Sewer Assessment and Rehabilitation Program

SPECIFICATIONS

Bellevue EQ Conveyance Design

PROJECT NUMBER:
406905.61.0119

City of Memphis

VOLUME 1 OF 1

February 2025

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LDA ENGINEERING

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LDA ENGINEERING

LDA SPECIFICATIONS

SECTION 140002 Fiberglass Gravity Jacking Pipe (FRPM)

LDA ENGINEERING

Professional Engineer's Certification

This is to certify that the following sections of the Specifications for the Bellevue EQ Storage Basin project dated February 2025 were prepared under my direction and supervision.

Civil

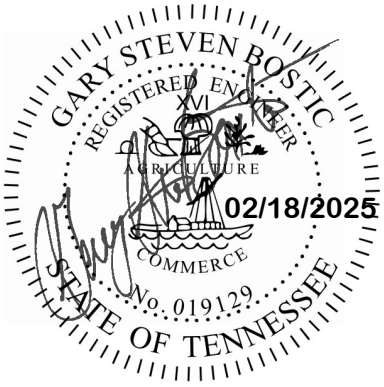
Sections 01551, 01610, 02230, 02370, 02530, 02531, 02534, 2541, 02543, 02544, 02630, 02631, 02820, 02920, 02921, 02950,01050, 01150, 01340, 01710, 02100, 02221,02540, 03300,

Steve Bostic

NAME
Tennessee Registration No. 19129

02/18/2025

DATE



Additional Specifications

140002

BRAD DAVIS

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Tennessee Registration No. 107008

02/19/2025

DATE

MEMPHIS SEWER ASSESSMENT & REHABILITATION PROGRAM
SARP 10

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SECTION 01551
TRAFFIC CONTROL FOR CONSTRUCTION WORK ZONES

PART 1 - SCOPE

This work shall consist of furnishing, erecting, illuminating, handling, and maintaining all construction signs (warning, regulatory, and guide), barricades, and other traffic control devices designated for installation at locations specified by the Plans or the approved Traffic Control Plan, or directed or approved by the Purchaser for the purpose of handling traffic safely through construction work zones. This work shall include the provision of flaggers or special measures necessary to assure the handling of traffic safety through construction work zones.

PART 2 - MATERIALS

2.01 GENERAL REQUIREMENTS

A. All signs, barricades, markers, lights, and other traffic control devices for use in construction work zones shall meet the requirements of Part VI of the Tennessee Manual on Uniform Traffic Control Devices (MUTCD). Materials used in the fabrication, construction, and installation of the construction signs, barricades, and other traffic control devices shall conform to the requirements of the MUTCD, and the City of Memphis Standard Construction Specifications.

B. Items are not required to be new. Used items may be acceptable provided the following conditions are met:

1. Units are in good repair, clean, and structurally sound.

2. Reflective sheeting on any unit is clean and in good repair.

3. All legends and messages are sharp, clean, and legible.

4. Reflectivity of said units during the hours of darkness shall provide acceptable, clean and uniform delineation without dead spots.

C. No test reports are required, but the Purchaser will visually inspect all units and accessories for compliance with the various dimensional and material stipulations noted before approving their use in the work. The approval of any unit for use is subject to satisfactory field performance and does not preclude the Purchaser ordering replacements for deteriorated, damaged or otherwise unsatisfactory performance of units; said replacements for these previously approved units shall be without additional compensation.

2.02 SUBMITTALS

1. A Traffic Control Plan shall be submitted to the Program Manager, including the following items:

- Outline of permit acquisition procedure for lane closures.

- Methods for proper signing and barricades, which comply with local requirements and the City.

- Major streets (e.g. Shelby County Principal Arterial & Minor Arterial) requiring a City

approved permit if taking a lane for mobile operations, secured through Traffic Control Plan submittal to the City and signed by a TN P.E. The City requires a two-week lead time for permit processing.

- The Contractor will be required to deliver a sample primary/arterial road Traffic Control Plan for review by the City and Bellevue Baptist Church.
- If the City determines that the nature of the work operation or the type of road in which the Contractor is working requires a permit, the Contractor will be required to modify the sample Traffic Control Plan to obtain a permit from the City.
- For everywhere else where a permit is not required, the Contractor shall develop, provide, and implement a Traffic Control Plan for all mobile operations in accordance with standard MUTCD specifications.
- The Contractor is also responsible for acquiring all necessary disposal and/or landfill site permits required to perform this work.
- Railroad Rights of Way: The Contractor shall notify the Program Manager when work or access to manholes and sanitary sewers lie within the 25 feet railroad easement, as measured by 25 feet outside the nearest rail of the tracks. To access sewer facilities within the 25 feet of the railroad right of way, the Contractor shall contact 48 hours in advance the Program Manager, who will alert the City's Zone Construction Inspector to coordinate individual railroad direction and guidance.

2.03 CHANNELIZING AND WARNING DEVICES

Reflectorization of channelizing and warning devices shall be accomplished using materials meeting the requirements of the City of Memphis Standard Construction Specifications.

A. Traffic Cones.

Traffic cones and tubular markers shall be a minimum of 18 inches in height with a broadened base and shall be made of materials to withstand impact without damage to themselves or to vehicles. Orange shall be the predominant color on cones and tubular markers. For nighttime use they shall be reflectorized or equipped with lighting devices for maximum visibility. The design of traffic cones and tubular markers shall be according to the requirements of Section 6C of the MUTCD.

B. Vertical Panels.

Vertical panels used as channelizing or warning devices shall be 8 to 12 inches in width and a minimum of 24 inches in height. They shall be orange and white striped and reflectorized. The design or vertical panels shall be according to Section 6C of the MUTCD.

C. Drums.

Drums used for traffic warning or channelization shall be approximately 36 inches in height and a minimum of 18 inches in diameter. The markings shall be horizontal, circumferential, orange and white reflectorized stripes meeting the requirements of Section 6C of the MUTCD.

D. Barricades.

A barricade is a portable or fixed device having from one to three rails with alternate orange and white reflectorized stripes used to control traffic by closing, restricting, or delineating all or a portion of the right-of-way. Barricades shall be of one of three types: Type I, Type II, and Type III. The characteristics and design of each type of barricade shall be according to Section 6C of the MUTCD.

E. High Level Warning Devices.

High level warning devices are used to supplement other controls and warning devices and are designed to be seen over the top of preceding vehicles. They shall consist of an orange diamond and three flags. The lowest point of all three flags shall be no less than 8 feet above the roadway. The design shall be according to the requirements of Section 6C of the MUTCD.

F. Warning Lights.

As used herein, warning lights are portable, lens directed, enclosed lights. The color of the light emitted shall be yellow. They may be used either in a steady burn or flashing mode. Warning lights shall be in accordance with the current requirements of ITE Standard for Flashing and Steady Burn Warning Lights (Table 01551-1) and Section 6E of the MUTCD.

TABLE 01551-1

WARNING LIGHTS

	Type A Low Intensity	Type B High Intensity	Type C Steady Burn
Lens Directional Faces	1 or 2	1	1 or 2
Flashing Rate per Minute	55 to 75	55 to 75	Constant
Flash Duration[1]	10%	8%	Constant
Minimum Effective Intensity[2]	4 Candelas	35 Candelas	
Minimum Beam Candle Power[2]			2 Candelas
Hours of Operation	Dusk to Dawn	24 hrs/day	Dusk to Dawn

[1] Length of time that instantaneous intensity is equal to or greater than effective intensity.
[2] These values must be maintained within a solid angle 9^0 on each side of the vertical axis and 5^0 above and 5^0 below the horizontal axis.

PART 3 - CONSTRUCTION REQUIREMENTS

3.01 GENERAL REQUIREMENTS.

A. A Traffic Control Plan shall be developed by the Subcontractor and approved by the Purchaser before any road, street, or highway, or any section or lane thereof is closed to traffic and construction operations that will for any reason render the roadway generally unsuitable for use of the traveling public are started. Where the Plans and Contract Documents for projects involving roads, streets, and highways do not specify a Traffic Control Plan, and where so required by the Contract Documents, the Subcontractor shall prepare and submit to the Purchaser for approval a Traffic Control Plan for the project which shall include, but not be limited to, signing; application and removal of pavement markings; construction; scheduling; closure of streets or lanes; detours; methods and devices for delineation and channelization; placement and maintenance of devices for delineation and channelization; roadway lighting; traffic regulations; and surveillance and inspection. The Traffic Control Plan shall define in detail the sequence of construction and the proposed number, type, color, size, and placement

of construction traffic control devices for each construction phase, all in accordance with Part VI of the Tennessee Manual on uniform Traffic Control Devices for Streets and Highways (MUTCD).

B. The Subcontractor shall designate or otherwise provide personnel to furnish continuous surveillance over his traffic control operations. This designee will also be available at night to respond to calls involving damage to barricades, lights, signs, and similar items, either through vandalism or traffic accident. The Subcontractor shall make known the name of the person providing the surveillance at the preconstruction conference.

C. All traffic control devices necessary for the first stage of construction shall be properly placed and in operation before any construction is allowed to start. When work of a progressive nature is involved, such as resurfacing a road under traffic, the necessary signs shall be moved concurrently with advancing operation.

D. All construction signs shall be erected such that all supports are vertical, sign panels generally perpendicular to the travelway and legends horizontal so that they effectively convey the intended message. These signs shall be mounted on stationary or temporary supports as directed by the Purchaser and dependent on the type work being performed. In general, work being performed at spot locations and of short duration will necessitate the use of temporary supports properly weighted for stability. If the construction signs are not to be lighted, the supports shall not extend above the top edge of the sign panel.

E. The location, horizontal and vertical placement with respect to the pavement, legends, sheeting, dimensions, and spacing of supports of warning signs, barricades, and other traffic control devices shall be as required by the Plans, the Traffic Control Plan, the MUTCD, and as directed or approved by the Purchaser. The Subcontractor must advise and have the approval of the Purchaser prior to installing or removing traffic control devices from the project.

F. During periods of nonuse, construction signs and other devices shall be removed from the work area, or covered with opaque material, or otherwise positioned so they do not convey their message to the traveling public. If covered, the covering material shall be installed in accordance with the Plans and in such manner that no damage will occur to the sign panel during installation. Covering material shall be maintained in a neat manner during its use.

G. All construction signs, barricades, and other devices which require lighting, as designated by Plans or directed by the Purchaser, shall be provided with warning lights or electric incandescent or fluorescent lighting. It will be the Subcontractor’s responsibility to install electric lighting in a safe manner and in accordance with the latest edition of the National Electrical Code, National Electrical Safety Code, and/or all local codes. The Subcontractor will be responsible for investigating, procuring, and bearing the expense of a continuous power source whether by battery, generator, or commercial A.C. supply.

H. Flaggers with proper attire and flags shall be provided when ordered by the City or Purchaser or when the Subcontractor deems flaggers necessary to safely handle traffic through the construction zone. Flaggers shall wear either an approved uniform or a vest of fluorescent orange color an be equipped with either a red flag of fluorescent material or a paddle with a reflective red and white STOP sign on one side and a reflective orange and black SLOW sign on the other side. Flaggers are considered a general requirement of all traffic control schemes and no direct payment will be made for such.

I. If at any time the City or Purchaser or Program Manager determines that proper provisions for safe traffic control are not being provided or maintained, he may order suspension of the work until the proper level is achieved. In cases of serious or willful disregard for safety of the public or his employees by the Subcontractor, the Purchaser may proceed forthwith to place the

traffic control measures in proper condition and deduct the cost thereof from payment due or becoming due the Subcontractor.

3.02 MAINTENANCE

A. The Subcontractor shall assume full responsibility for the continuous and expeditious maintenance of all construction warning signs, barricades, and other traffic control devices. Maintenance shall include but shall not be limited to replacement of sign panels, barricades, and other devices which in the opinion of the Purchaser or Program Manager are damaged or deteriorated beyond effective use; replacement of broken supports; plumbing of leaning signs; cleaning of dirty signs, barricades, and other devices; repair of defaced signs; and replacement of stolen items.

B. All items used for traffic control shall be generally maintained in its original placement condition and such maintenance will be considered a part of the original installation cost. Failure to maintain all traffic control devices in such manner as to provide adequate continuous safety to the public will be cause for action by the Purchaser as noted in Specification Section 01551 Paragraph 3.01.I.

PART 4 – MEASUREMENT

Each accepted item related to traffic control for construction work zones shall be measured as described herein. All work not described herein shall be considered incidental to the provision of traffic control for construction work zones.

4.01 TRAFFIC CONTROL PLAN.
Development of a Traffic Control Plan for the construction work zone will be paid for on a lump sum basis and no measurement will be made.

4.02 TRAFFIC CONTOL DEVICES FOR CONSTRUCTION WORK ZONES.
Furnishing, erecting, and maintaining traffic control devices and other incidentals and personnel required for handling traffic safely through construction work zones will be included in the lump sum payment for Traffic Control Plan and no measurement will be made.

PART 5 – PAYMENT

Payment for accepted work shall be made at the appropriate contract price which shall be payment in full for all work required under the pay item. Payment will be made under the pay items listed at the end of this Specification Section.

5.01 TRAFFIC CONTROL
Payment will be made for the work completed and accepted by the Purchaser at the contract lump sum price, which shall be full compensation for development of a Traffic Control Plan; for furnishing, erecting, illuminating, handling, and maintaining all construction signs (warning, regulatory, and guide), barricades, and other traffic control devices designated for installation at locations specified by the Plans, the Traffic Control Plan, or directed or approved by the Purchaser for the purpose of handling traffic safety through construction work zones for the duration for the project. Payment shall also include provision for flaggers or special measures necessary to assure the handling of traffic safely through construction work zones.

1.01 PAYMENT WILL BE MADE UNDER:

Item No.	Pay Item	Pay Unit
01551-5.01	TRAFFIC CONTROL (CONVEYANCE)	Lump Sum

END OF SECTION 01551

SECTION 01610
BASIC PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 SCOPE

A. All materials and permanently installed equipment (for example, traffic signalization equipment, sewer pumps, and other such items) furnished by the Subcontractor for the Work shall conform to the requirements of the Plans and Contract Documents, including the applicable City of Memphis Standard Construction Specifications and Design Standards.

B. Throughout the entire Project, all units of any one item of installed equipment shall be of the same manufacture and model unless otherwise approved by the Purchaser.

PART 2 PRODUCTS

2.01 MATERIALS & EQUIPMENT

A. Equivalent Materials and Equipment

1. The General Conditions allows for the substitution of equivalent materials and equipment, with the written approval of the Purchaser.

2. Reference to a particular product by manufacturer, trade name, or catalog number establishes the quality standards of materials and equipment required for the Work. It is not intended to exclude products equivalent in quality and similar in design. Whenever any article, material, or equipment is identified by using the name of a manufacturer or vendor, the term “or approved equal” if not inserted shall be implied.

