

EARTH EXCAVATION

ITEM 1

WORK INCLUDED (Sec. 1.01) The Contractor shall, under Item 1, make to the lines and grades and elevations given, all required earth excavation and backfill for the various pipe lines, sewers, conduits and structures, and shall dispose of all surplus excavated materials as specified herein, unless specifically included under other items of these specifications.

The Contractor shall furnish all labor, materials, equipment, and incidentals necessary for performing all excavation, backfill, fill, compaction, grading, and excavation stabilization required to perform the piping and structures work shown on the Drawings and specified herein. The work shall include, but not necessarily be limited to manholes and chambers; duct, conduit, and pipe; roadways and paving; backfill, fill, and borrow; grading; disposal of surplus and unsuitable materials; and all related work such as sheeting, bracing, and water handling. Excavation dewatering, groundwater control, surface water control, and backfill moisture control shall be as specified herein. The classification of excavated materials shall be "earth" unless it can be classified as "rock" excavation. Earth excavation shall also include the removal of trees and stumps less than eight (8) inches in diameter measured at a point of four (4) feet above the ground.

Elevations of the existing ground and the approximate elevations of finished grades of the fills around structures to be built under this Contract are shown on the drawings. The elevations of the present ground are believed to be reasonably accurate, but do not purport to be absolutely so, and are presented only as an approximation. The Contractor shall satisfy himself, however, by actual examination of the site of the work, as to the existing elevations and the amount of work required by this item. Prior to construction, the Contractor shall be responsible for taking sufficient measurements, horizontal and vertical, to ensure that all existing facilities, which includes but is not limited to pavement, curbs, gutters, and drainage facilities, are restored to their original lines and grades.

All excavation and trenching stabilization and related sheeting, bracing, etc., shall conform to the latest requirements of OSHA excavation safety standards.

Wherever a compaction percent is referred to herein it shall mean "at least that percent of maximum density or determined by compaction tests, ASTM D698, unless otherwise specified."

Any excavation specifically included for payment under other items, such as tunneling, or sewer or water pipe laying, manholes, etc., will be paid for under other items and is not included for payment under this item. Work not meeting the requirements of this Specification in the sole judgment of the Engineer will not be paid for.

EXCAVATION SUPPORT AND STABILIZATION (Sec. 1.02) All excavations shall be stabilized to protect the safety of workers in the excavations from earth slides and cave-ins and to protect the structural integrity of the pipe or structure being constructed. In addition, all

excavations shall control ground movement so as to protect adjacent structures and utilities. Groundwater control is necessary for creating stable foundations for pipes and structures and for stabilizing excavation slopes. The contract work includes deep sewer and structure excavations, high groundwater tables, and excavation adjacent to and below streams. The type of excavation support and stabilization systems to be used for different segments of sewers between manholes and structures shall be selected by the Contractor based upon geotechnical characteristics, excavation depth, groundwater elevation, proximity of existing structures, area available for excavation storage, use of excavation area, etc. Excavated material shall not be stored outside of the designated permanent easements on private properties unless approved in writing by the property owner and approved by the Engineer prior to Work.

The Contractor shall furnish, install, maintain, and remove such excavation support, sheeting, and bracing systems as may be required to support the sides of excavations, to prevent any movement which could in any way diminish the width of the excavation below that necessary for proper construction, and to protect adjacent structures from undermining, settling, or other damage. Where ordered by the Engineer, wood sheeting supporting trench walls below the top of the pipe shall be left in place and cut off as directed by the Engineer; payment for such sheeting left in place will be on a fixed price basis as specified under Item 9.

Except when ordered left in place by the Engineer, wood sheeting above the top of the pipe, braces, shores, walers, or stringers shall not be withdrawn until the backfill is practically complete. As the backfill progresses to the elevation of a set of walers and braces, such bracing shall be removed. All sheeting and bracing specified or shown on the drawings or directed by the Engineer to be left in place shall be so left. All sheeting left in place shall be cut off at least two feet below final finished grade. During the removal of sheeting, care must be taken to prevent movement of the sides of the excavation. All voids left by the withdrawal of sheeting shall immediately be carefully filled by flushing sand into the voids. Whenever the Engineer, in writing, orders any sheeting, shoring, bracing or foundation material left in place, or when so shown on the drawings or specified, the Contractor will be paid for the actual amount so left in place at the fixed prices stipulated for the applicable items. Sheeting, shoring and bracing left in place by the Contractor for his own convenience will not be paid for under any item.

The Contractor may, at his option, use movable earth retaining devices (trench boxes) to stabilize excavations for pipes where these devices can be effectively used. When moveable trench bracing such as trench boxes, moveable sheeting, shoring or plates are used to support the sides of the trench, care shall be taken in placing and moving the boxes or supporting bracing to prevent movement of the pipe, or disturbance of the pipe bedding and the screened gravel backfill. When installing rigid pipes such as RCP, any portion of the box extending below mid-diameter shall be raised above this point prior to moving the box ahead to install the next pipe. This is to prevent the separation of installed pipe joints due to movement of the box. When installing flexible pipes such as DIP and PVC pipe, trench boxes, moveable sheeting, shoring or plates shall not be allowed to extend below mid-diameter of the pipe. As trench boxes, moveable sheeting, shoring or plates are moved, screened gravel shall be placed to fill any voids created and the screened gravel and backfill shall be re-compacted to provide uniform side support for the pipe.

EXCAVATION DEWATERING (Sec. 1.03) The Contractor shall, at all times during construction, provide and maintain proper equipment and facilities to lower the groundwater table below the excavation, to remove promptly and properly dispose of all ground and rain water entering excavations and to keep such excavations dry so as to obtain an undisturbed sub-grade foundation condition until the fill, structure, or pipes to be built thereon have been completed to such extent that they will not be floated or otherwise damaged by allowing water levels to return to natural elevations. The Contractor shall furnish all materials and equipment and perform all work required to install and maintain the drainage systems he/she proposes for handling groundwater and surface water encountered during construction of structures, pipes, and compacted fills. All structures, casings, and pipes to be constructed below the natural groundwater table and adjacent streams will require dewatering. The Contractor shall construct and place all pipes, concrete structures, structural fill, and crushed stone bedding “in-the-dry”. Dewatering shall at all times be conducted in such a manner as to preserve the natural undisturbed bearing capacity of the sub-grade soils at the proposed bottom of the excavation. Groundwater shall be lowered to at least two (2) feet below the excavation level at all times.

The impact of anticipated subsurface soil/water conditions shall be considered when selecting methods of excavation and temporary dewatering and drainage systems. Where groundwater levels are above the proposed bottoms of excavations, a pumped dewatering system is expected for pre-drainage of the soils prior to excavation to final grade and for maintenance of the lowered groundwater level until construction has been completed to such an extent that the foundation, structure, pipe, conduit, or fill will not be floated or otherwise damaged. Type of dewatering system, spacing of dewatering units and other details of the work are expected to vary with soil/water conditions at a particular location.

All excavations shall be diked and ditched so as not to permit the entry of any surface drainage water. Surface drainage shall be controlled so that no surface drainage shall enter the excavation at any time. The surface area in the work area shall be continuously graded and compacted to drain surface water away rapidly. Any impassability of the work area to vehicles due to soft ground or mud shall be evidence that this requirement has not been fulfilled. The installed sewer pipe and manholes shall be protected from runoff water or stream flooding at all times. No accumulation of water shall be allowed in the sewer or manholes at any time.

Pipes, casings, and structures shall not be installed in water or come into contact with water within 24 hours after being placed. Water shall not flow over new concrete within 4 days after placement. Pipes not meeting this requirement shall not be paid for and shall be removed and reinstalled when the excavation is dry and stabilized as directed by the Engineer. In no event shall water rise to cause unbalanced pressure on structures until the concrete or mortar has set at least 24 hours. The Contractor shall prevent flotation of pipes by promptly placing and compacting backfill to project specifications.

The Contractor shall provide for the disposal of the water removed from the excavation in such a manner as not to cause erosion, siltation, or turbidity increases in any water course; injury to public

health; degradation or damage to private or public property, to any portion of the work completed or in progress, or to roads or streets; or cause any impediment to the reasonable use of the site by others. In no case shall trench water or groundwater be pumped into or allowed to enter the sanitary sewer system. At no time shall installed sewer pipe be used for dewatering, drainage, or dewatering water conveyance. Discharges to water courses shall comply with all applicable requirements of all governmental agencies having jurisdiction. All muddy or silty water shall be de-silted in temporary sedimentation basins before discharge to water courses.

The Contractor shall be responsible for correcting any disturbance to natural bearing soils or damage to structures caused by an inadequate dewatering system or by interruption of the continuous operation of the system as specified. Should the dewatering system be inadequate, improperly operated, or fail to the extent that groundwater rapidly enters the excavation, the new work shall stop and the system shall be repaired, modified or operated to lower the groundwater table to the specified elevation. Should the trench bottom at final excavation be loosened to the extent that proper support of the bedding or pipe has been compromised, the loosened material shall be removed and replaced with structural fill as directed by the Engineer and at no additional cost to the Owner.

Excavation, pipe and bedding installation and backfill shall be done only "in-the-dry", and all such work shall stop at any time that water appears in the excavation until the water is completely removed. Dewatering shall be continuous until all work in the area is completed and backfilled.

STRIPPING OF TOPSOIL (Sec. 1.04) Topsoil shall be provided in all lawns, landscaped areas, cultivated fields and pastures on the project. Contractor has the option to strip and stockpile existing topsoil prior to trenching operations for subsequent reuse if it meets the definition of topsoil in Item 24. Topsoil shall be kept separated from other excavated materials and shall be piled free of roots and other undesirable materials. Topsoil shall be protected with silt fencing for erosion control.

STORAGE OF SURFACE MATERIALS (Sec. 1.05) The Contractor shall remove all pavements, sidewalks, curbs, gutters, flagstones, crosswalks and other surface materials and all topsoil and shall properly classify and separate such materials and carefully store them for future use in backfilling, surfacing and repaving, provided such materials are suitable for such use. The Contractor shall be held responsible for any loss or damage to such materials and any deficiencies shall be made well with new materials, so that, when they are replaced, they will be in as good condition as they were before being disturbed. No extra compensation will be allowed for the removal and storage of such materials, the cost of this work being included in the unit prices stipulated for various items of this work.

The Contractor shall carefully remove and store, previous to starting the main excavation work, all loam or top soil which is suitable for subsequent use upon the work. Care shall be taken in removing the loam or top soil to avoid mixing it with the underlying materials. The loam or top soil stored shall be placed in storage piles on the site of the work.

CUTTING PAVEMENTS (Sec. 1.06) Whenever the removal of pavements other than gravel or surface treated types is required, the Contractor shall outline the area to be removed by making saw cuts providing vertical kerfs in straight lines in order to limit breakage.

EXCAVATION (Sec. 1.07) The Contractor shall clear the surface of the ground as required for the full width and length of the proposed trench or structure excavation.

Excavation shall include the removal of all soil, rock, weathered rock, rocks of all types, boulders, conduits, pipe, and all other obstacles encountered and shown to be removed within the limits of excavation shown on the Drawings or specified herein. The cost of excavation shall be included in the unit price of the pipe and no additional payment will be made for the removal of obstacles encountered within the excavation limits shown on the Drawings and specified herein. Additional earth excavation payment will be paid according to Item 2.

Excavated material which has suitable characteristics for backfill shall be covered and/or stockpiled in such a manner that it will not collect either surface water or rainwater. The stockpile top surface shall be sloped to drain away from the excavation site and graded smooth and compacted to drain rainwater rapidly. Backfill containing excessive moisture shall not be used. It shall be the Contractor's responsibility to control or adjust the moisture content of excavated materials to the requirements for common fill before such materials may be used for backfill at no additional cost to the Owner. **THE ENGINEER WILL DESIGNATE MATERIALS THAT ARE UNSUITABLE FOR BACKFILL.** The Contractor shall furnish offsite disposal areas for the excess and unsuitable material, unless disposal areas have otherwise been provided by the City.

All excavated material which has qualities unsuitable for common fill backfill and which is otherwise not used for backfill shall be removed from the site as unsuitable material. Unsuitable material disposal shall be paid per cubic yard of unsuitable material transported and shall include all necessary clearing, hauling, grading, and seeding and erosion/sediment control at the disposal site. Stockpile areas shall be prepared and seeded. Disposal shall be in compliance with all applicable regulations. The Contractor shall keep daily records of all unsuitable material disposal. These will be reviewed and approved by the Engineer prior to payment.

All rocks, stumps, roots, and organic muck, clay, or silt lenses removed in the preparation of the excavated material for common fill shall be disposed of offsite by the Contractor as unsuitable material. Soils which cannot qualify as common fill after preparation such as muck soil, high organic soil, or non-granular soil high in silt and clay content shall also be disposed of offsite by the Contractor as unsuitable material. At the end of the work after all stockpiled, prepared backfill has been utilized as needed, the remaining excavated material shall be removed from the site as unsuitable material.

Failure of the Contractor to prepare excavated material to qualify as backfill shall not relieve the Contractor from his/her obligation to furnish common fill for backfill, regardless of the circumstances. The Engineer shall be the sole judge of whether excavation will qualify as backfill after proper preparation and whether or not such preparation performed by the Contractor is

satisfactory. Should the Contractor's preparation not be satisfactory, the Contractor shall use imported fill for backfill at no additional cost to the Owner. If the Contractor has satisfactorily prepared the excavated material and it still can't meet the compaction requirements, it will be considered unsuitable material and its excavation and replacement will be covered under the unsuitable material bid item.

Where excavated material has good qualities for topsoil, such material shall be stored separately as extra topsoil in a common area for use where suitable topsoil is not available at the excavation site as directed by the Engineer. Such topsoil shall be used where directed by the Engineer. Otherwise, topsoil shall be collected and stored separately at the respective work sites for placement at the same sites.

The cost of stockpiling excavation and topsoil (both required and excess), the handling and transport of such material to the stockpile areas and the points of usage, the placement of such material, and the restoration of the stockpile areas and haul routes shall be included in the bid prices for the various bid items. No separate payment will be made.

No more than 50 linear feet of trench shall be open in advance of the pipe laying unless prior approval is given by the Engineer after consideration of ground conditions and/or location by the Engineer.

At the close of work each day pipeline trenches shall be completely backfilled or barricaded to prevent unauthorized entry. In paved areas the surface shall be restored as specified, to allow for traffic over the trench during non-working hours. Under no conditions shall any pipeline trench be left open during non-working hours unless approved by the Engineer.

WIDTH OF TRENCHES (Sec. 1.08) All excavation shall be made in such a manner and to such widths as will provide ample room for properly installing the pipe and permit thorough compaction of backfill around the pipe. All excavation and trenching shall be done in strict accordance with these specifications and all applicable parts of the OSHA Regulations, 29CFR 1926, Subpart P. Excavation of pipe trenches shall be made to the widths shown on the drawings. Should the trench width at the elevation of the top of the pipe be wider than shown because of the method of excavation, carelessness, or faultily placed sheeting, the additional bedding and backfill per the standard details shall be placed at no additional cost to the City. Where recommended trench widths are exceeded, redesign, stronger pipe, or special installation procedures shall be utilized by the Contractor. The cost of redesign, stronger pipe, or special installation procedures shall be borne by the Contractor without any additional cost to the Owner. All excavated material shall be kept at least two (2) feet from the edge of the open excavation in accordance with 29 CFR 1926.651 (j) (2).

UNAUTHORIZED EXCAVATIONS (Sec. 1.09) All excavations carried outside of the lines, grades or pavement limits given, specified or directed, together with the disposal of excavated material, and all excavations and other work resulting from slides, cave-ins, swellings or upheavals shall be at the Contractor's cost and expense. All spaces beneath foundations resulting from unauthorized excavations or from slides or cave-ins, shall be refilled at the Contractor's expense with concrete or

foundation material, and at no cost to the City. The final trimming of the bottom and sides of excavations against which masonry is to be built shall be done just before the concrete is placed.

STRUCTURE PROTECTION (Sec. 1.10) Temporary support, adequate protection and maintenance of all underground and surface structures, drains, sewers, water lines, gas lines, conduits and other obstructions adjacent to or encountered in the progress of the work shall be furnished by the Contractor as provided in the Bidding Documents. All structures, fences, etc., which have been disturbed shall be restored upon completion of the work.

BEDDING (Sec. 1.11) Bedding stone for structures and pipe shall be placed to the minimum excavation widths shown on the Drawings, and shall be at least 4 inches deep below the bottom of footings, base slabs, and bottoms of pipes. Bedding shall be placed only on dry, compacted subgrade or on rock. Subgrade shall include the sides of the trench outside the vertical projection of the pipe diameter. Sub-grade compaction shall be with a vibratory type mechanical compactor. Loose earth in the sub-grade shall not be acceptable.

PIPE, STRUCTURES, AND MANHOLE INSTALLATION (Sec. 1.12) If the Contractor is using a pipe laying laser for the pipe installation, the laser shall be calibrated each time the laser is moved. Calibration shall be performed in accordance with the manufacturer's guidelines. The Engineer may require additional calibration to verify the accuracy of the pipe laying laser. All pipe laying lasers that are not calibrated, do not meet the manufacturer's guidelines, or are determined to be inaccurate shall be replaced.

Under no circumstances should installation of sewer pipes, structures, and manholes to the tolerances specified herein result in a reverse grade. Any pipe, structures, or manholes installed outside of these tolerances or at an inverse grade shall be removed and replaced with correct work. Pipe and precast concrete manholes may be reinstalled only as approved in writing by the Engineer. Otherwise, removed pipe and manholes shall be removed from the site and replaced at no additional cost to the Owner.

The trench and bedding shall be prepared in such a manner to prevent contamination of pipe joints with soil or bedding and to provide complete support of each section of pipe except at the bells and spigots. When installation is not in progress and at the end of every working day, the open end of the pipe shall be sealed with a plug which has the capacity to resist a head of water of at least 40 feet.

Protect the pipe against flotation at all times. Where water inadvertently enters the excavation, remove all wet and softened material before continuing pipe installation and remove all soil and mud from the pipe and structures.

Trenches for sewers, water pipe, and conduits constructed in place, after the pipe has been placed and the joints have been properly made, shall be carefully backfilled by depositing without shock and by tamping with approved mechanical equipment suitable bedding material where called for under and around the sides of the conduit or pipe, and to a height of not less than six (6) inches above the top of

the pipe. This bedding shall be tamped and graded evenly across the trench and must be done at once, and in particular before any backfilling is deposited directly from a bulldozer, machine, bucket, trucks or other vehicles. The backfilling shall be brought up evenly and all eccentric loading shall be avoided. In no case shall dumpings from a bucket be allowed to fall directly upon the sewer, conduit or pipeline; in all cases the bucket must be lowered sufficiently so that shock of the falling backfill will not injure the structure.

BACKFILLING (Sec. 1.13) Backfilling of pipes and structures above the embedment shall be as shown on the Drawings. All backfill shall be of a non-plastic nature free from roots, vegetative matter, waste, construction material or other objectionable material. Fill shall be deposited in successive, uniform, approximately horizontal layers not exceeding twelve (12) inches in depth for the full width. Stones or fragmentary rock larger than 4-inches in their greatest dimension will not be allowed within the top 6-inches of the ground nor within 12 inches of pipes. No stone or fragmentary rock larger than 4-inches in their greatest dimension will be allowed for any portion of backfill. No objectionable or unsuitable material will be allowed in the backfill. Backfill material shall be capable of being tamped by mechanical tamps using relatively low velocity and heavy blows. The material shall have no tendency to flow or behave in a plastic manner under the tamping blows. Material deemed by the Engineer as unsuitable for backfill purposes shall be removed from the job site before backfilling operations begin.

Common backfill material shall consist of excavated materials except highly organic silts and clays. Material shall be free of roots, stones, and debris and capable of being compacted to 85% Standard Proctor. Common backfill shall not contain stone blocks, broken concrete, masonry rubble, or other similar materials. It shall have physical properties such that it can be readily spread and compacted during filling. Snow, ice, and frozen soil will not be permitted.

Where excavated material meets the requirements for common backfill, except for moisture content and/or the presence of unacceptable materials (e.g., excessive rock, muck, organics, clay, silt, or other material), it shall be the Contractor's responsibility to prepare such excavated materials to meet the requirements for common backfill in order to use the material as backfill. All costs associated with excavated materials to be used as common backfill and shall be included in the price bid for the sewer items.

Where excavated material, after removal of rocks, stumps, plant material, and other extraneous material and proper dewatering, drying, protection, and storage of the excavated material by the Contractor, cannot be prepared to meet the requirements for common backfill, due to the nature of the material (e.g., excessive rock, muck, organics, clay, silt, or other material), and as determined by the Engineer, the unacceptable excavation shall be removed from the site and disposed of by the Contractor and replaced by imported backfill meeting the requirements of structural backfill. When the moisture content of an otherwise suitable material is too high to achieve specified compaction, as determined by a moisture content and density test, the Contractor shall replace the material as necessary to meet backfill requirements. The wet material may be dried to optimum moisture content and used for backfill in subsequent phases of the project. Should an otherwise

suitable material be found too dry to achieve compaction requirements, water may be added to the material to raise the moisture content to optimum.

Imported structural backfill shall be free of organics, roots or other deleterious materials and shall not contain more than five percent (by weight) organic material, have a plasticity index (PI) greater than 25, or have a maximum dry density less than 90 pounds per cubic foot. Imported structural fill should consist of material classified as ML, CL, SC, or SM, or better per ASTM D-2487 and be capable of being compacted to the requirements below. The Contractor shall submit to the Engineer a sample of any proposed imported structural fill, weighing approximately 50 lbs, at least 14 days prior to the date of anticipated use of such material. Submittal shall include laboratory certifications meeting the USC classifications. Structural backfill shall not be placed on a frozen surface or one covered by snow or ice; nor shall snow; ice, or frozen earth be incorporated in the compact fill.

All backfill shall be placed only on dry, compacted surfaces. All water and soil loosened by water shall be removed before placing any backfill. The bedding and subgrade and previous backfill layers shall be compacted before any backfill placement. Backfill and topsoil of sewers in open areas shall be adjusted to match final grade initially and after 90 days as directed by the Engineer. Trenches shall be backfilled immediately after the pipe is laid.

COMPACTION (Sec. 1.14) Compaction shall be attained by the use of mechanical tamps only. Each layer of backfill shall be placed loose and thoroughly compacted in place. Heavy rollers, vehicles or other equipment shall not be used for compacting pipeline and structure backfill nor allowed to cross over completed work except at points adjudged capable of adequately protecting the pipeline. Pneumatic tamps, gasoline ram type tamps or vibrating tamps with sheepsfoot rollers will be required to meet the specifications of "Mechanical Tamp". Use of a backhoe bucket for compaction is prohibited. Variances shall only be with the explicit approval of the Engineer.

The densities specified herein refer to percentages of maximum density as determined by the noted test methods. Compaction of materials on the project shall be in accordance with the following schedule:

Minimum Compaction Limits	
Location	Density
Areas under roadway pavement shoulders, sidewalks, and curb and gutter	95% of the maximum dry density by ASTM D698 (Standard Proctor) AASHTO T-99
Trenches excavated outside existing road and railway rights-of-way (under turf, sodded, seeded non-traffic areas)	85% of the maximum dry density by ASTM D698 (Standard Proctor) AASHTO T-99

Under no circumstances shall water be permitted to rise in unbackfilled trenches after the pipe has been placed. Should water rise in an unbackfilled ditch after the pipe has been placed, the Engineer may require the Contractor to remove the pipe, muck the trench and re-lay the pipe.

The City reserves the right to acquire samples of and perform tests on the material intended to be used as backfill for the aforementioned applications. After material density has been determined by laboratory testing, and found to be acceptable, the applicable compaction requirements must be met.

When compaction test results indicate that the density is less than the percent specified, the Contractor shall excavate and re-compact the areas that have failed at no expense to the City. The Contractor shall be aware of the level of compaction required. If the work is suspect to be defective by the City, the work shall be retested. The water content of the backfill material shall also be tested and recorded for each test completed. The Contractor will be allowed to add water to the backfill material in order to obtain the optimum water content. However, the Contractor will not be allowed to utilize the addition of water as a means of compaction. Furthermore, should the backfill material be found to have water content ratios which in the opinion of the Engineer or the City prevents the appropriate compaction of the trench, the Contractor shall remove all defective material and undertake the necessary corrective work. Testing shall be accomplished by the City or its agent or by a laboratory selected by the City at no cost to the Contractor.

MAINTENANCE OF TRAFFIC (Sec. 1.15) When traffic is maintained over trenches after they are backfilled and before pavement is placed, the surface of the trenches shall be maintained in a manner to eliminate hazards and minimize inconvenience to vehicles with particular attention being given to keeping the temporary surface level to that of the adjoining pavement.

The Contractor shall provide emergency maintenance service twenty-four (24) hours per day, including Saturday, Sunday and holidays. The City and the Engineer shall be notified of the Contractor's maintenance superintendent's address and telephone number so that he may be contacted at any time between the starting and completion dates. If the Contractor cannot be reached or if he does not promptly do any repair work required, the City will make repairs at the Contractor's expense.

TUNNELING (Sec. 1.16) Tunneling will be permitted under trees and under water and gas service pipes for a length not to exceed fifteen (15) feet. Elsewhere tunneling will not be permitted unless specified under other items. Should tunneling under this item be permitted, measurement and payment for excavation will be made as specified for open cut for pipe.

MEASUREMENT AND PAYMENT (Sec.1.17) All excavation required to be furnished shall be included in the prices bid for other items and will not be measured or paid for under this item, except all stated below.

The number of cubic yards of unsuitable material disposal to be measured for payment under this item shall be the number of cubic yards, measured in place, of unsuitable material actually removed and disposed of by the Contractor where directed or shown on the drawings, except as specified

hereinafter or in other items of these specifications and within the same limits as specified for additional earth excavation under Item 2.

