given for excess pipe (rib) when the cross-sectional area has been reduced due to offset joints, out of round sections, etc.
- (c) Installation Of Cured-In-Place Pipe
- (1) CONTRACTOR shall provide for continuous sewage flow around the sections(s) of pipe designated for insertion of liners, when required for acceptable completion of an insertion process. The pump and bypass line shall be of adequate capacity and size to handle the flow.

- (2) The CONTRACTOR shall designate a location where the felt tube will be impregnated (“wetted out”) with resin. The CONTRACTOR shall inform the ENGINEER in advance to inspect the materials and the wet out procedure. The process shall use distribution rollers and vacuum, to thoroughly saturate the felt tube prior to its dispatch for installation. A catalyst system or additive(s) compatible with the resin and tube may be used as per the manufacturer’s recommendation. They shall, however, not impair or reduce the resin’s quality to withstand the minimum chemical resistance criteria.
- (3) The wetted out tube shall be transported and kept in a refrigerated truck until it is inserted through an existing manhole by approved techniques/process. The insertion area, equipment platform, etc., shall be securely protected, and all damaged yards, driveways, walks, etc., shall be repaired at no cost to the DISTRICT.
- (4) The liner may be installed by inversion method per ASTM F1216 or by the pulled-in-place method per ASTM F1743 and ASTM F219. The methods used to install and cure the liner are at the option of the CONTRACTOR but a method statement (and detail information) must be submitted to the ENGINEER for approval at least 3 weeks prior to mobilizing to the work site.
- (5) When the liner is to be installed using the inversion process, this process shall use either water column inversion or pressurized inversion (water or air). The heads or pressures used shall be in accordance with the head/pressure limits for the carrier tube. For water column/pressure inversion, the effect of pipeline fall of rise shall be taken into account when applying head/pressure at the inversion location so that the head/pressure anywhere along the run does not exceed allowances for the carrier tube.
- (6) All water used shall be from a metered supply, the costs of which shall be paid to the Water System owner through its regular billing system.
- (7) The inversion shall proceed in a uniform controlled method, and during inversion the head/pressure shall be maintained within a range that facilitates steady and controlled inversion. Unless special circumstances warrant, the head/pressure shall be maintained in the liner at all times during the inversion.
- (8) In installations where a pull-in type liner may be used instead of an inversion type liner, pull forces shall be maintained below the rating of the liner carrier tube.

(9) Curing with Hot Water

- (a) Hot water circulated within the liner shall be used to elevate the temperature of the resin to effect a cure. During the cure, the water in the liner shall be maintained at a head/pressure in accordance with the manufacturer's requirements for the specific size and thickness of the liner. A boiler of sufficient rating shall be used to add heat to the circulating water. Circulating pump(s) and internal hoses shall be sized to provide sufficient circulation of the hot water to uniformly heat the liner.
- (b) The temperature of the circulating hot water shall be per manufacturer recommendations and shall be monitored at the supply from and return to the boiler. The temperature of the liner outer surface shall be monitored at each end using thermocouples or other suitable measuring devices.
- (c) After the CIPP liner has changed to its hardened state, the cure heating shall be continued maintaining the liner at an elevated temperature for a period of time dependent on the size, thickness and ongoing temperature measurements to ensure the full level of cure has been achieved in accordance with manufacturing recommendations.
- (d) On completion of the heat cure, the liner shall be cooled down either naturally or by adding cold water to the circulating water. During cool down the head/pressure in the liner shall be maintained at the cure head. The rate of cool down shall be commensurate with the liner size and thickness to minimize shrinkage and internal stresses.

(10) Curing with Steam

- (a) Steam flowed through the interior of the liner shall be used to elevate temperature of the resin to effect a cure per manufacturer's recommendations. Compressed air shall be mixed with the steam as required to moderate the steam temperature to produce a controlled heating of the liner, avoid hot spotting and prevent blistering of the polyurethane coating.
- (b) The pressure of the steam/air mixture shall be controlled at the injection and venting manifold locations to maintain the required internal pressure on the liner in accordance with the manufacturer's requirements for the carrier tube internal pressure

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ratings. The temperature of the steam/air mixture shall be controlled and monitored at the mixing manifold. The temperature of the liner outer surfaces shall be monitored at each end using thermocouples or other suitable measuring devices.

- (c) After the CIPP liner has changed to its hardened state, the cure heating shall be continued maintaining the liner at an elevated temperature for a period of time dependent on the size, thickness and ongoing temperature measurements to ensure the full level of cure has been achieved in accordance with manufacturing recommendations.
- (d) On completion of the heat cure, the liner shall be cooled down either naturally or by gradually reducing the amount of heating steam in the steam/air mixture to all air. During cool down the pressure in the liner shall be maintained at the cure pressure. The rate of cool down shall be commensurate with the liner size and thickness to minimize shrinkage and internal stresses.

(11) Curing with Ultraviolet Light

- (a) Compressed air shall expand the impregnated fabric tube of sufficient capacity to insert the ultraviolet multi-lamp curing assembly. The ultraviolet lamp shall operate in the 200 to 400 nm range.
- (b) Air pressure shall be slowly adjusted to sufficient pressure to hold the impregnated fabric tube to the existing pipe. The desired pressure shall be maintained throughout the curing process. The ultraviolet lamp shall travel through the pipe at a pre-determined speed at which allows for curing of the CIPP resin.
- (c) The ultraviolet lamp assembly shall make a first pass through the pipe for inspection of CIPP liner before the curing process begins. Defects in the pulled-in-place CIPP liner shall be corrected before curing.
- (d) Documentation of time, rate of travel for ultraviolet lamp assembly, and pressure maintained shall be recorded during curing of the fabric tube.

- (12) The finished CIPP shall be continuous over the entire length from manhole to manhole and be free from visual defects such as foreign inclusions, dry spots, keel, boat hull, pinholes, wrinkles and other deformities. The liner passing through or terminating in a manhole shall

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be carefully cut out (also for samples) in a shape and manner approved by the ENGINEER. The invert and benches shall be streamlined and improved for smooth flow. The area/annular space between existing and the CIPP shall be sealed with approved materials in an approved manner described within the specifications. It shall also meet the leakage requirements of pressure test as specified. During the warranty period, which shall be defined as 12 calendar months after final acceptance by the DISTRICT, any defect which will affect the integrity or strength of the pipe or impede the flow through the pipe shall be repaired at the CONTRACTOR's expense, in a manner mutually agreed to by the ENGINEER and the CONTRACTOR.