3. If the Subcontractor proposes to furnish materials or supplies other than those specified, he shall furnish complete descriptive data, including performance capabilities, specifications, and other data as required in the Contract General Conditions. The provisions of this substitution of materials shall not relieve the Subcontractor of the responsibility of meeting the requirements of the Plans and Contract Documents. All materials must be approved by the Purchaser before any installation will be permitted.

B. List of Major Materials an Equipment

1. The Subcontractor shall submit to the Purchaser for approval, with due promptness after award of Contract but in no case later than at the preconstruction conference, a list of major equipment and materials which he proposes to provide. The list shall include in sufficient detail to identify the materials, the name of the manufacturer’s model number of all material that is identified on the Plans or in the Contract Documents, including catalog literature for standard equipment and detailed scale drawings of any nonstandard or special equipment and of any proposed deviation from the Plans. A signed statement shall accompany this list stating that materials and equipment are in exact accordance with Project specifications. No charge shall be made to the Purchaser for any materials or equipment purchased, labor performed, or delay to the Work prior to approval of materials by the Purchaser.

C. Source of Supply

1. The source of supply for each material to be supplied by the Subcontractor shall be subject to approval by the Purchaser before delivery is started.

PART 3 EXECUTION

A. Samples and Testing

1. Representative samples of materials included for incorporation in the Work shall be submitted to the Purchaser for his examination and/or testing when so specified or requested.

2. All testing of materials shall be made in accordance with the standard methods of testing of the ASTM, AASHTO, NEMA, ITE, or other applicable standard specifications.

PART 4 MEASUREMENT & PAYMENT

4.01 PROPOSAL QUANTITIES

A. The quantities appearing in the Proposal Sheet(s) of the Proposal are approximate and are proposed and shown for the comparison of bids and award of a Contract. The Purchaser does not guarantee or assume any responsibility that the quantities indicated on the Plans or in the Proposal will hold true and accurate in the construction of the Project. The Subcontractor shall not plead deception or misunderstanding because of variation from these quantities. Unless otherwise provided in the Contract Documents, payment to the Subcontractor will be made only for the actual quantities of Work performed and accepted, and materials and equipment furnished and placed in accordance with the Contract. The Subcontractor is reminded of the limitation provided by Section 838 of the Charter of the City of Memphis which limits the total amount of the increase in the Contract Price, for any reason, to ten (10) percent of the original Contract award amount. There are no specific limitations on the amount by which the Contract Price and project quantities may be decreased.

4.02 MEASUREMENT OF QUANTITIES

A. All Work completed under the Contract will be measured by the Purchaser according to United States standard measure.

B. The term “ton” will mean the short ton consisting of 2,000 pounds.

C. The determination of quantities for specific items will be made as set for the in the subsection titled “Measurement” under the applicable Sections of the Standard Construction and Material

D. Specifications hereof, or of other Specifications provided for the Work.

E. Longitudinal and transverse measurements for surface area computations will be to the exact dimensions shown in the horizontal plane on the Plans or as ordered in writing by the Purchaser.

F. Structures will be measured according to the lines and exact dimensions shown on the Plans or as altered to fit field conditions by direction to the Purchaser.

G. In all cases where measurement of materials is based on certified weights, the Subcontractor shall furnish the Purchaser certified weigh bills showing the net weight of materials received in each shipment. In no instance will the Purchaser pay for materials in excess of the amounts represented by the certified weigh bills.

H. When certified scale weights are not used for measurement, all materials which are measured

or proportioned by weight shall be weighed on accurate, approved scales, by competent, qualified personnel, at locations designated by the Purchaser.

I. Trucks used to haul material being paid for by weight shall be weighed empty at such times as the Purchaser directs, and each truck shall bear a plainly legible identification mark.

J. Measurements for payment will be made to the nearest fractional units specified below, unless otherwise specified herein or in the Contract Documents for the project.

Unit of Measurement	Nearest Unit
Linear Foot	0.1 LF
Square Foot	0.1 SF
Square Yard	0.1 SY
Ton	0.1 Ton
Cubic Yard	0.01CY
1,000 SF Unit	0.1 Unit

END OF SECTION 01610

SECTION 02230
SITE CLEARING

PART 1 – SCOPE

1.01 This work shall consist of clearing and grubbing, removal, and disposal of all vegetation and debris within the limits of the rights-of-way and easement areas. It shall also include the salvaging of designated materials and backfilling the resulting trenches, holes, and pits; the preservation from injury or defacement of all vegetation and objects designated to remain; and all necessary replacement of fences, trees, hedges, shrubs, and flowers.

PART 2 – EQUIPMENT

2.01 All equipment for the satisfactory performance of the Work shall be on the project and approved before the Work will be permitted to begin.

PART 3 – CONSTRUCTION REQUIREMENTS

3.01 CLEARING AND GRUBBING

A. The Purchaser will establish rights-of-way lines and construction limits. All trees, shrubs, edges, fences, and other items to remain shall be as indicated on the Plans or as directed by the Purchaser.

B. The rights-of-way shall be cleared of all vegetation and debris except items designated to remain. All other trees, stumps, roots, brush, hedges, and other protruding obstructions within the excavation area shall be completely grubbed. In embankment areas, sound undisturbed stumps and roots which will be a minimum of five (5) feet below subgrade or slope of embankment will be allowed to remain in place provided undercutting or other corrective measures are not stipulated in the plans or directed by the Purchaser and providing stumps do not extend more than six (6) inches above the ground surface. If excavation is not required, the area shall be grubbed to a minimum depth of six (6) inches below existing grade to remove grass, roots, and other organic material.

C. Low hanging branches and unsound or unsightly branches on trees or shrubs designated to remain shall be removed as directed by the Purchaser. Tree limbs and branches shall be trimmed to provide twenty (20) feet vertical clearance over the entire right-of-way. All trimming shall be done by skilled workmen in accordance with good tree surgery practices, and cut or scarred surfaces of trees or shrubs to remain shall be treated with an approved asphalt base paint prepared especially for tree surgery.

D. Within embankment areas, all depressions resulting from grubbing operations shall be backfilled with suitable material and left uniform. All depressions in excavation areas below subgrade elevation shall be backfilled with suitable material and compacted in accordance with the provisions of Specification Section 02315.

E. When specified on the Plans or Right-of-Way Agreement or so directed by the Engineer, all fences removed for construction purposes shall be replaced with salvaged existing materials or with acceptable in-kind new materials to enclose the original enclosed area as nearly as possible and tie back to the old fence.

3.02 DISPOSAL OF DEBRIS

A. All material from removal of structures and obstructions except salvaged items shall be disposed of off the Project and it shall be the Contractor’s responsibility to secure any permits necessary for the disposal.

PART 4 – MEASUREMENT

4.01 A. This item will be paid from a lump sum basis and no measurement will be made.

PART 5 – PAYMENT

5.01 Payment will be made for the work, completed and accepted by the Purchaser, at the contract lump sum price, which price will be full compensation for clearing and grubbing vegetation; removal and disposal of vegetation, debris, backfilling of depressions below subgrade elevation, protection of trees to remain; restoration of fences, trees, hedges, shrubs, flowers, or other growth as required; and moving salvageable materials to designated storage locations in accordance with the stipulations and provisions of the contract.

5.02 Payment will be made under:

Item No.	Pay Item	Pay Unit
02230-01	Clearing and Grubbing	Lump Sum

END OF SECTION 02230

SECTION 02370
RIP RAP

PART 1 – SCOPE

1.01 Rip-rap shall consist of furnishing and setting or placing, stones or sacked sand cement. The rip-rap shall be constructed in conformity to the lines, grades, and cross-sections, and at the locations indicated on the Plans or as directed by the Purchaser and in accordance with the requirements and provisions of these Specifications.

PART 2 – MATERIALS AND EQUIPMENT

2.01 MATERIAL

A. Stone.

1. Stone shall be sound, dense and durable, free from cracks, pyrite intrusions and other structural defects and have a density of not less than 150 pounds per solid cubic foot. When tested by the Los Angeles method, the percent of wear shall not exceed 60.

2. When the stone is subjected to five alternations of the sodium sulfate soundness test, the weighted percentage of loss shall be not more than 15.

3. Stone shall conform to one of the following gradations and shall be approximately rectangular in shape:

RIP-RAP GRADATIONS

Grade B
1,200 pound maximum weight

Weight	Percent
750 lbs. to 1,200 lbs.	27%
400 lbs. to 749 lbs.	25%
200 lbs. to 399 lbs.	25%
50 lbs. to 199 lbs.	15%
10 lbs. to 49 lbs.	5%
Less than 10 lbs.	3%

Grade C
400 pound maximum weight

Weight	Percent
250 lbs. to 400 lbs.	30%
50 lbs. to 249 lbs.	20%
30 lbs. to 49 lbs.	25%
10 lbs. to 29 lbs	20%
Less than 10 lbs.	5%

Grade D
125 pound maximum weight

Weight	Percent
90 lbs. to 125 lbs.	25%
25 lbs. to 89 lbs.	50%
10 lbs. to 24 lbs.	15%
Under 10 lbs.	10%

Grade E
(upper bank)

Weight	Percent
75 lbs. to 125 lbs.	10%
25 lbs. to 74 lbs.	40-60%
5 lbs. to 24 lbs.	20-40%
Under 5 lbs.	15%

B. Sacked Sand Cement.

1. Sand for sacked sand cement rip-rap shall be manufactured or natural sand and shall meet the quality requirements of Specification Section 03050. Cement for sacked sand cement rip-rap shall meet the requirements of Specification Section 03050.

2. Sacks shall be of either cotton or jute, standard grade of cloth, which will hold the sand cement mixture without leakage during handling and tamping. They shall be strong and shall be sized to hold approximately one cubic foot.

C. Filter Cloth and Fasteners.

1. The filter cloth material used as a base for rip-rap shall be pervious sheets of strong, rot-proof plastic fabric meeting the following Specifications:

Physical Property	Test Method	Acceptable Test Results
Tensile Strength, wet, lbs	ASTM D-1682	200 (min)
Elongation, wet, %	ASTM D-1682	40 (min)
Coefficient of Water Permeability, cm/scc	Constant Head	.03 (min)
Puncture Strength, lbs.	ASTM D-751	100 (min)
Pore Size – EOS U.S. Standard Sieve	Corps of Engineers CW-02215	40 (max)

2. The Contractor shall furnish a certified laboratory test report from an approved testing laboratory with each shipment of materials. Laboratory test reports shall include actual numerical test data obtained on this product.

3. Pins may be any commercially available pin 6 inches in length capable of retaining a washer.

4. Washers may be any commercially available washer 2 inches in diameter and compatible with the pin.

5. The pins and washers shall be manufactured from corrosion resistant metal material.

2.02 EQUIPMENT

A. All equipment necessary for the satisfactory performance of the work shall be on hand and approved by the Purchaser before construction will be permitted to begin.

B. The equipment shall include wooden or metal tamps of sufficient weight and number to properly compact the slopes on which the rip-rap is to be placed.

C. Wooden hand tamps, having a tamping face not greater than one square foot, and of sufficient weight and number to properly tamp the rip-rap, shall be furnished when sacked sand cement is used.

PART 3 – CONSTRUCTION REQUIREMENTS

3.01 SUBGRADE PREPARATION.

A. The area to be occupied by the rip-rap stabilization shall be cleared of all trees, roots, vegetation, and similar material. Immediately prior to the placement of rip-rap, the slopes or ground surface shall be trimmed in conformity to the lines and grades indicated on the Plans or as directed by the Purchaser and shall be thoroughly compacted by the use of hand or mechanical tamps. Unless otherwise specified herein make all fill with suitable materials excavated from site. All fills in dry areas shall be compacted to a maximum density of 90 percent as determined by ASTM D 698 (Standard Proctor). On slopes, the bottom of the rip-rap shall be placed at least 2 feet below the natural ground surface, unless otherwise directed.

B. Surplus excavated material shall be removed from the site and disposed of as shown on the Plans or as directed by the Purchaser. Spoil material shall not be disposed of in a watercourse or on the banks of a watercourse.

3.02 PLACING FILTER FABRIC.

A. Unless otherwise specified, filter fabric shall be placed on the prepared and compacted subgrade within the limits shown on the Plans for stone and sacked sand cement rip-rap. The filter fabric shall be laid loosely without wrinkles or creases. When more than one width or length of filter fabric is necessary, the joints shall be overlapped a minimum of 24 inches. Securing pins with washers shall be inserted through both strips of overlapped material and into the material beneath, until the washer bears against the fabric and secures it firmly to the base material. These securing pins shall be inserted through the overlapped fabric at no greater than 2 foot intervals along a line through the midpoint of the overlap. If the fabric is torn or damaged, a patch overlapping the edges of the damaged area by 2 feet shall be sewn securely to the fabric with a continuous, monofilament, rot-proof material.

3.03 PLACEMENT OF RIP-RAP

A. Stone Rip-Rap.

1. Stone rip-rap shall be constructed upon the prepared foundation by hand placing, so that the stones shall be as close together as is practicable in order to reduce the voids to a minimum.

2. When rip-rap is constructed in more than one layer, it shall be so placed that it will be thoroughly tied together with the larger stones protruding from one layer into the other.

3. Each stone shall be placed so that the depth will be perpendicular to the surface upon which it is set. The length shall be placed as directed by the Purchaser and each main stone shall be placed so that it will be against the adjoining stones. The stones shall be placed in such a manner as to stagger all joints as far as it is possible and practicable.

4. The main stones shall be thoroughly “chinked” and filled with the smaller stones by throwing them over the surface in any manner that is practicable for the smaller stones to fill the voids. This work shall continue with the progress of the construction. Tamping of the stones will not be required if the stones have been placed in a reasonable and satisfactory manner.

5. Knapping of the stones will not be required, except stones protruding more than 4 inches above the specified grade, in which case, these stones shall be broken down to come within 4 inches of the specified grade.

B. Sacked Sand Cement Rip-Rap.

1. Sacked sand cement rip-rap shall be constructed by placing sacks, filled approximately ¾ full with a mixture of sand and cement, on the prepared foundation. Sand and cement shall be mixed dry, with a mechanical mixer, in the proportion of one bag (94 pounds) of cement to five cubic feet of dry sand, until the mixture is uniform in color. After the mixing has been completed, the sand cement mixture shall be poured into sacks of approximately one cubic foot capacity until they are approximately three-fourths filled. The sacks shall then be securely fastened with hog rings, by sewing or other suitable methods that prohibit leakage of the mixture from the bags.

2. The sacks of sand cement shall be bedded, by hand, on the prepared grade with all the fastened ends on the grade and with the joints broken.