The unit price stipulated per cubic yard for unsuitable material disposal under Item 1 shall include the labor, materials, and equipment for excavation and disposal of unsuitable material encountered during excavation including loading and unloading, transporting, proper handling, disposal, grading and stabilization at an offsite disposal facility. The unit price shall also include any required clearing and grubbing at the disposal site. This unit price shall also include any Engineer-approved imported common fill materials from an offsite source including common fill material testing, processing/crushing/screening to meet common fill material requirements, loading, transporting, temporary stockpiling, placement and compaction as measured and verified by the Engineer necessary to complete the work as specified or as shown. **THE UNIT PRICE BID FOR UNSUITABLE MATERIAL DISPOSAL AND REPLACEMENT WITH COMMON BACKFILL SHALL BE AT LEAST \$20.00 PER CUBIC YARD. THE CONTRACTOR MAY USE A UNIT PRICE GREATER THAN \$20.00 PER CUBIC YARD. IF AN AMOUNT LESS THAN \$20.00 PER CUBIC YARD IS BID, THE OWNER WILL ADJUST THE FIGURE ON THE PROPOSAL TO THE CORRECT AMOUNT (\$20.00 PER CY) AND ADJUST THE TOTAL BID ACCORDINGLY.**

ADDITIONAL EARTH EXCAVATION

ITEM 2

WORK INCLUDED (Sec. 2.01) The Contractor shall, under Item 2, make all required additional earth excavation where necessitated for the proper execution of this contract.

ADDITIONAL EXCAVATIONS (Sec. 2.02) It is expected that satisfactory foundations will be found at the elevation shown on the drawings, but in case the materials encountered are not suitable, or in case it is found desirable or necessary to go to additional depth or width, the excavation shall be carried to additional depth or width. Additional authorized excavation will be paid under Item 2 and concrete or foundation materials used for refilling will be paid for under their respective items as the prices stipulated in the Proposal.

MEASUREMENT (Sec. 2.03) The quantity of additional earth excavation to be paid for under Item 2 shall be the total number of linear feet of pipe installed with additional excavation, measured from a plane two (2) feet below the invert of the pipe downward to the surface of suitable soil as determined by the Engineer. Any additional earth excavation to reach suitable pipe foundation from the pipe invert to a plane two (2) feet below the invert shall be included in other bid items. No separate payment will be made.

Unless otherwise specified, Item 2 will be paid for only when the material is placed directly in its final position or rehandled. Additional earth excavation will be measured as shown on the drawings or as specified with the lowest elevation at the surface of the rock (or excavation of any classification other than earth). Where the limits of excavation for one structure intersects or overlaps the limits of excavation for another structure, no additional excavation shall be measured for payment within this intersection or overlapping.

Should rock be encountered, additional earth excavation shall be measured to the top of the rock.

No allowance will be made for excavation beyond the above-defined limit when made by the Contractor for working space, pump sumps, drainage ditches or other like purposes.

PAYMENT (Sec. 2.04) The unit price stipulated per linear foot for additional earth excavation shall include the disposal of said excavation and the furnishing of all labor, materials, tools and appliances necessary to complete the work as specified or as shown.

ROCK EXCAVATION

ITEM 3

WORK INCLUDED (Sec. 3.01) The Contractor shall, under Item 3, make to the lines and grades given, all the rock excavation for pipe trenches and structures and dispose of all excavated materials as specified herein.

DEFINITION OF ROCK (Sec. 3.02) All excavated material in its natural state which, when not frozen, requires drilling and blasting or drilling and wedging for its removal, and all boulders one-half (1/2) cubic yard and over in volume, shall be termed rock excavation. Material which can be loosened with a pick but which, for convenience or economy, is loosened by drilling and blasting, or by drilling and wedging, and material which is exterior to the limits of measurement allowed, shall not be measured or classified as rock excavation.

Concrete, (not including pavements, pavement bases, curbs, sidewalks and steps encountered in the excavation) and boulders having a volume of one-half (1/2) cubic yard or over, shall be termed rock excavation.

REMOVING ROCK (Sec. 3.03) In removing rock, special care shall be taken to excavate it as closely as possible to the required line and grade. The surface of all rock shall be sufficiently rough to bond well with any masonry structure. Rock surfaces against which masonry will be constructed shall be thoroughly cleaned of all dirt, loose rock, boulders, gravel, snow, ice, or other objectionable substances.

BLASTING (Sec. 3.04) Blasting will be permitted for rock excavation unless prohibited by local ordinances or regulations. When permitted, the Contractor must use all possible precautions to prevent accidents or damage on account of explosions or the use or storage of explosives. The Contractor shall supply a certified seismologist during all blasting operations to monitor the shock waves.

Explosives shall be used, handled, and stored, as prescribed by the Laws and Regulations of the State of North Carolina and by all local regulations. All explosives shall be kept in a safe place at a sufficient distance from all work so that in case of accident no damage will occur to any part of the work.

The drilling of holes for explosives shall be done with pneumatic tools; dust from drilling operations must be controlled so as to cause no inconvenience to workmen or the public.

Blasting shall be conducted so as not to endanger persons or property and, whenever required, the blast shall be made before the original cover has been removed or it shall be covered or otherwise satisfactorily confined. The Contractor shall be held responsible for and shall make good any damage caused by blasting or any accidental explosions.

DISPOSAL OF MATERIALS (Sec. 3.05) If the City does not designate where such surplus materials are to be disposed of they become the property of the Contractor and he shall dispose of them at his own expense, except that no rock be permitted in the backfill.

BACKFILLING (Sec. 3.06) All backfilling shall be performed in accordance with the provisions of Item 1. No rock shall be used in the backfill.

Should additional earth, not available from the excavation, be required to complete the backfill, it shall be obtained and included under the item for which the excavation was necessary.

MEASUREMENT (Sec. 3.07) All rock excavation to be paid for under this item shall be measured in cut and will be paid for only once whether the material is placed directly in its final position or rehandled. Excavation above the elevation of the top of the rock will be paid for as earth excavation. Payment will be made only for rock excavation within the lines and grades given and within the following defined limits.

STRUCTURES: Rock excavation for structures, unless otherwise specified or shown on the drawings, shall be measured between vertical planes two (2) feet farther apart than the outside dimensions of the foundations of the structures and from the surface of the rock to the neat lines of the bottom of the structures.

TRENCHES: Rock excavation in trenches, unless otherwise specified, shall be measured as having vertical sides and a width one and one-half (1-1/2) feet greater than the internal diameter of the pipe, to a horizontal plane six (6) inches below the bottom of the pipe. Concrete conduits cast in place, or vitrified pipe encased in the concrete will not be considered as constructed in pipe trenches, and rock excavation for such will be paid for to the neat lines of the concrete unless such neat lines are narrower than the allowable trench width, in which case the trench width will apply.

PAYMENT: (Sec. 3.08) The unit price stipulated under Item 3 shall include the excavation of all rock and backfilling of all trenches and around all structures; the furnishing, placing and removing of all sheeting and shoring; blasting; the pumping and removal of water; the hauling and disposal of excavated materials; and the furnishing of all labor, tools and appliances necessary to complete the work as specified or as shown.

No payment for rock excavation under Item 3 will be made whenever rock excavation is specifically included in other items of these specifications.

FOUNDATION CUSHION

ITEM 4

WORK INCLUDED (Sec. 4.01) The Contractor shall, under Item 4, furnish all the materials for and shall properly place, at all locations shown on the drawings, or as required, cushion of well compacted railroad ballast stone, or other approved materials in order to obtain firm foundations for the structure to be built under this contract.

MATERIALS (Sec. 4.02) Foundation cushion material shall consist of #3 Railroad Ballast. Surge Stone, which is defined as NCDOT Class A riprap with stones ranging in size from 2 inches to 6 inches, is an acceptable substitute for #3 Railroad Ballast Stone.

PLACING (Sec. 4.03) The #3 Railroad Ballast Stone shall be placed in eight (8) inch lifts and thoroughly compacted into the material below. The placing of this material shall be continued until the required depth is placed, and the top of the cushion shall be furnished to the lines and grades given by the Engineer.

MEASUREMENT (Sec. 4.04) The foundation cushion (#3 Railroad Ballast Stone) shall be measured based on the actual weight of the material from delivery tickets. Placement of the foundation cushion shall closely follow the limits as specified for additional earth excavation under Item 2. Measurement of foundation cushion shall include material from the bottom of the excavation to the bottom of the pipe or structure bedding.

Foundation cushion or material required for unauthorized excavation, or excavation which has been carried too deep through the fault of the Contractor, will not be measured for payment.

Under no circumstances will material used be bedding material called for under other items of these specifications be measured for payment under this item.

PAYMENT (Sec. 4.05) The unit price stipulated per ton for foundation cushion under Item 4 shall include the furnishing, placing and compacting of the foundation material, and the furnishing of all labor, materials, tools, and appliances necessary to complete the work as specified or as shown.

CONCRETE

ITEM 5

SCOPE (Sec. 5.01) This Item includes furnishing, transporting, and placing of concrete used for site construction of conduits, pavements, curbing, foundation slabs, walls, floor, columns, beams, tanks and other structures as required.

Approved mix designs for specified classes of concrete shall be the responsibility of the Contractor.

STANDARDS (Sec. 5.02) Concrete work shall conform to requirements of ACI 301 latest edition, "Specifications for Structural Concrete for Buildings" except as modified herein.

The manufacture, delivery, and installation of cast-in-place concrete shall be in accordance with requirements of ASTM Designation C94 and applicable documents of that Standard, except as specified herein.

CONCRETE MIX DESIGN (Sec. 5.03) An independent testing laboratory shall provide initial mix designs to produce specified classes of concrete within the limiting requirements herein. Concrete shall conform with the requirements of Section 1000 of the North Carolina Department of Transportation (NCDOT) Standard Specifications for Roads and Structures 2012.

LABORATORY SERVICES (Sec. 5.04) Laboratory services shall be as provided under General Requirements of the Specifications.

The laboratory, assisted by the Contractor, shall make sample tests as required to assure production of concrete of the specified quality and composition.

Laboratory technicians shall have free access to the job and concrete production facilities at all times and receive the full cooperation of the Contractor for the preparation, storage, and transportation of concrete sample test cylinders and/or test beams.

The laboratory shall provide the forms for testing cylinders and beams.

CONCRETE PLANT (Sec. 5.05) Plant equipment and facilities shall be in accordance with applicable requirements of ASTM Designation C 94 and as specified herein.

Equipment shall comply with the following requirements:

The accuracy of the weighing equipment shall conform to the requirements of the United States Bureau of Standards.

Equipment shall be capable of compensating for the varying weight of moisture contained in the aggregates, or for changing the proportionate batch weights.

The equipment shall be capable for accurately controlling the weight of the cement and aggregate.

The equipment shall be so arranged as to permit the convenient removal of overweight material.

Standard testing weights and other necessary equipment for testing the accuracy of the weighing equipment shall be available at the plant at all times.

PLANT INSPECTION:

A qualified representative of the testing laboratory shall inspect the plant and determine if the necessary facilities and equipment are available and adequate for scheduled production of concrete as specified.

If the plant does not meet requirements, the Contractor shall be informed of the deficiencies so that they may be corrected.

When in the opinion of the laboratory representative the plant meets the requirements for specified production, he shall so notify the Engineer in writing. The notification shall include a list of all major facilities necessary for use in production of specified concrete for use in the Project.

In lieu of the requirements above, the Contractor may submit the latest edition of the National Ready Mixed Concrete Association's "Check List for Certification of Ready Mixed Concrete Production Facilities," executed and certified for conformance by a Registered Professional Engineer.

Production of concrete shall not be started until the Engineer has approved the plant for use.

SUBMITTALS (Sec. 5.06)

Contractor:

1. Plant certification
2. Cement certificate for each shipment
3. Admixture certificate
4. Concrete mix designs

Laboratory:

1. Design mixes
2. Mix approval
3. Test results
4. Sieve analysis of coarse and fine aggregates
5. Admixtures
6. Pozzolan admixture, Type F

MIXING AND TRANSPORTING CONCRETE (Sec. 5.07) Concrete may be mixed in portable mixers located at the job site, in central plant mixers, or in truck mixers. Mixers of any type shall conform to the requirements specified herein.

Portable and central plant mixed concrete shall be mixed in approved batch mixers of the rotary drum type having sufficient capacity to insure continuous delivery at the required rate, except that relatively small quantities may be mixed by hand by special permission. The mixing drum shall be kept free of set concrete at all times. A water storage tank equipped with a gauge glass and an accurate measuring device shall be provided to determine the exact amount of water added to each batch. The measuring device shall be readily adjustable, and so designed that it can be locked after setting and that the amount of added water cannot be altered after such setting. Mixing shall continue at least one minute at the manufacturer's rated speed of the drum after water and all aggregate and cement have been added, and until every particle of aggregate is coated with mortar and the whole mass uniform in color and homogeneous. The Contractor shall supply a discharge locking device so designed that concrete cannot be discharged in less than the required mixing time. The mixer shall also be equipped with a gong which sounds at the termination of the mixing time and with an approved batch meter which will accurately record each batch delivered.

Truck mixed concrete shall be mixed completely in truck mixers equipped with specified water-measuring control and locking devices. Each batch of concrete shall be mixed for not less than 70 nor more than 100 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of the equipment as mixing speed. Additional mixing shall be at the speed designated by the manufacturer of the equipment at their rated capacity. Trucks shall be equipped with counters that register the number of revolutions of the drum or blades.

Furnish two delivery tickets with each load containing the following information:

1. Date
2. Producer and Plant
3. Job, name and location
4. Truck number and time dispatched
5. Concrete designation and cement type
6. Admixtures description and content
7. Time discharge started and completed
8. Amount of concrete in load
9. Amount of any materials added at the site and authorized signature.

ON-SITE MIXING PLANT (Sec. 5.08) If the Contractor chooses to operate an on site mixing plant, the applicable provisions of ACI 301 Chapter 7.2 "Site-mixed concretes" shall apply.

The onsite mixing plant shall provide concrete of the types shown in Table I "Concrete Requirements" and as specified herein.

MATERIALS (Sec. 5.09) Cement shall conform to the requirements of ASTM C 150 or ASTM C 595. Types as provided in Table 1.

Admixtures:

Air entrainment admixtures conforming to ASTM Designation C 260 shall be introduced into the mix in quantities to entrain air as specified in Table 1000-1 of the North Carolina Department of Transportation (NCDOT) Standard Specifications for Roads and Structures 2012.

Pozzolan admixture shall conform to the requirements of ASTM Designation C 618, Class F.

The addition of the pozzolan admixture shall not change any of the requirements specified.

Calcium chloride or admixtures shall contain no more than 0.1% chloride ions and shall be thoroughly mixed to ensure uniform distribution. If the concrete is used with reinforcing steel, no calcium chloride is permitted.

High range water reducing admixture (superplasticizer) may be used as an option by the Contractor at no additional cost to the Owner.

The admixture shall conform to ASTM C494, Type F.

Approved products are Eucon - 37 by Euclid Chemical Company; Sikament by Sika Chemical Corporation or equal.

Fine Aggregate:

Fine aggregate shall consist of natural sand composed of clean, hard, strong, durable, uncoated grains. It shall be free from injurious amounts of shale, clay lumps, soft or flaky particles and other unsound or deleterious substances. It shall conform to Specifications for Concrete Aggregates, ASTM Designation C 33. Fine aggregates shall perform in a sieve analysis such that the percent passing a No. 50 sieve shall not exceed 5% and the percent passing a No. 100 sieve shall be 0%.

Coarse Aggregate:

Coarse aggregate shall consist of gravel, slag, or broken stone composed of strong, hard, clean, durable, uncoated pebbles or rock fragments free from injurious amounts of shale, coal, clay lumps, and soft fragments, dirt, glass and organic or other deleterious substances. It shall conform to Specifications for Concrete Aggregates, A.C.I. Standard 318, ASTM Designation C 33, Size 467, 57 or 67, Class 4S. Slag shall weigh at least 75 lbs/cf.

For thin sections a smaller maximum size stone shall be used when directed and for heavy sections a larger maximum size stone may be permitted, in which cases the gradation of other sizes shall be modified as directed. Crushed stone and gravel shall be washed if necessary to remove dust, dirt, or loam and if unsatisfactory shall be excluded from the work.

Materials for nonshrinking grout shall conform to CRD-C-621 "Corps of Engineers Specifications for Non-Shrink Grout". Approved products are Sauereisen F-100 Grout as manufactured by

Sauereisen Cements Co., Pittsburgh, Pennsylvania; Five-Star Grout as manufactured by U.S. Grout Corp., Old Greenwich, Connecticut; Masterflow 713 as manufactured by Master Builders, Cleveland, Ohio and "Euco N-S" by Euclid Chemical Co. Testing as specified for concrete may be required for acceptable grouts to include frequent checks for consistency by a time-of-flow measurements. Expansion grouts shall be either Gilco pre-mixed or Supreme non-metallic grout as manufactured by Gilford-Hill and Company, Inc., or Embeco 636 grout as manufactured by Master Builders or equal. Expansion grouts shall be used only as directed by the Engineer. Acceptable range of testing requirements:

Compressive Strength	10,500 to 12,500 PSI
Bond Strength	1,350 to 1,700 PSI
% Expansion	+0.025% to +0.75%

PROPORTIONING (Sec. 5.10)

Normal weight concrete shall be proportioned and mixed to develop not less than the minimum compressive strength shown in Table 1000-1 of the NCDOT Standard Specifications for Roads and Structures 2012. (ACI 301 - Proportioning on the basis of previous field experience or trial mixtures.)

**TABLE 1000-1
REQUIREMENTS FOR CONCRETE**

Class of Concrete	Min. Comp. Strength at 28 days	Maximum Water-Cement Ratio				Consistency Max. Slump		Cement Content			
		Air-Entrained Concrete		Non Air-Entrained Concrete		Vibrated	Non-Vibrated	Vibrated		Non-Vibrated	
		Rounded Aggregate	Angular Aggregate	Rounded Aggregate	Angular Aggregate			Min.	Max.	Min.	Max.
<i>Units</i>	<i>psi</i>					<i>inch</i>	<i>inch</i>	<i>lb/cy</i>	<i>lb/cy</i>	<i>lb/cy</i>	<i>lb/cy</i>
AA	4,500	0.381	0.426	-	-	3.5	-	639	715	-	-
AA Slip Form	4,500	0.381	0.426	-	-	1.5	-	639	715	-	-
Drilled Pier	4,500	-	-	0.450	0.450	-	5-7 dry 7-9 wet	-	-	640	800
A	3,000	0.488	0.532	0.550	0.594	3.5	4	564	677	602	602
B	2,500	0.488	0.567	0.559	0.630	2.5	4	508	610	545	654
B Slip Formed	2,500	0.488	0.567	-	-	1.5	-	508	610	-	-
Sand Lightweight	4,500	-	0.420	-	-	4	-	715	715	-	-
Latex Modified	3,000 7 day	0.400	0.400	-	-	6	-	658	658	-	-
Flowable Fill excavatable	150 max. at 56 days	as needed	as needed	as needed	as needed	-	Flow- able	-	-	40	100
Flowable Fill non-excavatable	125	as needed	as needed	as needed	as needed	-	Flow- able	-	-	100	as needed
Pavement	4,500 design, field 650 flexural, design only	0.559	0.559	-	-	1.5 slip form 3.0 hand place	-	526	-	-	-
Precast	See Table 1077-1	as needed	as needed	-	-	6	as needed	as needed	as needed	as needed	as needed
Prestress	per contract	See Table 1078-1	See Table 1078-1	-	-	8	-	564	as needed	-	-

Note: See 5.23 for the uses of the various classes of cast-in-place concrete.

Water-Cement Ratio:

Except by special written permission of the Engineer, maximum amounts of water (U.S. gallons), including the surface water carried by the fine and coarse aggregates per sack (94 lbs net) of cement shall be listed in Table 1. Standard methods shall be used for determination of surface moisture in the aggregates.

Concrete of the maximum strength, density, and durability possible with the specified water-cement ratio is required. No increase of these ratios will be permitted.

Refer to 5.17 if any concrete for the project is to be pumped.

With the approval of the Engineer, water may be added only if neither the maximum permissible water-cement ratio nor the maximum slump is exceeded.

Each cubic yard of concrete shall contain the minimum number of sack (94 lbs net) of cement listed in Table 1.

The minimum amounts of cement listed shall be used regardless of tests and design methods used.

Proportions:

The proportions of aggregate to cement for concrete of the specified water-cement ratio shall be such as to produce concrete that can be puddled readily into the corners and angles of forms and around reinforcement without excessive spading and without segregation of materials or collections of free water on the surface. In no case shall concrete be placed which shows slumps outside the limits listed in Table 1.

Consistency of the concrete shall be closely regulated and the proportions of fine and coarse aggregate shall be such as to produce no harshness in placing nor honeycombing in the structures. If required, the mixture shall be modified by changing the relative volume of fine and of coarse aggregate. The Contractor shall cooperate in every way to the end that concrete of the desired quality shall be obtained.

QUALITY CONTROL (Sec. 5.11)

Laboratory Control:

Design mixes are the laboratory's responsibility and shall include the weight in pounds of fine aggregate, coarse aggregate, cement, and water per cubic yard of concrete; the sacks of cement per cubic yard of concrete; the gallons of water per sack of cement; gross weight and yield per cubic yard of concrete; weight in ounces or pounds of admixture per sack of cement; slump; air content; and compressive strength of test cylinders at 7 days and 28 days. Weight of fine and coarse aggregate shall be determined in saturated, surface dry condition.

The laboratory will test and produce reports of mix designs for all concrete incorporated in the work.

The laboratory will adjust concrete mixes only as required to obtain a product in conformance with the specified limiting requirements.

The mix design of all concrete must be approved by the laboratory prior to submittal to the Engineer for approval. The design mix must be approved by the Engineer before starting concrete production.

The mix design for concrete to be pumped shall conform to 120.17.

The laboratory will make scheduled quality control tests consisting of the following:

- a. Test specimens (compressive strength)
- b. Slump
- c. Air Entertainment.

When concrete is procured from a central batching plant or transit mixers are used, the Owner may provide a representative at such plant to check the proportioning of aggregates and water, and mixing time.

Schedule of Tests:

Quality control tests for concrete mix will be performed for the first day of concrete production and for every following day when concrete will be delivered to the site.

Three test cylinders shall be made for each 20 cu. yds. or part thereof of concrete poured each day.

Two test beams shall be made for each 250 sq. yds. of concrete pavement placed.

When cylinders and/or beam samples are made, the slumps and air test shall be made using concrete from the same batch.

Samples of concrete tested for determining air content and slump and for test cylinders and beams shall be taken at the point of discharge into structure unless otherwise directed by the Engineer.

Standard Testing Specifications:

Test specimens shall be made in accordance with "Standard Method of Making and Curing Concrete Test Specimens in the Field," ASTM Designation C31.

Tests for compression shall performed in accordance with "Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens," ASTM Designation C 39.

Tests of beam specimens shall be in accordance with "Standard Test Method for Flexural Strength of Concrete" (Using Simple Beam with Center-Point Loading), ASTM Designation C 293.

Slump tests shall be made using "Standard Test Method for Slump of Portland Cement Concrete," ASTM Designation C 143.

Air content shall be determined for concrete mixes composed of sand, gravel, and stone aggregates by use of "Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method," ASTM Designation C 231. Where slag aggregate is used, the air content shall be determined by the Volumetric Method, ASTM Designation C 173.

Should the 28-day strength fall below that specified for the particular class of concrete, the Contractor shall improve his quality control.

Acceptance of concrete shall conform to AC1 301, Chapter 17.

FORMS FOR CONCRETE (Sec. 5.12)

Materials:

Forms for exposed surfaces shall be approved material to produce a smooth surface with minimal joint marks.

Wood forms shall be built of sound top construction grade western fir or hemlock, or equivalent acceptable lumber, dressed on forming sides and neatly fitted. Joints shall be of quality to produce a smooth surface compatible with the type of finish required.

Plywood used for form work shall be manufactured using waterproof glue made for this type of installation.

Erection

All walls shall be plumb with level tops; all floors shall be either level or sloped toward a floor drain where provided.

Forms for repeated use shall be supplied in numbers to provide for the required rate of progress. Defective forms shall not be used. Forms for all exposed surfaces of ceilings, beams and columns, and of walls of tanks, conduits and buildings shall be constructed of 3/4 in. or 7/8 in. plywood or lined with 1/4 in. plywood to insure smooth surfaces.

In general, forms shall not be removed until the concrete has attained sufficient strength to assure structural stability under all dead and construction loads, and so that removal can be accomplished without marring concrete surfaces. The determination of when forms may be removed shall take heed of temperature and humidity.

PLACING CONCRETE (Sec. 5.13)

Scheduling:

The Contractor shall notify the Engineer at least 24 hours in advance of placing concrete.

Concrete shall be placed between the hours of 8 a.m. and 6 p.m., unless permission is given to extend that time. No slab shall be placed after 12 noon on any last working day of the week.

Each concrete pour shall be completed in a continuous operation with no interruption in excess of 45 minutes.

No concrete shall be placed after its initial set has occurred, and no retempered concrete shall be used under any circumstances.

When columns, brackets, or walls are to support beams or slabs, the concrete in the vertical or supporting member shall be deposited up to 1/2 in. above the bottom of the supported member and a period of at least 12 hours shall elapse for settlement before placing concrete in the horizontal member.

No concrete shall be placed during rain, sleet, or snow unless adequate protection is provided and approval is obtained. Rainwater shall not be allowed to increase the mixing water nor damage the surface finish.

Before placing the concrete, all forms shall be thoroughly cleaned and the space to be occupied by the concrete shall be free from all laitance, silt, dirt, shavings, sawdust, and other debris.

Conveying Concrete to Forms:

The method or device used for conveying the concrete from the mixer to its place in the work shall be such as to insure against separation of the materials.