(d) Sealing And Benches In Manhole

- (1) The finished pipe shall make a tight fitting seal with the existing pipe(s) in the manhole. One-half inch diameter activated oakum band soaked in Scotch Seal 5600 or equal, shall be applied circumferentially near the annular space touching the end of existing pipe and encased with a cementitious mortar. The pipe shall be neatly cut off and not broken or sheared off, at least 3 inches away from the walls and a pipe collar built over pipe. The channel in the manhole shall be smooth continuation of the pipe(s) and shall be merged with other lines or channels, if any. Ponding in the upstream pipe or invert shall not be accepted if the condition could have been avoided by chipping out the existing invert prior to lining. Channel cross-section shall be U-shaped with a minimum depth of 6 inches for 8-inch pipe and full depth for greater sized pipes. The side of the channels shall be built up with mortar/concrete to provide benches at a minimum slope of 1 inch to 12 inches pitched toward the channel. All grout work including invert bench and pipe collars are to have a steel trowel finish.
- (2) Payment for above work shall be incidental to sewer rehabilitation by the required method, since that payment is made from centerline to centerline of manhole.
- (3) The liner and the existing pipe in the manhole must be sealed as specified above before proceeding to the next manhole section. All manholes will be individually inspected for liner cut-offs, benches and sealing works.

(e) Service / Outside Drop Reconnections

- (1) After the pipe liner has been formed in place, the CONTRACTOR shall reconnect the existing active service connections as designated by the ENGINEER. This will be done by open trench excavation in order to provide a positive connection to the liner. If the CONTRACTOR

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proposes to re-establish the connection by remote cut method, the ENGINEER shall approve the location prior to performing the work. In the event a service is to be re-established by remote cut, the finished penetration shall be brushed smooth and be no less than 90 percent of the original service size.

- (2) The exact location and number of service connections shall be determined from pre-work video and/or in the field. It shall be the CONTRACTOR's responsibility to accurately field locate all existing service connections whether in service or not. The CONTRACTOR shall reconnect all live service connections to the liner pipe, unless directed otherwise by the ENGINEER. The CONTRACTOR shall be responsible for restoring/correcting without any delay, all missed or faulty reconnections, as well as for any damage caused to property owners for not reconnecting the services in a timely manner or for not giving adequate notice to the owners. All services which are reconnected to rehabilitated liner shall be shown on the "Record Drawings" with the exact distance from the nearest upstream/downstream manhole.
- (3) In general, service connections shall be made by open cut excavation; however, if a remote cut method is allowed, and it does not meet the ENGINEER's approval with respect to quality and workmanship, the service connection shall be performed by excavation at no additional cost to the DISTRICT.
- (4) Service laterals shall be reconnected as described in the paragraphs above. Additionally, the CONTRACTOR shall replace the service lateral from the main line to the clean-out assembly, when directed to do so by the ENGINEER.
- (5) Service Connection by Remote Cut
 - (a) This operation shall be performed by experienced operators so that no blind attempt or holes are made in the liner pipe. Location shall be re-verified carefully with preconstruction videos for accuracy, especially where dimples are not defined or clearly ascertained. The ENGINEER reserves the right to require service connection by excavation at any or all locations at no additional cost to the DISTRICT, if the quality, workmanship and/or approval rating for remote cut is poor and unsatisfactory or is otherwise found not to meet project specifications.
 - (b) Where unsatisfactory remote cut reconnections are to be repaired by open cut method, the existing carrier or host pipe shall be carefully broken and removed so that only that amount of the liner which is absolutely necessary for the repair/re-connect is exposed. The liner

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shall not be damaged and shall be allowed to normalize to ambient temperature, before a 4-inch or 6-inch diameter hole is cored out of the liner with a hole saw. This coupon shall be retrieved and handed to the ENGINEER for inspection of the liner thickness at that location, if so required.

- (c) The remote cut shall be smooth and circular in nature as seen by a 360° TV camera. The hole shall be a maximum of 100% and a minimum of 90 percent of the service pipe diameter. It shall be properly aligned and be concentric to the existing connection. The locations of all remote cuts shall be verified carefully to match with pre-work videos for their exact locations. Excess, wrong holes and/or trial cuts shall not be made. However, in the event they do occur, they must be repaired at no cost to the DISTRICT to the full satisfaction of the ENGINEER. CONTRACTOR shall check the completed remote cut connections for the minimum 90% requirement when directed to do so by the ENGINEER, by excavating the site, in which case payment shall be made for the excavation at the location and for any special backfill, if necessary. Defective connections shall be repaired to the ENGINEER's satisfaction at no additional cost to the DISTRICT.
- (d) Protruding taps that will deform the finished liner or otherwise obstruct or hinder the insertion of the liner, shall be removed to allow the liner to pass through. If these taps are to be reinstated at a later time by excavation, the initial removal will be incidental. If the camera equipment cannot pass, the trimming will be paid as a removal of protruding service by remote cut upon approval by ENGINEER.
- (e) Outside drop pipes at drop manholes shall be reconnected by remote cut. Payment for this reconnection shall be the same as for a service connection by remote cut.

(6) Service Connection by Excavation

- (a) Service reconnections shall be made by open cut method, unless otherwise stated in the Project Plans, Special Conditions or directed by the ENGINEER. In the event of poor quality or workmanship of a remote cut, the existing service connections shall be done by Excavation method. The existing sewer (now the carrier or host pipe for the liner) shall be carefully broken/removed to expose the liner to the extent necessary. The liner pipe shall not be damaged and shall be allowed to normalize to ambient temperature, before a 4-inch or 6-inch diameter hole is cored out with a hole saw. This coupon shall be retrieved and handed over to the ENGINEER for inspection of the

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liner thickness at that location, if so required. The size of new service shall match the existing service size.

- (b) A 3 piece service connection shall be installed consisting of an IPS/Schedule 40 PVC hub, rubber sleeve and 301 stainless steel band. The service connection shall be a compression fitting such as INSERTA TEE as manufactured by Inserta Fittings Company or equal for 8 inches and larger mains. The rubber sleeve shall meet ASTM C443. The PVC hub gasket shall meet ASTM F477.
- (c) The rubber sleeve shall be lubricated as recommended by the manufacturer. The rubber sleeve shall be inserted into the pipe liner such that the entry lip forms a complete seal between the inside of the pipe liner and the sleeve entry lip. The PVC hub shall be inserted into the rubber sleeve to the mark shown on the outside of the hub. The hub shall not protrude into the pipe liner such that a TV camera cannot pass.
- (d) Place the stainless band around the top of the rubber sleeve and tighten down. Install lateral service pipe in the normal manner.
- (e) If directed by the ENGINEER, the CONTRACTOR shall replace the existing service line to the clean-out assembly.
- (f) One or more homes discharging into a common connection shall be considered as one service connection. Damage repair to residences or properties due to delay or faulty connections shall be incidental.
- (g) Compression fittings shall not be used on 6-inch main lines. Saddles shall be used for 6-inch lines as shown on the Plans, joined with two part epoxy and secured with stainless steel band.