3. The sacks shall be rammed and packed against each other and tamped on the surface in such a manner as to form close contact and secure a uniform surface. Immediately after placing and tamping the sacks of sand cement, they shall be thoroughly soaked by sprinkling with water. Water shall not be applied under high pressure.

4. Sacks of sand cement ripped or broken in placing shall be removed and replaced before being soaked with water.

3.04 DEPTH OF RIP-RAP.

A. The standard depth of stone rip-rap shall be 18 inches unless otherwise indicated or directed. The average depth for each 25 square feet of surface shall be not less than the depth indicated on the Plans or directed by the Purchaser, or the standard depth required in these Specifications.

B. The completed sacked sand cement rip-rap shall have a minimum thickness of 10 inches, measured perpendicular to the slope.

C. In no case shall any part of the finished depth of stone or sacked sand cement rip-rap vary more than 3 inches above or below the specified depth.

PART 4 – MEASUREMENT

4.01 RIP-RAP.

A. Stone rip-rap of various gradations will be measured for payment by the ton. Sacked sand cement rip-rap will be measured for payment by the square yard, complete in place. No measurement for payment will be made for excavation embankment construction or grading work required to prepare the foundation or for filter fabric.

4.02 COMPACTION TEST.

A. Soil test as required by the Purchaser will be paid for by the test as performed by a testing agency which meets the approval of the Purchaser.

PART 5 – PAYMENT

5.01 PNEUMATICALLY PLACED CONCRETE.

A. The accepted quantities of stone rip-rap, or sacked sand cement rip-rap will be paid for at the contract unit price per ton or square yard respectively for the depth and grade specified which price will be full compensation for preparing the foundation, furnishing and placing filter cloth fabric and rip-rap, and furnishing all labor, materials, equipment and incidentals necessary to complete the work.

5.02 COMPACTION TESTING.

A. Accepted quantities of soil compaction tests as required by the Purchaser will be paid for at the contract unit price per test.

5.03 PAYMENT WILL BE MADE UNDER:

Item No.	Pay Item	Pay Unit
02370-01	RIP-RAP	Square Yard
02370-01.01.__.__	__" Thickness Stone Rip-Rap, Grade __	Ton
02370-01.02	Sacked Sand Cement Rip-Rap	Square Yard
02370-02	SOIL COMPACTION TEST	Each

END OF SECTION 02370

SECTION 02530
SEWER PIPE INSTALLATION

PART 1 - SCOPE

1.01 This Work shall consist of the construction of sanitary sewers, siphons, service connections, and/or the removal & replacement of existing sanitary sewers and service connections of the kinds and dimensions shown on the Plans, stipulated in Contract Documents, or as directed by the Purchaser. The construction shall be accomplished by these Specifications and in conformity with the lines, grades, and details shown on the Drawings or established by the Purchaser. The Subcontractor shall perform all work necessary to complete the Contract with the best modern practice. Without specifications that state the quality of any work, the Subcontractor is required to perform such items using first-quality construction. Unless otherwise provided, the Subcontractor shall furnish all material, equipment, tools, labor and incidentals necessary to complete the Work.

PART 2 – MATERIALS AND EQUIPMENT

2.01 MATERIAL

A. Construction Material

1. All material furnished by the Subcontractor shall be new, high quality and free from defects. Previously used material in acceptable condition may be used for bracing, forms, false work, and similar uses. Material not conforming to the requirements of the Specifications shall be considered defective and will be removed immediately from the site.

B. Higher Strength Pipe

1. The Subcontractor may substitute a higher strength pipe of the same type as that specified subject to the approval of the Purchaser.

C. Qualifications of Manufacturers

1. Pipe for sanitary sewers shall be the standard product of an established, reputable manufacturer made in a permanent plant. Suppliers for each material to be used by the Subcontractor shall be subject to approval by the Purchaser. No material shall be delivered until the manufacturer and product have been approved by the Purchaser. For any construction project, pipe and appurtenances for each pipe material shall be the product of a single manufacturer having a minimum of 10 years domestic experience producing the type of pipe supplied.

D. Material Inspection and Testing

1. Representative samples of material intended for incorporation in the work shall be submitted for examination when so specified or requested. All material to be used in the work shall be sampled, inspected, and tested by current ASTM specifications, or other standard specifications approved by the Purchaser. The Subcontractor shall furnish the Purchaser with three copies of certified reports from a reputable testing laboratory showing the results of the tests carried out on representative samples of material to be used on the Project. Each length of pipe delivered to the project shall show the laboratory's stamp. The performance or cost of all testing is the responsibility of the Subcontractor.

2. The Subcontractor shall notify the Purchaser before any deliveries of material and shall

make whatever provisions are necessary to aid the Purchaser in the inspection and culling of the material before installation.

E. Storage

1. The Subcontractor shall provide and maintain storage facilities and exercise such measures to maintain the specified quality and fitness of material to be incorporated in the work. The interior and sealing surfaces of the pipe, fittings, and adapters shall be kept free from dirt and foreign matter. PVC pipe, fittings, and adapters stored outside and exposed to sunlight shall be covered with an opaque material with proper ventilation. All precautions taken to ensure safe storage of materials shall be the responsibility of the Subcontractor.

F. Polyvinyl Chloride (PVC) Gravity Pipe and Fittings (6-15 inch Diameter)

1. All PVC gravity pipe and fittings 6-15 inches in diameter shall be solid wall PVC; no profile wall PVC pipe is allowed for pipes 15 inches or less in diameter. PVC solid wall pipe and fittings for gravity sewer applications shall conform to the requirements of ASTM D 3034. The standard dimension ratio (SDR) shall be SDR 26 (Type PSM). PVC resin shall conform to ASTM D 1784 cell class 12454C. A different cell class shall be allowed only if the material meets the requirements of a superior cell class than 12454C. 6-inch diameter PVC pipe shall only be used for service laterals. Fittings for PVC gravity sewer pipe shall be fabricated from PVC meeting the respective ASTM PVC pipe standard for molded or extruded PVC. The wall thicknesses of the waterway and bell of fittings shall be no less than the respective minimum thicknesses for the equivalent pipe. All fittings shall be compatible with the pipe to which they are attached.

2. All PVC gravity pipe joints shall be gasketed bell and spigot push-on type conforming to ASTM D 3212, unless directed otherwise in these Specifications. Gaskets shall be part of a complete pipe section and purchased as such. Lubricant shall be as recommended by the pipe manufacturer.

G. Polyvinyl Chloride (PVC) Profile Pipe and Fittings (18-36 inch Diameter)

1. All 18-36 inch diameter PVC sewer pipe and fittings shall be designed and manufactured in accordance with ASTM F 679, F 794, F 949, or F 1803. All PVC sewer pipe and fittings shall be manufactured from PVC resin with a cell classification of either 12454C or 12364C as defined in specification ASTM D 1784. The pipe shall be furnished complete with gaskets, fittings, lubricant, etc. as required for proper installation and completion of the line. The minimum pipe stiffness at 5% deflection shall be 46 psi when tested in accordance with ASTM D 2412 and as specified in ASTM F 679, F 794, F 949, or F 1803, as applicable. Samples of the type of pipe to be used shall be tested in accordance with ASTM D 2412. Impact tests shall be conducted in accordance with ASTM D 2444 and shall comply with ASTM F 679, F 794, F 949, or F 1803. Tests shall be conducted by the manufacturer in the presence of the Purchaser's Resident Project Representative, unless otherwise directed by the Purchaser. The Owner and Purchaser will have the right to make unannounced visits to the pipe manufacturer's facility to inspect the manufacturing process.

2. All joints shall be the bell and spigot type and conform to ASTM D 3212. Gaskets shall meet ASTM F 477. All bells shall be formed integrally with the pipe and shall contain a factory installed elastomeric gasket which is positively retained. No solvent cement joints shall be permitted in field construction.

3. The pipe manufacturer shall furnish to the Purchaser a notarized certificate(s) of inspection stating that each piece of pipe used on this project was made and tested in accordance with these specifications.

4. All pipeline material shall be generically the same throughout the project with the permissible exception of utilizing different material for piping used for tie-ins of smaller lines, or as noted on the Drawings or as approved by the Purchaser.

H. Glass Fiber Reinforced Polymer Mortar Pipe and Fittings (up to 72 inch Diameter)

1 Pipe shall meet the requirements of ASTM D 3262 - Standard Specification for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe. The pipe shall be manufactured to form a dense, non-porous, corrosion-resistant, composite pipe that is resistant to corrosion from hydrogen sulfide and other corrosive materials normally found in sewerage systems, all without the use of special HDPE or PVC liners.

2 Minimum acceptable nominal length for joints of pipe shall be 20 feet except where field conditions require otherwise.

3 Design: The design of the pipe shall comply with all requirements of the latest revision of ASTM D - 3262 for non-pressure (gravity) flow conditions. The pipe shall also be designed for a variable depth of cover as shown on the profile; the maximum trench loading that can occur on an empty pipe after backfill is in place; and a live load equal to the AASHTO HS20 loading or the minimum live load as specified in the latest revision of ASTM D - 3262, whichever gives the greater live load.

4 Resin Systems: These shall be only polyester resin systems with a proven history of satisfactory performance in sewage applications. Historical data shall have been acquired from a composite material of similar construction and composition.

5 Glass Reinforcements: Reinforcing glass fibers used in the manufacture of the pipe shall be of the highest quality commercial grade E-glass filaments with binder and sizing compatible with impregnating resins.

6 Interior Lining: All interior surfaces of the pipe shall be lined with a fiberglass reinforced polyester lining as a part of the manufacturing process.

7 Joints: The pipe shall be field connected with fiberglass sleeve couplings that utilize full face elastomeric sealing gaskets of EPDM rubber compound, providing a zero leakage joint. The coupling shall be factory assembled to one end of the pipe. Each joint shall be pressure tested after installation.

8 Tests and Examinations: Tests, in-process and final examinations shall be performed by the manufacturer, or an independent testing laboratory approved by the Engineer, in accordance with the latest revision of ASTM D 3262, in order to assure conformance. All instruments, gauges, and other testing and measuring equipment shall be of the proper range, type and accuracy to verify conformance and test equipment shall be checked at least annually against calibrated and certified test gauges and instruments. The Engineer shall have access to all records of tests and inspections related to the manufacture of the pipe, and, without notice to the manufacturer, shall also have the right to witness the manufacture of the pipe and any tests being performed by the manufacturer or his suppliers relative to products, materials, or the pipe being produced. Copies of records of tests and inspections shall be submitted if requested by the Engineer.

   a. Pipes: These shall be manufactured and tested in accordance with ASTM D 3262.
   b. Joints: Coupling joints shall meet the requirements of ASTM D 4161 and/or produce a zero leakage joint.
   c. Stiffness: Minimum pipe stiffness when tested in accordance with ASTM D 2412 shall be 46 psi.

9. Fittings and Special Pipe: Fittings shall be contact molded or manufactured from mitered sections of pipe joined by glass-fiber-reinforced overlays, all capable of withstanding all operating conditions when installed.

10. Curves of long radius shall be formed by the use of bevel end pipe or by the use of bevel adapters. Deflection of pipe joints to form the long radius curves will not be accepted. Special pipes shall be designed to provide the same strength as the

adjacent pipe. Branch connections or openings, such as manholes and bypass pumping connections, shall be incorporated in straight pipe and shall be suitably reinforced. Special pipes shall be provided with joints corresponding to those on adjoining straight pipes. Special ends shall be provided on pipe, where required, to connect to pipe of other manufacturers and special structures.

11. Unloading Handling and Storage: All pipe shall be inspected at time of delivery, and damaged pieces rejected and removed from the site of the work. Unloading shall be done by mechanical equipment designed to properly handle the pipe, and dropping from delivery vehicles will not be permitted. Pipe shall be stored in an orderly manner to protect the pipe from injury, and from damage by freezing, all in accordance with the manufacturer's written instructions.

I. Ductile Iron

1 Ductile iron pipe for gravity sewer and service connections will conform to ASTM A 746. Ductile iron pipe for force main applications will conform to ANSI A 21.51. The pipe thickness design will conform to ANSI A 21.50. If no thickness class is specified on the Plans or Contract Documents, Class 50 or approved equivalent will be used. All ductile iron pipe will be lined with either Protecto 401 Ceramic Epoxy, SewPer Coat Cement Mortar Lining, or Polyethylene. Linings will be applied according to manufacturer's recommendations. Fittings will conform to the requirements of ANSI A 21.10. Unless otherwise specified, joints will be push-on gasket type conforming to the requirements of ANSI A 21.11. Mechanical joints will conform to the requirements of ANSI A 21.11. Flanged joints will conform to the requirements of ANSI A 21.15. Flexible joint ductile iron pipe for river crossing applications will conform to ASTM A 536 and will be Grade 70-50-05. Steel retainer rings will conform to ASTM A 148 for Grade 90-60.

J. Adapters and Couplings

1. At the direction of the Purchaser, a connection of sanitary sewer pipes, 8 inches through 16 inches, of dissimilar material, different sizes or for the repair of sanitary sewer pipes of similar material may be made by means of an approved compression or mechanical connector or adapter. The gaskets for compression connectors or adapters shall be manufactured of an approved preformed elastomeric material conforming to applicable sections of ASTM Standards C 143, C 425, C 564, and D 3212. Mechanical couplings or adapters shall have tightening clamps or devices made of 300 series stainless steel with a stainless steel shear ring and stainless steel hardware, as specified in ASTM A 167. If a stainless steel shear band is not used, a concrete collar shall be required. Each connector and adapter shall bear the manufacturer's name and required markings. Installation shall be by the manufacturer's recommendations.

2. At the direction of the Purchaser, a connection of sanitary sewer pipes (18 inches in diameter and larger) of dissimilar material, different sizes or for the repair of sanitary sewer pipes of similar material may be made in accordance with this Specification. Mechanical connectors meeting the above requirements may be used at the direction of the Purchaser.

K. Crushed Limestone

1. Crushed limestone shall be size No. 67 Coarse Aggregate meeting the requirements of the Tennessee DOT Standard Specifications for Road and Bridge Construction and the following gradation:

Total Percent by Dry Weight,

	Passing Each Sieve (U.S. Standard)				
Size No.	1"	3/4"	3/8"	No. 4	No. 8
67	100	90-100	20-55	0-10	0-5

L. Pit Run Gravel

1. Pit run gravel shall consist of one of the three gradations shown in the table below.

	Total Percent by Dry Weight, Passing Each Sieve (U.S. Standard)						
Size No.	2½"	2"	1½"	1"	3/8"	No.40	Clay *
1	100	95-100			35-65	10-30	1-12
2		100	95-100		40-65	10-30	1-12
3			100	90-100	45-65	10-35	2-12

*Clay content shall be determined by the Hydrometer Test - AASHTO T 88. Clay content up to 15 percent may be used with the approval of the Purchaser.