When placing operations would involve dropping the concrete more than 5 ft., it shall be deposited through sheet metal or other approved pipes. These pipes shall be made in sections not to exceed 5 ft. in length.

Placing Concrete in Forms:

Concrete placing shall conform to ACI 304.

Concrete shall be deposited at or near its final position and carried up evenly within forms, in layers not exceeding 18 in. depth. It shall be thoroughly consolidated around and into contact with forms, reinforcement, pipes, or other shapes built into the work, by spading and vibrating. Voids or pockets of coarse aggregate shall be prevented and the completed work shall be a solid, watertight unit with smooth form surfaces. A sufficient number of men shall be available at all times to perform the work properly. Control of methods and practices of placing shall be subject to the approval of the Engineer.

Where pipe or other shapes are built into the work, the concrete shall be placed from one side only and shall flow under the pipe or shape to the other side until all air is displaced.

PLACING CONCRETE DURING COLD WEATHER (Sec 5.14) Protect concrete work from frost, freezing, or low temperatures, in compliance with ACI 306 and as herein specified.

When concrete is placed at or below an atmospheric temperature of 40 degrees F or whenever in the opinion of the Engineer the temperature may fall below 40 degrees F within the curing period, the water, aggregate, or both shall be heated and suitable enclosures and heating devices shall be provided.

Heating of Materials:

Heating of mixing water shall be controlled to maintain uniform temperature from batch to batch. In no case shall the water be heated to a temperature greater than 140 degrees F.

Aggregate shall be uniformly heated to eliminate all frozen lumps, ice, and snow; however, the aggregates shall not be heated to a temperature of more than 100 degrees F.

Placing and Curing:

Concrete shall be placed at a temperature of not less than 50 degrees F and not more than 75 degrees F and the air surrounding the forms and deposited concrete shall be maintained within this temperature range for a period of not less than 7 days. The enclosures and heating devices shall not be removed at the end of this period until the temperature of the concrete has been permitted to drop, at a rate not to exceed 20 degrees F per 24 hours, to within 20 degrees F of the atmospheric temperature. Maximum/minimum thermometers shall be furnished by the Contractor so that the temperature within the enclosure may be determined.

Concrete shall not be placed in contact with materials having a temperature of less than 32 degrees F. If necessary, the forms, reinforcing steel, and foundation materials shall be enclosed and heated before the concrete is placed.

The completion of suitable enclosures and the application of heat to bring the air surrounding the forms and deposited concrete to the specified temperature shall follow the placing of concrete as soon as possible.

Heaters shall be vented at all times. No products of combustion shall be permitted to come in contact with concrete surfaces before 24 hours after finishing.

Form Insulation:

In lieu of heated enclosures, the Contractor may protect concrete in slabs more than 12 in. thick and in walls of structures by the use of insulation, if approved by the Engineer.

When form insulation is used, the concrete shall be placed at a temperature of not less than 50 degrees F and not more than 75 degrees F and maintained by the insulation at a surface temperature of the concrete of not less than 50 degrees F and not more than 100 degrees F. Sufficient thermometers shall be furnished and installed by the Contractor in such a manner that the surface temperature of the concrete may be readily determined. Whenever the surface temperature as indicated by the thermometer reading, exceeds the specified maximum temperature, the forms or insulation shall be

loosened or otherwise vented until the surface temperature is within the specified limits. If the thermometer readings indicate that the minimum required temperature is not being maintained, the structure shall be promptly enclosed and heat furnished as required.

The insulation material shall be wind and water-resistant. Special precautions shall be taken at edges and corners to insure that such points are adequately protected. The tops of pours shall be protected by a tarpaulin, or other approved waterproof cover over the insulation.

At the close of the protection period, the temperature of the concrete within the form shall be gradually decreased, by loosening the forms of insulation to permit a rate of cooling not to exceed 20 degrees F per 24 hours, to within 20 degrees F of the atmospheric temperature.

The Contractor shall provide sufficient 24-hour inspection to insure compliance with the above specified temperature requirements during the curing period.

PLACING CONCRETE DURING HOT WEATHER (Sec. 5.15) When hot weather conditions exist that would seriously impair the quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.

Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 F. Mixing water may be chilled, or chopped ice may be used to control the concrete temperature provided the water equivalent of the ice is included in the total amount of mixing water.

Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that the steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.

Wet forms thoroughly before placing concrete.

Do not use retarding admixtures without the written acceptance of the Engineer.

PLACING CONCRETE UNDER WATER (Sec. 5.16) Concrete may be deposited under water only when provided on the Drawings or by written permission of the Engineer.

Any concrete deposited under water shall contain at least 7.0 sacks of cement per cubic yard of concrete to compensate for losses due to water.

Preparation:

Care shall be exercised to prevent laitance and laitance on previously placed concrete shall be removed before depositing additional concrete.

Pumping shall be discontinued while depositing foundation concrete and all flow of water inside of forms or sheeting shall be stopped.

Concrete deposited under water shall be carefully placed in a compact mass in its final position by means of a tremie, a closed bottom dump bucket, or other approved method and shall not be disturbed

after being deposited. The lower end of the tremie shall be submerged in the fresh concrete to maintain a seal.

PLACING CONCRETE BY PUMPING METHODS (Sec. 5.17) Under this section the proposed concrete work defined above may be conveyed by pressure and discharged directly into the desired area. The Contractor shall furnish and install all of the necessary pumping equipment to maintain good quality control of the discharged concrete in conformance with ACI 304.2R "Placing Concrete by Pumping Methods".

The concrete shall be pumped by piston or pneumatic pumps with rigid pipe or a combination of rigid pipe and heavy-duty flexible hose. Where flexible hose is used, it shall be properly sized to reduce resistance to the movement of concrete. The line size to be used and the nominal maximum size aggregate furnished shall be as given in Table 1 - Data on Lines for Pumped Concrete in ACI 304.

Couplings used to connect pipe shall be nominally rated for at least 500 psi. Couplings should provide a full internal cross section with no constrictions or crevices to disrupt the smooth flow of concrete.

The pumping operations shall always be started with lubricating mortar or with a batch of regular concrete with the coarse aggregate omitted. It shall be wasted and not used in the concrete work. Mortar used in sanitary sewer manholes shall be hydraulic cement mortar in accordance with ASTM C-398. Mortar used in water meter vaults and water valve vaults shall be Type M mortar in accordance with ASTM C-270.

Emphasis on quality control is essential to the proper proportioning and use of a dependable pump mix. Reference shall be made to ACI 211.1 covering proportioning normal weight concrete. The maximum size of angular coarse aggregate shall be limited to one-third (1/3) of the smallest inside diameter of the hose or pipe. For well rounded aggregates, the maximum size should be limited to 40% of the pipe or hose diameter. Graduation of sizes of coarse aggregate to 40% of the pipe or hose diameter. Graduation of sizes of coarse aggregate should meet ASTM C33 requirements and be as close to the middle range as possible.

The gradation of the fine aggregate, which constitutes all of the particles passing the No. 4 screen, should conform to the requirements of ASTM C33 for sand. The fineness modulus of sand meeting this specification will fall between 2.13 and 3.37 with the median being 2.75. For uniformity, the fineness modulus of the sand shall not vary more than 0.20 from the average value used in proportioning. Table 2 in ACI 304 should be used as a guide to determine the amounts of coarse aggregate to be combined with sand of different fineness moduli.

A plastic mix should be obtained through proper proportioning rather than trying to overcome deficiencies by adding water. The slump range to be used for pumped concrete shall be the same as specified for regular Class concrete in Table 1000-1 of the NCDOT Standard Specifications for Roads and Structures 2012.

If the coarse and fine aggregates are properly combined as detailed in ACI 211.1, the cement factors for pump mixes should closely parallel those for conventionally placed concrete in these specifications. It is more desirable to correct any deficiencies in the aggregates, especially the sand.

Any admixtures to increase workability and improve pumpability of concrete shall receive the approval of the Engineer prior to its use. Such admixtures, if permitted, shall be used in strict accordance with the manufacturer's recommendations.

Trial mixes intended for pumping should be prepared and tested in a laboratory in accordance with ASTM C39 for seven (7) day and twenty-eight (28) day tests. A full scale field test for pumpability of the proposed trial mix as outlined under ACI 304.2R "Testing for Pumpability" may be required by the Engineer. The quality of the concrete shall be determined by sampling from the placement end of the discharge line in accordance with ASTM C94.

JOINTS AND BONDING (Sec. 5.18) Construction joints and expansion joints shall be placed as shown on the Drawings. Approval of the Engineer must be secured for the placing of any construction joints not shown on the Drawings.

Keyways shall be provided in all construction joints. Unless shown otherwise on the Drawings, the width of all keyways shall be 1/3 of the wall or slab thickness by 2 in. deep.

Horizontal Construction Joints (in walls):

Lower Joint Surface Construction

- a. Proposed joint surfaces shall be finished straight by use of temporary straight edges tacked to the inside of the form with the lower edges on the line of the joint.
- b. The keyway shall be formed before the concrete attains its initial set.

Completing Joint

- a. Within 12 hours after the keyway has been formed, the lower surface of the joint shall be thoroughly cleaned by the use of wire brushes and all laitance and loose material removed so as to expose clean, solid concrete. Care must be taken not to loosen any of the coarse aggregate in the concrete. If for any reason this laitance is not removed within 12 hours after the concrete is placed, it shall be removed using such tools and methods as may be necessary to secure the results specified above.
- b. After the lower surface has been prepared and immediately before placing concrete above the joint, the lower surface shall be thoroughly wetted and flushed and a bed of mortar composed of 1 part Portland Cement and 2 parts sand spread over the entire surface (2-in. minimum depth in wall pours). The mortar shall be thoroughly worked into all openings and crevices.

SURFACE FINISH (Sec. 5.19) Concrete surfaces shall be finished even and reasonably free from imperfections and roughness. Angles shall be true and edges straight.

Patching:

Upon removal of forms, cavities produced by form ties, honeycombed spots, broken corners or edges, and other defects shall be cleaned, saturated with water, and completely filled, pointed and trued with a mortar of cement and fine aggregate of the same proportions used in the concrete being finished. Form tie holes shall be completely filled by use of a pressure gun or hand ramming method.

On all exposed surfaces, all fins and irregular projections shall be removed with a stone or power grinder, in such a way as to avoid contrasting surface textures. Holes and other areas requiring corrective work shall be coated with a bonding compound and patched. Except where the surface is to be painted or otherwise covered, sufficient white cement shall be substituted for the regular cement in the patching mortar to produce finished patches of the same color as the surrounding concrete.

Wall finish shall be cast as smooth form finish unless otherwise shown on the drawings.

Concrete surfaces to be painted shall have a smooth rubbed finish as specified in the ACI 301.

Interior floors and slabs shall receive a troweled finish.

Exterior slabs shall receive a troweled finish.

Concrete floor hardener shall be furnished and applied to all interior exposed concrete floors, unless indicated otherwise on the Drawings. Floor hardener shall be Lapidolith as manufactured by Sonneborn, Inc., Hornolith as manufactured by A.C. Horn, Inc., Surfhard as manufactured by Euclid Chemical Co. or equal. Products shall be applied in conformance with the manufacturer's instructions and as specified herewith. The hardener shall be applied diluted with water in the following proportions:

1. First application-1 part hardener to 2 parts water
2. Second application-1 part hardener to 1 part water
3. Third application-2 parts hardener to 1 part water

CURING OF CONCRETE (Sec. 5.20) Curing of concrete shall be in conformance with "Standard Practice for Curing Concrete" ACI 308 and as specified herein. All concrete curing compounds shall conform to the standard specifications for LIQUID MEMBRANE – FORMING COMPOUNDS FOR CURING CONCRETE, ASTM C-309, Type 2. Curing compounds shall be applied as forms are stripped.

Beginning immediately after placement, concrete shall be protected from premature drying, excessively hot or cold temperatures, and mechanical injury; and shall be maintained with minimal moisture loss and at a relatively constant temperature for the period necessary for hydration of the cement and hardening of the concrete. The Contractor shall provide thermometers as required by the Engineer.

Horizontal units such as floor slabs and sidewalks shall be cured in two stages:

Initial curing shall begin immediately after concrete finishing is complete and shall be continued 24 hours and shall be in conformance with one of the following methods:

- a. The concrete shall be covered with two thicknesses of an acceptable woven fabric such as burlap thoroughly saturated with water and shall be maintained in a saturated condition for the specified period. Lap the burlap strips by half widths when placing to give greater moisture retention and aid in preventing displacement of burlap during high wind or heavy rain.
- b. Ponding of water over the entire surface for the specified period.
- c. Continuous application of water by means of suitable sprinkling devices for the specified period.

Final curing shall last for a minimum of 6 days and shall employ one of the following methods.

- a. Continuation of the water curing process employed in the initial curing period.
- b. An impervious paper or plastic covering, meeting ASTM Specification C 171, placed and maintained in contact with the concrete.

Vertical elements such as walls and columns shall be cured in two stages:

Initial curing shall begin immediately after the finishing of the concrete or within 3 hours after placing operations cease. Curing shall consist of covering exposed surfaces with two thicknesses of an approved woven fabric such as burlap, thoroughly saturated with water and maintained in a saturated state by means of a soaker hose placed on top of the burlap. If form work is to be left in place for more than 48 hours, the forms should be loosened to assure that water runs down the inside of the forms, to keep the concrete surfaces wet.

Immediately following removal of the wet coverings and form work used for the initial curing, one of the following methods for final curing may be used:

- a. Application of a continuous mist spray of water directly on the concrete.
- b. Application of an impervious paper or plastic covering, meeting ASTM Specifications C 171, or water-saturated fabric directly upon the surface of the concrete.

When the mean daily temperature of the surrounding air is less than 40 degrees F, the concrete shall be protected to maintain the temperature of the concrete between 50 degrees F and 70 degrees F for the curing period.

Curing water shall be approximately the same temperature as the concrete to alleviate temperature-change stresses that could be detrimental to the concrete.

PROTECTION (Sec. 5.21)

Free Water:

Concrete for structures shall not be placed in water, nor shall water be allowed to come into contact with freshly poured concrete until it has attained a sufficient set, except where written permission has been given to place concrete under water by tremie.

Water used for cleaning the placing equipment shall be discharged outside the forms.

All forms and reinforcing steel, located above the concrete being placed, and all placing equipment shall be kept clean and free of hardened concrete.

Aluminum Inserts: All aluminum materials inserted in concrete shall have the contact surface coated with bitumastic.

MUD MATS (Sec 5.22) Where called for on the plans or as directed by the Engineer, the Contractor shall construct concrete mud mats immediately after cleaning the excavation bottom, to preserve the bearing surface condition. Concrete for mud mats shall be not less than 3 in. thick. Bottom of excavation shall be free of water, mud and loose material prior to mud mat placement.

CAST-IN-PLACE CONCRETE (Sec. 5.23) All reinforced concrete shall be Class A, except as otherwise specified or shown on the Drawings. Concrete used for mud mats, fill and channeling in manholes and chambers shall be Class B unless otherwise noted on the Drawings.

Class A concrete conforming to NCDOT Section 1000 shall be used for all concrete pavement, curbing, driveways, and sidewalks, unless noted otherwise on the Drawings.

Class B concrete may be used for encasing pipelines, fill, and pipe bedding.

Where Class B concrete fill is called for and installed in or on structures, the following steps shall be taken:

1. Scrub concrete slabs and/or walls with a stiff wire brush and streams of clean water.
2. Apply a bonding agent with a product name of Euco-Weld as manufactured by Euclid Chemical Company or equal.
3. The Class B concrete shall then be placed and screeded to bring the surface to final grade.

SPECIAL PROVISIONS (Sec. 5.24)

Whether concrete is provided from transit mixers or from an on-site central batching plant, the following procedures shall be initiated after award of the contract and before starting concrete production:

1. Proportioning on the basis of trial mixtures.
 - a. The Contractor shall provide samples of proposed materials for testing.
 - b. The Owner will determine the 3 different water-cement ratio which will produce a range of strengths 1200 psi above the specified strengths. The water cement ratio so determined shall govern for this project.
2. Proportioning on the basis of previous field experience.
 - a. The concrete supplier shall submit 30 consecutive strength tests of similar mixes obtained within the past year representing similar materials and conditions so that the standard deviation may be determined and from this standard deviation the average strength used as a basis of selecting proportions for the concrete mix can be established.

MEASUREMENT AND PAYMENT (Sec. 5.25)

The unit price stipulated per cubic yard for concrete under Item 5 shall include the furnishing of cement, aggregates, water, admixtures, water stops, bituminous joints, mixing, transporting, placing, finishing, curing and protecting the concrete, all centers and forms and the furnishing of all labor, materials, tools and appliances which are necessary to complete the work as specified or as shown.

The number of cubic yards of concrete encasement or cradle of pipe to be paid for shall be the number of cubic yards actually used in accordance with these specifications within the pay limits shown on the plans. All such necessary concrete outside the pay limits for concrete encasement shall be furnished and placed by the Contractor but will not be measured for payment.

Payment for grout quantities will be made under Class B concrete.

No payment for concrete under Item 5 will be made if such concrete is specifically included for payment in some other item.

Furnishing and placing water stops, expansion joints and other special joints shall be included in the class of concrete of which they are a paid.

STEEL REINFORCEMENT

ITEM 6

WORK INCLUDED (Sec. 6.01) The contractor shall, under Item 6, furnish all the materials for and shall properly place in the concrete, at the locations shown on the contract drawings or working drawings furnished by the Engineer, or as directed, all reinforcing steel which is required for properly reinforcing all structures which are to be built under this contract.

QUALITY AND GRADE (Sec. 6.02) All bar reinforcement shall meet the requirements of the "Standard Specifications for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement", ASTM Designation: A 625, Grade 60. No re-rolled or high carbon steel bars will be permitted in the work.

All wire mesh reinforcement shall be of approved make, and of minimum weight indicated on the contract drawings. Wire mesh shall meet the requirements of the "Standard Specifications for Welded Steel Wire Fabric for Concrete Reinforcement", ASTM Designation: A 185.

All steel used for reinforcement purposes shall be of clean, new stock, free from defects and bends not required by the drawings. Only corrugated or deformed bars of an approved type shall be used in the work.

TESTS (Sec. 6.03) Reinforcement bars shall be inspected and tested at the mill at which they are rolled, in accordance with "Standard Specifications for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement", ASTM Designation: A 615, and two (2) certified copies of such tests shall be furnished to the Engineer. All tests shall be made on the full size finished bars, and at least one (1) tensile and one (1) bending test shall be made for each lot of ten (10) tons or less from each melt of steel from which reinforcement steel is furnished for this work.

DETAILED DRAWINGS (Sec. 6.04) The Contractor shall submit to the Engineer detailed drawings showing the number, size, length, bending and placing of the steel he proposes to furnish, and no steel reinforcing bars shall be delivered to the site of the work prior to the approval of the bending and placing diagrams. Bending diagrams and reinforcing details shall conform to "The Manual of Standard Practice for Detailing Concrete Structures", as issued by the American Concrete Institute, (ACI 315-71) except as herein modified.

STORAGE AND PROTECTION (Sec. 6.05) All steel for reinforcement shall be delivered at the site of the work without rust other than that which may have accumulated in normal transit. It shall be stored according to size and length and properly tagged with substantial tags securely attached to each bundle and protected from the weather by housing. Reinforcing steel shall not be stored on the ground.

All steel shall be kept free from oil, grease, dirt or other objectionable adhering substances, and it shall be satisfactorily cleaned of scale and heavy or flaky rust before being placed in the work.

If, after having been placed in the work, the concreting shall be delayed or interrupted for any considerable number of days, the steel shall be well protected.

BENDING (Sec. 6.06) All reinforcement bars shall be bent to the shapes as shown on the drawings or as ordered. Bars of a single length shall be used in all cases, except where the length required is such that they cannot be so obtained, or where the Engineer shall give permission to use shorter lengths or allow lapping. Cold bends shall be made around a pin having a diameter at least six (6) times the least dimension of the reinforcing bar for one-quarter (1/4) to seven-eighths (7/8) inch bars, and eight (8) times the least dimension for bars one (1) to one and one-quarter (1-1/4) inches in diameter.

PLACING AND LAPPING (Sec. 6.07) All steel reinforcement shall be carefully placed and fastened in position so as to maintain the proper spacing between adjacent bars. Joints shall be wired with annealed iron wire of diameter not less than No. 18 US Standard gauge or by using acceptable clips. All reinforcement shall be firmly supported by the use of metal bolsters, bars, spacers, chairs, or hangers, or by the use of precast concrete piers. All lapped bars shall be fastened together securely, and, for bonding adjacent bars, overlapping shall be not less than forty (40) diameters of the smaller bar in the lap.

CONCRETE COVER (Sec. 6.08) Concrete cover over the principal reinforcing steel shall be provided as follows, unless otherwise shown:

Concrete columns and walls	1-1/2 inches
Concrete Beams and Girders	1-1/2 inches
Concrete Slabs and Joists	3/4 inches
Concrete in contact with water and weather	2 inches
Concrete in contact with Earth	2 inches
Concrete Slabs poured against Earth such as Bottom Slabs, Footers, Walls without outside forms, etc.	3 inches

MEASUREMENT AND PAYMENT (Sec. 6.09) All steel reinforcement required to be furnished and placed under the Contract shall be included in the price bid for other items and will not be measured or paid for under this, Item 6.

GRANULAR BACKFILL

ITEM 7

WORK INCLUDED (Sec. 7.01)

The Contractor shall, under this item, furnish granular backfill where shown on the drawings, or directed by the Engineer, for the proper completion of the work included under this Contract. In general, this work shall include the removal of excavated materials from the site of the work and the furnishing of granular backfill. Under no condition will materials used for pipe bedding be considered as granular backfill.

MATERIALS (Sec. 7.02)

Granular backfill material shall be sound, hard, and be free from loam, clay, organic matter or other injurious impurities. Materials shall be Compacted Aggregate Base Course as specified in Section 1008 of the latest edition of the State of North Carolina, Department of Transportation, Standard Specifications for Roads and Structures, or the latest revision thereof.

PLACING GRANULAR BACKFILL (Sec. 7.03)

Granular backfill shall be placed as specified in Item No. 1 and payment for such placing shall be included under other applicable items in the Contract.

Whenever granular backfill is required within the excavation limits, the entire excavation shall be backfilled with granular material.

REMOVAL OF UNSATISFACTORY EXCAVATED MATERIAL (Sec. 7.04)

All excavated materials for which granular backfill materials are substituted, must be disposed of as provided for in Item No. 1.

PAYMENT (Sec. 7.05)

Material used for pipe bedding, foundation cushion, or foundation material, trench topping, or that specifically called for under some other item, will not be paid for under this Item.

No separate payment shall be made for work specified in this item. All materials, labor, tools and equipment to complete the work as called for on the drawings and as specified herein shall be included in the bid price for other sewer and/or water items.

FLOWABLE FILL BACKFILL MATERIAL

ITEM 8

WORK INCLUDED (Sec. 8.01) The contractor shall, under this item, furnish flowable fill backfill where shown on the drawings, or directed by the Engineer. In general, this work shall include the removal of excavated materials from the site, and the furnishing of flowable fill backfill in place of the excavated material. The flowable fill backfill shall consist of the placement of a flowable mixture of portland cement, water, pozzolan and/or fine aggregate, and, optionally, conventional concrete admixtures and/or a high-air entraining agent or foaming agent for backfilling trenches as shown on the plans or as specified. The work shall be in accordance with NCDOT Section 1000-7 unless otherwise specified herein.

MIXING EQUIPMENT (Sec. 8.02) Sufficient mixing capacity of mixers shall be provided to permit the mortar to be placed without interruption.

PLACING FLOWABLE FILL (Sec. 8.03) Flowable fill shall be discharged from the mixer by any reasonable means into the space to be filled. The fill material shall be brought up uniformly to the fill line shown on the plans or as directed by the Engineer. Placing of material over flowable fill backfill may commence as soon as the surface water is gone or as directed.

REMOVAL OF UNSATISFACTORY EXCAVATED MATERIAL (Sec. 8.04) All excavated materials for which flowable fill backfill materials are substituted, must be disposed of as provided for in Item No. 1

MEASUREMENT (Sec. 8.05) Unless specifically ordered otherwise by the Engineer, the number of cubic yards of flowable fill will be paid for shall be the number of cubic yards actually used in accordance with these specifications within the pay limits as shown on the plans. Wherever flowable fill backfill is required within the pay limits for excavation, the entire excavation shall be backfilled with flowable fill materials; all such backfill outside the pay limits for excavation shall be furnished and placed by the Contractor but will not be measured for payment.

PAYMENT (Sec. 8.06) The unit price stipulated in the proposal under this item per cubic yard for flowable fill backfill shall include the furnishing of all labor, materials, equipment and incidentals necessary to complete this work as specified or as shown.

Material used in pipe bedding, foundation cushion, or foundation material, trench topping, or that specifically called for under some other item, will not be paid for under this item.

EXCAVATION SUPPORT SYSTEMS

ITEM 9

GENERAL (Sec. 9.01) The Contractor shall, under Item 9, furnish and install excavation support systems which includes, but is not limited to, the following:

1. Shoring and bracing necessary to protect existing buildings, streets, walkways, utilities and other improvements and excavation against loss of ground or caving embankments.
2. Maintenance of shoring and bracing.
3. Removal of shoring and bracing, as required.

Types of shoring and bracing systems include, but are not limited to the following:

1. Steel H-section (solder) piles.
2. Timber lagging.
3. Steel piles.

The system of sheeting, shoring and bracing shall be designed and installed by the Contractor for the materials and depths encountered using as a minimum standard the requirements prescribed by the Department of Labor and Industry having jurisdiction over the safety standards of this type of work.

If a Contractor purposes to use a sheeting, shoring and bracing system which deviates in any way from these Department of Labor and Industry requirements he shall submit to the Owner a copy of the written permission from the Department of Labor and Industry having jurisdiction before the system is employed.