(f) Testing

(1) Fold And Formed

- (a) Gravity sewers rehabilitated using fold and formed pipe shall be tested in accordance with DISTRICT's Technical Specifications, with the exception that tests relating to grade and alignment are not required.
- (b) All service line connections noted as leaking shall be repaired or replaced and then retested. If service line connection repair or replacement, testing or retesting, and backfilling of the excavation is not completed within the work day, the CONTRACTOR shall properly

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cover each excavation with steel plates, plywood, or some other approved material, to make the area secure from accidents or hazard.

(2) Cured In Place

- (a) A sample shall be cut from a section of cured CIPP liner at the installed liner termination point, that has been inverted through a like diameter pipe which has been held in place by a suitable heat sink, such as sandbags. Each sample shall be 6-8 inches in length. Sample shall be labeled with date and manhole to manhole numbers. Labeled samples shall be handed to Inspection staff at time of installation and preparation.
- (b) Thickness measurements, flexural stress, flexural modulus of elasticity, and tensile tests shall be performed for each sample. The costs for these tests will be borne by the DISTRICT.
- (c) Eight thickness measurements shall be made per ASTM D2122 and ASTM D3567 and the average thickness shall be the determined sample thickness. The minimum wall thickness at any point shall not be less than 87.5 percent of the specified thickness.
- (d) Five specimens of each sample shall be tested for flexural stress and flexural modulus of elasticity per ASTM D790. The dimensions of each specimen including width, depth, and span shall be reported. Data items shall be reported for each of 5 specimens tested as follows:
 - Specimen Number
 - Displacement at Yield (in)
 - Strain at Yield (in / in)
 - Load at Yield (lbs.)
 - Stress at Yield (psi)
 - Modulus of Elasticity (psi)
- (e) The mean, standard deviation, minimum value, and maximum value for the group of specimens shall be reported for each data item.
- (f) Each report shall contain sample identification information for each sample including project name, sample number, date sample received, date sample tested, diameter of liner sample, upstream manhole number and downstream manhole number where sample was taken.

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(g) Sample conditioning information such as humidity and temperature shall be provided on each report. Sample reports submitted to the ENGINEER without the specified data shall be rejected.

(h) Tensile tests shall be performed per ASTM D 638-01.

(3) Preliminary Acceptance of Cured In Place Pipe

(a) Following installation of the liner and re-establishment of all live service connections, the CONTRACTOR shall conduct a final digitally recorded color television inspection of the completed work as instructed in other sections of this Specification. Copies of these post-installation digital recordings, as well as the digital recordings made prior to the liner installation shall be submitted to the ENGINEER for approval and shall be retained by the DISTRICT. Payment will not be made for any CIPP lining until the ENGINEER has reviewed and approved these digital recordings. The CONTRACTOR shall submit the CD or DVD disks a minimum of 10 days in advance of any payment request to provide the ENGINEER ample time to review the recordings.

(b) There shall be no dry spots, lifts, wrinkles, ridges, splits, cracks, delaminations or other type defects in the CIPP lining. Defective lining will be removed and the pipe re-lined at no additional cost to the DISTRICT. If during the removal process, the host pipe is damaged, CONTRACTOR will perform a point repair at CONTRACTOR's own expense.

(c) Groundwater infiltration through the liner shall be zero.

(d) All service connections shall be open, clear and watertight. The liner opening shall conform neatly with the opening in the host pipe and shall be free of burrs or debris.

(e) Preliminary acceptance of CIPP lining shall be based on the ENGINEER's evaluation of the installation and curing data, results of air testing where required, and review of the TV digital recordings.

(4) Final Acceptance Of Cured In Place Pipe

(a) Final acceptance of the liner shall be based on the preliminary acceptance of the liner by the ENGINEER and on the results of the certified laboratory tests on the liner specimens as specified in the Section entitled "Testing".

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(b) Liners meeting or exceeding the specified thicknesses and strengths, as evidenced by the certified laboratory testing results, shall be paid for in full according to the contract unit rate for the finished diameter per linear foot.

(c) Where the laboratory analysis results indicate that the liner section does not comply with either the minimum thickness specified or the minimum flexural modules specified, payment for the section of liner represented by the specimen shall be modified, or the liner rejected, as follows:

(1) The minimum cured thickness required for the indicated liner section shall be recalculated using the actual liner cured flexural strength and tensile strength reported by the certified laboratory for the liner specimen taken from that section of liner. The values used shall be the average of the test values reported for that specimen. The minimum required thickness shall be calculated as described in the Section entitled “System Description”.

(2) Calculate the value factor for the liner segment according to the following equation:

$$\text{Value Factor} = (\text{Average thickness} / \text{calculated minimum required thickness})^{1.5}$$

In words, the Value Factor is equal to the ratio of the average of the actual reported thickness and the calculated minimum required thickness, all to the 1.5 power.

$$\text{Ex: } (0.162 \text{ inches (average)} / 0.180 \text{ inches (min. req.)})^{1.5} = 0.85 \text{ Value Factor}$$

(3) Where the Value Factor is calculated at 0.95 or greater, the payment for the liner shall be at the full unit price bid per linear foot for that diameter liner.

(4) Where the Value Factor is calculated at less than 0.95 but equal to or greater than 0.85, payment for the liner segment in question shall be based on the product of the Value Factor times the contractual unit price per linear foot for that diameter liner times the total length of the liner segment.

(5) Where the Value Factor is calculated at less than 0.85, the liner shall be rejected and the CONTRACTOR shall replace the non-conforming liner or shall propose an alternate method for

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modifying the finished liner to conform to the specified strength and thickness, all at the CONTRACTOR's expense.

6.14 Service Lateral Rehabilitation

- (a) CONTRACTOR shall install a clean-out assembly on the existing service lateral connections that do not currently have a clean-out assembly installed at the edge of the road right-of-way or easement right-of-way, and shall be approved by the ENGINEER prior to installation.
- (b) Clean-out assemblies shall be installed in accordance with DISTRICT's Standard Details and Technical Specifications.
- (c) In addition to the television inspection that will be required prior to installation of the pipe, all service laterals shall be inspected. The method of CCTV inspection of service laterals may be chosen by the CONTRACTOR, but must be coordinated and approved by the ENGINEER prior to inspection of the laterals.
- (d) The CONTRACTOR shall coordinate each service lateral inspection with the ENGINEER. At the time of the inspection, the ENGINEER shall make a decision whether to replace the lateral or not. The ENGINEER may determine that replacement of the lateral is not required.
- (e) If it is determined that the lateral needs to be replaced, the CONTRACTOR shall replace the existing service line from the clean-out to the main collection system line by means of open-cut excavation. Service laterals shall be constructed in accordance with DISTRICT's Standard Details of the Technical Specifications.