2. The portion passing the No. 40 sieve shall be known as the binder. The binder aggregate shall consist of hard durable particles of limestone or sound siliceous material. Shale

aggregate or pipe clay binder shall not be acceptable. The percent of silt shall not exceed the percent of clay by more than 25 percent. If the binder material is insufficient to bond the aggregate a satisfactory binding material may be incorporated, as approved by the Purchaser, so that the resultant mixture shall comply with these Specifications. The mixing shall be done uniformly, and blending of material on stockpiles or in the pits by bulldozers, clamshells, draglines, or similar equipment shall not be permitted.

M. Non-Shrinking Grout

1. Grout shall be mixed in small quantities as needed and shall not be re-tempered or used after it has begun to set. Unless otherwise specified, the grout shall consist of one part Portland cement, two parts masonry sand by volume, a non-shrinking, nonmetallic admixture and sufficient water to form a grout of proper consistency. When non-shrinking or non-shrinking fast setting grout is specified it shall be formulated by the incorporation of an admixture, or a premixed grout may be used.

N. High Density Polyethylene (HDPE) Pipe and Fittings

1. High Density Polyethylene Pipe (HDPE) may be used in construction of inverted siphons. No HDPE will be allowed in any other gravity sewer application. All HDPE shall be manufactured from virgin, extra high molecular weight, high density PE3408 or PE3608 polyethylene pipe grade resin to a minimum cell classification of PE345434C as determined by ASTM D3350. No post-consumer recycled polyethylene materials shall be allowed. The minimum material classification shall conform to III C 5 P34 as determined by ASTM D1248.

2. All HDPE pipe and fittings shall conform to ASTM F714 and ASTM D3261,

respectively, and have a Standard Dimension Ratio (SDR) of 17, maximum.

3. Successive joints of HDPE pipe shall be joined by heat fusion at a fusion pressure of 75 psi and temperature of 400° F. All such connections shall be performed in strict accordance with the manufacturer's instructions.

O. Steel Casing Pipe

1. Casing pipe will conform to ASTM A 139. Minimum yield strength will be 35,000 psi. Wall thickness will meet the requirements of the latest revision of the American Railway Engineering Association Manual of Recommended Practice unless otherwise specified. Wall thickness will be:

Nominal Thickness Inches	Nominal Diameter Inches
0.188	Less than 14
0.219	14 and 16
0.250	18
0.281	20
0.312	22
0.344	24
0.375	26
0.406	28 and 30
0.438	32
0.469	34 and 36
0.500	38, 40, and 42

2. When casing is installed without a protective coating and is not cathodically protected, the wall thickness shown above will be increased to the nearest standard size that is a minimum of 0.063 inches greater than the thickness shown. This requirement does not apply to casing diameters less than 12 3/4 inches.

P. Tracer Wire for Sewer Line and Force Mains

1. Tracer wire shall be installed along the length of all sewer pipes, service connections manholes and stubs. All tracer wire shall have HDPE insulation intended for direct bury, green in color, and be suitable for wet or dry applications. All system components, including tracer wire, connectors, ground rods and access points, must be compatible.

2. Tracer wire shall be copper-clad steel 12-AWG, and must conform to ASTM B910/ B910M. Minimum brake load of tracer wire is 450 lb. in open cut and 1,150 lb. in directional drilling Tracer wire for pipe bursting shall be copperhead with Extreme Strength 7x7 stranded 4,700 lb. break load. Conductor shall be annealed copper and meet or exceed all applicable ASTM standards, including ASTM B3 and ASTM B170.

3. Insulation shall be high density, high molecular weight, polyethylene (HDPE) with a minimum flexural strength of 120,000 psi and shall meet or exceed ASTM D790. Insulation shall be green in color with a minimum thickness for open cut, directional drilling, and pipe bursting of 30, 45, and 50 mils respectively.

4. Connector shall be specifically manufactured for use in underground tracer wire and shall be dielectric silicone filled to seal out moisture and corrosion, and shall be

installed in a manner to prevent any uninsulated wire exposure. Non-locking, friction fit, twist on, or taped connectors are prohibited.

5. Grounding of tracer wire shall be achieved by using a 1.5-lb, drive-in, magnesium ground rod with a minimum 20-feet HDPE insulated copper-clad steel wire connected to the rod specifically manufactured for this purpose.

6. All two-terminal tracer wire access points must include a manually interruptible conductive/ connective link between the terminal for the tracer wire connection and the terminal for the ground rod wire connection. All at-grade access points shall include an encapsulated magnet molded into the top portion of the tube, to allow for detection by a ferrous metal detector. On both public and private properties, tracer wire shall terminate at an approved at-grade, two-terminal access box near the sewer clean-out. For sewer lines over 500 linear feet without service laterals, tracer wire access must be provided utilizing an approved grade level/in-ground trace wire access box, located at the edge of the road right-of-way, and out of the roadway. The grade level/in-ground tracer wire access box shall be delineated using a minimum 48* polyethylene marker post, green in color. All at-grade access points shall be supplied with anti-corrosion wax-gel to protect wires.

2.02 EQUIPMENT

A. The Subcontractor shall furnish and maintain in good condition all equipment and facilities as required for the proper execution and inspection of the Work. All equipment and facilities shall be on site and approved by the Purchaser before work will be permitted to begin.

PART 3 - CONSTRUCTION REQUIREMENTS

3.01 EXCAVATION

A. All excavation performed under this Section including trench excavation, structure excavation, and channel excavation, but excluding undercut excavation, shall be considered unclassified excavation despite the nature of the material and objects excavated and shall not be measured or paid for separately except as specifically noted. Pavement removal and replacement shall be accomplished as specified in Specification Section 02950.

B. Trench Excavation

1. All trenches shall be open cut unless otherwise shown on the Drawings. Tunneling, boring, or jacking may be allowed by written permission of the Purchaser.

2. Trenches may be excavated by machinery to a depth that will not disturb the finished subgrade. The remaining material shall be hand excavated so that the pipe is bedded on a firm, undisturbed subgrade.

3. No more than 300 feet of trench shall be opened ahead of the completed sanitary sewer, nor will more than 100 feet be left unfilled except by written permission from the Purchaser. In special cases, the Purchaser may limit the distance to which the trench may be opened by notifying the Subcontractor in writing.

4. The width of trenches below a level 1 foot above the outside top of pipe shall be at least 6 inches but not more than 12 inches on each side of the outside of the pipe for all sizes up to and including 16 inches in diameter. A maximum trench width dimension for these pipe sizes shall be 42 inches. For 18-inch diameter pipes, the width of trenches below a level 1 foot above the outside top of pipes shall be at least 6 inches on each side of the pipe, with a maximum trench width of 42 inches. For pipe sizes more than 18 inches, the width of trenches below a level 1 foot above the outside top of the pipe shall be at least 12 inches but no more than 15 inches on each side of the outside of the pipe. If the trench width at or below 1 foot above the top of pipe exceeds the width specified, provisions shall be made at the Subcontractor's expense to compensate for the additional load upon the pipe.

5. The sides of the trench shall be as nearly vertical as possible. The bottom of the trench shall be carefully graded, formed, and aligned according to SARP10 *Trench Cross Section Showing Terminology* Figure and to the satisfaction of the Purchaser before sanitary sewers are laid.

C. Other Excavation

1. Undercut Excavation: Undercut excavation shall consist of removing and disposing of unsatisfactory material below the grade established on the Drawings for sanitary sewers, structures, and manholes. No undercut excavation shall be done without prior authorization of the Purchaser. The limits of undercut excavation shall be determined by the Purchaser’s Resident Project Representative who will be present during the undercut operations.

2. Undercut areas shall be backfilled with No. 67 limestone or other aggregate approved by the Purchaser to the grade established on the Drawings to produce a suitable foundation. The backfill shall be placed in 6 inch maximum lifts and compacted to 95 percent of maximum density at plus or minus 2 percent of optimum moisture content as determined by Laboratory Standard Proctor Test (ASTM D 698) or a minimum relative density of 0.75.

3. Unauthorized Excavation Below Subgrade or Outside Limits: Any unauthorized excavation and subsequent removal and backfilling beyond the lines and grades shown on the Drawings shall be at the Subcontractor’s expense. The excess space between the undisturbed bottom and sides of the excavation and subgrade limits shown on the Drawings shall be backfilled according to this Specification.

D. Change in Location and Grade

1. If the Purchaser orders in writing that the location or grade of a proposed sanitary sewer facility be changed from that shown on the Drawings, the following provisions will apply. If the change is made before excavation work has begun and the item being constructed is covered in the Proposal Sheet(s) by pay items with appropriate depth classifications, the appropriate pay item will apply. If the facility being constructed is not covered in the

   Proposal Sheet(s) and if the average excavation per linear foot at the changed location or grade is within 10 percent of the original Plan quantity, there will be no change in the unit price for this work. If the average excavation per linear foot at the changed location varies more than 10 percent above or below original Plan quantities, a Contract Revision will be prepared to cover the new work. For purposes of comparing changed quantities with Plan quantities, a 1 foot long strip will be calculated from natural ground line to invert along both the revised and original

locations. These calculations will then be multiplied by the proper lengths to determine the total cost.

2. If the change is made after excavation has already begun on the original Plan location, the procedures described above shall apply to payment for work along the changed location. If abandonment of an existing excavation is required due to a change by the Purchaser, a Contract Revision shall be prepared covering the backfilling and restoration of the abandoned excavation. Backfilling and restoration of the abandoned excavation shall be accomplished according to the appropriate section of these Specifications.

3. Filling a portion of existing excavation to meet changed grades shall be accomplished in accordance with this Specification.

4. If a change in a location and/or grade is authorized in writing by the Purchaser at the written request of the Subcontractor, the Subcontractor shall not receive any additional compensation for the changed work. Backfilling and restoration of abandoned excavation work shall be accomplished totally at the Subcontractor's expense. If changes requested by the Subcontractor result in reduced lengths and/or depth of excavation, the revised quantities using Proposal unit prices or Contract Revisions as appropriate shall be used to develop payment.

E. Disposition of Excavated Material

1. Excavated material suitable for backfill shall be stored no closer than 2 feet from the edge of the excavation. Excavated material shall not obstruct crosswalks, sidewalks, driveways, street intersections, nor interfere unreasonably with travel on streets. Gutters or other surface drainage facilities shall not be obstructed. The Subcontractor must provide access to fire hydrants, mailboxes, sewer and conduit manholes, and similar utility or municipal service facility as required. Excavated material intended for backfill shall be stored in a way that minimizes loss of excavated material due to erosion. The Subcontractor shall comply with all applicable OSHA regulations and City of Memphis Storm Water Ordinances.

2. Unless otherwise directed, all excavated material that will not be used for backfilling or restoration shall be removed from the site and disposed of by the Subcontractor. If the Subcontractor proposes to store or place such excess excavated material upon any private property, written consent of the property owner or owners must be obtained by the Subcontractor in advance. A certified copy shall be given to the Purchaser. No surplus or excess material shall be deposited in any stream channel nor anywhere that would change preconstruction surface drainage.

F. Control of Water

1. The Subcontractor shall keep all excavations free of water. If the trench subgrade consists of good soil in good condition at the time of excavation, it shall be the Subcontractor's responsibility to maintain it in suitable condition. Dams, flumes, channels, sumps, or other work and equipment necessary to keep the excavation clear of water shall be provided by the Subcontractor. Dewatering of trenches shall be incidental to trench excavation. The Subcontractor shall avoid producing mud in the trench bottom by

his operations. If necessary or so ordered by the Purchaser, the Subcontractor shall remove any soil that becomes unacceptable and replace it with limestone or other approved aggregate at his own expense to maintain a firm, dry base.

2. Pipe embedment, laying, jointing, and the placing of concrete or masonry shall be done in a water free trench or excavation. Trenches shall be kept clear of water until pipe joints, concrete and masonry have set and are resistant to water damage. The water shall be disposed of in a manner acceptable to the Purchaser.

3. All gutters, pipes, drains, conduits, culverts, catch basins, storm water inlets, ditches, creeks, and other storm water facilities shall be kept in operation, or their flows shall be satisfactorily diverted and provided for during construction. Any facilities disturbed during construction shall be restored to the satisfaction of the Purchaser.

G. Excavation Around Obstructions

1. The Subcontractor shall cautiously excavate to find the limits of underground obstructions anticipated within the excavation. When a water pipe, gas pipe, other sanitary sewer, storm drain, or similar utility comes within the limits of the trench, such facilities will be properly supported.

2. The Subcontractor shall perform all excavation by hand where excavation machinery would endanger trees, structures, or utilities that otherwise might be saved by hand excavation.

3. Hydroexcavation/Hand Digging

   a. The Subcontractor, in order to protect existing utilities, shall cautiously hydroexcavate or hand excavate the entire perimeter of the excavation to a minimum depth of four feet to locate all underground obstructions within the excavation. The excavation method to be utilized on any given repair (hydroexcavation or hand digging) is at the Subcontractor's discretion. When a water pipe, gas pipe, other sanitary sewer, storm drain, or similar utility comes within the limits of the trench, such facilities shall be properly supported.

H. Excavation for Manholes and Special Structures

1. The Subcontractor shall be responsible for performing the Work according to the lines and elevations shown on the Drawings or as directed by the Purchaser. The Subcontractor shall excavate as required for all structures with foundations carried to firm, undisturbed earth at the elevation of the underside of the structure.

2. The outside dimensions of excavations for manholes and special structure shall be at least 12 inches greater than the outside of the masonry or concrete work to permit backfilling around the structure.

3. Where structures are to be built in street rights-of-way or paved areas, the excavation shall not exceed 2 feet from the outside of the masonry or concrete work. If the excavation exceeds this limit, the Subcontractor shall be required to backfill the entire space around the structure with pit run gravel compacted as specified in this Specification.

I. Special Protection

1. Treacherous Ground: When running sand, quicksand, or other treacherous ground is encountered, the work shall be carried on with the utmost urgency and shall continue day and night should the Purchaser so direct.

2. Sheeting and Shoring: The Subcontractor shall furnish, place, and maintain sheeting

and shoring as required to support the sides of any excavation to prevent earth movement that could endanger the workers or public and to prevent damage to the excavation, adjacent utilities or property. The Subcontractor shall place this sheeting and shoring without the Purchaser's instructions.

3. Sheeting shall extend below structure invert a sufficient depth to assure adequate support. In the installation of sheeting, the use of vibratory type pile drivers (as opposed to impact type) shall be limited to sheeting driven no greater than 5 feet below the invert. The sheeted trench width, as measured between those faces of the sheeting in contact with the earth trench wall, shall not exceed the maximum width of a trench. Walers and struts shall be designed and installed to present no obstructions to proper placement of the pipe, pipe embedment, cradle or encasement, and they shall not interfere with the satisfactory installation of the pipe.