Wood, steel, cast iron, or any other material used to support excavations in tunnel, casing pipe or specifically included in any other item shall not be included for payment under Item 15.

SUBMITTALS (Sec. 9.02) The Contractor shall submit the following in accordance with requirements of this Contract:

- A. Layout drawings for excavation support system and other data prepared by, or under the supervision of, a qualified professional engineer. System design and calculations must be acceptable to all authorities having jurisdiction.

QUALITY ASSURANCE (Sec. 9.03)

Engineer Qualifications: a professional engineer legally authorized to practice in North Carolina.

Regulations: Comply with codes and ordinances of governing authorities having jurisdiction.

MATERIALS (Sec. 9.04) provide adequate shoring and bracing materials which will support loads imposed. Materials need not be new, but should be in serviceable condition.

A. Structural Steel: ASTM A 36.

B. Steel Sheet Piles: ASTM A 328.

C. Timber Lagging: Any species, rough cut, mixed hardwood, nominal 3 inches thick unless otherwise indicated.

SHORING (Sec. 9.05) Wherever shoring is required, locate the system to clear permanent construction and to permit forming and finishing of concrete surfaces. Provide shoring system adequately anchored and braced to resist earth and hydrostatic pressures.

Shoring systems retaining earth on which the support or stability of existing structures is dependent must be left in place at completion of work.

Sheeting, sheet piling, bracing and shores shall be withdrawn and removed as the excavations are being backfilled, except where and to such an extent as the engineer shall order, that the same be left in place, or where he shall permit the Contractor to leave the same in place, at the Contractor's own cost and request.

No sheeting left in place shall extend within two feet of surface.

In withdrawing sheeting and sheet piling, special care should be taken to insure that all remaining voids or holes are filled with satisfactory material and thoroughly rammed with thin rammers provided especially for that purpose.

BRACING (Sec. 9.06) Install internal bracing, if required, to prevent spreading or distortion of braced frames.

Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressure.

Remove sheeting, shoring, and bracing in stages to avoid disturbance to underlying soils and damage to structures, pavements, facilities, and utilities.

Repair or replace, as acceptable to Engineer, adjacent work damage or displaced through installation or removal of shoring and bracing work.

PLANK FLOOR (Sec. 9.07) Where called for on the drawings or ordered, a plank floor shall be built in the bottom of the trenches or pits upon which is to rest the masonry of the sewer or other structure. This floor shall be built by bedding parallel longitudinal sleepers of the size shown on the drawings, or as shown or directed, into the bottom of the trench. In bedding such sleepers, care must be taken not to excavate material from between sleepers, and any spaces so caused must be filled and rammed tight with concrete, at the Contractor's expense.

The lines of the sleepers shall, in no case, exceed a distance from each other of four (4) feet measured from center to center. The outer line of sleepers on either side of the sewer shall be laid with the outer edge of the plank parallel with and immediately under the outer toe of the masonry foundation to be built thereon. The sleepers shall be laid continuously throughout such length of the sewer and upon these sleeper planks shall be laid transversely to the axis of the sewer. These planks shall be of the size shown on the drawings and shall be laid so as to form a tight floor over the entire bottom surface of the excavation. Each plank of such floor must be of such length as to extend across the full width of the excavation as specified and shall be securely nailed to each sleeper with nails of a length of not less than twice the thickness of the plank.

MEASUREMENT (Sec. 9.08) The quantity of lumber to be paid for under Item 9A shall be the actual number of thousand (1,000) feet board measure (MFBM), of lumber actually left in place in the finished work shown on the drawings or as ordered by the Resident Engineer. No allowance will be made for wasted ends.

The number of square feet of steel sheet piling to be paid for under Item 9B shall be the actual number of square feet measured in the plane of the face of the sheeting complete in place as required by the plans or as ordered by the Resident Engineer. No allowance will be made for cut ends.

PAYMENT (Sec. 9.09) The unit price per one thousand (1,000) feet board measure (MFBM), stipulated for sheeting and timbering left in place under Item 9A, shall include the furnishing and framing of all lumber, the furnishing of all spikes, nails, bolts, and other fastenings, the excavation and refill for all lumber in foundations, the cutting off of sheeting, and the furnishing of all labor, materials, tools and appliances necessary to complete the work as specified, shown or directed.

The unit price per square feet stipulated for steel sheet piling left in place under Item 9B shall include the furnishing, placing and cutting off of the steel sheeting and furnishing of all labor, materials, tools and appliances as specified or directed.

Any additional cost incurred due to the widening of the trench necessitated by sheeting operations shall be included in the unit price bid for Item 9A and 9B.

No payment will be made for wood sheeting, timbering or steel sheet piling left in place which is specifically included under another item, nor for sheeting, timbering or steel sheet piling left in place without the written order of the Resident Engineer, unless the drawings specifically indicate that such material shall be left in place. The cost of all other required sheeting, timbering or steel sheet piling shall be included in the per foot cost of the installed sewerline. No additional payment for this Item 9A and 9B will be authorized or made.

DUCTILE IRON PIPE AND FITTINGS

ITEM 10

WORK INCLUDED (Sec 10.01) The Contractor shall, under Item 10, furnish all the materials for and shall fabricate and properly connect in place, at the locations shown on the contract drawings, or as directed, all the double cement lined bell and spigot ductile iron pipe, which is necessary for the proper completion of the work included under this contract, excepting cast iron pipe and fittings specifically included under other items.

All ductile iron pipe and fittings supplied under this specification shall include inside cement lining and outside asphaltic coating at the point of manufacture. Exposed pipe shall be coal tar pitch coated on the outside in accordance with manufacturer's standard practices.

DUCTILE IRON PIPE (Sec. 10.02) Ductile iron pipe shall be of the bell and spigot type using the type of joint which employs a single elongated grooved gasket to effect the joint seal. 12-inch and smaller diameter pipe shall be pressure class 350. 16-inch and larger diameter pipe shall be minimum pressure class 250. The ductile iron pipe shall be manufactured in accordance with manufacturing standards ANSI A21.51 and ANSI A21.4 (AWWA C151-91).

FITTINGS (Sec. 10.03) Fittings for ductile iron pipe shall be compact body double cement lined fittings of the bell and spigot type using the type joint which employs a single elongated grooved gasket to effect the joint seal. Fittings for ductile iron pipe shall be gray-iron fittings, unless otherwise specified on the contract drawings, and conform to ANSI/AWWA C153/A21.53 ANSI and AWWA C111/A21.11 Standards and their latest revisions. Bolts and nuts shall be stainless steel and conform to the chemical and mechanical requirements of ASTM A307 with 60,000 PSI Tensile Strength, grade B.

CEMENT LINING (Sec. 10.04) All ductile iron pipe shall be given a cement mortar lining at the point of manufacture in accordance with ANSI/AWWA A21.4-90/C104. The mortar shall be made using a strong, durable, uncoated siliceous material and of the following analyses:

Total Passing	Percent
12 mesh sieve	100%
40 mesh sieve	not more than 50%
100 mesh sieve	not more than 5%

The mortar shall be made using Portland cement meeting the latest revision of the American Society for Testing Materials Specifications C-150. It shall be thoroughly mixed using potable water, and shall contain not less than one (1) part cement to two (2) parts dry sand by volume. In general, the slump shall not be in excess of nine (9) inches nor less than four (4) inches.

All pipe shall be thoroughly cleaned of foreign matter and given a hydrostatic test before application of the lining. The waterway surfaces of the pipe and fittings shall be completely covered with as nearly as practicable a uniform thickness of mortar entirely free from holes or bubbles, and shall be thoroughly compact throughout. Straight pipe shall be lined by the centrifugal process. Defective linings which have set shall not be patched.

After the application of the lining, all mortar shall be removed from the joint surface of the bells. The lining of the pipe shall be done in a building and in such a manner as to protect the same from extreme weather conditions. The products shall not be placed in the yard or handled until the cement mortar has sufficiently set to avoid damage thereto.

The lining when completed, shall have a minimum thickness of one-eighth ($1/8$) inch for pipe of twelve (12) inches and smaller nominal diameters three sixteenths ($3/16$) inch for pipes of fourteen (14) inch to twenty-seven (27) inch diameter, and one-quarter ($1/4$) inch for pipes of thirty (30) inch and larger nominal diameters.

The linings shall have a length of taper from the end of the spigot and from the seat of the bell to lining of the full specified thickness of not more than three (3) inches. A plus tolerance of one-eighth ($1/8$) inch in thickness, but not more, shall be permitted on all sizes of pipe, and one-quarter ($1/4$) inch, but not more, on all sizes and patterns of fittings.

The thickness of lining shall be determined by means of measurements using a steel point not larger than one-sixteenths ($1/16$) inch in diameter.

The inspector shall pierce the lining immediately after it is placed in the pipe and before the mortar has set, at four (4) diametrically opposite points of the pipe at bell and spigot ends, making two (2) sets of measurements at each end. The first set shall not be more than four (4) inches from the respective ends of the pipe and the second set shall be made as far into the interior of the pipe as can readily be reached without injuring the lining. Not more than three (3) percent of the lining shall be subjected to this test.

The lining shall be sealed by the application of a continuous bituminous seal coating applied over the cement mortar after drying for forty-eight (48) hours in the pipe. The bituminous seal coating shall be applied to the lining as soon as it is sufficiently dry. No pipe or fittings shall be shipped in less than twelve (12) hours after lining is set and hard.

Upon completion, the finished linings of pipe and fittings shall have hard, smooth, dense surfaces, free from noticeable ridges, corrugations, elevations and depressions. The linings of the pipe shall be cylindrical and the linings of fittings shall be as nearly as practicable, or uniform thickness throughout, and shall afford a smooth waterway.

Any pipe or fitting showing three (3) or more loose spots measuring twelve (12) inches or more in diameter, or three (3) or more shrinkage cracks of nine (9) inches in length, or any cracks standing open perceptibly, shall be rejected. Slight surface crazing shall be no cause for rejection.

INSPECTION (Sec. 10.05) The Contractor shall furnish six (6) copies of the manufacturer's sworn certificate of inspection and testing of all ductile iron pipe used on the work. All ductile iron pipe will be subject to inspection and approval by the City after delivery of material to job site. No broken, cracked, misshaped, imperfectly coated, unsatisfactory or otherwise damaged ductile iron pipe or fittings shall be used.

The Contractor shall furnish the Engineer with lists, in duplicate, of all pieces of pipe in each shipment received, and these lists shall give the serial or mark number, weight, class, size and description of each item received at the job site.

LAYING (Sec. 10.06) Installation procedures shall be in accordance with ASTM C12 and AWWA recommendations, except bedding shall be per standard details.

Proper implements, tools and facilities satisfactory to the Engineer shall be provided and used by the Contractor for the safe and convenient prosecution of the work. All pipe shall be carefully lowered into the trench piece by piece by means of a derrick, ropes or other suitable tools or equipment, in such a manner as to prevent damage to the pipe and protective coatings and linings. Under no circumstances shall pipe materials be dropped or dumped into the trench. The pipe and fittings shall be inspected for defects and, while suspended above grade, be rung with a light hammer to detect cracks.

All lumps, blisters and excess coating shall be removed from the bell and spigot end of each pipe, and the outside of the spigot and inside of the bell shall be wire brushed and wiped clean and dry and free from oil and grease before the pipe is laid. Open ends of pipe shall be kept plugged with a Bulkhead during construction.

All ductile iron pipe to be laid in trenches shall be placed only after the trench has been excavated a minimum of six (6) inches below the bottom of the pipe are brought back with a cradle of sand thoroughly compacted to grade and shaped to provide a firm trough for receiving the pipe. Sand shall be clean, free-running material, free from stones, lumps, or foreign materials. Bell holes shall be properly located and dug for each joint. No blocking of any kind shall remain under the pipe. Excavation and backfilling of trenches shall be as specified under Item 1.

Pipe shall be laid with bell ends facing in the direction of laying, unless directed otherwise by the Inspector.

No pipe shall be laid in water or when, in the opinion of the Engineer, trench conditions are unsuitable.

CUTTING PIPE (Sec 10.07) Whenever pipes require cutting to fit into lines, the work shall be done in a satisfactory manner so as to leave a smooth end at right angles to the axis of the pipe. When a piece of pipe is cut to fit into a line, no payment will be made for that portion cut off and

not used in the line. All cutting done for pump suction lines shall be done so as to leave a smooth cut surface.

JOINTING PUSH - ON JOINT PIPE (Sec. 10.08) Before assembly, the inside of the bell, the gasket, and the outside of the pipe from the plain end to the stripe must be wiped clean.

Insert gasket into groove in bell. Check correct position by pulling the gasket toward the bell face in all 360 degrees of perimeter.

Before starting joint assembly, apply a liberal coating of lubricant (supplied by pipe manufacturer) to the outside of the pipe from the plain end to the painted stripe.

With plain end centered in the bell, the plain end is pushed home. When the stripe is no longer visible, the joint is assembled.

DRILLING - TAPPING (Sec 10.09) Where shown on the Contract Drawings or as required, ductile iron pipe shall be drilled and tapped to receive drainage or other piping or plugs. All holes shall be drilled accurately at right angles to the axis of any pipe or fittings.

Where the size of pipe to be connected to such as to require bosses for connection, the Contractor shall furnish such pipe with cast bosses suitable for drilling, tapping and connecting such pipe.

All tapping shall be carefully and neatly done by skilled workmen with suitable tools.

PAINTING (Sec. 10.10) All field painting work required for cast iron pipe and fittings, shall be performed and paid for under this item.

The cost of painting of nuts and bolts as herein specified shall be paid for under this item.

POLYETHYLENE TAPE MARKER (Sec. 10.11) The Contractor shall furnish and install during backfill operation for ductile iron gravity mainline sewer, laterals, and force mains printed polyethylene green (SEWER) tape above the sand backfill, three (3) feet above the crown of the pipe.

No separate or extra payment will be made for the furnishing and installation of the marker tape and all costs shall be included for payment under the applicable bid item(s) to which it is related.

ANCHORAGE FOR FORCE MAINS (Sec. 10.12) All cleanouts, air release valves, vacuum valves, plugs caps, tees and bends shall be provided with a reaction backing in addition to being restrained by attaching suitable metal rods, clamps, anchored fittings or harnessed joints, as shown on the plans or as specified so as to prevent movement.

Reaction backing shall be concrete, with steel reinforcement as required, unless otherwise shown on the drawings. Backing shall be placed between solid ground and the fitting or other part of the

pipeline to be anchored; the area of bearing on the pipe and on the ground in each instance shall be that as indicated on the plans. The backing shall be so placed unless otherwise directed, that the pipe and fitting joints will be accessible for repair.

Mechanical joint restraint system when used, shall be Megalug, as manufactured by EBBA Iron, Inc., or approved equal.

LEAKAGE TESTS (Sec. 10.13) All force main pipeline construction shall be subjected to hydrostatic leakage testing as line sections are completed, unless otherwise directed by the Engineer.

Before sections are tested, the following must be considered. The pipe must be sufficiently backfilled to prevent movement. Where reaction or thrust blocks are being used, adequate curing time must be allowed. A curing time of seven (7) days shall be required. Test ends shall be capped and braced to withstand thrusts that are developed under test pressures.

The test shall be under the direction of the Engineer. The Contractor is to furnish pressure gauge, pumps, pipe, bulkheads and any other suitable appurtenances necessary to make these tests.

Each section being tested shall be filled slowly with water, and all air shall be expelled during filling and prior to testing.

After testing, the section shall be drained and in cold weather, special care and precautions shall be taken in order to prevent injury due to freezing of the piping and appurtenances.

Leakage is defined as the quantity of water that must be supplied into the pipe as required to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled as herein required.

In calculating leakage, no allowance will be given for any leakage at valves, bulkheads, etc.

For force main pipe, the leakage tests as specified herein or as directed by the Engineer shall govern. Generally, the line shall be filled and allowed to stand for twenty-four (24) hours, and then hydrostatically tested for two (2) hours at the specified pressure. Allowable leakage shall be determined by the following formula:

$$L = \frac{ND \sqrt{P}}{7,400}$$

L = Allowable leakage in gal./hour

N = Number of joints in section tested

D = Nominal diameter of pipe in inches

P = Test pressure in pounds per square inch gauge

The test pressure shall be 150% of the pump shut-off head, or 100 psi whichever is greater.

All defective materials and construction found in the pipeline as a result of the leakage test shall be corrected by removal of the defective materials and reconstruction with sound materials and construction. The entire section shall then be retested in accordance with the foregoing.

Any testing performed without the knowledge of the Engineer shall not be considered as a test meeting these specifications.

MEASUREMENT (Sec 10.14) The length of ductile iron pipe sewer to be paid for under Item 10 shall be the number of lineal feet actually placed in accordance with the Contract Drawings as measured along the longitudinal axis of the pipe.

The number of ductile iron bends to be paid for under Item 10 shall be the attached number furnished in accordance with the Contract Drawings.

PAYMENT (Sec 10.15) The unit price stipulated per lineal feet for ductile iron pipe sanitary sewer and ductile iron pipe under Item 10 shall be in compensation for the furnishing, placing and testing of the pipe and jointing materials and placing of sand cradle, connection to manholes or fittings, polyethylene encasement, and the furnishing of all labor, materials, tools and appliances necessary to complete the work as specified or as shown. The unit price shall also include all dust control as specified in Item 23.

Concrete supports and all concrete work will be paid for under Item 5.

Ductile iron pipe specifically included under other items, such as in tunnel casing pipe, shall be furnished and placed and be paid for as stipulated under those items.

PVC PRESSURE PIPE

ITEM 11

WORK INCLUDED (Sec. 11.01) The Contractor shall, under Item 11, furnish all the materials for and shall properly construct and install all Poly Vinyl Chloride (PVC) pressure pipe and fittings required for the proper completion of work under this contract. Earth excavation and backfill shall be done as specified under Item 1, and payment thereof will be included under Item 11.

QUALITY OF PIPE (Sec. 11.02) All PVC pressure shall be new and of the best quality and of the sizes and dimensions shown on the drawings or as specified, and shall conform to ASTM designations D1784.

DIMENSIONS OF PIPE (Sec. 11.03) The sizes of PVC pressure pipe shown on the drawings or as specified either refer to inside diameters and standard dimension ratios (SDR) conforming to ASTM designation D2241, or refer to inside diameters and dimension ratios (DR) conforming to AWWA designation C900 with cast iron pipe equivalent O.D.'s. Where pipe sizes are not specified on the contract drawings, SDR 21 shall be supplied for ASTM D-2241 pipe and DR 18 shall be supplied for AWWA C900 pipe.

FITTINGS (Sec. 11.04)

For Gravity Applications: Fittings for ASTM D2241 (SDR) pressure pipe shall be PVC conforming to ASTM D2466 or ASTM D2467. Fittings for AWWA C900 (DR) pipe shall be PVC conforming to AWWA C900.

For Force Main Applications: Fittings shall be compact ductile iron conforming to the latest revisions of ANSI/AWWA C153/A21.53 ANSI/ and AWWA C111/A21.11.

PIPE LAYING (Sec. 11.05) All pipe under this item shall be installed in accordance with ASTM D2321. All trenches, when pipe laying is in progress, shall be kept dry.

All pipe and fittings shall be uniformly supported along their entire length with bedding material as shown on the drawings unless otherwise specified by the Engineer. Bedding material shall consist of gravel or crushed limestone. The material shall be free from dirt and shall be graded as follows:

100% -	Shall pass 1" square opening
90% - 100%	Shall pass 3/4" square opening
20% - 55%	Shall pass 1/2" square opening
0% - 15%	Shall pass 3/8" square opening
0% - 5%	Shall pass #4 sieve opening

Bedding materials below the pipe and that under and around the pipe to spring line shall be well tamped; that above spring line shall be placed in six (6) inch layers and be well tamped.

Reaction or thrust blocks shall be provided at valves, reducers, bends or fittings, or where changes in direction or diameter occur. The detail and quantity of these blocks shall be as shown on the drawings.

CUTTING PIPE (Sec. 11.06) Whenever pipes require cutting to fit into the lines, it is essential that a square cut be made to insure proper fit. This is accomplished by using either a tubing cutter or a miter box and fine-toothed hand saw or hacksaw.

For beveling, use a factory finished beveled end as a guide. The cut end may be beveled using a "pilot" beveling tool, or a thin steel hand tool, such as a "Stanley Surform No. 339".

After cutting a pipe, place a reference mark at the proper distance from the bevel end. This is accomplished by using a factory marked end of the same size pipe as a guide.

JOINTS (Sec. 11.07) Joints for PVC Pressure Pipe shall be in accordance with ASTM designation D3139, latest edition.

Before assembly, the inside of the bell, the gasket, (and gasket groove area if gaskets are shipped loose), and the outside of the spigot end are to be cleaned of all dirt or foreign material.

Apply manufacturer's specified lubricant to the spigot end only. Align spigot to bell and insert spigot until it contacts uniformly with gasket. A completed joint will be made when the reference mark on the spigot is flush with the end of the bell.

If undue resistance to insertion is encountered, or if the reference mark does not reach the flush position, disassemble and check the position of the ring gasket. If it is twisted or pushed out of its seat, clean the ring, bell and spigot end and repeat assembly. If the gasket was not out of position, check the reference mark location on the spigot end.

DRILLING AND TAPPING (Sec. 11.08) Where shown on the contract drawings or as required, PVC pressure pipe shall be drilled or tapped to receive piping or plugs. For small connections up to two (2) inches, service clamps or saddles may be used. For connections larger than two (2) inches, tapping sleeves and valves are to be used. Installations of connections are to be in accordance with manufacturer's recommendations.

ANCHORAGE (Sec. 11.09) For force main applications, all cleanouts, air release valves, vacuum valves, plugs caps, tees and bends shall be provided with a reaction backing in addition to being restrained by attaching suitable metal rods, clamps, anchored fittings or harnessed joints, as shown on the plans or as specified so as to prevent movement.

Reaction backing shall be of concrete, with steel reinforcement as required, unless otherwise shown on the drawings. Backing shall be placed between solid ground and the fitting or other part of the pipeline to be anchored; the area of bearing on the pipe and on the ground in each instance shall be that as indicated on the plans. The backing shall be so placed unless otherwise directed, that the pipe and fitting joints will be accessible for repair.

Mechanical joint restraint system when used, shall be Megalug, as manufactured by EBBA Iron, Inc., or approved equal.

POLYETHYLENE TAPE MARKER (Sec. 11.10) The Contractor shall furnish and install during backfill operation for gravity mainline sewer, laterals, and force mains printed polyethylene green (SEWER) tape, three (3) feet above the crown of the pipe.

No separate or extra payment will be made for the furnishing and installation of the marker tape and all costs shall be included for payment under the applicable bid item(s) to which it is related.

HOUSE SERVICES, STACKS OR WYES (Sec. 11.11) This section shall apply to PVC pressure pipe used in a gravity sewer application. The following are included for payment under this item:

- Item 11A - Taps as indicated on the drawings or in the proposal for standard service sewer
- Item 11B - Ductile Iron Service stack for standard service sewer
- Item 11C - Standard service sewer
- Item 11D - Reconnecting existing service sewer

All Y-branches, T-branches, service stacks and house service sewers shall be four (4) inches in diameter unless specifically shown or called for as of a different size.

All stoppers shall be sealed in the pipe in such a manner that they will be watertight and will not move during testing for leakage.

Each tap for standard service sewer, Item 11A, shall consist of the furnishing and placing of a Romac style "CB" sewer saddle or approved equal in the trunk or street sewer complete with stopper, joint materials, required excavation, bedding, backfill and location marker.

Each service stack for a standard service sewer, or sewers, Item 11B, shall consist of the furnishing and placing of a straight ductile iron pipe riser (and curved ductile iron pipe riser, if necessary) to the 90 degree long radius ductile iron bend, stoppers, bedding, required excavation and location marker. A stack will be used where shown on the plans or where directed by the Resident Engineer. Payment for a ductile iron T-branch in the trunk or street sewer will be paid for under Item 11A. All ductile iron pipe and fittings supplied for use with service stacks shall meet the requirements of Item 10.

Each standard service sewer, Item 11C, shall consist of furnishing and installing all curved and straight pipe from the tap or service stack to the property line, unless otherwise shown on the drawings, including bedding, backfill, excavation, stopper and location marker. Item 11C shall include the ductile iron pipe used from the 90° bend at the top of a stack that runs to virgin ground.

The flowline elevation at the end of each service sewer shall be minimum of (3'-6") three feet six inches below the lowest basement elevation of the particular building to be served. The flowline elevation at the end of each service sewer running to vacant property shall be a minimum of (8) eight feet below ground elevation. In those instances where it is impossible to maintain the above minimums or where the ground elevation at the building setback line is lower than the ground

elevation at the right-of-way line, the Contractor shall obtain approval of the Engineer for depth and location of the service sewer. The minimum grade for service sewer shall be 0.62 feet/100 feet (0.62%).

The Contractor shall, under item 11C, furnish flowline elevations at each manhole, and at the end of all sewers. This information shall be submitted to the Engineer at the completion of each sewer reach between manholes. The information shall be supplied on the "Flowline Elevation Form". The Flowline Elevation Form will be supplied by the Engineer.

Reconnecting of existing service sewers shall each consist of the furnishing and installing of the tap and all curved and straight pipe as required, the removal of such existing service sewer as is necessary, and the furnishing and placing of all materials to securely plug the discontinued service to the old sewer and make proper connection to the new sewer. All excavation required to complete the reconnection shall be included.

The Contractor shall furnish and place all pipe, specials, joint materials, bedding and concrete encasement or supports for all service connections as shown on the drawings. All pipe and specials shall be new and no salvaged materials shall be used.

Service stacks, taps, service sewers and reconnections, shall be constructed at the location shown on the drawings or where ordered by the Resident Engineer.

The location of taps, stacks and the ends of the service connections shall, unless otherwise ordered, be marked by a vertical oak strip two (2) inches in cross-section, extending from the end of the branch to the bottom of the pavement or to within one (1) foot of the surface of the ground.