6.15 Field Quality Control

- (a) The manufacturer of the liner material shall provide technical and installation advice to the CONTRACTOR's work force when first installing the liner. The service of an experienced installation representative shall be provided for a minimum of two days at no additional cost to the DISTRICT.
- (b) CD's or DVD's shall be required after the liner has been installed in the existing sewer pipe, at no additional cost to the DISTRICT. The televising shall be done after all service connections have been made, unless required earlier by the ENGINEER.
- (c) A dye test may be required to confirm reconnection of all services. Dye shall be introduced into all service lines and then flooded with water. The CONTRACTOR and the ENGINEER shall look to the downstream manhole to detect the dye coming out of the sewer main. This shall confirm a reconnection. If any more than one service connection is dye tested at a time, these dye tests

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shall be done with enough time allowed between each test to allow the dye to be purged from the line. Otherwise, different colored dyes shall be used. Dye testing shall be performed by the CONTRACTOR at no additional cost to the DISTRICT.

6.16 Post Televising of Completed Sections

- (a) The CONTRACTOR will provide to the ENGINEER color video CD's or DVD's taken by a 360° radial view camera for close up view, showing the completed work, including the condition of the restored pipes prior to requesting final payment.
- (b) Television inspection, CD's or DVD's, reports, etc., shall be as specified elsewhere in this section. Upon completion of the installation work and testing, the CONTRACTOR shall restore/clear the project area affected by his operations.

6.17 Clean-Up

- (a) The CONTRACTOR shall restore or replace all removed or damaged paving, curbing, sidewalks, gutters, shrubbery, fences, sod or other disturbed surfaces or structures in a condition equal to that before the work began, to the satisfaction of the ENGINEER, and shall furnish all labor and material incidental thereto.
- (b) Surplus liner material, tools and temporary structures shall be removed by the CONTRACTOR. All dirt, rubbish and excess earth from operation shall be legally disposed of by the CONTRACTOR, and the construction site shall be left clean, to the satisfaction of the ENGINEER, in accordance with all appropriate regulations.

6.18 PATENTS

The CONTRACTOR shall warrant and hold harmless the DISTRICT against claims for patent infringement and any loss thereof.

ITEM VIII – MANHOLE REHABILITATION

8.01 Description

- (a) The work included in this section consists of providing all labor, materials and equipment necessary for rehabilitating existing manholes (by methods other than complete replacement) including:
 - (1) Manhole Sealing, Plugging, and Patching
 - (2) Manhole Invert Construction
 - (3) Manhole Lining and Structural Enhancement using a Spray Applied Cementitious Liner
 - (4) Manhole Inside Drop System
- (b) Manholes requiring rehabilitation or replacement are indicated on the plans.
- (c) Manholes that are indicated to be completely replaced shall be built in accordance with MSD's standard details and Section VI-II, 2.11 of the Technical Specifications.

8.02 Quality Assurance

- (a) Manhole rehabilitation involving cementitious liners shall be performed using a qualified manufacturer's product. The installer must be approved by the manufacturer. Both the installer and the manufacturer shall show evidence of at least 3 years of successful experience in the specific type of manhole rehabilitation.
- (b) Storage, mixing, handling, and use of all materials and compounds shall be in strict accordance with manufacturer's instructions and specifications.
- (c) Standards: NASSCO Specification Guidelines for Sewer Collection System Maintenance and Rehabilitation, Current Edition.

8.03 Submittals

- (a) Shop Drawings shall be submitted in accordance with the General Conditions of these specifications. In addition, the following shall be submitted to the ENGINEER for approval prior to construction:
 - (1) A detailed description of equipment, materials, and operational procedures to accomplish the manhole sealing and lining including, but not limited to, sealant mixture design, patching material mixture design, coatings, liner materials, application patching/lining procedures, samples and test data.

- (2) A detailed description of equipment, materials, and operational procedures to accomplish manhole invert construction including, but not limited to, concrete or grout mixture design, prefabricated inverts, samples and test data.
- (3) A detailed description of equipment, materials, and operational procedures to construct manhole inside drop systems including, but not limited to, drop bowl and piping drawings with dimensions and specifications, installation procedures, samples and test data.
- (4) A detailed time schedule.

8.04 General

The materials used shall be designed, manufactured, and intended for sewer manhole rehabilitation and the specific application in which they are used. The materials shall have a proven history of performance in sewer manhole rehabilitation. The materials shall be delivered to the job site in original unopened packages and clearly labeled with the manufacturer's identification and printed instructions. All material shall be stored and handled in accordance with recommendations of the manufacturer.

8.05 Sealing, Plugging, and Patching Materials

Materials used for specific applications shall be as follows:

- (a) Plugging holes and stopping active hydrostatic infiltration at points in concrete and masonry manholes:
 - (1) A premixed fast-setting volume stable waterproof cement plug consisting of hydraulic cement, graded silica aggregates, special plasticizing and accelerating agents. It shall not contain chlorides, gypsums, plasters, iron particles, aluminum powder, or gas-forming agents, or promote the corrosion of steel that it may come in contact with. Set time shall be approximately 60 seconds or less. Ten-minute compressive strength shall be a minimum of 500 psi.
 - (2) Chemical grouts may be used for stopping very active infiltration, and shall be mixed per the manufacturer's recommendations.
 - (3) After surface preparation and prior to the application of coatings, infiltration shall be stopped by plugging as previously described herein.
- (b) Patching, repointing, filling and repairing non-infiltrating holes, cracks, and breaks in concrete and masonry manholes:
 - (1) A premixed nonshrink cement-based patching material consisting of portland cement, graded silica aggregates, special plasticizing and accelerating agents,

ITEM VIII – MANHOLE REHABILITATION

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which has been formulated for vertical or overhead use. It shall not contain chlorides, gypsums, plasters, iron particles, aluminum powder, or gas-forming agents or promote the corrosion of steel it may come in contact with. Set time shall be less than 30 minutes. One-hour compressive strength shall be a minimum of 200 psi, and the ultimate compressive strength shall be a minimum of 5,000 psi.

- (2) Loose material shall be removed from the area to be patched or re-pointed exposing a sound sub-base. Holes or voids around steps, joints or pipes, spalled areas, and cavities caused by missing or broken brick shall be patched and missing mortar re-pointed using a non-shrink patching mortar conforming to the requirements of this section. Cracks not subject to movement and greater than 1/16 inch in width shall be routed out to a minimum width and depth of 1/2 inch and patched with non-shrink patching mortar as indicated above.