4. Sheeting, bracing, and shoring shall be withdrawn and removed as the backfilling is being done, except where the Purchaser permits the material to be left in place. The Subcontractor shall cut off sheeting left in place at least 2 feet below the surface and shall remove the cut off material from the excavation.

5. All sheeting, bracing, and shoring which is not left in place under this provision shall be removed in a way that will not endanger the completed work or other structures, utilities, storm drains, sewers, or property. The Subcontractor shall be careful to prevent the opening of voids during the extraction process.

6. If sheeting and shoring are not specifically required on the Drawings or in the Specifications, steel drag shields or trench boxes may be used subject to the authorization of the Purchaser. Voids left by the advancement of the shield shall be carefully backfilled and compacted following trench backfill requirements.

7. Excess Width of Trench: If the Subcontractor is permitted to use equipment that results in wider trenches than specified, approved methods shall be used around the pipe to resist the additional load caused by the extra width. The dimensions of the cradle or other methods will be specified by the Purchaser. The Subcontractor shall be responsible for meeting all applicable OSHA requirements. No extra compensation will be allowed for the additional material or work. Excess width trenches for semi-rigid and flexible pipe shall be backfilled and compacted according to ASTM D 2321, and no concrete cradle shall be used.

8. Underpinning: When excavations require underpinning of existing structures, the Subcontractor shall submit shop drawings of underpinning details to the Purchaser for review before commencement of excavation below the foundation of the structure. Review of underpinning details by the Purchaser shall not relieve the Subcontractor of his responsibility for protection of the structure and its contents.

J. Existing Utilities

1. It shall be the Subcontractor's responsibility to arrange for the location of existing utilities prior to excavation. The Subcontractor will also be responsible for coordinating the relocation of any existing utilities with the appropriate utility owner.

2. Protection: The Subcontractor shall protect any storm drain, sewer, or utility within the limits of the construction. The Subcontractor shall proceed with caution and shall use every means to establish the exact location of underground structures and facilities before excavating in the vicinity. The Purchaser shall not be responsible for the cost of protection or repair or replacement of any structure, pipe line, conduit,

service connection, or similar facility broken or damaged by the Subcontractor's operations. All water and gas pipes and other conduits near or crossing the excavation shall be properly supported and protected by the Subcontractor.

3. If the construction requires the removal and replacement of any overhead wires or poles, underground pipes, conduits, structures or other facilities, the Subcontractor shall arrange for such work with the Owner or Owners of the facilities. No additional payment will be made by the Purchaser for this work.

4. Service Connections: Sewer and utility services between mains and buildings shall be maintained and adjusted as necessary by the Subcontractor to provide as nearly a continuous operation as can be expected. This shall be accomplished in any way that the Subcontractor chooses, provided the individual service is not interrupted for more than two consecutive hours. The occupants shall be notified by the Subcontractor at least six hours before such service interruptions. When a break occurs, the Subcontractor shall notify the affected occupant(s) of the probable length of time that the service will be interrupted. New service laterals with double-sweep cleanouts will be required to be installed to the property line for each service and reconnected to the existing service if one exists. If no service exists, the Subcontractor shall cap the pipe after installing a cleanout.

5. If existing underground facilities or utilities require removal and replacement for the performance of this work, all replacements shall be made with new material conforming to the requirements of these Specifications. If not specified, the material will be as approved by the Owner.

6. The removal and replacement and relocation of water services to adapt to new construction shall be the Subcontractor's responsibility within the limits of construction.

7. The Subcontractor shall be responsible for any damage to the sewer house connection because of his operations. The Purchaser does not guarantee the number, size, condition, nor length of adjustment necessary to bring a service to a new grade.

3.02 SEWER PIPE INSTALLATION

A. General

1. Sewer pipe and pipe embedment shall be constructed as shown on the Drawings. It shall be the Subcontractor's responsibility to find all underground utilities before construction to ensure there are no conflicts with the proposed line and grade. The Subcontractor’s surveyor shall verify the base information on the Drawings prior to commencement of construction. Any discrepancies in the Drawings shall be reported to the Purchaser immediately. If approved by the Purchaser, minor changes in the alignment or grade will be permitted to avoid underground facilities, if straight alignment can be maintained between manholes. If minor changes in line or grade cannot avoid a conflict with the existing utility, the Subcontractor shall arrange with the owner of said utility to have it adjusted as required to accommodate the proposed sewer at no additional expense to the Purchaser.

B. Modifications of Existing Sanitary Sewer Facilities

1. Maintenance of Flow: Where existing sewer lines are being modified, the

Subcontractor shall arrange his work so that sewage flow will be maintained during the construction period with no discharge of sewage into the open trench, and no back up of sewage in the existing line. The Subcontractor shall provide necessary bypass pumping capacity to carry flow downstream of the section to be modified.

2. Abandonment of Sewer Pipe: Sewer pipe called for in the Specifications or Drawings to be abandoned shall be sealed at each end for a minimum distance of 18 inches, or one-half the diameter of the pipe, whichever is greater. Unless otherwise specified, the pipe shall be sealed with a brick bulkhead and/or acceptable cement grout to form a solid watertight plug completely bonded to the pipe.

3. The Subcontractor shall be allowed to remove pipe to be abandoned if wanted. If the Subcontractor elects the removal method, all associated costs shall be included in the cost for other Pay items.

4. Connection to Existing Manholes: The Subcontractor shall cut suitable openings into existing manholes or remove existing pipe to accommodate the sewer pipe at the proper elevation, location, and direction, as indicated on the Drawings. Care shall be used to avoid unnecessary damage to the existing manhole.

5. All loose material shall be removed from the cut surfaces that will be completely coated with non-shrinking grout before setting the pipe. Before inserting the pipe, a sufficient thickness of grout shall be placed at the bottom and sides of the opening for proper bedding of the pipe. For semi-rigid and flexible pipe installations a water stops as approved by the pipe supplier shall be installed on the pipe according to the manufacturer's recommendations. After setting, all spaces around the pipe shall be solidly filled with non-shrinking grout and neatly pointed up on the inside to present a smooth joint, flush with the inner wall surface. Any necessary revisions on the existing manhole invert shall be made to provide a smooth, plastered surface for properly channeled sewage flow from the new connection. Plaster on the exterior of brick manholes shall be repaired with non-shrinking grout. Particular care shall be given to ensure that the earth sub-base and bedding next to the manhole will provide firm solid support to the pipe.

6. Removal of Sewer Pipe: Existing pipes and manholes to be removed and their locations shall be shown on the Drawings. Existing sewer pipe and manholes that must be removed to excavate for the proposed sewer shall be included in the cost of the proposed sewer pipe and no additional compensation shall be made to the Subcontractor. The City reserves the right to retain or reject salvage of any material encountered. All remaining material becomes the property of the Subcontractor who shall be responsible for properly disposing of the same.

C. Tracer Wire Installation

Tracer Wire

1. Tracer wire must be installed per manufacturer recommendations, and all service lateral tracer wires properly connected to the mainline tracer wire, to ensure full tracing/locating capabilities from a single connection point. Lay mainline tracer wire continuously, by-passing around the outside of manholes/structures. Tracer wire must be fastened on all pipe (mainline and service connections) with plastic zip ties at 5-foot intervals. Tracer wire on all sanitary service laterals must terminate at an approved at-grade, two-terminal access box color coded green and located directly above the service lateral at the road right of way.

2. Service connection tracer wire shall be a single wire, connected to the mainline tracer wire using a lug connector, installed without cutting/splicing the mainline tracer wire.

3. New tracer wire being extended or tied into an existing tracer wire shall be connected using approved splice connectors, and shall be grounded at the splice location specified.

4. Tracer wire must be properly grounded at all dead-ends/stubs. Grounding of tracer wire shall be achieved by use of a drive-in magnesium grounding anode rod with a minimum of 20 feet of HDPE copper clad wire connected to anode specifically manufactured for this purpose, and buried at the same elevation as the sewer line.

5. In case of occurring damage to the wire during installation, an immediate repair is required by removing the damaged wire and installing a new section of wire with approved connectors.

Connectors

1. All mainline trace wires shall be interconnected at intersections, at mainline tees, and mainline crosses. At tees Direct bury wire connectors shall include 3-way lockable connectors and mainline to lateral lug connectors specifically manufactured for use in underground tracer installation. Connectors shall be dielectric silicon filled to seal out moisture and corrosion, and shall be installed in a manner to prevent any uninsulated wire exposure. Non-locking, friction fit, twist on, or taped connectors are prohibited.

3.03 PIPE EMBEDMENT

A. Pipe embedment will be defined as that material supporting, surrounding and extending to 6 inches above the top of the pipe. Pipe Embedment for sewer pipe shall conform to the requirements given below. At the direction of the Purchaser or as shown on the Drawings, sewer pipe and backfill shall be encapsulated in geotextile fabric meeting the following requirements:

Physical Property	Test Method	Acceptable Test Result
Tensile Strength, wet, lbs.	ASTM D-1682	200 (min)
Elongation, wet, %	ASTM D-1682	40 (min)
Coefficient of Water Permeability, cm/sec	Constant Head	0.03 (min)
Puncture Strength, lbs.	ASTM D-751	100 (min)
Pore Size - EOS U.S. Standard Sieve	Corps of Engineers CW-02215	40 (max)

B. Crushed Limestone

1. Pipe embedment material shall be Number 67 crushed limestone. Pipe 8 inches to 24 inches in diameter shall be bedded on 4-inches of Number 67 crushed limestone. Pipe 27 inches to 48 inches in diameter shall be bedded on 6-inches of bedding material. Pipe embedment for pipes larger than 48 inches in diameter shall be by

design based on anticipated soil conditions. After pipe installation, crushed limestone shall then be tamped under the haunches and continued in layers not more than 6 inches in loose thickness around and above the pipe to a level 6 inches above the outside top of the pipe. The remainder of the installation shall be as outlined in this Specification's Backfill requirements.

3.04 PIPE LAYING

A. Inspection Before Laying

1. All pipe shall be inspected upon delivery. Pipe that does not conform to the requirements of these Specifications or is not suitable for use will be rejected by the Purchaser and immediately removed from the work site.

B. Preparation of Pipe Ends

1. All surfaces of the pipe to be joined shall be clean and dry. All necessary lubricants, primer, adhesives, and similar material shall be used as recommended by the pipe or joint manufacturer's specifications.

C. Care During Hoisting, Placing, And Shoving Home

1. Equipment used to handle, lay, and join pipe shall be equipped and used as to prevent damage to the pipe. All pipe and fittings shall be carefully handled and lowered into the trench. Damaged pipe or jointing material shall not be installed.

D. Direction of Work

1. The laying of pipe shall be commenced at the lowest point. The bell or grooved end shall be laid upgrade. All pipe shall be laid with ends abutting and true to line and grade. The pipe ends shall be carefully centered so that when laid they will form a sewer with a uniform invert.

E. Uniform Pipe Bearing

1. Special care shall be taken to insure that the pipe is solidly and uniformly bedded, cradled, or encased according to the Drawings. For pipe with a bell that is larger than the barrel of the pipe, the bedding material shall be removed to a depth that will provide continuous support for the bell and barrel. No pipe shall be brought into position for joining until the preceding length has been bedded, joined, and secured in place. Where a concrete cradle is required, the pipe shall be supported at no more than two places with masonry supports of minimum size sufficient to provide the required clearance and to prevent displacement during placing of concrete.

F. Alignment and Grade

1. Each piece of pipe shall be checked for vertical and horizontal alignment immediately after being laid. All adjustments to alignment and grade must be made by scraping away or filling in under the barrel of the pipe and not by wedging or blocking up any portion of the pipe or striking the pipe to drive it down. Curved alignments shall not be allowed except as directed by the Purchaser.

G. Backfilling to Secure Pipe

1. When the joint is made, sufficient backfill material shall be simultaneously placed along each side of the pipe to prevent moving the pipe off line and grade. Particular

care shall be used to prevent disturbance or damage to the pipe and the joints during backfilling.

H. Flotation and Water in the Trench

1. The Subcontractor shall take all necessary precautions to prevent flotation of the pipe in the trench. Water shall not be allowed to rise in the trench. The Subcontractor shall use well points, sump pumps, or another approved method of dewatering as required to lower the water table below the bottom of the excavation while minimizing the migration of fines from the surrounding area. The Subcontractor shall make a request to the Purchaser and receive approval prior to the use of special dewatering equipment other than well points or sump pumps. Dewatering operations are considered incidental to the work and no additional compensation will be made to the Subcontractor.

I. Open Ends

1. Whenever pipe laying is stopped for any significant length of time, such as at the end of a workday, the unfinished end shall be protected from damage and a temporary tight fitting plug or bulkhead shall be placed in the exposed ends of the pipe to keep soil or other debris from entering the pipe.

J. Concrete Cradle Section next to Manhole

1. The pipe shall be supported from the manhole wall to the limits of the manhole excavation in a normal sewer trench with a concrete cradle, structurally continuous with the manhole base slab or footing. Cost for this work is incidental to the cost of the pipe installation.

K. Cutting Pipe

1. Cutting shall be in a neat workmanlike manner at right angles to the pipe axis without damage to the pipe. The Subcontractor shall smooth the cut end by power grinding or filing to remove burrs and sharp edges.

L. Wyes and Special Fittings

1. Wyes, stubs, reducers, fittings, or other special pipes shall be installed as shown on the Drawings or where ordered by the Purchaser. The fittings and special pipes shall be made of a compatible material, type, and class and/or strength designation as the pipe and installed as required by the Drawings and Specifications. The cost for providing and installing the above items is incidental to the cost of the pipes.

M. Detection Tape or Wire

1. All buried, non-metallic water and sewer pipe shall be identified by buried detection tape or wire. Tape shall be placed directly over the pipe between one foot and three feet below finished grade and at least one foot above the top of the pipe. Detection wire shall be placed just below or beside the pipe.

3.05 PIPE JOINTS

A. General

1. Pipe shall be jointed immediately following the laying of each section. No pipe section shall be left overnight which has not been completely jointed to the preceding pipe section in conformance with these Specifications.

2. The following provisions will apply to insure tight and sound joints:

    a. The joint will be placed with special care to avoid breaking joints and to leave gasket, if required, in proper position.
    b. All pipe 12 inches in diameter or larger will have dead weight held by crane while being lined up and pushed home.
    c. Pipe will be pushed home with a constant and even force and not jarred home by the momentum of a moving force that will place an impact load on pipe.
    d. Cement and lubricant will be used as recommended by the manufacturer and designated by the Purchaser.

B. Compression Joints

1. The two ends to be joined shall be thoroughly cleaned and a compression gasket compatible with the type of pipe to be joined shall be at the position recommended by the pipe manufacturer.