Where curbs are available the location of the end of each service connection shall be marked by a two (2) inch cross cut into the top of the curb on the side of the street to be served by the connection.

In all cases, the open ends of pipe shall be securely closed with carefully fitted stoppers and sealed to prevent the entrance of water, earth or other substance into the sewer.

INSPECTION (Sec. 11.12) The Contractor shall furnish six (6) copies of the manufacturer's sworn certificate of inspection and testing of all PVC pipe in accordance with applicable ASTM requirements, indicating compliance with all requirements. All pipe will be subject to inspection and approval by the City after delivery of material to the job site. Any pipe or fittings found to be unsatisfactory or otherwise damaged shall not be approved for use.

The Contractor shall furnish the Engineer two (2) copies of lists of all pieces of pipe and fittings in each shipment received and shall include mark numbers, class, size and description of each item.

TESTING FORCE MAINS (Sec. 11.13) All PVC pressure pipe installed as force main shall be subject to hydrostatic leakage testing as line sections are completed unless otherwise directed by the Engineer.

Before sections are tested, the following must be considered. The pipe must be sufficiently backfilled to prevent movement. Where reaction or thrust blocks are being used, adequate curing time must be allowed. A curing time of seven (7) days shall be required. Test ends shall be capped and braced to withstand thrusts that are developed under test pressures.

The test shall be under the direction of the Engineer. The Contractor is to furnish pressure gauge, pumps, pipe, bulkheads and any other suitable appurtenances necessary to make these tests.

Each section being tested shall be filled slowly with water, and all air shall be expelled during filling and prior to testing.

After testing, the section shall be drained and in cold weather, special care and precautions shall be taken in order to prevent injury due to freezing of the piping and appurtenances.

Leakage is defined as the quantity of water that must be supplied into the pipe as required to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled as herein required.

In calculating leakage, no allowance will be given for any leakage at valves, bulkheads, etc.

For force main pipe, the leakage tests as specified herein or as directed by the Engineer shall govern. Generally, the line shall be filled and allowed to stand for twenty-four (24) hours, and then hydrostatically tested for two (2) hours at the specified pressure. Allowable leakage shall be determined by the following formula:

$$L = \frac{ND \sqrt{P}}{7,400}$$

L = Allowable leakage in gal./hour

N = Number of joints in section tested

D = Nominal diameter of pipe in inches

P = Test pressure in pounds per square inch gauge

The test pressure shall be 150% of the pump shut-off head, or 100 psi whichever is greater.

All defective materials and construction found in the pipeline as a result of the leakage test shall be corrected by removal of the defective materials and reconstruction with sound materials and construction. The entire section shall then be retested in accordance with the foregoing.

Any testing performed without the knowledge of the Engineer shall not be considered as a test meeting these specifications.

TESTING GRAVITY SEWER (Sec. 11.14) PVC pressure pipe installed in gravity sewer applications shall be subject to deflection testing as specified below.

Deflection testing shall be conducted 30 days after installation and backfilling of the pipe or as otherwise directed by the Engineer.

The contractor shall furnish all necessary equipment including an approvable mandrel or other approved device and conduct the deflection tests at the direction of the Engineer.

The allowable deflection rate shall not exceed 5%. The Engineer has the option to require a second test anytime between initial testing and release of the maintenance bond. Any sections found to have a deflection in excess of the specified rate shall be excavated and corrected either by re-bedding, pipe replacement or both as directed by the engineer. These corrections shall be required if warranted by either initial or secondary testing.

PVC pressure pipe installed in gravity sewer applications shall also be air tested as the project is being installed. This includes all mainline between manholes, future mainline stubs and laterals out of manholes. Air testing shall be in accordance with ASTM F1417.

MEASUREMENT (Sec. 11.15) The length of PVC pressure pipe to be paid for under Item 11 shall be the number of lineal feet actually placed in accordance with the Contract Drawings as measured along the longitudinal axis of the pipe.

PAYMENT (Sec. 11.16) The unit price stipulated per lineal foot for PVC pressure pipe under Item 11 shall include earth excavation, bedding and backfill, the furnishing of all labor, materials, tools, and appliances necessary to complete the work as shown or directed. The unit price shall include reaction or thrust blocks, and also all dust control as specified in Item 23.

PVC pressure pipe specifically included under other items, such as in tunnel or casing pipe, shall be furnished and placed and be paid for as stipulated under those items.

No payment will be made for repairing house service sewers, or any public or privately owned utility line when broken or when cut by the Contractor.

In gravity applications, should the elevation of the sewers, or a change in alignment as ordered by the Resident Engineer result in a depth greater than shown on the drawings, the additional required excavation will be paid for under Item 2 Additional Earth Excavation.

Rock excavation will be paid for as a fixed price under Item 3, Rock Excavation; payment therefore will be in addition to the unit prices stipulated under Item 11.

Service connections whenever required in gravity applications will be paid for under Items 11A, 11B, 11C, and 11D. Additional payment will be made for any stack required in any reconnection under Item 11B.

No payment for service sewers will be made until the Flowline Elevation Form has been completed and submitted to the Engineer.

All ductile iron pipe and fittings supplied for stacks under Items 11A, 11B, 11C and 11D shall be paid for under Items 11A, 11B, 11C and 11D.

PVC GRAVITY PIPE SEWERS

ITEM 12

WORK INCLUDED (Sec. 12.01) The Contractor shall, under Item 12, furnish all the materials for and shall properly construct all Poly Vinyl Chloride (PVC) gravity pipe sewers, including pipe, specials, stoppers, etc., as shown on the drawings, or required for the proper completion of the work included under this Contract. Earth excavation and backfill shall be done as specified under Item 1; payment, therefore, will be included under Item 12.

In general, this work shall include the furnishing and laying of all straight PVC pipe and PVC specials required in the construction of the sewers, risers, underdrains, rebuilding or reconnection of existing sewers, inlet connection, house connections and appurtenant work. This work shall also include the furnishing of service sewer elevations.

QUALITY OF PIPE (Sec. 12.02) All PVC pipe and fittings shall be new and of the best quality and of the sizes and dimensions shown or specified and shall conform to ASTM Designation D-3034.

DIMENSIONS OF PIPE (Sec. 12.03) The sizes of PVC Gravity pipe and fittings as shown on the drawings or as specified refer to inside diameters. A Standard Dimension Ratio (SDR) of 35 shall be the maximum allowed for pipe supplied under ASTM D-3034.

PIPE LAYING (Sec. 12.04) Installation shall be in accordance with the latest edition of ASTM D2321, Underground Installation of Flexible Thermoplastic Sewer Pipe.

All trenches, when pipe laying is in progress, shall be kept dry and all pipes and specials shall be laid accurately to the required lines and grades and shall be uniformly supported along their entire lengths with stone bedding as shown on the drawings unless otherwise specified or ordered by the Resident Engineer. Pipe shall be pushed "home" and kept in the position.

The material used for bedding shall be gravel or crushed limestone. The material shall be free from dirt and shall be graded as follows:

100% -	Shall pass 1" square opening
90% - 100%	Shall pass 3/4" square opening
20% - 55%	Shall pass 1/2" square opening
0% - 15%	Shall pass 3/8" square opening
0% - 5%	Shall pass #4 sieve opening

Bedding material below the pipe and that under and around the pipe to spring line shall be well tamped; that above spring line shall be placed in six (6) inch layers and be well tamped.

When pipes enter or pass through concrete walls or other sections, holes shall be cut through and the pipes properly grouted in place so as to form a watertight joint. Wherever possible a bell shall be flush with the outside edge of the masonry.

All trenches shall be drained so that pipe shall be laid under dry conditions.

In all cases the open ends of pipe shall be securely closed with carefully fitted stoppers, so as to prevent any earth or other substance from entering them. Wood shall be used only for temporary closures or where shown on the drawings.

The Contractor will be required to set up and use batter boards, located at every established grade and line point. A line shall be set on these batter boards at an elevation such that it is parallel to the invert grade line and on the proper centerline of the pipe. Not less than three (3) batter boards shall be set before any pipe is placed. A grade stick provided with a bracket on the bottom shall be used to locate the pipe at the proper elevation, and a plumb bob shall be used to locate it on line.

In lieu of the above method, the Contractor may, if he has suitable equipment and a capable operator, use a laser beam for establishing line and grade. The method used shall be as recommended by the manufacturer of the laser equipment and must be satisfactory to the Resident Engineer. The laser beam shall be of no greater power than 2.5 Milliwatts (0.0025 watts). A continual visual check shall be provided by the laser equipment.

No PVC sewer pipe shall be laid until a sufficient length of trench has been properly prepared to permit laying of pipe. No pipes shall be laid except in the presence of the Resident Engineer or an inspector, and no pipes shall be covered or backfilled until they have been examined and directions given to cover the same.

CUTTING PIPE (Sec. 12.05) Whenever pipes require cutting to fit into the lines, it is essential that a square cut is made to insure proper fit. This is accomplished by using either a tubing cutter or a miter box and fine-toothed hand saw or hacksaw. For beveling, use a factory finished beveled end as a guide. The cut end may be beveled using a "pilot" beveling tool, or a thin, steel hand tool, such as a "Stanley Surform No. 399".

After cutting a pipe, place a reference mark at the proper distance from the bevel end. This is accomplished by using a factory marked end of the same size pipe as a guide.

JOINTS (Sec. 12.06) All joints shall conform to ASTM D-3212. Before assembly, the inside of the bell, the gasket, (and gasket groove area if gaskets are shipped loose), and the outside of the spigot end are to be cleaned of all dirt or foreign material.

Apply manufacturer's specified lubricant to the spigot end only. Align spigot to bell and insert spigot until it contacts uniformly with gasket. A completed joint will be made when the reference mark on the spigot is flush with the end of the bell.

If undue resistance to insertion is encountered, or if the reference mark does not reach the flush position, disassemble and check the position of the ring gasket. If it is twisted or pushed out of its

seat, clean the ring, bell and spigot end and repeat assembly. If the gasket was not out of position, check the reference mark location on the spigot end.

CONNECTIONS (Sec. 12.07) Tees and wyes for service connections shall be factory made whenever possible. When circumstances warrant, field installed service connections shall be used and shall be of the gasketed variety or, when approved, the solvent cement type. Installation of connections is to be in accordance with the manufacturing recommendations and the applicable ASTM Designation.

CONCRETE CRADLE OR ENCASEMENT (Sec. 12.08) Class B concrete shall be used to encase or support PVC sewer pipe at locations called for on the drawings and where directed by the Resident Engineer. Concrete so used shall be paid for under the provisions of Item 5 except that the encasement of the vertical drop pipes and the tees and ells used in constructing drop manholes and of service stacks are parts of the structures and are included in the prices bid for such structures, and no additional payment will be made therefore.

Wherever concrete bedding is used instead of stone bedding because of excessive width of trench, no payment will be made for the concrete used. Concrete shall be placed as specified in Item 5.

HOUSE SERVICES, STACKS OR WYES (Sec. 12.09) The following are included for payment under this item:

- Item 12A - Y-branch or T-branch as indicated on the drawings or in the proposal for standard service sewer
- Item 12B - Ductile Iron Service stack for standard service sewer
- Item 12C - Standard service sewer
- Item 12D - Reconnecting existing service sewer

All Y-branches, T-branches, service stacks and house service sewers shall be four (4) inches in diameter unless specifically shown or called for as of a different size.

All stoppers shall be sealed in the pipe in such a manner that they will be watertight and will not move during testing for leakage.

Each Y-branch or T-branch for standard service sewer, Item 12A, shall consist of the furnishing and placing of a Y-branch or a T-branch in the trunk or street sewer complete with stopper, joint materials, required excavation, bedding, backfill and location marker.

Each service stack for a standard service sewer, or sewers, Item 12B, shall consist of the furnishing and placing of a straight ductile iron pipe riser (and curved ductile iron pipe riser, if necessary) to the 90 degree long radius ductile iron bend, stoppers, bedding, required excavation and location marker. A stack will be used where shown on the plans or where directed by the Resident Engineer. Payment for a ductile iron T-branch in the trunk or street sewer will be paid for under Item 12A. All ductile iron pipe and fittings supplied for use with service stacks shall meet the requirements of Item 10.

Each standard service sewer, Item 12C, shall consist of furnishing and installing all curved and straight pipe from the Y-branch or T-branch or service stack to the property line, unless otherwise shown on the drawings, including bedding, backfill, excavation, stopper and location marker. Item 12C shall include the ductile iron pipe used from the 90° bend at the top of a stack that runs to virgin ground.

The flowline elevation at the end of each service sewer shall be minimum of (3'-6") three feet six inches below the lowest basement elevation of the particular building to be served. The flowline elevation at the end of each service sewer running to vacant property shall be a minimum of (8) eight feet below ground elevation. In those instances where it is impossible to maintain the above minimums or where the ground elevation at the building setback line is lower than the ground elevation at the right-of-way line, the Contractor shall obtain approval of the Engineer for depth and location of the service sewer. The minimum grade for 6" service sewer shall be 0.62 feet/100 feet (0.62%).

The Contractor shall, under item 12C, furnish flowline elevations at each manhole, and at the end of all sewers. This information shall be submitted to the Engineer at the completion of each sewer reach between manholes. The information shall be supplied on the "Flowline Elevation Form". The Flowline Elevation Form will be supplied by the Engineer.

Reconnecting of existing service sewers shall each consist of the furnishing and installing of the Y-branch or T-branch and all curved and straight pipe as required, the removal of such existing service sewer as is necessary, and the furnishing and placing of all materials to securely plug the discontinued service to the old sewer and make proper connection to the new sewer. All excavation required to complete the reconnection shall be included.

The Contractor shall furnish and place all pipe, specials, joint materials, bedding and concrete encasement or supports for all service connections as shown on the drawings. All pipe and specials shall be new and no salvaged materials shall be used.

Service stacks, Y-branches or T-branches, service sewers and reconnections, shall be constructed at the location shown on the drawings or where ordered by the Resident Engineer.

The location of Y-branches, or T-branches, stacks and the ends of the service connections shall, unless otherwise ordered, be marked by a vertical oak strip two (2) inches in cross-section, extending from the end of the branch to the bottom of the pavement or to within one (1) foot of the surface of the ground.

Where curbs are available the location of the end of each service connection shall be marked by a two (2) inch cross cut into the top of the curb on the side of the street to be served by the connection.

In all cases, the open ends of pipe shall be securely closed with carefully fitted stoppers and sealed to prevent the entrance of water, earth or other substance into the sewer.

AIR TESTING (Sec. 12.10) Air-testing of projects will be conducted as the project is being installed. This includes all mainline between manholes, future mainline stubs and laterals out of manholes. The air testing shall be in accordance with ASTM F-1417.

DEFLECTION TESTING (Sec. 12.11) Deflection testing shall be conducted 30 days after installation and backfilling of the pipe or as otherwise directed by the Engineer.

The contractor shall furnish all necessary equipment including an approvable mandrel or other approved device and conduct the deflection tests at the direction of the Engineer.

The maximum allowable limits for deflection of installed pipe under this specification shall be 7.5%. Base inside diameters and 7.5% deflection mandrel dimensions shall be per ASTM F-679 (latest edition). Deflection shall be measured with a rigid mandrel (Go/No Go) device cylindrical in shape and constructed with a minimum of nine evenly spaced arms or prongs. Drawings of the mandrel with complete dimensions shall be submitted to the Engineer for each diameter of pipe to be tested. The mandrel shall be hand pulled through all sewer lines.

Any section of sewer not passing the mandrel shall be uncovered at no additional cost to the Owner and the bedding and backfill replaced to prevent excessive deflection. Repaired pipe shall be retested at no additional cost to the Owner. The Engineer has the option to require a second test at the Contractor's expense anytime between initial testing and release of the maintenance bond. Repairs shall be required if warranted by either initial or secondary testing and will be completed at no additional cost to the Owner.

POLYETHYLENE TAPE MARKER (Sec. 12.12) The Contractor shall furnish and install during backfill operation for all gravity mainline sewers and laterals printed polyethylene green (SEWER) tape above the bedding material, three (3) feet above the crown of the pipe.

No separate or extra payment will be made for the furnishing and installation of the marker tape and all costs shall be included for payment under the applicable bid item(s) to which it is related.

INSPECTION (Sec. 12.13) The Contractor shall furnish six (6) copies of the manufacturer's sworn certificate of inspection and testing of all PVC pipe in accordance with ASTM D-3034 or F-679, as applicable, indicating compliance with all requirements. All pipe will be subject to inspection and approval by the City after delivery of material to the job site. Any pipe or fittings found to be unsatisfactory or otherwise damaged shall not be approved for use.

The Contractor shall furnish the Engineer two (2) copies of lists of all pieces of pipe and fittings in each shipment received and shall include mark numbers, class, size and description of each item.

MEASUREMENT (Sec. 12.14) The number of Y-branches or T-branches for standard service sewers to be paid for under Item 12A, shall be the number of Y-branches or T-branches actually installed in the completed work under this Contract.

The number of lineal feet of service stacks for standard service sewers to be paid for under Item 12B, shall be the number of lineal feet of service stacks actually installed in the completed work

under this Contract measured as defined on the drawings. A service stack used for more than one (1) service sewer shall be considered for payment as only one (1) service stack.

Any stack required for a reconnection under Item 12D will be included in the number of service stacks measured for payment under Item 12B.

The number of lineal feet of standard service to be paid for under Item 12C shall be the total number of lineal feet of standard service sewers actually installed in the completed work under this Contract, as measured parallel to the centerline of the standard service sewer from the connection point of the trunk or street sewer and the service sewer to the end of each service sewer as installed.

The lengths of PVC sewer pipe to be paid for under this Item, shall be the total number of lineal feet of each size actually furnished and placed in accordance with the Specifications, measured along the axis of the pipe after the pipe has been connected in place. The inside diameter of manholes and the length of special structures will be deducted.

PAYMENT (Sec. 12.15) The unit price stipulated per lineal foot for the various sizes of PVC pipe sewer shall include earth excavation and backfill, the furnishing of all labor, materials, tools, and appliances necessary to complete the work as specified, shown or directed. No additional payment will be made for specials left in the sewer or drain lines except as provided for the Items 12A and 12B.

No payment will be made for repairing house service sewers, or any public or privately owned utility line when broken or when cut by the Contractor.

Should the elevation of the sewers, or a change in alignment as ordered by the Resident Engineer result in a depth greater than shown on the drawings, the additional required excavation will be paid for under Item 2, Additional Earth Excavation.

Rock excavation will be paid for as a fixed price under Item 3, Rock Excavation; payment therefore will be in addition to the unit prices stipulated under Item 12.

PVC pipe specifically included under other items, such as in tunnel or casing pipe, shall be furnished and placed and will be paid for as stipulated under those items.

Service connections whenever required will be paid for under Items 12A, 12B, 12C, and 12D. Additional payment will be made for any stack required in any reconnection under Item 12B.

No payment for service sewers will be made until the Flowline Elevation Form has been completed and submitted to the Engineer.

All ductile iron pipe and fittings supplied for stacks under Items 12A, 12B, 12C and 12D shall be paid for under Items 12A, 12B, 12C and 12D.

LARGE-DIAMETER PVC GRAVITY PIPE SEWERS

ITEM 13

WORK INCLUDED (Sec. 13.01) The Contractor shall, under Item 13, furnish all the materials for and shall properly construct all large-diameter Polyvinyl Chloride (PVC) gravity pipe sewers, including pipe, specials, stoppers, etc., as shown on the drawings, or required for the proper completion of the work included under this Contract. Earth excavation and backfill shall be done as specified under Item 1; payment, therefore, will be included under Item 13.

In general, this work shall include the furnishing and laying of all straight PVC pipe and PVC specials required in the construction of the sewers, risers, underdrains, rebuilding or reconnection of existing sewers, inlet connection, house connections and appurtenant work. This work shall also include the furnishing of service sewer elevations.

QUALITY OF PIPE (Sec. 13.02) All PVC pipe and fittings shall be new and of the best quality and of the sizes and dimensions shown or specified and shall conform to ASTM Designation F-679 latest edition.

DIMENSIONS OF PIPE (Sec. 13.03) The sizes of large-diameter PVC gravity pipe and fittings as shown on the drawings or as specified refer to nominal diameters. The pipe wall thickness for PVC pipe shall be as indicated in ASTM F-679 latest edition.

PIPE LAYING (Sec. 13.04) All trenches, when pipe laying is in progress, shall be kept dry and all pipes and specials shall be laid accurately to the required lines and grades and shall be uniformly supported along their entire lengths with stone bedding as shown on the drawings unless otherwise specified or ordered by the Resident Engineer. Pipe shall be pushed "home" and kept in the position. Pipe installation shall conform to ASTM D-2321.

The material used for bedding shall be gravel or crushed limestone. The material shall be free from dirt and shall be graded as follows:

100% -	Shall pass 1" square opening
90% - 100%	Shall pass 3/4" square opening
20% - 55%	Shall pass 1/2" square opening
0% - 15%	Shall pass 3/8" square opening
0% - 5%	Shall pass #4 sieve opening

Bedding material below the pipe and that under and around the pipe to spring line shall be well tamped; that above spring line shall be placed in six (6) inch layers and be well tamped. When pipes enter or pass through concrete walls or other sections, the connection shall be made as per Item 14.

All trenches shall be drained so that pipe shall be laid under dry conditions.

In all cases, the open ends of pipe shall be securely closed with carefully fitted stoppers, so as to prevent any earth or other substance from entering them. Wood shall be used only for temporary closures or where shown on the drawings.

The Contractor will be required to set up and use batter boards, located at every established grade and line point. A line shall be set on these batter boards at an elevation such that it is parallel to the invert grade line and on the proper centerline of the pipe. Not less than three (3) batter boards shall be set before any pipe is placed. A grade stick provided with a bracket on the bottom shall be used to locate the pipe at the proper elevation, and a plumb bob shall be used to locate it on line.

In lieu of the above method, the Contractor may, if he has suitable equipment and a capable operator, use a laser beam for establishing line and grade. The method used shall be as recommended by the manufacturer of the laser equipment and must be satisfactory to the Resident Engineer. The laser beam shall be of no greater power than 2.5 Milliwatts (0.0025 watts). A continual visual check shall be provided by the laser equipment.

No PVC sewer pipe shall be laid until a sufficient length of trench has been properly prepared to permit laying of pipe. No pipes shall be laid except in the presence of the Resident Engineer or an inspector, and no pipes shall be covered or backfilled until they have been examined and directions given to cover the same.

CUTTING PIPE (Sec. 13.05) Whenever pipes require cutting to fit into the lines, it is essential that a square cut is made to insure proper fit. This is accomplished by using either a tubing cutter or a miter box and fine-toothed handsaw or hacksaw. For beveling, use a factory finished beveled end as a guide. The cut end may be beveled using a "pilot" beveling tool, or a thin, steel hand tool.

After cutting a pipe, place a reference mark at the proper distance from the bevel end. This is accomplished by using a factory marked end of the same size pipe as a guide.

JOINTS (Sec. 13.06) All joints shall conform to ASTM D-3212.

Before assembly, the inside of the bell, the gasket, (and gasket groove area if gaskets are shipped loose), and the outside of the spigot end are to be cleaned of all dirt or foreign material.

Apply manufacturer's specified lubricant to the spigot end only. Align spigot to bell and insert spigot until it contacts uniformly with gasket. A completed joint will be made when the reference mark on the spigot is flush with the end of the bell.

If undue resistance to insertion is encountered, or if the reference mark does not reach the flush position, disassemble and check the position of the ring gasket. If it is twisted or pushed out of its seat, clean the ring, bell and spigot end and repeat assembly. If the gasket was not out of position, check the reference mark location on the spigot end.

CONNECTIONS (Sec. 13.07) Tees and wyes for service connections shall be factory made whenever possible. When circumstances warrant, field installed service connections shall be the Inserta Tee connection as made by the Fowler Manufacturing Company. Installation of connections is to be in accordance with the manufacturer's recommendations and the applicable ASTM specifications.

CONCRETE CRADLE OR ENCASEMENT (Sec. 13.08) Class B concrete shall be used to encase or support sewer pipe at locations called for on the drawings and where directed by the Resident Engineer. Concrete so used shall be paid for under the provisions of Item 5 except that the encasement of the vertical drip pipes and the tees and ells used in constructing drop manholes, service stacks, and T-Branched for service stacks are parts of the structures and are included in the prices bid for such structures, and no additional payment will be made therefore.

Wherever concrete bedding is used instead of stone bedding because of excessive width of trench, no payment will be made for the concrete used. Concrete shall be placed as specified in Item 5.

HOUSE SERVICES, STACKS OR WYES (Sec. 13.09) The following are included for payment under this item:

- Item 13A - Y-branch or T-branch as indicated on the drawings or in the proposal for standard service sewer or service stack
- Item 13B - Ductile Iron Service stack for standard service sewer
- Item 13C - Standard service sewer
- Item 13D - Reconnecting existing service sewer

All Y-branches, T-branches, service stacks and house service sewers shall be four (4) inches in diameter unless specifically shown or called for as of a different size.

All stoppers shall be sealed in the pipe in such a manner that they will be watertight and will not move during testing for leakage.

Each Y-branch or T-branch for standard service sewer, Item 13A, shall consist of the furnishing and placing of a Y-branch or a T-branch in the trunk or street sewer complete with stopper, joint materials, required excavation, bedding, backfill and location marker.

Each service stack for a standard service sewer, or sewers, Item 13B, shall consist of the furnishing and placing of a straight ductile iron pipe riser (and curved ductile iron pipe riser, if necessary) to the 90 degree long radius ductile iron bend at the top of the stack, stoppers, concrete encasement, required excavation and location marker. A stack will be used where shown on the plans or where directed by the Resident Engineer. Payment for a T-branch in the trunk or street sewer will be paid for under Item 13A. All ductile iron pipe and fittings supplied for use with service stacks shall meet the requirements of Item 10.