8.06 Manhole Inverts

- (a) Inverts shall be constructed to transition flow between any influent main or service line and the effluent pipe where the difference in elevation between influent and effluent lines are 2 feet 0 inches or less. Inverts shall also be constructed to receive inside drop system pipes.
- (b) Manhole inverts shall be in accordance with Section VI-II, 2.11 (i) of the Technical Specifications and the Standard Details for new construction. Constructed inverts shall match flow lines on lined pipe.
- (c) Invert construction shall start with the demolition of existing brick or concrete to a point which assures the rebuild invert work shall be no less than 2 inches thick. Other demolition shall be required where it is necessary to enhance flow lines through the manhole in order to provide the longest curves possible.
- (d) Manhole invert demolition shall take place prior to lining.
- (e) Invert reconstruction shall not take place until after mainline and manhole walls have been rehabilitated.

8.07 Manhole Lining and Structural Enhancement

Cementitious Liner (spray applied)

- (a) Materials:
 - (1) Specially formulated pre-packaged mixes shall be used. The material shall be fiber reinforced and contain special additives which produce a minimum 24-hour compressive strength of 3,000 psi, and a minimum 28-day compressive strength of 8,000 psi. The material shall form a

ITEM VIII – MANHOLE REHABILITATION

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mechanical and chemical bond to the manhole surface and have zero shrinkage.

- (2) The mortar shall include calcium aluminate or other ENGINEER-approved substance to be suited for resistance against corrosion.

(b) Mixing:

- (1) For each bag of product, the Installer shall follow the manufacturer's defined guidelines for mixing.
- (2) Empty the mixed material into the holding hopper and prepare another batch with timing such that the nozzleman can spray in a continuous manner without interruption until each application is complete.

(c) Spraying:

- (1) This work consists of spray applying the cementitious-based liner to the inside of the existing manhole. The necessary equipment and application methods to apply to the cementitious-based liner materials shall be approved by the material manufacturer.
- (2) The material shall be pumped for spray application. The material shall only be applied when the manhole is in a damp state, with no visible water dripping or running over the manhole walls.
- (3) Spraying shall be performed by starting at the manhole invert and progressing up the wall to the corbel and chimney areas. The material shall be applied to allow a uniform minimum thickness of 1 inch for the cured liner on all vertical surfaces, such as barrel sections. Minimum thickness on inclined sections, such as brick chimneys and cone sections, shall be one-half inch.
- (4) Troweling of the materials shall begin immediately following the spray application. Initial troweling shall be in an upward motion, to compress the material into voids and solidify the manhole wall. Proper precautions shall be taken not to overtrowel.

(d) Bench Application:

- (1) The material to be sprayed on the bench will form a gradual slope from the walls to the invert with the thickness at the edge of the invert being no less than 1 inch. The material shall be applied to the bench area in such a manner as to provide for proper drainage without ponding. The material shall be a smooth steel trowel finish sloping from wall to invert. The wall bench intersection shall be rounded to a uniform radius the full circumference of the

ITEM VIII – MANHOLE REHABILITATION

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manhole. Benches shall not be rehabilitated until after the manhole walls have been completed.

(e) Invert Repair:

- (1) Invert repair shall be performed on all inverts. After blocking the flow through the manhole and thoroughly cleaning the invert, a quick-setting patch mix shall be applied to the invert in an expeditious manner. The mix shall be troweled uniformly onto the invert, extending out onto the bench sufficiently to tie into the liner spray applied to the bench. The finished invert shall be U-shaped uniform with pipe diameter with a minimum depth of 6 inches for 8-inch pipe and full depth for greater sized mains. Finish is to be that accomplished by steel trowel. Pipe crowns are to be built on all pipes. Invert shall be at least 2 inches thick, and be smooth and free of ridges. Invert reconstruction shall not take place until after the manhole wall rehabilitation has been completed.

(f) Curing:

- (1) The material shall be cured according to the manufacturer's instructions and recommendations.
- (2) Caution should be taken to minimize exposure of applied product to sunlight and air movement. At no time should the finished product be exposed to sunlight or air movement for longer than 15 minutes before replacing the manhole cover.

8.08 Manhole Inside Drop System

(a) Material:

- (1) The inside drop system shall be a PVC collection device that facilitates the controlled drop of effluent into the main stream flow of a sanitary manhole. The system shall be constructed of PVC pipe and fittings as shown on the drawings. The system shall permit easy inspection and cleaning without the need to enter the structure. Adjustable stainless steel straps shall fully support the drop pipe.
- (2) The inside drop system shall consist of the following components:
 1. SDR 35 PVC Fittings
 2. SDR 35 PVC drop pipe
 3. New grouted invert for drop pipe

(b) Application:

- (1) All existing manhole structures to receive inside drops shall be outfitted with drop bowl system components as specified on the Plans. The drop pipe size shall be determined by incoming pipe size. Provide a 4-inch bowl and 4-inch drop pipe for a 4-inch inlet. Provide a 6-inch bowl and 6-inch drop pipe for a 6-inch inlet. The appropriately sized drop pipe of SDR 35 PVC shall be securely attached to the manhole wall using stainless steel adjustable clamping brackets and stainless steel fasteners. The clamping pipe supports shall be of 304 (11 gage) stainless steel with 3/8 x 18 stainless nuts and bolts. The turn-out at the base end of the drop pipe shall be accomplished with a newly constructed grouted invert to the main stream invert.
 - (2) All services that are to receive a drop bowl shall be located in the barrel section of the manhole. Services entering the cone section or having velocities sufficient to overshoot the bowl shall, at the ENGINEER's discretion, be relocated to either the barrel section of the manhole, removed from the manhole and connected to the mainline or lowered to the invert of the manhole.
- (c) Installation:
- (1) Manhole wall rehabilitation shall take place prior to installing inside drop systems.
 - (2) Select bowl size in accordance with these Specifications.
 - (3) Cut and mount SDR 35 PVC drop pipe of diameter appropriate to drop bowl size and flow using adjustable stainless steel clamping brackets (clamping brackets shall adjust to allow drop pipe to maintain correct stand off from wall).
 - (4) Construct invert to provide smooth transition into channel flow. If pipe crown does not match pipe crown of effluent main from manhole, an invert shall be built according to DISTRICT's Specifications.

8.09 Manhole Frame and Cover Replacement

- (a) Where indicated on the Plans, the manhole frame and cover shall be replaced with a new frame and cover. The new frame and cover shall be in accordance with DISTRICT's Specifications and the Standard Details.

8.10 Preparation

- (a) Cleaning: All concrete and masonry surfaces must be clean. Grease, laitance, organic matter, loose bricks, mortar, unsound concrete, and other materials must be completely removed. Water blasting using proper nozzles shall be the primary method of cleaning; however, other methods such as wet or dry sandblasting, acid wash, concrete cleaners, degreasers or mechanical means may be required to properly clean the surfaces. Surfaces on which these other methods are used shall

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be thoroughly rinsed, scrubbed, and neutralized to remove cleaning agents and their reactant products.