2. Lubricant recommended by the gasket manufacturer shall be liberally applied to the gasket and both ends immediately before pipe ends are joined. The upstream pipe shall be positioned such that the spigot may enter the bell squarely. The pipe being laid shall be pushed home and the gasket position checked with a feeler gauge before installation of the next section. Flat, unconfined gaskets on concrete pipe shall be cemented to the spigot at the position recommended by the pipe manufacturer.

C. Mechanical Joints

1. The two ends to be joined shall be thoroughly cleaned with a wire brush and the plain end, socket end, and gasket shall be brushed with soapy water. The end shall be centered in the socket and adequate anchorage shall be provided to hold the pipe in position until the joint can be completed. When deflecting pipe from a straight line is necessary, the deflection shall be made after joint assembly and before tightening bolts. Pipe deflection shall not exceed that specified by ANSI C 600.

2. When tightening bolts, it is essential that the gland be brought up toward the pipe flange evenly, maintaining approximately the same distance between the gland and the face of the flange at all points around the socket. All bolts shall be torqued to the required range recommended by the pipe manufacturer. The Subcontractor shall avoid over stressing the bolts. Gauge lines on the spigot end shall be checked following assembly to ensure proper positioning of bell and spigot has been accomplished.

3. Any joints not properly positioned shall be disassembled, cleaned, and reassembled as previously indicated.

D. Flanged Joints

1. The two ends to be joined shall be thoroughly cleaned with a wire brush. Bolt holes on each pipe flange to be joined shall be aligned and bolts inserted. Bolts shall be torqued evenly by alternating tightening of bolts opposite one another until all bolts are torqued to the recommended pressure.

F. Restrained Joints

1. Restrained push-on joints are to be used as specified on the Drawings or by the Purchaser. These special joints shall be installed as specified by the manufacturer.

The length of the pipe to be restrained will be determined by the Purchaser based on pipe size, internal pressure, depth of cover, and soil characteristics around the pipe.

3.06 SERVICE CONNECTIONS

A. The Subcontractor shall install a new lateral with cleanout for each house connection. Cleanouts should be located on the property line or easement with 6-inch PVC (SDR 26) with a minimum slope of 1 percent unless otherwise directed by the Purchaser.

B. The Subcontractor shall provide a Double Sweep PVC cleanout with a PVC screw plug cap and 4-inch PVC stack pipe. When installed, the cap shall lie 3-inches below finished grade.

C. If the existing service connection is 4-inch diameter, the Subcontractor shall provide a 6-inch to 4-inch concentric PVC reducer to connect the new 6-inch lateral to an existing 4-inch private property lateral.

D. The Subcontractor shall connect the new lateral to the PVC main with a PVC fitting in accordance with the details shown on *Typical Installation of Service Lateral*.

3.07 PIPE CAPS AND PLUGS

A. Wyes, stubs, or other fittings installed in the pipe for future connections shall be closed at the open end. For pipes 21 inches in diameter or smaller, an approved cap or plug shall be installed in the bell or socket using the same type joint or jointing material as required for the sewer. For pipes larger than 21 inches in diameter, temporary approved masonry bulkheads of the thickness required by the Drawings and Specifications to close the open end may be substituted for stoppers. Care in backfilling shall be used so that such closure and its seal will not be disturbed. This stopper shall be jointed so that it may be removed later without injury to the pipe itself. Work and material is incidental to the cost of the pipe installation.

3.08 INVERTED SIPHONS

A. Each siphon will include inlet, outlet, and any intermediate manholes where shown on the Plans with all foundations, pipes, and pipe encasement and other appurtenances. Pipe to be included in the cost of the siphon is to be all pipe, fittings and specials between the center of the inlet manhole and the center of the outlet manhole.

B. The Contractor will construct cofferdams, temporary bulkheads, perform all pumping and other work necessary to protect the siphon during construction. The Contractor will be required to maintain a dry trench during construction, and will never be permitted to lay pipe or place concrete with water in the trench. Trenches will be kept free from water until the material in the joints and masonry has sufficiently hardened.

C. Unless otherwise specified, inverted siphon pipe will be HDPE conforming to Specification Section 02530 Paragraph 2.01.N. The siphon pipes will be encased in concrete at the locations and to the dimensions shown on the Plans or Design Standards. The excavation, bedding, laying, jointing, pipe encasement, and backfill operations will conform to the applicable sections of this Specification.

D. When shown on the Plans, flexible joint ductile iron pipe will be used instead of push-on joint pipe as shown on Design Standards. Flexible joint pipe will be laid such that the maximum joint deflection as specified by the pipe manufacturer for each joint is not exceeded.

E. The inlet, outlet, and any intermediate manholes will be constructed according to the requirements of Specification Section 02531.

F. The inlet and outlet manhole inverts will be carefully shaped to conform to the inlet and outlet pipes and cause the least possible resistance to flow. The inlet manhole will have an invert weir constructed to contain low flows to a single siphon pipe. The invert weir will be level across the top and constructed to the elevation shown on the Plans. The outlet manhole invert will be formed to reduce backflow into the inactive siphon pipes.

3.10 BACKFILLING

A. General

1. After sanitary sewer facilities have been bedded and installed according to these Specifications and upon permission of the Purchaser, the backfill may be placed. Backfilling operations shall continue following as closely behind pipe installation as practical. All backfill shall be placed in uniform horizontal layers. Pushing backfill material down a ramp into excavated areas will not be permitted. No trash will be allowed to accumulate in the space to be backfilled. Particular care shall be taken to avoid allowing wood to be included in the backfill, other than sheeting and shoring that has been approved by the Purchaser to be left in place.

2. The Subcontractor shall be responsible for the condition of the trenches and filled areas during the contract and warranty period. The Subcontractor shall maintain frequent inspection of the same. If at any time during the 12-month warranty period the trenches or filled areas settle and sunken places appear, the Subcontractor shall be required to refill these sunken places when they are discovered with suitable material and will replace all damaged curb, gutter, and sidewalk. All soft or dangerous trenches shall be marked, barricaded and caution lighted for the protection of the public.

3. Property with an existing dwelling located on it or lots within a developed subdivision or planned development are considered improved property.

B. Street Right-of-Way and Improved Property

1. Backfill Material: Backfill for manhole and pipe trench excavations through pavements in street or highway right-of-way or where the Purchaser orders, shall be made with pit run gravel or other acceptable material as approved by the Purchaser. The backfill shall be from the top of the pipe embedment material or manhole foundation to the subgrade elevation of the pavement. Pea gravel or similar granular material approximately uniform in size and without bonding properties will not be used.

2. Backfill for manhole and pipe trench excavations beyond pavements in street or highway right-of-way or outside public right-of-way shall be made with select earth from the top level of the pipe embedment material or foundation to the subgrade elevation in paved area, or within 1 inch of the surface in areas to be sodded, or to the surface in all other areas.

3. Select material shall be free from debris, organic matter, perishable compressible material and will contain no stones or lumps larger than 6 inches. Rocks and lumps smaller than 6 inches will not exceed an amount that will interfere with the consolidating properties of the fill material. Care shall be taken that stones and lumps are kept separated and well distributed, and that all voids are completely filled with fine material. No rocks or lumps will come in direct contact with the pipe. The upper

3 feet of backfill in sodded or planted areas will be free of rocks or lumps larger than 1 inch in diameter.

4. Placement and Compaction:

   a. Sanitary Sewer Trenches: Backfill material shall be placed by hand in 6 inch loose layers and tamped to a point 2 feet above the outside top of the pipe. Backfill will be compacted with suitable mechanical tamping equipment with special care being taken not to damage the pipe or joints. Use of compaction equipment directly above semi-rigid and flexible pipe should be avoided until sufficient backfill has been placed to ensure that the equipment will not damage the pipe. A minimum of 36 inches of compacted backfill above the top of semi-rigid and flexible pipe shall be in place before wheel loading and a minimum of 48 inches of compacted backfill before use of pneumatic tampers. From these elevations to the subgrade elevation of the pavement, bottom of the sod, or to the original ground surface, suitable backfill shall be mechanically placed in 9 inch, maximum, loose layers. All backfill material shall be compacted to 95 percent of maximum density at plus or minus 2 percent of optimum moisture content as determined by Laboratory Standard Proctor Test (ASTM D 698).

   b. Manholes and Special Structures: When the masonry or concrete work has set sufficiently to withstand compaction, and the Purchaser authorizes, backfill material will be placed in 6 inch loose layers and compacted with heavy tampers or pneumatic tampers to 95 percent of maximum density at plus or minus 2 percent of optimum moisture content as determined by Laboratory Standard Proctor Test (ASTM D 698). Suitable backfill shall be placed in this manner from the foundation of the structure to the subgrade elevation of the pavement, the bottom of the sod or to the original ground surface.

C. Open Areas and Unimproved Property

1. Backfill Material: Backfill of excavations on unimproved property shall be made with select material from the top level of pipe embedment material or foundation to the surface. Non-granular select material to be used for backfill will be free from debris, organic matter and perishable compressible material, and will contain no stones or lumps or rock fragments larger than 6 inches. Rocks or lumps smaller than 6 inches in diameter will not exceed an amount that will interfere with the consolidating properties of the fill material. No rocks or lumps shall come in direct contact with the pipe. Stones and lumps shall be kept separated and well distributed, and all voids shall be completely filled with fine material.

2. Placement of Backfill: Backfill procedures specified in Specification Section 02530 Paragraph 3.10.B shall apply from the trench bottom to a point 2 feet above the outside of the pipe. From this point to slightly above the surrounding surface elevation, suitable backfill may be placed by bulldozer or other mechanical means.

E. Removal of Excess Material

1. After the trench or excavation has been properly backfilled, all excess dirt shall be removed from the streets, roadways and improved private property so pavements or turfed areas may be replaced and properties cleaned.

2. In open areas and unimproved property, the excess material may be used to fill low spots on property next to the right-of-way/easement. Before spreading excess soil, the Subcontractor shall obtain written permission from the property owner for the spreading of excess soil, and a copy of the written permission shall be submitted to

the Purchaser. Such spreading or filling shall not obstruct surface drainage and be to the satisfaction of the property owner. Excess material shall be disposed of by the Subcontractor.

3.11 BYPASS PUMPING

A. As required for acceptable completion of the work and/or to avoid damages due to sewer spills or overflows, the Subcontractor shall provide for sewer flow maintenance around the line segments and manholes designated for rehabilitation. The bypass shall typically be made by plugging the line at an existing upstream manhole and pumping the flow into a downstream manhole or adjacent sanitary sewer system. The pump and bypass lines shall be of adequate capacity and size to handle the anticipated flow. Bypassing of sanitary sewage into the storm water system will not be allowed. For all bypass pumping, pump noise shall be kept to a minimum to the satisfaction of the Purchaser. The Subcontractor shall be required to contact all residential and commercial customers whose service lines connect to the sewer main being bypassed and inform them that they will be temporarily out of service. The Subcontractor shall also advise those customers against water usage until the mainline is back in service. After completing the necessary work on the main line, the Subcontractor shall advise those customers that the sewer main is back in service.

B. Bypass pumping is defined as providing pumps, standby pumps, piping, elevated structural support for aerial crossings, manpower to operate, routine maintenance and repair capability, pipe plugs, fuel, route and pump site clearing and any other work necessary to provide a complete bypass pumping operation. Any structures proposed by the Subcontractor for construction over or penetration into the interceptor piping for the purpose of performing the bypass operations must be approved by the Purchaser prior to implementation. The Subcontractor shall submit design drawings and details that are signed and sealed by a professional engineer licensed in the State of Tennessee. All bypass pump schemes must be submitted to and approved by the Purchaser in advance.

C. Public advisory services shall be required to notify all parties whose service laterals will be out of service and to advise against water usage until the mainline is back in service.

D. The Subcontractor shall be required to provide businesses with temporary service, as needed, and shall be responsible for all necessary bypass pumping flows.

3.12 TUNNELING, BORING, AND JACKING

A. General

1. Sewer pipe will be constructed by tunneling, boring, or jacking only at those locations shown on the plans or directed by the Engineer. Carrier pipe for these applications will be of the type specified in the Plans and Specifications. Grade and alignment will be maintained through all liner pipes. The Contractor will submit shop drawings detailing the method, equipment and material to be used for tunneling, boring and jacking operations to the Engineer for review and approval. The approval by the Engineer of any drawings or plans will not in any way be deemed to release the Contractor from full responsibility for complete and accurate performance of the Work according to the Contract Drawings and Specifications.

2. When tunneling, boring, or jacking is required under railroads, highways, streets, or other facilities, construction will not interfere with the operation of the railroad, street, highway, or other facility and will not weaken or damage any embankment or structure. No water shall be introduced into any tunneling, boring or jacking excavation that lies within City, State or Rail Road right-of-way. A boring that uses a bentonite slurry may be

allowed at the discretion of the Engineer and the owner of the right-of-way.

3. The Contractor will be responsible for protection of utilities and sewers against damage by his work. If any utility above or near the tunnel is endangered or has been damaged because of the construction operations, the utility owner will be notified immediately and will be given access to the area to carry out all necessary repairs to such utilities. If any sewers are damaged, it will be the responsibility of the Contractor to make the necessary repairs. If any public or private property is endangered or has been damaged due to tunneling, boring, or jacking operations, it will be repaired at the Contractor's expense. All cost and expense to the Contractor of carrying out the above requirements will be considered included in his bid prices for the completed sewer installation.

4. Access pits will be of sufficient size to provide ample working space for the jacking or boring equipment, reaction blocks, bracing, liner plates, spoil removal, and 2 sections of pipe. Provisions will be made for the erection of guide rails in the bottom of the pit where applicable. If drainage is to be discharged from the jacking pit, a collection sump will be provided. Wherever end trenches are cut in the sides of the embankment or beyond it, such work will be sheeted securely and braced satisfactorily to prevent earth caving.

5. The Contractor will furnish and operate all necessary pumping equipment of ample capacity and arrange to keep tunnels and shafts free of water during construction and to dispose of water satisfactorily. During placement of concrete, drainage and pumping will be arranged so concrete is placed in dry conditions. No water will flow over the concrete until it has set and will not be damaged.

B. Tunneling

1. The Contractor will carry out the work of tunneling so there will be no cave-in or heaving of earth or other material into the tunnel excavation. If there should be any fall or movement of earth into the tunnel, the Contractor will proceed with the work with all necessary precautions to insure the safety of life and of sewers, utilities and public and private property above and near the tunnel.

2. The Contractor will furnish, place, and maintain all sheeting, bracing, lining or casing required to support the tunnel until the pipe and its bedding, jointing, encasement, and backfilling have been completed. All liners will remain in place.

3. Care will be used in trimming the surfaces of the excavated section and in placing the liners or sheeting and bracing so that the required minimum clearance between the outside of the pipe and the final position of the liners, sheeting and bracing in the tunnel will be attained without any deviation in sewer alignment. Sheeting or lining must be placed and held tightly against the trimmed earth surface of the excavated section so that there will be no voids between the earth and the lining or sheeting.