Each standard service sewer shall consist of furnishing and installing all curved and straight pipe from the Y-branch or T-branch or service stack to the property line, unless otherwise shown on the drawings including bedding, backfill, excavation, stopper and location marker. Item 13C shall include the ductile iron pipe used from the 90° bend at the top of a stack that runs to virgin ground.

The flowline elevation at the end of each service sewer shall be a minimum of (3'-6") three feet six inches below the lowest basement elevation of the particular building to be served. The flowline elevation at the end of each service sewer running to vacant property shall be a minimum of (8) eight feet below ground elevation. In those instances where it is impossible to maintain the above minimums or where the ground elevation at the building setback line is lower than the ground elevation at the right-of-way line, the Contractor shall obtain approval of the Engineer for depth and location of the service sewer. The minimum grade for 6" service sewer shall be 0.62 feet/100 feet (0.62%)

The Contractor shall, under 13C, furnish flowline elevations at each manhole, and at the end of all service sewers. This information shall be submitted to the Engineer at the completion of each sewer reach between manholes. The information shall be supplied on the "Flowline Elevation Form". The Flowline Elevation Form will be supplied by the Engineer.

Reconnecting of existing service sewers shall each consist of the furnishing and installing of the Y-branch or T-branch and all curved and straight pipe as required, the removal of such existing service sewer as is necessary, and the furnishing and placing of all materials to securely plug the discontinued service to the old sewer and make proper connection to the new sewer. All excavation required to complete the reconnection shall be included.

The Contractor shall furnish and place all pipe, specials, joint materials, bedding and concrete encasement or supports for all service connections as shown on the drawings. All pipe and specials shall be new and no salvaged materials shall be used.

Service stacks, Y-branches or T-branches, service sewers and reconnections, shall be constructed at the location shown on the drawings or where ordered by the Resident Engineer.

The location of Y-branches or T-branches, stacks and the ends of the service connections shall, unless otherwise ordered, be marked by a vertical oak strip two inches (2") in cross-section, extending from the end of the branch to the bottom of the pavement or to within one foot (1') of the surface of the ground.

Where curbs are available the location of the end of each service connection shall be marked by a two inch (2") cross cut into the top of the curb on the side of the street to be served by the connection.

In all cases, the open ends of pipe shall be securely closed with carefully fitted stoppers and sealed to prevent the entrance of water, earth or other substance into the sewer.

AIR TESTING (Sec. 13.10) Air-testing of sewer will be conducted as the project is being installed. This includes all mainline between manholes, future mainline stubs and laterals out of manholes. The air testing shall be in accordance with ASTM F-1417.

DEFLECTION TESTING (Sec. 13.11) Deflection testing shall be conducted 30 days after installation and backfilling of the pipe or as otherwise directed by the Engineer.

The contractor shall furnish all necessary equipment including an approvable mandrel or other approved device and conduct the deflection tests at the direction of the Engineer.

The maximum allowable limits for deflection of installed pipe under this specification shall be 7.5%. Base inside diameters and 7.5% deflection mandrel dimensions shall be per ASTM F-679 (latest edition). Deflection shall be measured with a rigid mandrel (Go/No Go) device cylindrical in shape and constructed with a minimum of nine evenly spaced arms or prongs. Drawings of the mandrel with complete dimensions shall be submitted to the Engineer for each diameter of pipe to be tested. The mandrel shall be hand pulled through all sewer lines.

Any section of sewer not passing the mandrel shall be uncovered at no additional cost to the Owner and the bedding and backfill replaced to prevent excessive deflection. Repaired pipe shall be retested at no additional cost to the Owner. The Engineer has the option to require a second test at the Contractor's expense anytime between initial testing and release of the maintenance bond. Repairs shall be required if warranted by either initial or secondary testing and will be completed at no additional cost to the Owner.

POLYETHYLENE TAPE MARKER (Sec. 13.12) The Contractor shall furnish and install during backfill operation for all gravity mainline sewers and laterals printed polyethylene green (SEWER) tape above the bedding material, three (3) feet above the crown of the pipe.

No separate or extra payment will be made for the furnishing and installation of the marker tape and all costs shall be included for payment under the applicable bid item(s) to which it is related.

INSPECTION (Sec. 13.13) The Contractor shall furnish six (6) copies of the manufacturer's sworn certificate of inspection and testing of all PVC pipe in accordance with ASTM F-679, as applicable, indicating compliance with all requirements. All pipe will be subject to inspection and approval by the City after delivery of material to the job site. Any pipe or fittings found to be unsatisfactory or otherwise damaged shall not be approved for use.

The Contractor shall furnish the Engineer two (2) copies of lists of all pieces of pipe and fittings in each shipment received and shall include mark numbers, class, size and description of each item.

MEASUREMENT (Sec. 13.14) The number of Y-branches or T-branches for standard service sewers to be paid for under Item 13A shall be the number of Y-branches or T-branches actually installed in the completed work under this Contract.

The number of lineal feet of service stacks for standard service sewers to be paid for under Item 13B, shall be the number of lineal feet of service stacks actually installed in the completed work under this Contract measured as defined on the drawings. A service stack used for more than one (1) service sewer shall be considered for payment as only one (1) service stack.

Any stack required for a reconnection under Item 13D will be included in the number of service stacks measured for payment under Item 13B.

The number of lineal feet of standard service to be paid for under Item 13C shall be the total number of lineal feet of standard service sewers actually installed in the completed work under this Contract as measured parallel to the centerline of the standard service sewer from the connection point of the trunk or street sewer and the service sewer to the end of each service sewer as installed.

The lengths of large-diameter sewer pipe to be paid for under this Item shall be the total number of lineal feet of each size actually furnished and placed in accordance with the Specifications, measured along the axis of the pipe after the pipe has been connected in place. The inside diameter of manholes and the length of special structures will be deducted.

PAYMENT (Sec. 13.15) The unit price stipulated per lineal foot for the various sizes of large-diameter pipe sewer shall include earth excavation and backfill, the furnishing of all labor, materials, tools, and appliances necessary to complete the work as specified, shown or directed. No additional payment will be made for specials left in the sewer or drain lines except as provided for in Items 13A and 13B.

No payment will be made for repairing house service sewers, or any public or privately owned utility line when broken or when cut by the Contractor.

Should the elevation of the sewers, or a change in alignment as ordered by the Resident Engineer result in a depth greater than shown on the drawings, the additional required excavation will be paid for under Item 2, Additional Earth Excavation.

Rock excavation will be paid for as a fixed price under Item 3, Rock Excavation; payment, therefore, will be in addition to the unit prices stipulated under Item 13.

Pipe specifically included under other items, such as in tunnel or casing pipe, shall be furnished and placed and will be paid for as stipulated under those items.

Service connections whenever required will be paid for under Items 13A, 13B, 13C, and 13D. Additional payment will be made for any stack required in any reconnection under Item 13B.

No payment for service sewers will be made until the Flowline Elevation Form has been completed and submitted to the Engineer.

All ductile iron pipe and fittings supplied for stacks under Items 13A, 13B, 13C, and 13D shall be paid for under Items 13A, 13B, 13C, and 13D.

MANHOLES - ITEM 14

DROP ATTACHMENTS - ITEM 14A

CORROSION RESISTANT LINER – ITEM 14B

CONNECTIONS TO EXISTING MANHOLES – ITEM 14C

WORK INCLUDED (Sec. 14.01) The Contractor shall, under this item, make all required earth excavation, backfill and dewatering, furnish all the materials and labor necessary, and shall build standard manholes, drop attachments, shallow manholes, and provide connections to existing manholes to the diameter indicated, where shown or ordered and as shown or specified. These items shall not include the manholes mounted on the special structures listed under the Item for Special Structures or under any other Item wherein specifically mentioned.

MATERIALS (Sec. 14.02) Manholes shall be constructed of precast reinforced concrete sections on poured-in-place monolithic concrete bases, or approved precast concrete bases, with troughs to be formed as approved by the Engineer. All concrete used in manholes shall conform to the requirements of Precast Class Concrete with the exception of benches and channels for which Class B concrete shall be used. Concrete shall conform with the requirements of Section 1000 of the North Carolina Department of Transportation (NCDOT) Standard Specifications for Roads and Structures 2012. Requirements for various Concrete Classes are detailed in Table 1000-1 of the NCDOT publication specified above.

Manhole frames and covers shall be of the size and style shown on the drawings, which is known as City Standard. Castings shall be made in USA and shall be EJ Model number 1045Z frame and 1040A or 1040AGS cover (as required on plans) or approved equal. Approved equal must meet the requirements of this specification. Manufacturer shall certify that the gray iron conforms to ASTM A48/AASHTO M105 Class 35B. Castings must contain a minimum of 85% recycled content. All products shall have the product name or series number (example: 1045Z or 1040A), country of origin, specific part number, production date, material information, and the manufactures identification or name (EJ) permanently cast on the product. The top of manhole covers shall have the country of origin and manufacturers identification. Bottom of the casting shall have the product name or series number, part number, production date (example: mm/dd/yy) for tracking purposes, and material quality (such as ASTM A48) to verify the materials used. Castings without proper markings shall be rejected. Covers shall come equipped with two (2) non-penetrating ergonomic pick slots for safety and ease of removal by one operator, with one “J” style hook or similar. Each pick slot shall have dual openings for ease of removal of any debris. The pick slots shall be the EPIC® pick bar as designed by EJ USA, INC. or approved equal. As required on plans, covers shall be lockable, using two EJ 1935R Cam Lock assemblies. Cams shall be assembled with hardware as shown on the drawing. Covers shall have machined bearing surface and a machined dove tail style groove for a ¼” diameter neoprene gasket, which shall be glued into the machined groove described above. 1045Z and 1045AGS frame and cover, as described herein, shall be watertight when properly assembled. Frames shall have machined bearing surfaces and be designed and produced so that they nest together, providing greater safety in shipping, storage, and handling. Standard frames and covers shall be made

from gray iron and can be made from ductile iron, upon request. Castings shall be suitable for a minimum of H25 traffic loading, and therefore shall have passed a 50,000 pound proof load test as outlined in AASHTO M306. Castings shall be of uniform quality, free from sand holes, gas holes, cracks, shrinkage and other surface defects. Castings shall be reasonably well cleaned by shot blasting. Runners, risers, fins and other cast-on pieces shall be removed from the castings and such areas shall be ground smooth. As-cast dimensions may vary within accepted foundry tolerances as outlined in the Iron Castings Handbook published by the American Foundrymen's Society, Inc. Nominal, casting dimensional tolerances shall be +/- 1/16 inch per foot. Castings shall be furnished uncoated. If desired, the product shall be provided with customer specific labeling. System of manufacturing quality assurance must conform to the requirements of ISO 9001:2008 and be certified by a third party. Producing foundry must be an approved supplier to North Carolina Department of Transportation.

Steps shall be of reinforced plastic of the style indicated on the drawings or approved by the City.

All cast iron shall be of good quality cast iron conforming to ASTM Specification A48, Class 35B Iron. Casting shall be cleaned by shot blasting and shall be coated with coal tar pitch varnish to provide a smooth, tough and tenacious coating.

Orifice plates, where called for, shall be furnished and installed as shown on the drawings.

GENERAL (Sec. 14.03) Manhole bottom sections shall be thoroughly bonded to the barrel of the sewer and all connections neatly made without projections or voids, and shall be watertight. The bottom of manholes shall be channeled to a depth equal to the inside diameter of the largest pipe entering or leaving the manhole and of a width equal to the diameter of the pipe. Channels shall be smooth, curved where required, and shall provide clear flow lines. Channels shall be of formed concrete or of pipe sections. Manholes shall be narrow at the top to fit the cast iron frame and cover as shown on the contract drawings. Manhole steps shall be set with uniform spacing not over sixteen (16) inches center to center.

PRECAST CONCRETE (Sec. 14.04) The design of precast concrete manholes shall be approved by the Engineer before any sections are delivered to the site of the work. Precast concrete manhole rings and dome sections shall meet ASTM Designation C478.

All joints shall be made with rubber gaskets conforming to ASTM Specification Designation C443. All joints shall be watertight. Inside joints shall be smooth. Details of pipe through manhole walls shall be submitted to the Engineer for approval prior to commencement of construction.

Tar strips shall be installed at all manhole joints. The Contractor shall also apply tar over the cement parging on the outside of the adjustment rings and the exterior of the manhole casting.

Manhole steps will be furnished in accordance with the Standard Detail Drawings ASTM C-478 and current OSHA regulations. In addition to the testing requirements of ASTM C-478 each step installed in pre-cast manholes will be tested to resist a 1000 lb pullout. The manhole manufacturer will furnish certification of each test with each shipment showing manhole location, date of test, and results.

STANDARD MANHOLES (Sec. 14.05) Standard manholes shall be of the size shown on the

drawings and be of the design and materials shown or specified. All "handling holes" shall be plugged with non-shrink grout and shall be finished on the inside to conform with the manhole wall.

The finished grade for manhole castings shall be one-half (1/2) inch above paved roadway surfaces and shall be three (3) feet above ground line in all other areas, unless otherwise directed by the Engineer or noted in the Contract Drawings. The roadway material topcoat shall be feathered up to the top of the casting from a distance of five (5) feet in all directions outside the manhole casting and be ¼-inch higher at the edge of the casting. Masonry brick and cement shall be used under the casting as required to slope the top of the casting to match the roadway surface, i.e. the casting shall not be constructed level on a roadway with a grade.

Openings for pipes eighteen (18) inches and smaller entering above the top of the outlet pipe (as for drops) may be cut in the field. Pipes over eighteen (18) inches in diameter entering the manhole above the top of the outlet pipe shall be connected to the manhole by a tee connection, precast with the barrel of the manhole.

Dome sections shall be of precast reinforced concrete of the same quality materials specified for the rings and shall have a taper as shown on the drawings. Dome sections shall be eight (8) inches thick at the top.

Precast concrete rings, cast irons rings or brickwork shall be used to adjust the manhole cover to the proper elevation, as shown on the drawings.

Manhole steps shall be cast in place, grouted in place, or "drive-in" type; they must be watertight. If grouted in place a non-shrinking agent shall be added to the grout.

Aggregate shall be sound, crushed, angular granitic stone only, substantially in accordance with ASTM C-33, except that the requirement for gradation in that standard shall not apply.. Smooth or rounded stone (river rock) shall not be acceptable.

In lieu of Type II cement and granitic aggregate, precast manhole sections may be furnished of Type III cement with calcareous (limestone) aggregate. The manufacturer will submit lab tests certifying the amount of Alkalinity (minimum 78%) present in the complete mix.

Manhole riser sections, transition slabs, flat top slabs, and cone sections shall be designed for H-20 loadings.

The manufacturer shall furnish the Engineer with test results on compression and absorption for one section in every twenty-five sections poured, and certification from cement manufacturer and aggregate supplier certifying chemical content. The Engineer reserves the right to pick random sections for the required testing.

T-BASE MANHOLES (Sec 14.05A) T-Base manholes shall be accepted as equal to the standard round precast bases provided they meet all of the following requirements:

- Precast components on the project to be manufactured in a plant certified in the National Precast Concrete Associations (NPCA) Plant Certification Program.

- The precast manufacturer shall employ at least one Registered Professional Engineer at the manufacturing facility through the life of the project.
- Precast manufacturer shall provide list of projects with submittals.
- T-Base must be poured on steel forms without the use of water stop or wall ties. T-Base must be poured monolithically.
- Supplier/seller of T-Base structures shall be manufacturer of entire structure.
- Precast manufacturer shall provide detailed design calculations for T-Base configurations, which shall include floatation, depth calculations, and all other items necessary for design.
- T-Base manufacturer shall provide buoyancy calculations showing that all of the T-Base sections on the project will not become buoyant with groundwater or flooding. The calculations shall include a Factor of Safety of 1.25 per ACI 350. The calculations shall be stamped by a Professional Engineer and provided with the submittals.

DROP ATTACHMENTS (Sec. 14.06) Item 14A, Drop attachments shall be provided as shown in the Standard Drawing.

SHALLOW MANHOLES (Sec. 14.07) Shallow manholes shall be as shown on the drawings and shall be similar in detail to standard manholes, except that, in order to obtain all possible headroom, a reinforced concrete slab shall be placed near the top instead of domed construction.

CORROSION PROTECTION (14.08) Item 14B: Where manholes are shown on the Drawings to be provided with a corrosion protection, they shall be factory lined with Dura Plate 100 as manufactured by A-LOK products, or equal in accordance with Item 43, Corrosion Resistant Liner.

CONNECTIONS TO EXISTING MANHOLES (14.09) Item 14C: Where existing manholes require connections for proposed sanitary sewer, the contractor shall core drill manholes for openings required, if openings do not exist. Approved gasketing method and any grouting for new pipe connection to manhole shall also be supplied. Any rework of the existing manhole bench required to provide a new channel for the proposed connection shall be supplied. Any bypassing of flows required to perform this work shall also be supplied.

AIR TESTING (Sec. 14.10) Air Testing of all new manholes is required and shall meet the requirements of ASTM C-1244. Manholes shall be sealed with plate-style sealing equipment on top of the casting so that the adjustment rings can also be tested. Bladder-style sealers are not acceptable. If a lateral is extended out of a manhole to a property the lateral shall be air tested with the manhole test, i.e. the lateral shall not be sealed off during the test.

MEASUREMENT (Sec. 14.11) All standard, shallow manholes, and lined manholes Item 14, drop attachments, Item 14A, and lined manholes Item 14B, will be measured for payment upon their final completion and acceptance. Measurement for manholes will be made from the flow line to the top of the casting. Measurement for drop attachments shall be made from the flow line of the manhole to the flow line of the upper inlet pipe, as shown on the drawings.

PAYMENT (Sec. 14.12) The unit price stipulated per vertical foot of depth for standard, shallow and lined manholes for each diameter shall include all the construction of each manhole in place,

including all labor, materials, tools and appliances, cast iron manhole frame and cover, steps, toe pockets, orifice plates (if called for), reinforcing steel, concrete, precast concrete sections, top elevation adjusting rings or brickwork, linings or coatings complete as specified or shown. The unit price per vertical foot of depth shall also include all sewer stubs and plugs as indicated on the contract drawings, specified or shown.

The unit price stipulated per vertical foot of drop attachments shall include the required earth excavation and the furnishing of all labor, materials, tools, and appliances necessary to complete the work as specified or shown.

When PVC pipe is being used the price for drop attachment shall include all Ductile Iron Pipe that is required.

All earth excavation and backfilling shall be done as specified under Item 1: Payment therefore shall be included under Item 14 and/or Item 14A.

Rock excavation, if required, will be paid for under Item 3 Rock Excavation.

Cost for Connections to Existing Manholes – Item 14C, shall be included in the cost bid for other items. No separate payment will be made for Item 14C.

PIPELINES IN CASING PIPE OR TUNNEL

ITEM 15

WORK INCLUDED (Sec. 15.01) Under Item 15, the Contractor shall furnish all labor and materials and shall properly construct all pipe lines or sewers in casing pipe and/or tunnel, to the sizes indicated and to the lines and grades, and at the locations shown on the drawings; including all earth excavation for shafts and tunnels; casing pipe; casing spacers; tunnel lining; grout; concrete; pipe; fill and dewatering; all bore pit and receiving pit wood or steel sheeting; granular backfill; and any and all restoration of disturbed areas.

Wherever possible, casing pipes of smooth bore and smooth exterior shall be jacked in place; casing pipes shall be of the sizes and weights hereinafter specified or as shown on the drawings.

Whenever it is not feasible to jack a casing pipe in place, the work may be done in a tunnel. No tunnel work will be permitted under state highways except with special permission.

Bore or tunnel pits shall be safed-up, shored, well-marked, lighted, and not left unattended except as approved by the City. Requirements for stabilization and dewatering of bore pits shall be as hereinbefore specified. The angle of repose method (sloping pit walls) for creating a safe working area shall not be used.

REFERENCE TO OTHER ITEMS (Sec. 15.02) The work done under this item, in general, includes but is not limited to the following work which shall be performed as specified under the items which apply. All of the work is included for payment under this item.

Earth Excavation	Item 1
Concrete	Item 5
Granular Backfill	Item 7
Excavation Support Systems	Item 9
Ductile Iron	Item 10
PVC Pressure	Item 11
PVC Gravity Pipe	Item 12
Large Diameter Gravity Pipe	Item 13
Catch Basins, Inlets and Storm Sewers	Item 18
Restoring Existing Sewer Pipelines	Item 19
Pavement, Curbs and Gutters and Sidewalks	Item 20
Topsoil and Seeding	Item 24

JACKING CASING PIPE (Sec. 15.03) Whenever jacking operations are to be performed, a suitable jacking pit shall be excavated as specified under Item 1. A cradle of timber or concrete shall be built upon which the pipe to be jacked shall be placed to the correct line and grade. Suitable reaction bracing shall be installed and no damage shall result from any part of the entire jacking operation.

The end of the casing pipe shall be kept ahead of excavation unless the earth is too hard to permit such jacking.

Extreme care must be used to keep the casing pipe on the proper line and grade. No changes in line or grade of the pipe line or sewer will be permitted, except with written permission of the Resident Engineer.

Boring inside the casing pipe will be permitted provided the Contractor has suitable equipment for such work. If the casing pipe comes in short lengths the sections shall be welded circumferentially in a workmanlike manner; such welds must be watertight and capable of withstanding the jacking pressure without distortion or breakage.

Smooth wall or spiral weld steel 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.

If voids are encountered or occur outside the encasement pipe, grout holes shall be installed in the top section of the encasement pipe at ten (10) foot centers and the voids filled with 1:3 Portland Cement grout at sufficient pressure to prevent settlement in the roadway/railway.

Boring operations shall be continuous to their completion, and unnecessary or prolonged stoppages shall not be allowed.

In the event an obstruction is encountered during the boring and 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 City for permission to open cut, bore at an alternate location, or install a tunnel.

Installation shall be to the limits specified by the City and/or as delineated in the encroachment issued to the City. (A copy of the encroachment agreement must be kept at the site throughout boring operations).

The complete casing installation shall be such as to prevent the formation of a waterway under the road or railbed.

The City shall have full authority to require remedial measures and/or to stop all work if, in its operation, said work will cause any damage to the roadway/railway section or endanger traffic. In all instances the City reserves the right to sample, test, and approve all materials and methods used.

The contractor shall notify the City through the Construction Engineer and acknowledgement shall be received a minimum of five (5) working days prior to beginning any work within roadway or rights-of-way. If required, 24-hours notice will be given prior to completion.

CASING PIPE (Sec. 15.04) Casing pipes for the various sizes and kinds of pipe lines shall be of steel with a smooth bore and smooth exterior. The sizes of the casing pipe and the thickness of the walls shall not be less than those listed below:

Table of Minimum Wall Thickness for Steel Casing Pipe

Nominal Diameter <u>Inches</u>	Coated or Cathodically <u>Protected</u>	Uncoated or <u>Unprotected</u>
under 14	0.188	0.251
14,16	0.219	0.282
18	0.250	0.313
20	0.281	0.344
22	0.312	0.375
24	0.344	0.407
26	0.375	0.438
28,30	0.406	0.469
32	0.438	0.501
34,36	0.469	0.532
38,40,42	0.500	0.563
48	0.563	0.626
54	0.625	0.688
60,66	---	0.750
72	---	0.750
84	---	0.875

The casing shall be installed by jacking, with simultaneous removal of spoil. The spoil removal shall not proceed more than 18-inches ahead of the casing. The diameter of the excavated hole shall be no larger than necessary to keep the casing moving freely and lubricant may be used to reduce the jacking forces. Casing sections shall be joined by butt weld.

After the casing is jacked in place, 2-inch grout holes shall be used to pump a 1:3 portland cement grout to fill the void outside the casing. Sufficient pressure should be applied to force grout out of the adjacent grout hole. Grout holes shall be a maximum of ten feet apart at the top of the casing.

The casing size and thickness shall be as shown on the Plans or Special Provisions

TUNNEL EXCAVATION (Sec. 15.05) Tunnel excavation in earth shall be lined and braced with timber, steel, or other suitable material complying with all applicable regulations and requirements of the State of North Carolina. All material used for lining shall be so placed that there will be no voids between it and the earth. Should any voids between it and the earth occur they shall be filled with grout.

The Contractor shall provide all supports necessary to prevent settlement of the pavement, buildings, railroad tracks, or other structures; if the Resident Engineer is of the opinion that

sufficient supports have not been provided, he may order the furnishing and placing of additional bracing, sheeting or timbering, at the expense of the Contractor; but compliance with such orders, or failure of the Resident Engineer to give such orders, shall not release the Contractor from his responsibility for the sufficiency of such supports.

Before any work is done in tunnel, the Contractor shall discuss with the Resident Engineer the methods, materials and equipment he intends to use. He shall obtain approval of such methods, procedures, materials and equipment from the Resident Engineer, but such approval will not in any way relieve the Contractor of full responsibility in all phases of the construction.

All tunnels shall be lighted by electricity with a minimum illumination of one (1) 50 watt lamp per 25 feet, plus additional lighting wherever operations are in progress. No open flames will be permitted in the tunnel.

Approved safety lamps shall be placed in each heading where men are employed. Should explosive or lethal gas be present in any heading in such quantity that conditions are dangerous, sufficient ventilation shall be provided to make the atmospheric conditions safe for working.

The minimum dimensions inside the lining of tunnels, in which men are permitted to work, shall not be less than thirty-six (36) inches.

Tunnel excavation in rock may be unsupported provided the rock is solid enough to safely support the superimposed load. The roof of the tunnel shall be checked at frequent intervals and all loose rock shall be removed.

Tunnel excavation shall be performed only by workmen experienced in such operations.

All excavated materials shall be removed from the site of the work; no accumulation of spoil will be permitted in or near tunnel shafts.

Shafts shall be properly sheeted and shored to protect the work and adjacent structures. The shafts shall wherever possible be located at the site of manholes or special structures. In the location of tunnel shafts particular attention shall be given to the maintenance of vehicular traffic and the convenience of the public.