- (b) For the rehabilitation processes described herein, active infiltration shall be stopped as described in Section 7.05. All large voids in the manhole wall, corbel or riser sections shall be patched.
- (c) Manhole steps, lifting hook or eyes or other protrusions shall be removed flush with the manhole interior.
- (d) Where the process requires interruption of flow, the CONTRACTOR shall provide all necessary diversion or bypass pumping equipment to handle the flow for the duration of the manhole rehabilitation, including curing times where applicable.
- (e) Where overspray or droppings may affect the benching or flow channels, the manhole base shall be covered with plywood and braced to provide a firm working platform.
- (f) All spoil material resulting from the preparatory cleaning, plugging, and patching operation shall be removed from the manhole and not allowed to enter the collection system. All spoils removed from the manhole shall be disposed of in accordance with local or state regulations.
- (g) The CONTRACTOR shall keep his work areas neat, clean and reasonably free of debris. The CONTRACTOR shall bear the responsibility for and provide immediate cleanup of any spills at or near the site or during transport operations.

8.11 Field Quality Control and Testing

- (a) Prior to demobilization from the site, the CONTRACTOR shall remove all construction debris, stabilize any spill areas and wash roadway areas affected by the work.
 - (b) Visual inspection of the finished product shall verify a leak free, uniform appearance.
 - (c) The Cementitious lining shall provide a continuous surface with uniform thickness throughout the manhole interior.
- (1) The CONTRACTOR shall work with the ENGINEER to develop an easy method for measuring the liner thickness. This method should be such that the ENGINEER does not have to enter the manhole to measure the thickness. One possible method would be to install a pin (such as plastic adhesive pins) at every two-foot vertical spacing on the manhole wall. This spacing should occur in a random fashion such that no directly adjacent pins are located in the same quadrant of the manhole. The pins should protrude slightly less than an inch

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from the wall. The liner would be installed over the pins, and the ENGINEER could verify the thickness visually without entering the manhole. The CONTRACTOR may develop other methods for verifying the thickness and present them to the ENGINEER for consideration.

- (2) If the thickness of the lining is not uniform or less than specified, it shall be repaired or replaced at no additional cost to the DISTRICT.
- (d) Performance Testing: All rehabilitated manholes shall be vacuum tested in accordance with DISTRICT'S Specification Section VI-II, Paragraph 2.12(b) with one exception. The duration of the test shall be 20 seconds.
- (e) Material Testing: A minimum of four 2 X 2-inch mortar cube test samples shall be taken from the material used each day. The samples shall be properly packaged, labeled, and provided to ENGINEER for subsequent testing as described in ASTM C-109.
- (f) All manhole rehabilitative sealing and/or lining work shall be guaranteed against faulty workmanship and/or materials for a period of 5 years after completion of the work. Inspection by the ENGINEER will be scheduled 1 year, 3 years, and 5 years after the work is complete to verify that there is no visible leakage. Visible leakage, if found, will be corrected by the CONTRACTOR at no additional cost to the DISTRICT.

ITEM X – MISCELLANEOUS

10.01 Conformity With Plans

- (a) All Work shall conform to the lines, grades, cross-sections, details and dimensions shown on the Plans or listed in the Specifications. There shall be no deviation from the Plans or Specifications unless authorized by the ENGINEER.

10.02 Easement Plats and Special Provisions Detail Sheets

- (a) The CONTRACTOR is advised to review the easement plat for each parcel on this project, as applicable. The plats show the specific metes and bounds of the easement for each parcel. Copies of the plats will be made available, if not included in these Contract documents.
- (b) The CONTRACTOR shall review each Special Provision Detail Sheet attached herewith. These sheets describe any special requirements agreed to by the DISTRICT during easement negotiations with the individual property owner. The CONTRACTOR shall assume all responsibilities and liabilities accepted by the DISTRICT described on these sheets, except those provisions which involve financial considerations (payments) from DISTRICT to a property owner.
- (c) Unless specifically listed in the Bid Schedule, all work items listed within the Special Provisions Detail Sheets shall be incidental to the Work, and no extra payment will be made therefore.

10.03 Property Corner Markers

- (a) Property corner markers shall be protected by the CONTRACTOR. Property corner markers removed or disturbed by construction shall be replaced by a N.C. Professional Land Surveyor (PLS).
- (b) The CONTRACTOR shall take appropriate means to protect existing property corner markers found by the DISTRICT's surveyor during location and right of way surveys, as shown on the construction plans or right of way acquisition maps, or if found during construction and not shown on the Plans.
- (c) Where construction proposes to disturb these markers, the CONTRACTOR shall replace the existing markers in accordance to the provisions of this section.
- (d) Existing fences and posts identifying existing property lines and corners, shall be re-located by a PLS.
- (e) It is the intent of this requirement that the property owner's corner marker be replaced, as near possible, to the location it occupied prior to construction and that

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the Surveyor certify that, to the best of his ability and belief, he has done so. It is not the intent of this requirement that the Surveyor provide a certified survey of the property or to certify that the marker set is the property owner's actual property corner.

10.04 Advance Notice of Street Closures

- (a) When a major road or street will be continuously closed for more than one day, the CONTRACTOR shall post a conspicuous sign along each entrance to the road at least **two weeks** in advance of the closure. The sign shall state that the road will be closed beginning on a certain day and shall also state the expected date of re-opening.
- (b) The sign shall be fabricated in accordance with the North Carolina Construction and Maintenance Operations Supplement to the Manual on Uniform Traffic Control Devices for Streets and Highways, or in accordance with the requirements of the owner of the Right-of Way.
- (c) Local traffic shall be maintained at all times in accordance with these Specifications. No separate payment will be made for this requirement.

10.05 Street Cut and Street Closure Permits

- (a) The CONTRACTOR shall obtain street cut permits for public streets, as may be applicable to work done on this project. The cost of securing any and all Street Cut Permits shall be included in the various items bid. A copy shall be submitted to the DISTRICT prior to commencement of the Work. The CONTRACTOR shall also obtain any required permits for the closure of public streets. No separate payment will be made for this requirement

10.06 Traffic Control and Traffic Routing Plan

- (a) Where the Work encroaches upon the right-of-way of any public highway or street, the CONTRACTOR shall make all arrangements and necessary scheduling with the owner of the right-of-way for the actual construction work and shall perform the work on or across the right-of-way in the manner and at the time agreed upon with the owner of the right-of-way, and shall pay the costs thereof, including the costs, if any, of temporary construction performed by the highway street owner as a means of providing safe and continuous operation of its facilities during the construction period. The CONTRACTOR shall take extra precautions for the safety of the work, the owner's facilities and the general public as may be necessary by sheeting, bracing and thoroughly supporting the sides of the excavation and supporting and protecting any adjacent structures.
- or
- (b) Various areas of construction may require closure of streets to through traffic for limited periods. Through traffic shall be detoured. Local traffic shall be maintained at all times. All drives to residences and businesses shall be

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maintained passable or temporary drives constructed around the work area. All traffic control devices shall be in accordance with current edition of The Manual on Uniform Traffic Control Devices for Streets and Highways. Any supplemental information or manuals published or provided by NCDOT shall be approved by the NCDOT Division Traffic Engineer prior to closure of any section of street or highway.