4. No part of the lining, bracing, or flanges of steel liner plates will project closer to the outside of the pipe or pipe bells than the clearance limits shown on the Plans, or a minimum of two inches, if not shown on the Plans.

5. If timber is used for lining and bracing instead of steel liner plates, invert struts will be placed at the required intervals but in such manner that the pipe and its bedding will be supported entirely by the original earth floor of the tunnel and not on timber lining or bracing. All timbers, when placed for the support of the roof and sides of the tunnel, will be properly fitted and wedged in place. Timber sets in tunnels will be abutting. All voids behind timbers will be filled with blocking or other suitable material.

6. Timbering will be designed and placed to allow the filling of voids. All excavated

material not required for backfilling abandoned shafts or for reuse by the City will be removed from the site and disposed of by the Contractor at his expense. Contractor shall coordinate with the City before disposing excavated material.

7. Shafts will be constructed at the location shown on the Plans. Temporary construction shafts will be of adequate size and properly constructed and equipped to meet all safety requirements. All shafts will be barricaded, lighted, fenced, and properly guarded from the beginning of the excavation until the completion of the construction requiring the shaft.

8. Provision will be made at all shafts so that plumb lines suspended on the centerline of the sewer at each end of the shaft will hang freely from the surface.

9. A ladder meeting OSHA requirements will be provided in each shaft and will be kept in safe, good repair, clean and clear of debris.

10. Cavities between the surfaces of excavation and the tunnel liner plates or sheeting will be completely filled with a uniform sand cement grout consisting of 1 part portland cement and 7 parts sand and the minimum amount of water necessary for proper placement. Grout will be placed under pressure through grout holes in the steel liner plates or sheeting. The grout holes will be located and the grout placed in such sequence to insure the complete filling of all cavities and to transfer the load from the undisturbed material to the tunnel lining or sheeting uniformly.

11. After the tunnel section is excavated, lined, and braced, the pipe will be placed on and supported by steel rails or other approved supports. The supporting system will assure line and grade and will allow space below the pipe for concrete grout. Care will be used to avoid damage to the pipe and the liner plates.

12. The space between the pipe and the tunnel will be completely grouted with a mixture of sand and portland cement, mixed in the proportions of 1 part cement to 7 parts sand by volume and a minimum amount of water necessary for proper placement whether placed under pressure or by hand.

13. Temporary shafts will be completely abandoned. Unless otherwise specified in the Plans or Contract Documents all sheeting, bracing, and similar items may be removed unless the Contractor requests and receives authorization from the Engineer to leave it in place. No payment will be made for items left in place at the Contractor's option. If the Plans or the Engineer requires leaving the sheeting, bracing, and similar items in place, measurement will be made as provided in Specification Section 02530.5 and payment will be made as provided in Specification Section 02530.6.

C. Boring

1. When required by the Plans, sewers will be installed in bored holes. The holes will be bored from the downstream end, unless site conditions dictate otherwise and the Engineer approves.

2. The boring machine to be used will be in good condition and capable of drilling the bore hole within the required limits of accuracy. A smooth liner of sufficient strength will be forced into the bored hole to give a tight fit against the earth sides of the bore hole and still provide a uniform clearance of at least two inches around the pipe flange to permit pressure grouting. The liner pipe will be carefully inspected to insure that the carrier pipe can be properly placed.

3. All carrier pipe shall be mechanical joint or restrained joint pipe. Manholes at the ends

of a section of bored pipe will not be constructed until the bored section is completed.

4. The following procedures will be used for carrier pipe 18 inches and larger in diameter. The assembled pipe will be placed in the bored hole with approved, non-metallic, casing spacers attached. Casing spacers will be attached in accordance with the manufacturer's recommendations and with a casing spacer installed within 6 inches of each end of the bore. The assembled pipe will be placed in the bored hole only by such method that will keep the joints in compression. Any method that disjoints the pipe while being placed will not be permitted.

5. The ends of the bore shall be sealed with an approved, flexible end seal. The end seals shall be attached in accordance with the manufacturer's recommendations using stainless steel hardware.

6. When unforeseen obstructions or conditions require abandonment of a partially completed bore hole, and the starting of a new hole, the Contractor will grout the abandoned bore hole solid. The Contractor will receive no compensation for any expenses incurred by any unsuccessful attempt.

D. Jacking

1. The Contractor will furnish for the Engineer's review, a plan showing his proposed method of jacking, including the design for the jacking head, jacking support or back stop, arrangement and position of jacks, pipe guides, and similar items in the assembled position. The review of this plan by the Engineer will not relieve the Contractor from his responsibility to obtain the specified results.

2. Heavy duty jacks suitable for forcing the pipe through the embankment will be provided by the Contractor. In operating jacks even pressure will be applied to all jacks used. A suitable jacking head and bracing between jacks and jacking head will be provided so that pressure will be applied to the pipe uniformly around the circumference of the pipe. A suitable jacking frame or backstop capable of resisting the jacking forces will be provided. The pipe to be jacked will be set on guides, properly braced together to support the section of the pipe and to direct it in the proper line and grade. The whole jacking assembly will be placed to line up with the direction and grade of the pipe. The Contractor may use a cutting edge of steel plate around the head end of the pipe extending a short distance beyond the end of the pipe with the inside angles or lugs to keep the cutting edge from slipping back onto pipe. Jacking pressures will be continuously recorded and available for inspection. Jacking pressure logs will be made available to construction inspectors for review at the end of daily. A final compiled log of jacking pressures shall be submitted to Owner at completion of Jack-Boring operation.

3. The pipe will be jacked from the downstream end. Manholes at the ends of a section of jacked pipe will not be constructed until jacked section is completed.

4. Any pipe damaged in jacking operations will be removed and replaced by the Contractor at his own expense. Embankment material will be excavated just ahead of the pipe and material removed through the pipe, and the pipe forced through the embankment with jacks, into the space thus provided.

5. The excavation for the underside of the pipe, for at least one-third of the circumference of
the pipe, will conform to the contour and grade of the pipe. A clearance of not more than 2 inches may be provided for the upper half of the pipe. This clearance is to be tapered off to zero at the point where the excavation conforms to the contour of the pipe.

6. The distance that the excavation will extend beyond the end of the pipe depends on the character of the material, but it will not exceed 2 feet in any case. This distance will be decreased if the character of the material being excavated makes it desirable to keep the advance excavation closer to the end of the pipe.

7. A cushion material will be placed in the joints between each pipe section adequate to distribute the jacking forces around the entire periphery of the pipe uniformly.

8. When jacking of pipe is begun, the operation will be carried on without interruption, as much as practicable, to prevent the pipe from becoming firmly set in the embankment.

9. The pits or trenches excavated to allow jacking operations will be backfilled immediately after the jacking of the pipe has been completed according to Specification Section 02530 Paragraph 3.11.

E. Sewer Pipe in Jacked Liner

1. When required by the Plans or Contract Documents, a sewer pipe will be installed by jacking a pipe as a liner and inserting a carrier pipe of required size, type, and class. When using jacking for liners, the steel liner will be welded steel, 35,000 psi yield strength, and of the diameter and wall thickness required on the Plans and Specifications. The Contractor will provide, at his own expense, thicker walled lines if necessary to withstand the forces of jacking. In any case, the Contractor will retain full responsibility for the adequacy of this jacking operation, equipment and material.

3.13 FINAL GRADING

A. Final grading around sanitary sewer facilities shall conform to the elevation of adjacent undisturbed ground or as shown on the Drawings. Sufficient grading shall be done to provide adequate drainage.

3.14 CLEANING

A. All necessary precautions shall be taken to prevent the entrance of mud, sand, or other obstructing material into the pipelines. As the work progresses, the interior of the sewer shall be cleaned of all dirt, jointing material and extraneous material. On small pipe where cleaning after laying may be difficult, a squeegee shall be kept in the pipeline and pulled forward past each joint immediately after its completion. Before final inspection the Subcontractor shall remove all debris and foreign material.

3.15 TRAFFIC CONTROL

A. All traffic control shall be installed and maintained in accordance Section 01551 – Traffic Control for Work Zones. At a minimum, the Subcontractor must have two trucks with flashing yellow lights on the work site. Traffic cones must also be placed downstream of the construction site to divert cars into the adjacent lane(s) per MUTCD requirements. On roads with a heavy traffic volume, a flagman may also be needed to assist with traffic control. At the end of each working period, the Subcontractor shall plate all open excavations to maintain traffic flow.

3.16 FALL PROTECTION

A. Subcontractor shall install and maintain all fall protection measures in accordance with the SARP10 Loss Control Manual. The Subcontractor shall construct a controlled access

zone around the manhole being adjusted. At a minimum, the fall protection zone shall include traffic cones encircled with pennant tape. The controlled access zone must have one point of access with an entrance log.

3.17 PROTECTION OF DOWNSTREAM FACILITIES

A. The Subcontractor must take all steps necessary to assure that no material is allowed to fall into the line during his installation process. The Subcontractor shall bear all cost of repairs resulting from any damages to downstream facilities resulting from failure to abide by this stipulation.

3.18 WASTEWATER SPILLS

A. Should the Subcontractor spill any wastewater, such that the sewage either immediately or ultimately enters the waters of the State of Tennessee, then the Subcontractor shall be completely responsible for any fines or penalties imposed on the Purchaser or the Subcontractor by the USEPA or the State of Tennessee. The Subcontractor shall notify the Program Manager immediately in the event of a spill.

PART 4- FINAL TESTING AND ACCEPTANCE

4.01 VISUAL INSPECTION

A. All work will be subject to visual inspection for faults or defects and any such deviation or omission will be corrected at once.

B. A PACP CCTV inspection in accordance with Section 00003 shall be submitted after pipe replacement is competed.

4.02 LEAKAGE TESTS

A. On sewers with no house connections, leakage tests shall be performed on the full length of all sewer lines and manholes in the presence of the Purchaser before acceptance. On all other sewers, an infiltration test shall be performed. The cost of all testing will be included in the unit price for the item being tested.

B. Air Leakage Test for 8-24 inch Diameter Pipe

1. Upon completion of construction, or earlier if the Purchaser deems advisable, the Subcontractor shall provide the necessary equipment and labor to perform low pressure air tests according to ASTM F1417. This test shall be performed in the presence of the Purchaser and shall be for all types of gravity sewer pipe. This test shall also include service lines from manholes.

2. The pressure test gauge will meet the following minimum specifications:

a.	Size (diameter)	4 ½ inches
b.	Pressure Range	0-15 PSI
c.	Figure Intervals	1 PSI Increments
d.	Minor Subdivisions	0.05 PSI
e.	Pressure Tube	Bourdon Tube or diaphragm
f.	Accuracy	Plus or minus 0.25% of Maximum scale reading
g.	Dial	White coated aluminum with black lettering, 270° arc and mirror edges
h.	Pipe Connection	Low male ½ inch NPT

3. Calibration data shall be supplied with all pressure test gauges. Certification of pressure test gauges shall be required from the gauge manufacturer. This certification and calibration data shall be available to the Purchaser whenever air tests are done.

4. Air leakage tests shall be performed on each reach of sewer pipe between manholes after completion of the installation of pipe and appurtenances and the backfill of sewer trenches. The test time shall be determined from the following table. If air tests fail to meet the following requirements, the Subcontractor shall repeat tests as necessary after all leaks and defects have been repaired. Before acceptance, the same sewer reach shall pass the low pressure air test.

Time Required for a 1.0 psig Pressure Drop for Size and Length of Pipe Indicated[1]

Pipe Diameter (in.)	Minimum Time (min:sec)	Test Time for Length of Sewer Tested (min)
8	7:34	1.52 X L(ft)/60
10	9:26	2.374 X L(ft)/60
12	11:20	3.418 X L(ft)/60
15	14:10	5.342 X L(ft)/60
18	17:00	7.692 X L(ft)/60
21	19:50	10.47 X L(ft)/60
24	22:40	13.674 X L(ft)/60

1. Establish the test time for the sewer length from the formula or the minimum time, whichever is greater.

C. Infiltration Test

1. Infiltration tests may be required for the complete line or any portion of it. Failure of any part of the line to pass an infiltration test shall be sufficient reason to require additional work by the Subcontractor to reduce the infiltration in such portions of the line tested. The passing of an infiltration test shall in no way relieve the Subcontractor of any responsibility to repair visible leaks found during the visual inspection.

2. Maximum allowable infiltration shall be 0 gallons per mile per inch of diameter of sewer per 24-hour day at a time. The joints shall be tight, and visible leakage in the joints of leakage greater than that specified above shall be repaired at the Subcontractor's expense by any means necessary.

4.03 DEFLECTION TEST - SEMIRIGID AND FLEXIBLE PIPE

A. All polyvinyl chloride (PVC) pipe and glass fiber reinforced polymer mortar pipe shall be tested for deflection. All testing shall take place after backfill has been in place at least 30 days. All lines shall be thoroughly cleaned before testing to assure accuracy.

B. Tests shall be run using a rigid ball or nine arm mandrel having a diameter of 95% of the inside diameter of the pipe for PVC and 96% of the inside diameter of the pipe for glass

fiber reinforced polymer mortar pipe. The mandrel will be pulled freely by hand through the pipe from manhole to manhole. No pipe deflection will exceed 5% for PVC and 4% for glass fiber reinforced polymer mortar pipe. Any section failing the test shall be repaired by re-bedding or pipe replacement and retested to the satisfaction of the Purchaser.

C. The cost of this service shall be included in the unit price bid for the pipe.

4.04 FINAL ACCEPTANCE

A. When all work required by the Contract has been completed, the Subcontractor shall submit to the Purchaser written certification from a registered land surveyor that the centerline of each structure is within 2.0 feet of the centerline of the sewer easement or the location designated on the Drawings. After receiving the surveyor's certification from the Subcontractor, the Purchaser will make a final inspection of the Work, including any tests for operation. After completion of this inspection, the Purchaser will, if all things are satisfactory to him, issue to the Subcontractor a Certificate of Completion certifying that the Work required by the Contract has been completed according to the Contract Drawings and Specifications. However, the Certificate will not operate to release the Subcontractor or his sureties from any guarantees under the Contract or the Performance Bond. Upon receipt of the Certificate of Completion the Subcontractor will clean the premises and see that they are in an orderly condition.

PART 5- MEASUREMENT

5.01 LOCATE AND EXPOSE MAINLINE TERMINUS

A. Locate and expose mainline terminus shall be measured per each.

5.02 UNDERCUT BACKFILL

A. Undercut backfill will be measured by the ton of stone or soil in place.

5.03 SEWER PIPE

A. Sewer pipe length will be measured per linear foot along the centerline of the pipe from center of manhole to center of manhole. When there are special structures, sewer pipe will be measured from inside face to inside face for the various sizes, types, classes or wall thicknesses.