For tunneling operations using structural steel liner plates, all plates shall be formed to provide circumferential flanged joints. Longitudinal joints may be flanged or offset lap seam type. All plates shall be punched for bolting on both longitudinal and circumferential seam or joints. Bolt spacing in circumferential flanges shall be in accordance with the manufacturer's standard spacing and shall be multiples of the plate length so that plates having the same curvature shall be interchangeable to permit staggering of the longitudinal seam. Bolt spacing at flanged longitudinal seams shall be in accordance with the manufacturer's standard spacing. For lapped longitudinal seams, bolt size and spacing shall be in accordance with the manufacturer's standard but not less than that required to meet the longitudinal seam strength requirements of the design specifications. All liner plates for the full length of a specified tunnel shall be either the flanged or the lapped seam type. The two types shall not be mixed in the same tunnel.

Liner plates shall be assembled in accordance with the manufacturer's instructions. Galvanized and coated 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, except that small areas with minor damage may be repaired to the satisfaction of the Construction Engineer or his representative.

Galvanized surfaces shall be repaired by thoroughly wire brushing the damaged areas and removing all loose cracked coating, after which the cleaned areas shall be painted with two (2) coats of zinc rich paint as approved, and an acceptable bituminous coating restored.

When tunneling has proceeded a distance sufficient for placing one section of the tunnel liner, that section of liner will be placed before excavating further. Excavation shall be controlled so that the space outside the liner plate shall be held to a minimum. All voids between the liner plate and the tunnel wall shall be filled with 1:3 Portland Cement grout, containing no more water than necessary, placed under sufficient pressure to fill all voids. Grout shall be placed through the grout holes provided in the top of the tunnel liner plates. Grout holes 2" in diameter shall be provided at not more than 4.5 foot centers or every third ring of plates to permit grouting as the erection of the tunnel liner progresses. At no time will the grouting operations be further than 10' from the front end or head of the tunnel construction.

At the end of each day's operations, the voids outside installed liner plates shall be grouted whether 10' or less. Grout will be forced into each grout hole. If the grout from one hole should flow along the liner plates so as to plug the next hole, the plug shall be opened by punching through the grout 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.

The tunnel shall be constructed to the limits, grade and alignment shown on the Construction Plans. Excavation, without the use of jetting, shall be done in such a manner as to protect public and/or private property from damage. Prior to beginning any construction, the Contractor shall submit pit shoring and tunnel liner details for approval, and no tunneling may begin prior to approval of these details by the appropriate City. After approval of tunnel liner and pit shoring details, a five (5) day notice to the City, through the Construction Engineer, shall be provided as previously specified.

No blasting will be done without prior written approval of the City and then only in strict accordance with all Federal, State, and Local laws, ordinances, rules, or regulations governing the storage and use of explosives. Where blasting is required, only small controlled charges of 40% dynamite or plastic explosives shall be used. The depths of the holes for these charges shall not exceed the depth necessary to clear an area sufficient to place one section of tunnel liner.

The charges for the initial series of blasts should be placed in the triangle method. The second series should be placed in the radial method a minimum distance from the desired diameter of the tunnel. The triangular 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 railway or shoulders or pavement of the highway as applicable. If rock is encountered after tunneling progresses beneath the pavement or railway, the charges will initially be set at very low levels and increased in small increments until the proper amount of charge is determined.

In no case will an overshoot be permitted. If a boulder is encountered and 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 railway fill, all operations shall be stopped and the City notified immediately. If the vertical split is not determined to be of too great a magnitude or too close to the rails/pavement, the split shall be filled with grout at a pressure specified by the City, allowed to set and tunneling operations may be continued.

If it is determined that the vertical split is too great of a magnitude or too close to the pavement or railway, the City shall determine the method to be used to correct the split. If settlement of the roadway or railway occurs, the City will advise the Owner and his Contractor of the proper steps to be taken to correct the settlement. If deemed necessary by the City, adequate warning devices (signs, flashers, etc.) accompanied by responsible flagmen shall be placed at a distance allowing any and all traffic time to stop safely before reaching the questionable area. At the option of the City, it may provide the necessary flagmen, warning devices, etc., at the Contractor's expense. Traffic shall be allowed over the questionable area only as directed by the City.

The City shall have full authority to inspect entire tunnel operation, require disposition of remedial measures, and to stop all work if, in its opinion, the work will cause any damage to the roadway/railway section or endanger traffic. In all instances the City reserves the right to sample, test, and approve all materials used.

The completed liner shall consist of a series of structural steel liner plates assembled with staggered longitudinal joints. Liner plates shall have been fabricated to fit the cross section of the tunnel. All plates shall be connected by bolts on both longitudinal and circumferential seams or joints.

After tunnelling operations have been completed the Contractor will install the carrier pipe in a manner approved by the Engineer. Concrete fill (1:3 Portland Cement grout) will then be placed after completing installation of the sewer pipe within the tunnel liner as directed by the Engineer and end enclosure walls installed as shown on the Construction Plans or Standard Details. Ends of the tunnel liner will be sealed with an eight-inch (8") masonry wall on the lower end and a twelve-inch (12") masonry wall on the higher end. Weep holes will be provided on the downstream end for drainage. The Contractor shall then remove the vertical shoring for pits (if ground conditions allow), surplus spoils, and material from the site.

The site shall then be returned to its original condition, seeded, mulched, or restored as specified and left in a neat and satisfactory condition. Shoring material 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 these Specifications or the requirements of the City.

The Contractor will notify the Engineer, in writing, upon completion of the tunnel liner installation. Notification of completion of the tunnel operation will then be forwarded to the Division Engineer, in writing, by letter with a copy to the attention of the State Design Services Engineer, North Carolina Department of Transportation, Division of Highways, Raleigh, North Carolina 27611 by the Engineer.

The Contractor shall reimburse the City and the City shall reimburse the Division of Highways should any settlement or damage result to the roadway within a period of one (1) year after completion of the tunneling operations.

The Contractor and any of his subcontractors performing work on the State's (N.C. DOT) right-of-way in connection with tunneling operations shall furnish for approval, through the Construction Engineer, to the Department of Transportation, attention State Design Services Engineer, North Carolina Department of Transportation, Division of Highways, Raleigh, North Carolina, 27611, a certificate of insurance. An original and one copy of the certificate in the minimum amounts of \$500,000 Bodily Injury and \$250,000/\$500,000 Property Damage shall be submitted for approval as evidence of proper coverage before beginning any work at the site. The Certificate is to show explosion, collapse, and underground insurance coverage is provided. The Certificate will also reference the project, county and the Design Services Units file number.

Insurance requirements for work performed on Railroad (CSX, Norfolk-Southern, etc.) property will be as outlined in the Special Provision Section of this contract. The Contractor shall furnish for approval a certificate of Insurance to this office. All required submittals will be sent to the City for review and this office will then forward the documentation on to the railroad.

Insurance will remain in full force and effect for one (1) year after acceptance by the owner and the City. The Certificate is to be countersigned by an authorized North Carolina Resident Agent with the name and address of the agent denoted thereon.

PIPE (Sec. 15.06) The Contractor shall furnish and install pipe of the kind and size designated on the drawings. Pipe shall conform to the specifications of Items 10, 11, 12, and 13. Pipe shall be of the strength of class shown on the drawings. All pressure pipes in casings shall have a mechanical joint restraint system where possible, which shall be Megalug, as manufactured by EBBA Iron, Inc., Field Lok gaskets, as manufactured by U.S. Pipe, Inc., or approved equivalent. PVC gravity sewer pipe within casing pipe does not require joint restraint.

PIPELINE SUPPORT/SPACERS (Sec. 15.07) Pipeline support shall be accomplished using treated wood blocking with stainless steel straps or with premanufactured casing spacers of stainless steel with glass-reinforced polyester insulating runners.

Wood blocking shall be as shown on the drawings. Wood blocks shall be of pressure treated lumber meeting the requirements of American wood Preservers Bureau (AWPB) Standard LP-22. All end cuts across the grain after treatment shall be field coated with preservative in accordance

with AWPB m4, Paragraphs 1.313 and 1.32. Banding straps for holding wood blocks in place shall be of stainless steel with a liner.

Premanufactured casing spacers shall be heavy duty steel with glass reinforced polyester insulating runners as manufactured by Pipeline Seal and Insulator, Inc. of Houston, Texas or approved equal. Spacers shall be installed on each side of pipe joints. Maximum spacing is 10 feet and spacers shall be installed within 6 inches of each casing pipe end. Manufacturer's recommended installation instructions shall be followed. Shop drawing submittal is required including manufacturers catalog cuts and scale drawing showing proposed spacer locations for each bore specified.

BACKFILL IN CASING PIPE OR TUNNEL (Sec. 15.08) After the pipe is properly jointed, aligned and secured or braced in the casing pipe or tunnel lining so that no movement of the pipe will take place, the entire space outside of the pipe and the inside of the tunnel or casing pipe shall be completely filled with sand as specified for the aggregate under Item 5, in mixture with cement in a ratio of one (1) part cement to five (5) parts sand. Sand shall be carefully placed so that proper alignment and grade of the pipe line or sewer will be maintained. Concrete or grout shall be used instead of sand to fill voids whenever specifically called for on the drawings. If the drawings do not call out fill material, the sand/cement mixture described above shall be used.

BORE AND RECEIVING PIT SHEETING (Sec. 15.08) Bore and receiving pits required for this work shall be sheeted with wood or steel sheeting as specified on the plans. Where steel sheeting is specified, bore and receiving pits shall be sheeted with steel sheeting in accordance with the requirements of Item 9, but the steel shall be pulled after construction. Where wood sheeting is specified the bore and receiving pits shall be sheeted with wood sheeting left in place in accordance with the requirements of Item 9.

MEASUREMENT (Sec. 15.09) The number of linear feet of pipe line or sewer in casing pipe and/or in tunnel to be measured for payment under this item shall be the actual length of pipe line or sewer constructed in casing pipe and/or tunnel, measured along the center line of the pipe.

No separate measurement will be made for bore and receiving pit sheeting required under this item.

PAYMENT (Sec. 15.10) The unit price per linear foot of pipe line or sewer in casing pipe and/or tunnel stipulated in the proposal under the various divisions of Item 15 shall include earth excavation, disposal of soil, shaft construction, ventilating, lighting, pumping, and the furnishing and placing of all casing pipe and/or tunnel lining, sheeting, shoring, bracing, grout, concrete, specified carrier pipe, casing spacers, steel pipe, joint materials, sand fill, and the furnishing of all labor, materials, tools and appliances necessary to complete the work as specified or shown.

Costs for bore and receiving pit sheeting (wood left in place or steel pulled after construction) required under Item 15 shall be included in the costs for Item 15. No separate measurement or payment will be made.

All costs for restoration of disturbed areas by boring operations shall be included in Item 15 costs including granular backfill under pavement and any and all restoration as required but not limited to the items as specified in Section 15.02.

REMOVING AND REPLACING DRIVEWAY CULVERTS

ITEM 17

WORK INCLUDED (Sec. 17.01) The Contractor shall, under Item 17, furnish all materials, tools and labor necessary for removing, cleaning and replacing driveway culverts encountered along the routes of the sewers, including the necessary excavation and backfilling.

DESCRIPTIONS (Sec. 17.02) All driveway culverts within the pay limits of the excavation for the main sewers, and such other as may be ordered by the Engineer, shall be carefully removed from the driveways ahead of the sewer excavation and stored temporarily during the construction of the sewer across driveways. After the sewer is built, and culvert pipes shall be cleaned, replaced in their original locations and backfilled as called for in Item 1.

If the Engineer determines that any culvert pipe is in such condition that it cannot be cleaned and reinstalled because of collapse, corrosion or for any other reason, it shall be replaced with new pipe equal to that type which it replaces.

PAYMENT (Sec. 17.03) The price for this item shall be included in prices for sewers under Items 10, 11, 12, or 13, as applicable and shall include all material, labor, tools and appliances required to accomplish this work.

CATCH BASINS, INLETS AND STORM SEWERS

ITEM 18

WORK INCLUDED (Sec. 18.01) Under Item 18, the Contractor shall furnish all labor and materials and shall construct catch basins, inlets and storm sewers of the type shown on the plans or required during project installation and as required by the Engineer, including all earth, shale and rock excavation, sheeting and bracing, concrete brick or solid block walls, cast iron frames, grates, sewer pipe and connections to new or old sewers.

MATERIALS (Sec. 18.02) Earth excavation, shale and rock excavation, concrete and sewer pipe, frames and grates, shall be made and placed in accordance with the appropriate items.

Frames and grates shall be made of the type called for on the plans or of that type which they replace. Concrete shall be as specified under Item 5.

Walls shall be concrete brick, precast units or solid block placed in a bed of cement mortar with a shoved joint; all joints shall be completely filled. Brick shall be laid with alternate header and stretcher courses. Block shall have staggered joints. Cement mortar shall consist of clean, well graded sand, Portland cement, and clean water. The interior surfaces shall be given a plaster coat one-half (1/2) in. thick and shall be left smooth. The cast iron frame shall be set in a full bed of mortar.

CONSTRUCTION (Sec. 18.03) The catch basins and inlets shall be constructed in shapes and sizes shown on the drawings, or as required during project installation except as otherwise provided, and to the lines and grades given by the Engineer. Installation of storm sewers shall be in accordance with the appropriate sanitary sewer item, based on material applicable.

The excavation shall not be larger than required and shall be well sheeted and shored. Should excavation be made deeper than required by the structure, the excavated space shall be filled with concrete, at the Contractor's expense, up to the base of the structure as shown on the drawings. No earth or gravel fill or foundation cushion will be permitted underneath special structures. All excavation for catch basins, inlets and storm sewers shall be properly enclosed, barricaded and lighted.

PAYMENT (Sec. 18.04) The price for this item shall be included in prices bid for sewers under Items 10, 11, 12, or 13, as applicable and shall include all material, labor, tools and appliances required to accomplish this work.

RESTORING EXISTING SEWER PIPELINES

ITEM 19

WORK INCLUDED (Sec. 19.01) Under this item, the Contractor shall furnish and install bridges to support the replacement for existing sewer lines cut during the normal operations of this Contract.

The bridges shall be of the type and dimensions shown on the drawings and shall be located where shown by the Resident Engineer and shall be of such length so that the bearing on undisturbed earth is at least twelve (12) inches.

MATERIALS (Sec. 19.02) The replaced pipe shall insofar as possible be of the same kind and size as that of the old pipe. Salvaged pipe may be used if in good condition and if approved by the Resident Engineer. Joints shall be made so as to be watertight; junctions with old work shall be made with concrete as shown.

Timber shall be Douglas Fir, Southern Pine or similar species having a unit working stress in bending of at least 1,100 pounds per square inch. All timber shall be sound, free from cracks, shakes, loose knots and large knots. Timber shall be rough, full dimension of the size shown in the table on the drawing. Wherever any timber is in contact with other timber the pieces shall be securely nailed together.

Concrete shall be Class B as specified in the Concrete item, except that no aggregate larger than 3/4 inch shall be used.

CONSTRUCTION (Sec. 19.03) Backfilling of the main trench shall be completed and compacted to the elevation of the sewer to be restored. The foot blocks shall be placed on tamped undisturbed earth and shall be seated in position. The vertical member shall be installed and backfilling shall be brought up to the top of the vertical member. The remainder of the bridge shall be completed. Backfill under and around the bridge must be carefully placed and thoroughly tamped so as to provide all possible support to the replaced pipe line. Pipe shall be laid to the proper grade and alignment. Then the concrete shall be carefully placed, taking care that the pipe does not float or shift in position.

PAYMENT (Sec. 19.04) The price for this item shall be included in prices bid for sewers under Items 10, 11, 12, or 13, as applicable and shall include all material, labor, tools and appliance required to accomplish this work.

PAVEMENT, CURBS AND GUTTERS AND SIDEWALKS

ITEM 20

WORK INCLUDED (Sec. 20.01) The Contractor shall, under Item 20, furnish all materials for and shall properly construct new or properly restore all pavements, all curbs and gutters and all sidewalks as specified, shown or directed. The construction and completion of work covered by this item shall be accomplished immediately after the completion of specified and acceptable backfill operations in the work area. Should weather conditions preclude proper specified road restoration, trench topping may be ordered by the Engineer but only until such time as permanent replacement can be executed.

The plans indicate the type and location of base and surface courses to be placed, however, this may be changed by order of the Engineer, to any of the types of pavement included in this item and paid for at the price stipulated in the proposal for the particular type of material actually placed. Driveways restored will be included for payment under the item for the type of material used in the restoration.

Following is a general description of the work included under the various subheadings of this item:

Item 20A	Asphalt Concrete over Asphalt Concrete Base Pavement Replacement
Item 20B	Brick Pavement Replacement
Item 20C	Cinder, Gravel or Earth Driveway or Roadway Replacement
Item 20D	Brick, Flagstone, Asphalt or Concrete Driveway Replacement
Item 20E	Temporary Bituminous or Asphalt Concrete Trench Topping
Item 20F	Curbs and Gutters
Item 20G	Concrete Sidewalks
Item 20H	Asphalt Concrete Pavement Replacement w/Full Width Overlay
Item 20I	Asphalt Concrete Full Width Overlay
Item 20J	Rolled Asphalt Curb
Item 20X	Job Specific

MATERIALS (Sec. 20.02) All materials and construction methods used in the work performed under this item shall conform to the latest revision of Standard Specifications for Roads and Structures of the State of North Carolina, Department of Transportation, or to the latest revision thereof, hereinafter referred to as "NCDOT Specifications", unless otherwise excepted herein.

RESTORING PAVEMENTS (Sec. 20.03) After thorough compaction of the trench or subgrade, as specified under Item 1, the surface to be repaved shall be bladed and rolled to the proper elevation and crown as required or directed. Subgrade shall be compact, uniform, and free from excessive moisture. All places, which, in the opinion of the Engineer, cannot be properly rolled, shall be tamped with mechanical hand tampers weighing not less than eighty (80) pounds per square foot of tamping surface.

Wherever existing pavements are to be patched, the cut lines of the patches shall be straight lines, in general parallel or perpendicular to the line of traffic (unless the entire patch crosses the line of traffic at an angle.) The edges of the existing pavement shall be cut vertically before making the patches.

NEW PAVEMENTS (Sec. 20.04) The subgrade for all new pavements shall be bladed and rolled to the proper elevation and crown and shall be compact, uniform and free from excessive moisture.

Before any pavement is constructed, the subgrade must be properly prepared.

ASPHALT CONCRETE OVER ASPHALT CONCRETE BASE (Sec. 20.05) under item 20A, the Contractor shall furnish all materials and labor to construct an Asphalt Concrete Base Course, Type B 25.0B, six (6) inches thick in two (2) three (3) inch layers in accordance with NCDOT Specifications, Item 610.

After preparation of the subgrade, the faces of existing work such as curbs, castings, manholes, and existing pavements, and all non-asphalt base courses, shall be painted, primed or sealed with bituminous material in accordance with Sec. 605 of the NCDOT Specifications.

Under this item, the Contractor shall, in addition, install Asphalt Concrete Surface Course, Type SF 9.5A of two (2) inch thickness over the asphalt concrete base in accordance with NCDOT Specifications, Item 640.

All joints with existing work shall be sealed and sanded after compaction of the surface course.

Materials for use in shoulders shall meet the requirements of NCDOT Item 560, Shoulder Construction.

BRICK ROADWAY REPLACEMENT (Sec 20.06) Under Item 20B, the Contractor shall furnish all materials and labor to replace brick pavement. A bed of sand a minimum of 3/4" in depth shall be placed on six (6) inch aggregate base and screeded to the proper elevation.

Brick removed from the street may be used for repaving if thoroughly cleaned. The surface and coursing shall match the existing pavement and the same sized joint shall be used. Brick shall be handled carefully to prevent breakage. Bats less than one-third (1/3) of a brick shall not be used. New brick, if required, shall match the old brick as closely as possible.

Immediately after placing, the brick shall be rolled with a five (5) to eight (8) ton roller, parallel to the line of the coursing and generally perpendicular to the direction of the traffic.

Joints shall be filled with asphalt brick filler by pouring directly into the joint or with cement mortar if required to match adjacent pavement. Joints shall be completely filled. Excess filling shall be cut off.

CINDER, GRAVEL, OR EARTH DRIVEWAY, OR ROADWAY REPLACEMENT (Sec. 20.07)
Under Item 20C, the Contractor shall furnish all materials and labor to construct a six (6) inch thick compacted cinder or gravel driveway or roadway.

The aggregate placed under Item 20C shall be Compacted Aggregate Base Course material in accordance with NCDOT Specifications, Item 1008.

BRICK, FLAGSTONE, ASPHALT OR CONCRETE DRIVEWAY REPLACEMENT (Sec. 20.08) Under Item 20D, the contractor shall replace all brick, flagstone, asphalt or concrete driveways.

Concrete replacement for driveways shall be reinforced to match the existing concrete driveway reinforcement and shall be six (6) inches thick. Existing concrete driveways that are not reinforced shall be replaced with fiberglass reinforced, six (6) inch thick concrete. Concrete driveways shall be constructed in accordance with NCDOT Specifications, Item 848. Pads that are damaged shall be taken out in their entirety to include approaches to match existing spacing, finish and color as directed by the Engineer.

Brick, flagstone or asphalt shall be placed over a six (6) inch Compacted Aggregate Base Course in accordance with NCDOT Specifications, Item 1008.

Asphalt for driveways shall be placed in accordance with NCDOT Specifications – one (1) inch Asphalt Concrete Surface Course, Type SF 9.5A over two (2) inch Asphalt Binder Grade PG 64-22 over six (6) inch Compacted Aggregate Base Course. The final one (1) inch thickness of Asphalt Concrete Surface Course pavement shall be constructed at the same time that the adjacent street is paved. Patching asphalt approaches is prohibited.

Brick or flagstone shall be placed in accordance with Item 20B of these specifications.

TEMPORARY BITUMINOUS OR ASPHALT CONCRETE TRENCH TOPPING (Sec. 20.09)
The Contractor shall, under Item 20E furnish, place and maintain a temporary trench topping of cold mix or hot mix bituminous materials, conforming to NCDOT Specifications, wherever ordered by the Engineer. It is intended that this temporary topping will be used only in heavily traveled paved streets.

Wherever ordered, the Contractor shall roll or tamp in place a two (2) inch minimum course of mix over trenches, which had previously been given a topping under Item 22. The gravel or stone topping shall, under Item 20E, be removed for a depth of two (2) inches prior to the placing of temporary bituminous or asphalt concrete material. The temporary paving shall be flush with the adjacent paving and shall be maintained as directed until replaced with the permanent pavement.

CURBS AND GUTTERS (Sec. 20.10) The Contractor shall furnish Under Item 20F all curb and gutter constructed in accordance with the typical sections and as specified below.

Forms and Joints: Forms for curb shall be approved metal forms. Forms for combined curb and gutter shall be of the following material: flexible steel or an approved grade of plywood not less

than 1/4 inch nominal thickness for curves with radii of 25 feet or less; an approved grade of wood not less than one inch nominal thickness for curves with radii of 25 to 200 feet; rigid steel for a straight line and curves with radii greater than 200 feet. They shall be securely braced and held to line and grade specified. The inner surface of the forms shall be clean and coated with oil immediately before the concrete is placed.

All curb combination curb and gutter shall have a minimum of 1/8 inch contraction joints constructed at ten foot intervals. The joint may be constructed with the use of metal separator plates, by the use of a grooving tool, or sawed. The depth of joint shall average 2 inches or more for combination curb and gutter, and for curb shall average 1/5 or more of the curb height. When the joints are made by the use of grooving tool or by sawing, a 1/2 inch expansion joint strip the depth of the curb and gutter shall be used at the beginning and end of curves which radius is less than 200 feet and at the end of each days' operation.

Curb forms shall be left in place for such length of time that the removal of same does not crack, shatter or otherwise injure the concrete.

Aggregate Base: After the curb and gutter forms have been placed in position, the subgrade shall be cleaned of materials displaced by such operation and the aggregate base formed in conformity to the cross section shown on the plans. Furnish compacted ABC as specified and shown on the details.

Placing: The concrete shall be placed in the forms, prepared as above described, in layers thin enough to permit thorough spading. It shall be spaded in such a manner as to eliminate all voids.

Curb Machine: Concrete curb or curb and gutter may be placed with a self-propelled machine. The proper density and cross section shall be obtained by forcing the concrete through a mold of the proper cross section. Where a track is used the track on which the machine operates shall be set and held to the exact line and grade. The concrete shall be of such consistency that it can be molded into the desired shape and then will remain as placed without slumping of the vertical faces.

Finishing: The top of the curb shall be floated in such a manner to thoroughly compact the concrete and produce a smooth and even surface. The addition of extra mortar to secure this result will not be permitted. Under no circumstances shall water be added to the concrete surface, nor will retampering of mortar or a grout paint coat be permitted in finishing. The edge of the curb shall be rounded by the use of a tool especially designed for the purpose. The exposed face of the curb shall be rubbed with a float immediately after removing the forms. Unnecessary tool marks shall be eliminated. The finished surface shall be free of irregularities and wavers and shall be uniform in texture.

When scoring of curb face is required all rounded edges shall be given a smooth finish with edging tools of the required shape.

Vibrating screen equipment may not be operated on existing curb or lane until the concrete has been in place for at least 72 hours.

SIDEWALKS (Sec. 20.11) The Contractor shall furnish Under Item 20G all concrete sidewalks constructed in accordance with the typical sections and as specified below.

Subbase material under sidewalk shall consist of compacted ABC as specified and shown on the details. Contractor shall set forms to line and grade and install forms over full length of sidewalk. Locate, place, and support reinforcement if necessary. Size of reinforcement shall be as shown on the Drawings. Place concrete in one course, monolithic construction, for the full width and depth of walks. Concrete thickness of all curb ramps shall taper to six (6) inches at the edge of the pavement.