Where work in City or Town streets requires closure, prior approval of traffic control devices shall be obtained from the Owner of the right-of-way. In addition, the appropriate Fire Department, Police Office, and School System shall be notified by the CONTRACTOR any time that any street requires closure. The CONTRACTOR shall maintain all traffic control devices in a clean and highly visible state in good working order and shall provide the necessary traffic control devices and flagmen as required by NCDOT, or the owner of the right-of-way. All signs shall be of the size, dimensions and construction as required by the Manual on Uniform Traffic Control Devices and the NCDOT Division Traffic Engineer. No separate payment will be made for this requirement.

10.07 Traffic Control Signs

- (a) The State of North Carolina Department of Transportation requires that construction sites within State rights-of-way have signs fabricated in accordance with the AASHTO Manual on Uniform Traffic Control Devices for Streets and Highways and with the North Carolina Construction and Maintenance Operations Supplement to the AASHTO manual. Copies of the NC Sign Supplement manual may be obtained from the N.C. Department of Transportation, Division of Highways, Raleigh, N.C. 27611. No separate payment will be made for signs provided or fabricated to meet this requirement.
- (b) Work within the jurisdiction of local governments shall comply with the signing requirements of the appropriate local government as well as those set forth in the Uniform Traffic Control Manual and the NC Sign Supplement. In case of a conflict between the local regulations and the AASHTO/NC manuals, the more restrictive of the regulations shall control. No separate payment will be made for signs provided or constructed to meet this requirement.

10.08 Tree Permits – City of Asheville

- (a) Tree Permits shall be obtained from the City of Asheville Parks and Recreation Department prior to any work on City Street rights-of-way. This pertains to any trimming of limbs or removal of trees on this project for trees located within City Rights-of-Way. See also Article 6.11, “Tree Protection Guidelines”. No separate payment will be made for this requirement.

10.09 Tree Protection Guidelines

1. **Root Protection** – Feeding tree roots are located within the top 12 inches – 18 inches of soil. Care should be taken not to disturb the roots located within the dripline of the tree. This includes vehicle and equipment movement within this area. Delicate root hairs are broken when heavy machinery is moved across the rooting zone located within the dripline of the tree. It is best to completely barricade the dripline area to prevent damage to the root hairs. No debris, supplies, equipment, or soil should be stored in the area and should be treated as off limits.
2. **Trunk Protection** – If the dripline area is breached then appropriate steps should be taken to ensure the trunk is left unscarred. Boards may be used TIED vertically around the trunk to provide protection to the main stem.
3. **Limb Protection** – If the tree is in a position where a limb will be broken the course of work performed the limb should be removed before it becomes damaged. Some limbs may be tied up to upper limbs to prevent damage to the low lying limbs. Care should be taken not to put too much stress on the limbs.
4. **Root Damage** – If during the course of the prescribed work roots are damaged, the root should be pruned cleanly with a sharp saw or lopper at an angle behind the damaged area. This includes both small and large roots. NO wound protectants or dressings should be used on root cuts.
5. **Trunk Wounds** – If during the course of the prescribed work, the trunk protection fails and a wound occurs on the main stem, remove only the loose bark until clean. DO NOT use a wound dressing on any tree other than a *Quercus alba* – White Oak. Wound dressings are no longer recommended for scarred areas except on White Oak.
6. **Limb Damage** – If during the course of the prescribed work limbs are damaged or broken, the loose bark should be removed and the damage assessed. If there are cracks in the wood behind the damage and the cracks are significant then prune if possible to the next lateral branch towards the trunk. If this is not possible, remove the entire limb or branch. Wound dressings again should only be used on wounds on White Oak.

10.10 Erosion Control Violations and Fines

- (a) If required by State Statutes, the DISTRICT shall submit an Erosion Control Plan and Application to NCDENR and shall obtain an Erosion Control Permit from said agency on this project. The CONTRACTOR shall be responsible for installation and maintenance of all erosion control measures as shown on the approved Plans and as required in North Carolina Administrative Code Title 15A Chapter 4 and NCGS 113A.

- (b) If a fine is assessed against the DISTRICT due to one or more of the following reasons, the CONTRACTOR shall be responsible for payment of such fine(s):
 - (1) Non-compliance with the approved Erosion Control Plan.
 - (2) Failure to follow the approved Erosion Control Plan.
 - (3) Failure to properly install and/or maintain erosion control measures as required in the Plans.
 - (4) Failure to install adequate ground cover.
 - (5) Failure to correct deficiencies cited in a NCDENR Notice of Violation (NOV) letter within 7 working days of such notice when such corrections are authorized by the ENGINEER.
 - (6) Any other citation, for items that should have been the CONTRACTOR's responsibility to construct, install, and/or maintain.
- (c) At the discretion of the DISTRICT, the dollar value of any fine levied by NCDENR against the DISTRICT on a project for which the CONTRACTOR is responsible, may be withheld from any payment due the CONTRACTOR until the CONTRACTOR has paid to the DISTRICT the amount of such fine or has negotiated with NCDENR officials to release the DISTRICT from any and all obligations to pay such fines or any portion thereof.
- (d) The CONTRACTOR's attention is hereby called to other sections of MSD's Project Plans and Specifications referring to Erosion Control measures, devices, and requirements.

10.11 Soil Density Tests

- (a) As specified in Technical Specifications, Backfilling Trenches, compaction tests shall be made by a commercial testing laboratory in areas designated by the ENGINEER. Should any test fail, the costs of any subsequent test(s) shall be at the expense of the CONTRACTOR. Copies of test results shall be forwarded to the ENGINEER. Compaction tests shall be made in each trench extending across paved highways and at a maximum spacing of 200 feet where trenches are along highways and streets.

10.12 Landscape Plantings

- (a) The CONTRACTOR shall provide or replant trees, shrubs, and other landscape plantings which have been moved or disturbed as a result of sewer construction, in accordance with the Special Provisions Detail Sheets included herein or as shown on the Plans. The CONTRACTOR is directed to note that the one year project warranty applies to plantings. Payment for this item will be considered included in the unit price items for sewers, unless shown otherwise in the Bid Schedule.

10.13 Storm Drain Piping

- (a) Reinforced concrete storm drain pipe shall comply with the requirements of ASTM Specification C76, except as modified herein. Reinforced concrete storm drain pipe shall be Class III, unless otherwise shown on the plans. Wall thickness shall be "Wall B" in sizes 36 inches and smaller and "Wall C" in sizes 42 inches and larger. Joints shall be sealed with grout consisting of one part Portland Cement and two parts sand by volume. The quantity of water used in the mixture shall be sufficient to produce a stiff, workable mortar but shall in no case exceed five and one half (5.5) gallons per sack of cement. Sand shall conform to Specification M-85 of the American Association of State Highway and Transportation (AASHTO) Officials.
- (b) The pipe shall be thoroughly cleaned and wetted with water before the joint is made. Stiff mortar shall then be placed in the lower half of the groove of the pipe section already laid. Mortar shall be applied to the upper half of the tongue of the pipe section being laid. The tongue end of this pipe shall be inserted in the groove end of the pipe already laid, the joint pulled up tight taking care to see that the interior surfaces of the adjoining pipe sections are flush and even. Sufficient mortar shall be used to fill the joints of tongue and groove pipe to fill the joint completely and to form a bead on the outside of the pipe. Concrete used in the manufacture of pipe shall have an absorption rate not to exceed 6.0 percent. Steel reinforcement shall be circular. Materials used in the manufacture of concrete sewer pipe shall comply with the following ASTM Specifications: Portland Cement C150, Type II or C, Type II A, or C205 for Blast Furnace Slag Cement; Aggregates, C33 except that the fine aggregate shall be natural silica sand. Manufactured sand shall not be used. Coarse aggregates shall be crushed limestone. Each joint of pipe shall have stamped thereon the class of reinforcement and the wall thickness designation.
- (c) Corrugated steel storm drain pipe (or "CMP") shall comply with the requirements of ASTM Specification A444, and shall be zinc coated in conformance with AASHTO Specification M128. Corrugated steel pipe shall be asphalt coated with a minimum thickness of 0.05-inches of high purity asphalt in accordance with AASHTO Specification M190 and shall have a paved invert covering the bottom quarter of the pipe with a minimum cover of 1/8-inch over the corrugations. Pipe ends shall be reformed with reformed ends covering two full corrugations. Field joints shall be made with bolted corrugated bands. Connecting bands shall be zinc and asphalt coated as above described. Bolts shall be asphalt coated in the field after joints are made up. Fifteen (15)-inch and eighteen (18)-inch diameter CSP shall be 16 gauge, twenty-four (24)-inch diameter shall be 14 gauge, and thirty (30)-inch diameter shall be 12 gauge.

10.14 Fence Replacement

- (a) All fences crossed by the sewer line shall be replaced promptly after backfilling the trench. Fences shall be replaced with the same type of materials, and in the same

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location, as existed prior to construction. All materials shall be new and of good quality. If the CONTRACTOR has been able to remove the existing fence without damaging the materials, he may reuse these materials in replacing the fence, upon the approval of the ENGINEER. Replacement of existing fences is incidental to sewer construction, and no extra payment will be made therefore.

10.15 References to NCDOT Specifications

- (a) References have been made to Standard Specifications for Road and Structures of the N.C. Department of Transportation in order to allow the CONTRACTOR to utilize structures, materials, and construction methods conforming to N.C. Department of Transportation Requirements.
- (b) In the event of a conflict between the Standard Specifications for Road Structures of the N.C. Department of Transportation and these Special Conditions, General Conditions, and/or Technical Specifications, the provisions of these documents shall govern over N.C. Department of Transportation Specifications.
- (c) Standard Specifications for Road Structures of the N.C. Department of Transportation shall not be utilized for any basis of payment or compensation.

10.16 Maintenance of Sewer System

- (a) The CONTRACTOR shall furnish all necessary labor, pumping equipment, including standby pumps, temporary piping, temporary connections, and miscellaneous materials and supplies to satisfactorily contain the wastewater within the sewerage system during construction.
- (b) The CONTRACTOR shall satisfy himself as to the work and equipment necessary to maintain wastewater flow within the system during construction and to prevent spillage to the ground or to surface waters. See also Section 2.19 of the Technical Specifications.
- (c) The CONTRACTOR shall submit a plan for review to the ENGINEER, detailing how the CONTRACTOR will handle the sewage flow during construction. This plan must be approved by the ENGINEER prior to any work being performed on the project.
- (d) No separate payment will be made for the temporary measures which are used to contain the wastewater within the sewer system. Payment for this work be considered included in the unit price items for sewers.

10.17 Field Orders

- (a) Minor miscellaneous repairs executed by the CONTRACTOR at the instructions of the ENGINEER on work already completed and for which the CONTRACTOR is repairing or replacing due to no fault of his own shall be paid

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for on a time and materials basis. Copies of field orders authorizing the above work shall be brought to the monthly progress meetings at which time reimbursement for the work will be agreed upon for submittal with the subsequent monthly payment request. Time charges for all laborers and equipment shall be agreed upon prior to submittal of pay request and shall remain constant throughout the project.

10.18 Change Orders

- (a) In general, work requiring the issuance of a Contract Change Order shall commence only after the Change Order has been fully executed by the DISTRICT and then only upon proper notice to proceed. Reimbursement for the work will be mutually agreed upon prior to the issuance of a Change Order.

10.19 Project Closeout

- (a) Final Documentation - Prior to final payment, and before the issuance of a final certificate for payment in accordance with the provisions of the General Conditions, the CONTRACTOR shall file with the DISTRICT the documents listed hereinafter.
- CONTRACTOR's Certification of Completion - MSD Form
 - Release of Waiver of Liens – MSD Form
 - Consent of Surety to Final Payment from Insurance Company
 - Sales Tax Record - The CONTRACTOR shall provide to the DISTRICT a certified statement listing all invoices, invoice number, vendor, total amount of invoice, State tax, County tax, and City tax.
 - Project Record Documents - Record documents shall be as specified in General Conditions.
 - Guarantees - The guarantee required by the General Conditions and all other guarantees stated in the Specifications.
- (b) The above records shall be arranged in order, in accordance with the various sections of the Specifications, and properly indexed. At the completion of the work, the CONTRACTOR shall certify by endorsement thereof that each of the revised and marked-up prints of the Drawings and Specifications is complete and accurate.
- (c) No review or receipt of such records by the DISTRICT shall be a waiver of any change from the Contract Documents or the shop drawings, or in any way relieve the CONTRACTOR of his responsibility to perform the work as required by the Contract Documents, and the shop drawings to the extent they are in accordance with the Contract Documents.