Contraction, Construction, and Expansion Joints: Construct expansion, contraction, and construction joints with faces perpendicular to surface of sidewalk. Construct transverse joints at right angles to the Work centerline and as shown. Provide contraction joints as shown on the Contract Drawings and in general 4 feet spacing. Place contraction joints at locations where placement operations are stopped for a period of more than 1/2-hour, except where such pours terminate at expansion joints. Provide 1/4-inch expansion joint filler where Work abuts structures; at returns; and as indicated on the Contract Drawings and directed by the Engineer. Apply joint sealant on top of expansion joint material flush with concrete surface, and in accordance with manufacturer's instructions.

Contractor shall smooth the exposed surface by screeding and floating. Work edges of sidewalks and round to 1/8-inch radius. Complete surface finishing by drawing a fine-hair broom across surface, perpendicular to line of traffic. Protect and cure finished concrete sidewalks, complying with applicable requirements of Item 5.

ASPHALT PAVEMENT REPLACEMENT W/FULL WIDTH OVERLAY (Sec. 20.12) Under Item 20H, the Contractor shall furnish all materials and labor to construct an asphalt base four (4) inches thick in two (2), two (2) inch Asphalt Binder Grade PG 64-22 layers.

The entire existing pavement width shall be ground down 1 1/2" and according to NCDOT Item 607 Milling Asphalt Pavement, for the full width overlay in order to maintain existing roadway elevations. After preparation of the subgrade, the faces of existing work such as curbs, castings, manholes, existing pavements, and all base courses, shall be painted, primed or sealed with bituminous material in accordance with Section 605 of the NCDOT Specifications.

The Contractor shall furnish all materials and labor to install a one and one-half (1 1/2) inch thick layer of Asphalt Concrete Surface Course, Type SF 9.5A in accordance with NCDOT Specifications, Item 640. The layer of asphalt concrete shall be installed the full width of the existing pavement or as specified.

Materials for use in shoulders shall meet the requirements of NCDOT Item 560, Shoulder Construction and shall be included in the unit price bid for Item 20H.

ASPHALT CONCRETE FULL WIDTH OVERLAY (Sec. 20.13) Under Item 20I, the Contractor shall furnish all materials, labor, and equipment to grind and asphalt-pave the full width of existing

roadways where shown on the drawings and while maintaining existing roadway elevations. This specification (Item 20I) and its associated detail applies to areas outside of trench restoration.

The entire existing pavement width shall be ground down 1½” and according to NCDOT Item 607 Milling Asphalt Pavement, for the full width overlay in order to maintain existing roadway elevations. After preparation of the subgrade, the faces of existing work such as curbs, castings, manholes, existing pavement, and all base courses, shall be painted, primed or sealed with bituminous material in accordance with Section 605 of the NCDOT Specifications.

The Contractor shall furnish all materials and labor to install a one and one-half (1½) inch thick layer Asphalt Concrete Surface Course, Type SF 9.5A in accordance with NCDOT Specifications, Item 640. The layer of asphalt concrete shall be installed the full width of the existing pavement or as specified.

Materials for use in shoulders shall meet the requirements of NCDOT Item 560, Shoulder Construction and shall be included in the unit price bid for Item 20I.

ROLLED ASPHALT CURB (Sec. 20.14) Rolled asphalt curbs under Item 20J shall be of the shape, dimensions, and specifications shown on the drawings.

GREENWAY PAVEMENT REPLACEMENT (Sec. 20.15) Under Item 20X, the Contractor shall furnish all materials and labor to replace the asphalt greenway as detailed.

STRIPING (Sec. 20.16) Wherever pavement replaces that which was striped, the Contractor shall repair the stripes with suitable paint of matching color. The cost of this striping shall be included with that of the Item of which it is a part.

DISTURBED MAILBOXES (Sec. 20.17) If mailboxes are disturbed during construction they shall be replaced at a location conforming to the United States Postal Service specifications and recommendations regardless of the original configuration. Generally, mailboxes should be installed at a height of 41 to 45 inches from the road surface to the bottom of the mailbox or point of mail entry. Mailboxes shall be set back 6 to 8 inches from the front face of the curb or road edge to the mailbox door.

MEASUREMENT (Sec. 20.18) The number of square yards of pavement or driveway to be measured for payment under Items 20A, 20B, 20C, 20 D and 20E shall be the actual number of square yards of new or replaced pavements or driveways placed in the location shown, or as directed, except that the width for payment shall not exceed the payment limits as shown on the drawings for the size and type of pipe laid. Measurement for payment will not be made as called for in the NCDOT Specifications.

The number of linear feet of full width pavement to be measured for payment under Item 20H shall be the actual length of new full width pavement overlay installed in accordance with these Specifications. Measurement for Item 20H payment will not be made as called for in the NCDOT Specifications.

The number of square yards of full width pavement to be measured for payment under Item 20I shall be the actual number of square yards of pavement placed in the location shown, or as directed by the Engineer.

The number of linear feet of curb and gutter to be measured for payment under Item 20F shall be the actual length of new or replaced curb and gutter installed in accordance with these Specifications, except that no curb and gutter replaced beyond the pavement replacement limits shown on the drawings will be measured for payment.

The number of linear feet of rolled asphalt curb to be measured for payment under Item 20J shall be the actual length of new or replaced curb installed in accordance with these Specifications, except that no curb replaced beyond the pavement replacement limits shown on the drawings will be measured for payment.

The number of square feet of sidewalk to be measured for payment under Item 20G shall be the actual area of new or replaced sidewalk laid in accordance with these specifications, except that no sidewalk beyond the pavement replacement limits, as shown on the drawings for the size and type of pipe installed, will be measured for payment.

PAYMENT (Sec. 21.20) The unit price per square yard stipulated in the proposal for each type of pavement replacement under Items 20A, 20B, 20C, 20D, 20E and 20I, and the unit price per linear foot stipulated in the proposal for pavement replacement under Item 20H shall include excavation, the preparation of the subgrade courses, the pavement and the required curing, milling, sealing, grading and rolling, and the furnishing of all labor, materials, tools and appliances necessary to complete the work as specified, shown or directed.

The unit price stipulated per linear foot for curb and gutter under Item 20F shall include all excavation, preparation of the subgrade, concrete, formwork, finishing and curing, and the furnishing of all labor, materials, tools and appliances necessary to complete the work as specified, shown or directed.

The unit price stipulated per linear foot for rolled asphalt curb under Item 20J shall include the furnishing of all labor, materials, and equipment necessary to complete the work as specified, shown or directed.

The unit price per square foot stipulated for concrete sidewalks under Item 20G shall include all excavation, preparation of the subgrade, concrete, formwork, asphalt plank, finishing and curing, and the furnishing of all labor, materials, tools and appliances necessary to complete the work as specified, shown or directed.

All payments will be made as specified in this Section and not as provided for in the NCDOT Specifications.

REMOVAL OF TREES AND/OR STUMPS

ITEM 21

WORK INCLUDED (Sec. 21.01) The Contractor shall, under Item 21, remove trees and/or stumps wherever shown on the drawings or ordered by the Resident Engineer.

DESCRIPTION (Sec. 21.02) The removal of small and incidental trees and stumps where required is included in the item for excavation; this includes trees and stumps less than eight (8) inches in diameter; trees and stumps eight (8) inches and over in diameter shall be removed under Item 21.

Trees and stumps shall be removed from the site in their entirety. All debris must be disposed of off the site of the work.

Blasting of stumps will not be permitted except with special permission of the City and the Resident Engineer, and then only under such regulations as they may prescribe.

Any hole that is left open shall be completely filled as called for under Backfilling in Item 1, or as may be directed by the Resident Engineer. If granular backfill is ordered to be installed, it shall meet the requirements of Item 7 and will be paid for under Item 7.

PAYMENT (Sec. 21.03) The price for this item shall be included in prices for sewers under Items 10, 11, 12 or 13, as applicable and shall include all material, labor, tools and appliances required to accomplish this work.

TRENCH TOPPING

ITEM 22

WORK INCLUDED (Sec. 22.01) The Contractor shall, under Item 22, furnish, properly place and maintain trench topping where ordered by the City as a temporary pavement.

MATERIAL (Sec. 22.02) The crushed stone to be used as trench topping shall be crushed run material having a maximum size of two (2) inches. It is intended that trench topping under this item shall be used only where ordered by the Engineer when required by traffic conditions.

CONSTRUCTION (Sec. 22.03) The Contractor shall furnish and place the material for the trench topping over the full width of the excavated space; it shall consist of eight (8) inches of crushed stone conforming to the above specifications. The crushed stone shall be rolled or tamped so that the finished surface of the trench topping will conform to the adjacent surfaces. When required, the finished surface of the trench topping shall be immediately dust-proofed by such treatment as approved by the Engineer, and this treatment shall be repeated at subsequent periods as may be ordered by the Engineer. Any settlement or irregularities which occur in the trench topping after completion of the work specified above shall be promptly refilled with stone and maintained until permanently resurfaced.

MEASUREMENT (Sec. 22.04) Unless specifically ordered otherwise by the Engineer the number of tons of trench topping to be paid for shall be the number of tons (2,000 pounds) actually used in accordance with these specifications, within the pay limits for pavement, as shown on the drawings. Whenever trench topping is required within the pay limits for paving, the entire width of disturbed pavement shall be filled with trench topping for a depth of eight (8) inches; all such trench topping outside the pay limits for paving shall be furnished and placed by the Contractor at no expense to the City. Whenever all the trench topping delivered is placed within the pay limits as defined above, certified weight slips shall be delivered to the Engineer at the end of each day. Whenever part of the delivered trench topping is placed outside the pay limits as defined above, the actual volume of trench topping placed within the specified pay limits of a cubic yard of dry material shall be measured by ascertaining the volume and weight in a truck body; if that, or some similar method cannot be used, then a cubic yard of crushed stone shall be assumed to weigh 2,700 pounds.

PAYMENT (Sec. 22.05) The price stipulated per ton for trench topping under Item 22 shall include furnishing, placing, rolling, and maintaining the trench topping, and the furnishing of all labor, materials, tools and appliances necessary to complete the work as specified where ordered by the City.

DUST CONTROL - CALCIUM CHLORIDE

ITEM 23

SCOPE (Sec. 23.01) The Contractor shall, under Item 23, furnish and apply calcium chloride to the surface of the trenches or trench topping, as directed by the Engineer, for the alleviation or prevention of dust nuisance.

MATERIAL (Sec. 23.02) The calcium chloride shall meet the requirements of ASTM Standard Specifications for Calcium Chloride, Designation D98-05, or its latest revision.

APPLICATION (Sec. 23.03) Calcium chloride shall be applied when ordered at the rate of one (1) pound per square yard with an approved type spreader on the larger trenches. Hand spreading may be used when the width of cut pavement is less than the width of the spreader, or the trench is short.

MEASUREMENT (Sec. 23.04) Unless specifically ordered otherwise by the Engineer, the number of tons of 2,000 pounds of calcium chloride to be paid for under Item 23 shall be the amount actually used in accordance with these Specifications within the pay limits for pavement as shown on the Drawings. Calcium chloride used outside such pay limits shall be furnished and placed by the Contractor at no expense to the City.

PAYMENT (Sec. 23.05) The unit price per ton stipulated in the proposal under Item 23 for calcium chloride shall include the furnishing of all materials, labor, tools and appliances necessary to place the calcium chloride as ordered by the Engineer and as specified.

TOPSOIL AND SEEDING

ITEM 24

WORK INCLUDED (Sec. 24.01) The Contractor shall, under Item 24, furnish all labor required to prepare the ground surface; place all topsoil over the areas shown on the drawings, or where ordered by the Engineer, or wherever required for the proper completion of this Contract, in those areas where exposed earth surface is to be reseeded; and furnish and apply fertilizer, seed and mulch as specified for the proper completion of the work included under this Contract.

Topsoil material shall consist of loose, friable, loamy topsoil without admixture of subsoil or refuse. For topsoil to be considered loamy, that fraction passing a number 10 sieve shall contain not more than 30 percent clay. Acceptable topsoil shall contain not less than 5 percent nor more than 20 percent organic matter as determined by loss on ignition of samples oven dried to constant weight at 212 degrees Fahrenheit. Furnish topsoil that is free of manmade materials, grass, brush, roots and rocks/clay pieces bigger than three-fourths ($\frac{3}{4}$) inch in diameter.

In general, the areas to be seeded shall consist of the area as outlined on the drawings or where ordered by the Engineer. At the completion of the work, the Contractor shall be responsible for a good crop of grass upon the areas seeded.

PLACING TOPSOIL (Sec. 24.02) The topsoil shall be, unless indicated otherwise on the drawings or in the proposal, a minimum of four (4) inches in thickness after compaction in residential areas and to whatever thickness exists in other areas, accurately graded to the required lines and grades, and rolled with a light roller to secure smoothness. Any sliding, settling, or washing out which may occur before the completion of the Contract shall be repaired in a satisfactory manner.

SURFACE PREPARATION AND FERTILIZATION (Sec. 24.03) In residential or commercial areas, and as directed by the Engineer in unimproved areas, the exposed earth surface shall be seeded. The topsoil shall be worked to a finely divided planting surface by hand raking or by the use of a harrow. All rubbish, twigs, pieces of bark and all stones three-fourths ($\frac{3}{4}$) inch in diameter or over, shall be removed. A grass fertilizer such as 12-12-12 as approved by the Engineer shall be applied at the rate of twenty (20) pounds per one thousand (1,000) square feet (870 pounds per acre).

Fertilizer shall be raked into the soil to a depth of about one (1) inch.

SEEDING (Sec. 24.04) Seed shall be sown immediately after the preparation of the surface. The kind of seed to be used depends upon the type of work to be done, the location, weather and other conditions. All seed shall be inoculated against disease. Seeding shall be done at the rate of five (5) pounds per one thousand (1,000) square foot.

In the residential, commercial areas, the following seed mix shall be used. Rates shown are per one thousand (1,000) square feet.

In early Spring and late Summer

2-1/2 pounds of Kentucky Bluegrass (108 pounds/acre)
2-1/2 pounds of fine leaved fescue (108 pounds/acre)

In mid Summer and late Fall

2-1/2 pounds of Kentucky Bluegrass (108 pounds/acre)
1-1/4 pounds of fine leaved fescue (54 pounds/acre)
1-1/4 pounds of annual ryegrass (54 pounds/acre)

For unimproved areas

4-1/2 pounds perennial ryegrass (194 pounds/acre)
1/2 pounds alsike clover (22 pounds/acre)

Under all conditions after the seed is sown, it shall be raked to a depth of one-fourth (1/4) inch and rolled with an approved roller weighing not over sixty-five (65) pounds per foot of width for sandy soils, except that when intervening precipitation causes such rolling to be unnecessary or detrimental to seeded areas, such rolling may be omitted when permission to do so has been obtained from the Engineer.

MULCHING (Sec. 24.05) Immediately after seeding and rolling, clean new wheat or oats straw or other approved mulching material shall be placed at the rate of one hundred (100) pounds per one thousand (1000) square feet, or such other rate as may be approved. Mulching material must be free of weed seeds. Straw shall be wetted down to prevent blowing away by wind. On slopes and ditches, straw shall be tied down with pinned jute matting. Mulch shall not be removed until a good strand of grass has been well started. When removed, all straw or other mulch must be disposed of off the site of the work.

The Contractor may, at his option, apply an approved emulsion, such as SS-I, (applied at a rate of 120 gallons per acre), instead of wetting the mulch.

WATERING (Sec. 24.06) Thoroughly water all permanent seeded areas after the seed has germinated. Apply a total rate of 300 gallons per 1,000 square feet in at least two (2) applications spread over seven (7) days. Apply the water using a hydro-seeder or a water tank under pressure with a nozzle that produces a spray that will not dislodge the mulch material.

Perform a secondary water application between seven (7) and ten (10) days after the primary applications. If 1/2-inch or greater of rainfall has occurred within the first 7-day period, the

Contractor may delay or omit the secondary application, with the approval of the Engineer, depending on weather conditions.

MAINTENANCE (Sec. 24.07) The Contractor shall maintain the seeded areas until one (1) month after the final payment; included shall be watering and cutting as necessary. Watering and cutting following the period of the Contractor's responsibility shall be the City's responsibility.

If at any time before the expiration of the Contract Bond (usually one (1) year after final payment is made) any part of the seeded area is not in good condition, the Contractor shall fertilize such area and shall reseed it as often as may be necessary to get a good stand of grass.

PAYMENT (Sec. 24.08) The area to be paid for under this item shall include all areas within or adjacent to the project site that have been cleared, filled, backfilled, or disturbed during the process of construction.

The lump sum price stipulated in the proposal for topsoil and seeding under Item 24 shall include all materials, labor, tools and equipment to complete the work as called for on the drawings and as specified herein, including the furnishing of the seed and other required materials, preparation of the surfaces, fertilizing, the seeding, rolling, mulching, watering and cutting of the grass, the maintenance of the surfaces in good condition, and the fertilizing and reseeding of areas where the first seeding and subsequent seedings are not successful.

EROSION AND SEDIMENT CONTROL

ITEM 41

SCOPE (Sec. 41.01) All labor, materials, fixtures, equipment, tools and services required for the installation and maintenance of erosion and sediment control measures shall be furnished and installed in compliance with the following specifications and as specified on the project plans and the Erosion Sediment Control Plan (ESC).

All properties adjacent to the site of soil-disturbing activity shall be protected to the maximum extent practicable, from soil erosion and sediment runoff and drainage, including, but not limited to private properties, natural and artificial waterways, wetlands, storm sewers, sanitary sewers and public lands. Off-site dumping, erosion and sediment control measures shall be the responsibility of the contractor.

MATERIALS (Sec. 41.02) Materials shall be as specified in the Erosion and Sediment Control Details contained in these specifications. Materials supplied shall consist of but not be limited to; stone sized as required, geotextile cloth, wire mesh, culvert pipe, jute matting, sod staples, lime, fertilizer, grass seed, riprap, concrete, concrete headwall, fill, backfill, compacted fill, perforated riser piping, trash rack, fence posts, geotextile fabric, straw and straw bales, dewatering pipe and lumber.

REQUIREMENTS (Sec. 41.03) Erosion and sediment control measures shall be installed as specified in the Erosion and Sediment Control Details contained in these specifications.

Construction site erosion and sediment control practices used to satisfy this requirement shall conform, as a minimum, to State of North Carolina Standards

An approved Storm Water Pollution Prevention Plan (SWPPP) or approval letter from the State of North Carolina shall be located on the site for review. The Engineer will supply the information to the Contractor.

CONSTRUCTION (Sec. 41.04)

1. Install erosion and sediment perimeter controls as a first action of construction as specified by the construction sequence. Regular inspection and maintenance of all erosion and control measures shall be the responsibility of the contractor. This shall include and is not limited to protective BMP's (Best Management Practices) for stream corridors and crossings, wetlands, site entrance, sediment traps and basins, barriers, and diversion dikes.
2. Concentrated storm water runoff shall pass through a sediment control device before exiting the site boundaries. Concentrated runoff from bare soil areas shall be diverted into a settling pond or sediment control structure, or other approved sediment barrier before leaving the site.

3. Earthen structures such as dams, basins, stream modifications and water diversions shall be seeded and mulched within seven (7) days of the completion of installation. Dams shall conform to the State of North Carolina Dam Laws.
4. Stabilization of critical areas within 50 feet of any stream or wetland shall be temporarily stabilized within two (2) days of disturbance if area will remain inactive for fourteen (14) days or longer. Construction vehicles shall avoid streams and the 50 foot buffer areas. If an active drainage way must be crossed by construction vehicles repeatedly during construction, a temporary stream crossing shall be constructed according to the specifications. Construction of bridges, culverts or sediment control structures shall not place soil, debris and other fine particulate material into or close to the water resource in such a manner that it may slough, slip or erode.
5. Storm sewer inlets (and sanitary) shall be protected so that sediment-laden runoff will not enter the storm sewer system without first being filtered and/or treated. Silt fences are to be constructed in front of all headwalls and pipe inlets.
6. Re-Vegetation of Soil Requirements: Temporary soil stabilization shall occur within seven (7) days after rough grading if the area will remain idle longer than thirty (30) days. Permanent soil stabilization shall be installed within seven (7) days after final grade is reached on any portion of the site. Permanent vegetation is a groundcover dense enough to cover 80% of the soil surface and mature enough to survive winter weather conditions.
7. Soil stockpiles shall be stabilized or protected to prevent soil loss. Stabilization shall be required if stockpiles are located within critical areas near streams or wetlands, or if determined by the Engineer that sediment from stockpiles will leave the site.
8. Unstable soils prone to slipping or sloughing shall not be cleared, graded, excavated, filled or have loads imposed upon them unless the work is planned by a qualified professional engineer and installed in accordance with the ESC Plan. Cut and fill slopes should be designed to minimize erosion problems.

Adequate slope design includes use of rough soil surface along the face of the slope; water diversion along the top of the slope away from the face; terraces to reduce slope length; delivery of concentrated storm water flows to the base of the slope via adequate channel or pipe; and drainage for water seeps in the slope that endanger slope stability.
9. Soil shall be removed from paved surfaces and/or public roads at the end of each day in such a manner that does not create off-site sedimentation in order to ensure safety and abate off-site soil loss. Collected sediments shall be placed in a stable location on site or taken off-site to a stable location.

10. Stabilize disturbed or modified drainage ways. Reduce erosion effects of storm water by using and/or maintaining grassed swales, infiltration structures, or water diversions.
11. Sediment and erosion controls shall be inspected once every seven (7) days and within 24 hours of a 0.5 inch or greater rainfall event. A written log of these inspections and improvements to controls shall be kept on site. The inspections shall include the date of inspection, name of inspector, weather conditions, actions taken to correct any problems and the date corrective actions were taken.
12. Trenches for underground utility lines and pipes shall be temporally stabilized within seven (7) days if they are to remain inactive for thirty (30) days. Trench dewatering devices shall discharge in a manner that filters soil-laden water before discharging it to a receiving drainage ditch or pond. If seeding, mulching, or other erosion and sediment control measures were previously installed; these protective measures shall be reinstalled.

CONSTRUCTION SEQUENCE (Sec. 41.05)

- A. Pre-construction Meeting
- B. Initial clearing and grubbing to gain access, and installation of perimeter controls within seven (7) days of clearing and grubbing.
- C. Cleaning and grubbing followed by excavation of sediment traps and basins; temporary soil stabilization for these sediment settling devices within fourteen (14) days of excavation.
- D. Maintenance inspection schedule established and party responsible for inspection and repair of erosion and sediment control devices named.
- E. Pre-winter stabilization meeting if project is to run through winter.
- F. Final grading and permanent soil stabilization within 30 days of finishing final grade.
- G. Removal of temporary erosion and sediment control devices.
- H. Final stabilization meeting with provisions for long-term maintenance of storm water facilities including mechanisms for notification of future responsible parties and/or property owners.

MEASUREMENT AND PAYMENT (Sec 41.06) The number of linear feet of silt fence to be measured for payment under Item 41 shall be the actual length of silt fence installed in accordance with these specifications and details. The unit price per linear foot stipulated in the proposal for silt fence under Item 41 shall include the furnishing of all

labor, materials, tools and appurtenances necessary to complete the work as specified, shown or directed.

The number of inlets protected to be paid for under Item 41, shall be the number of inlets actually protected in the completed work under this Contract. The unit price for each inlet protected stipulated in the proposal for inlet protection under Item 41 shall include the furnishing of all labor, materials, tools and appurtenances necessary to complete the work as specified, shown or directed.

The price for all other erosion and sediment control work as called for in this specification or on the drawings shall be included in prices for other items and shall include all material, labor, tools and appliances to accomplish this work. No separate payment for this other work will be made.

SEWER AND MANHOLE ABANDONMENT

ITEM 46

WORK INCLUDED (Sec. 46.01) This item shall include all labor, materials, and equipment required for the abandonment of existing sewers and manholes noted as such on the plans.

Sewers that are to be abandoned shall be plugged or sealed where they join manholes. All existing sewers encountered in construction operations that are inactive or are to be abandoned as determined by the Engineer, shall be plugged or sealed, at both ends where broken into, before proceeding with backfilling.

Where plugged or sealing is required, pipe ten (10) inches or less in diameter shall be sealed by the installation of a suitable precast concrete or vitrified clay stopper properly cemented into place. Pipe larger than ten (10) inches in diameter shall be sealed at the required locations by the construction of masonry bulkheads of brick or concrete having a thickness of one-half of the sewer diameter, except that the minimum thickness shall be one (1) foot and the maximum thickness shall be two (2) feet.

All sewers ten (10) inches or less in diameter to be abandoned shall be sealed. All sewers larger than ten (10) inches in diameter shall be sealed or filled and sealed as indicated in the Contract Drawings. Where filling is required, the Contractor shall have the option of filling by the method of mud jacking or hydraulically. If the mud jack method is used, the material shall be clay which is suitable for this method of work. If the hydraulic method is used, the material shall consist of sand or gravel or material similar to strippings from a gravel pit. Regardless of the method adopted by the Contractor, the material used shall be acceptable to the Engineer. The fill material placed in the sewers shall occupy, after solidification, at least seventy-five percent (75%) of the cross-sectional area of the sewer for the entire length.

In order to meet these specifications, the Contractor may, if approved by the Engineers, dig pit holes to carry out the filling of the sewers. No separate payment will be made.

Manholes designated to be abandoned shall be removed to a minimum of two (2) feet below the finished surface. Castings shall be carefully removed and delivered to the City as directed by the Engineer. After sealing the existing pipes as described above and removing the walls to the required depth, backfill the remaining cavities according to Item 1 outside of pavement and Item 7 beneath pavement. Pavement restoration shall be performed as designated by the Engineer and shall be included in the unit price bid for the various sewer items.

PAYMENT (Sec. 46.02) No separate payment shall be made for work specified in this item. All materials, labor, tools and equipment to complete the work as called for on the drawings and as specified herein shall be included in the unit price bid for the various sewer items.