B. Sewer pipe length measurement will include the length of wyes as measured along the primary axis for all sizes of sewer pipe.

5.04 SERVICE CONNECTION REMOVAL AND REPLACEMENT

A. Service connection removal and replacement for construction of sewer facilities will be measured per each. Service Connections damaged by the Subcontractor that do not require removal and replacement for construction of sewer facilities will not be measured for payment.

5.05 PAVEMENT BACKFILL

A. Pit run gravel or other acceptable material used for backfill under pavements or other areas directed by the Purchaser will be measured by the cubic yard in the following manner. Cubic yards of Pavement Backfill equals the linear feet of sewer pipe installed directly below pavement as measured along the centerline of the pipe multiplied by the

trench payline width in feet multiplied by the depth of pavement backfill material in feet divided by 27. The trench payline width is defined as the outside diameter of the sewer pipe plus 2 feet. The depth of pavement backfill is defined as the distance from 6 inches above the top of the sewer pipe to the subgrade elevation of the pavement.

5.06 BYPASS PUMPING

A. Bypass pumping will be measured as a lump sum item.

5.07 TRAFFIC CONTROL

A. Traffic control will be measured as specified in Section 01551 – Traffic Control for Construction Work Zones.

5.08 INVERTED SIPHONS

A. Inverted siphons constructed according to Plans and Specifications will be measured per lump sum for each siphon complete in place.

5.09 HYDROEXCAVATION/HAND DIGGING

A. Hydroexcavation and/or hand digging of the trench perimeter will be measured per linear foot of sewer pipe replaced.

5.10 EXCAVATION

A. All work for excavation, blasting, drainage of trenches and dewatering, backfilling of excavation, compaction, grading, protection of existing utilities, disposal of excess material, and all other similar items included in this section of the Specifications but not covered by a Pay Item herein will be considered obligations of the Subcontractor under other Pay Items of the Contract.

5.09 PIPE WYES

A. Pipe wyes on sewer lines will not be measured for payment, but are incidental to the cost of furnishing and installing sewer pipe.

5.10 STEEL CASING

A. Measurement shall be along the centerline of the installed steel casing pipe. Measurement shall not be made of incidental work, including sheeting, shoring, grout, excavation, backfill, dewatering, or other work related to installing the steel casing pipe complete and in place.

5.11 TRACER WIRE

A. No separate measurement shall be made for tracer wire or appurtenances. Tracer wire and appurtenances shall be considered incidental to the sewer and/or service connection installation.

PART 6 - PAYMENT

6.01 LOCATE AND EXPOSE MAINLINE TERMINUS

A. Locate and expose mainline terminus will be paid for at the contract unit price per each.

This item will include but not be limited to all means necessary for locating and excavating the terminus of the sewer when no manhole exists. This item will not include any pay items related to the installation of a new manhole.

6.02 UNDERCUT BACKFILL

A. Accepted quantities of undercut backfill will be paid for at the contract unit price per ton of limestone furnished and placed, which will be full compensation for undercut excavation, special protection, protection of existing utilities, and backfilling to bottom of facility subgrade elevations, complete in place.

6.03 SEWER PIPE

A. The accepted quantities of all sewer pipe will be paid for at the contract unit price per linear foot furnished and laid for the various sizes, types, classes, or wall thicknesses of pipe, which will be full compensation for material and material testing, excavation, special protection, protection of existing utilities, maintenance of sewage flow, proper pipe embedment, laying, jointing, cleaning and inspection, conducting acceptance tests, installation of pipe wyes, connection to manholes, adapters and couplings, stoppers, and removal and/or abandonment of existing pipe within the limits of excavation and backfilling outside pavement areas.

6.04 SERVICE CONNECTION REMOVAL AND REPLACEMENT

A. Accepted quantities of building connections removed and replaced will be paid for at the contract unit price per each for various types of building connections, which will be full compensation of excavation, removal of old service line and appurtenances, furnishing and construction of new service lines, connection fitting to main sewer, PVC 4-inch stack pipe, double sweep cleanout, PVC cap with screw plug, 6-inch by 4-inch PVC reducer, and connection to the existing private lateral and appurtenances to remain, backfilling, testing and inspection, complete in place.

6.05 PAVEMENT BACKFILL

A. Accepted quantities of pit run gravel or other acceptable material used for backfill under pavements or other areas designated by the Purchaser will be paid for at the contract unit price per cubic yard furnished and placed, which will be full compensation for furnishing, placing and compacting the selected material.

6.06 BYPASS PUMPING

A. Bypass pumping will be paid at the appropriate contract lump sum price. This item includes all materials and labor necessary to properly comply with the bypass pumping requirements listed in the specification.

6.07 TRAFFIC CONTROL

A. Traffic Control will be paid as specified in Section 01551 – Traffic Control for Construction Work Zones. Traffic control does not apply to segments being replaced in alleys or other locations where traffic is not impacted.

6.08 HYDROEXCAVATION/HAND DIGGING

A. Hydroexcavation and/or hand digging of the trench perimeter will be paid per linear foot

of pipe installed where one of these methods is used. Payment shall include all material and labor required to complete the item as specified.

6.09 STEEL CASING

A. The accepted quantities of all still casing pipe will paid for at the contract unit price per linear foot furnished and laid for the various sizes, types, classes, or wall thicknesses of pipe, which will be full compensation for installation, labor, pipe, materials, equipment, tools and incidentals necessary to complete the work.

6.10 TRACER WIRE

A. No separate payment shall be made for tracer wire or appurtenances. Tracer wire and appurtenances shall be considered incidental to the sewer and/or service connection installation.

PAYMENT WILL BE MADE UNDER:

Item No.	Pay Item	Pay Unit
02530-6.01	LOCATE AND EXPOSE MAINLINE TERMINUS	Each
02530-6.02	UNDERCUT BACKFILL	Ton
02530-6.03.6.01	6” POLYVINYL CHLORIDE (PVC) ALL DEPTHS	Linear Foot
02530-6.03.12.01	12” FIBERGLASS REINFORCED (FRP) 14.1’ - 20’ DEEP	Linear Foot
02530-6.03.18.01	18” POLYVINYL CHLORIDE (PVC) ALL DEPTHS	Linear Foot
02530-6.03.18.02	18” DUCTILE IRON PIPE (DIP) ALL DEPTHS	Linear Foot
02530-6.03.24.01	24” POLYVINYL CHLORIDE (PVC) 0’ - 6’ DEEP	Linear Foot
02530-6.03.24.02	24” POLYVINYL CHLORIDE (PVC) 6.1’ - 12’ DEEP	Linear Foot
02530-6.03.24.03	24” FIBERGLASS REINFORCED (FRP) ALL DEPTHS	Linear Foot
02530-6.03.36.01	36” FIBERGLASS REINFORCED (FRP) ALL DEPTHS	Linear Foot
02530-6.03.42.01	42” FIBERGLASS REINFORCED (FRP) 14.1’-16’ DEEP	Linear Foot
02530-6.03.42.02	42” FIBERGLASS REINFORCED (FRP) 16.1’-18’ DEEP	Linear Foot
02530-6.03.42.03	42” FIBERGLASS REINFORCED (FRP) 18.1’-20’ DEEP	Linear Foot
02530-6.04	SERVICE CONNECTION REMOVAL AND REPLACEMENT	Each
02530-6.05	PAVEMENT BACKFILL	Cubic Yard
02530-6.06	BYPASS PUMPING	Lump Sum
02530-6.08	HYDROEXCAVATION/HAND DIGGING	Linear Foot
02530-6.09	STEEL CASING	Linear Foot
02530-6.09.42	JACK & BORE – 42” FRP	Linear Foot

END OF SECTION 02530

fSECTION 02531
INSTALLATION AND REPLACEMENT OF MANHOLES

PART 1 GENERAL

1.01 SCOPE

A. This Work shall consist of the removal and replacement of existing or installation of new manholes for sanitary sewers as shown on the Drawings, stipulated in the Contract Documents, or as directed by the Purchaser. The construction shall be accomplished by these Specifications and in conformity with the details shown on the Drawings or established by the Purchaser.

B. Where existing manholes are being replaced, the Subcontractor shall arrange the work such that sewage flow shall be maintained during the construction period with no discharge of sewage slowing into an open trench and provide necessary bypass pumping capacity to carry flow downstream of the manhole to be replaced. Additionally, the Subcontractor shall be responsible for properly removing and disposing of the existing manhole when replaced.

C. All new manholes shall be precast concrete. The top section of the manholes shall be either flat top or eccentric cones as shown on Drawings.

D. Cast iron frames shall be set at the required elevation and properly bonded to the flat top, eccentric cone, or grade rings with two rings of butyl mastic sealant and anchor bolts.

1.02 SUBMITTALS

A. Unless otherwise specified all sample submittals shall be delivered to the Program Manager within two weeks of the NTP.

B. Shop Drawings:

1. Precast Manholes: Details of construction.

2. Precast Base, Cones, and Top Slab Sections: Details of construction.

3. Manholes Over Existing Piping:

    a. Drawings and schedule for diverting flow.

    b. Certificate from manufacturer of castings indicating they meet applicable requirements of these Specifications.

    c. Precast Manhole Sections: Manufacturer’s results of tests performed on representative sections to be furnished.

    d. Certified load test data for precast manhole steps.

    e. Plan for diversion of flow during installation of manhole over existing piping

1.03 DELIVERABLES

A. Manhole Acceptance

1. All manholes shall be subject to visual inspection by the Purchaser’s Representative for faults, defects, or deviations from the Drawings and any such deviation or omission will

be corrected by the Subcontractor. All tests shall be made by the Subcontractor who will provide necessary equipment for testing in the presence of and under the supervision and instructions of the Purchaser's Representative.

B. Manhole Vacuum testing for Precast Manholes

1. The Subcontractor shall provide all labor and equipment for vacuum testing.

2. All manholes shall be vacuum tested following backfill and compaction. The ring and lid casting assembly shall be installed prior to testing. The testing equipment shall consist of a gasoline-powered vacuum pump with sufficient vacuum hose length and a test head of proper size to fit the inside opening of the manhole. The test head shall be equipped with an inflatable rubber bladder to affect the seal to the manhole, an air pressure gauge, and a safety valve for filling the bladder, a 30-inch Hg liquid-filled vacuum gauge, a double air exhaust manifold with quarter turn ball valves, three bolt-on feet, and a bridge assembly with height adjustment rod.

3. Subcontractor shall plug all pipe openings, taking care to securely brace the plugs and the pipe. The plugs shall be placed a minimum of 6 feet beyond the manhole wall.

4. With the vacuum tester in place, Subcontractor shall inflate the compression to affect a seal between the vacuum base and the structure. Subcontractor shall connect the vacuum pump to the outlet port with the valve open and evacuate the manhole to 10-inches Hg (0.3 bar) for 48 inch diameter manholes and 5-inches Hg (0.15 bar) for 60-inch and greater diameter manholes.

5. Subcontractor shall close vacuum inlet/outlet ball valve, disconnect the vacuum pump, and monitor the vacuum for the specified time period. If the vacuum does not drop in excess of 1-inch Hg over the specified time period, the manhole is considered acceptable and passes the test. If the manhole fails the test, the Subcontractor shall identify the leaking areas by removing the head assembly, coating the interior surfaces of the manhole with a soap and water solution, and repeating the vacuum test for approximately thirty seconds. Once the leaks have been identified, Subcontractor shall complete all necessary repairs by sealing the leaks of the manhole to the satisfaction of the Purchaser, and repeat test procedures until satisfactory results are obtained.

Vacuum Test Timetable			
	Manhole Diameter (Inches)		
Depth (Feet)	**48"**	**60"**	**72"**
4'	10 sec.	13 sec.	16 sec.
8'	20 sec.	26 sec.	32 sec.
12'	30 sec.	39 sec.	48 sec.
16'	40 sec.	52 sec.	64 sec.
20'	50 sec.	65 sec.	80 sec.
24'	60 sec.	78 sec.	96 sec.
*	5.0 sec.	6.5 sec.	8.0 sec.
*Add extra testing time "T", for each additional 2-foot depth. (The values listed above have been extrapolated for ASTM designation C924-85.			

C. Warranty and Guarantee for Precast Manholes

1. The Subcontractor shall guarantee the rehabilitated manholes for ten (10) years after acceptance by the Owner to the extent that he will repair any leaks that may appear in them during this period because of faulty workmanship or materials furnished by him at no additional expense to the Owner.

D. Deliverables

1. The Subcontractor shall provide post-rehabilitation MACP inspections for each manhole in accordance with **Specification Section 00001 – Manhole GPS and MACP Inspection.**

PART 2 PRODUCTS

2.01 MATERIALS

A. Construction Material

1. All material furnished by the Subcontractor shall be new, high quality and free from defects. Previously used material in acceptable condition shall be allowed for bracing, forms, false work, and similar uses. Material not conforming to the requirements of the Specifications shall be considered defective and will be removed immediately from the site.

B. Qualification of Manufacturer

1. Manhole for sanitary sewers shall be the standard product of an established, reputable manufacturer made in a permanent plant. Suppliers for each material to be used by the Contractor shall be subject to the approval of the Purchaser. No material shall be delivered until the manufacturer and product have been approved by the Purchaser.

C. Mortar

1. Mortar shall be composed of one part Portland cement and two parts sand (volumetric measure) thoroughly mixed in a tight box, with water added gradually and mixed continually until mortar has attained the proper consistency for use in brick masonry; prepared only in such quantities as needed for immediate use; mortar mixed for more than 30 minutes, retempered, or previously set will not be allowed.

D. Cast Iron Castings

1. Castings shall be cast iron conforming to the Standard Drawings and the requirements of Class 30 ASTM A48; made accurately to the required dimensions; sound, smooth, clean, and free from blisters and other defects; not plugged or otherwise treated to remedy defects; machined so that covers rest securely in the frames with no rocking, and such that they are in contact with frame flanges for the entire perimeter of the contact surfaces. Castings shall be obtained from Universal Scaffolding.

E. Manhole Steps

1. Manhole steps shall not be allowed in sewer structures.

F. Butyl Mastic Sealant

1. The sealant shall be used when joining the casting frame to the precast manhole to provide a watertight structure. The sealing compound shall be produced from blends of refined hydrocarbon resins and plasticizing compounds reinforced with inert mineral filler,

and shall contain no solvents, irritating fumes, or obnoxious odors. The compound shall not depend on oxidizing, evaporating, or chemical action for its adhesive or cohesive strength. It shall be supplied in extruded rope form of suitable cross section and in such sizes as to seal the joint space. The Subcontractor shall use two complete ropes at each joint. The sealing compound shall be protected by a suitable removable two-piece wrapper, which shall be designed so that half may be removed longitudinally without disturbing the other half in order to facilitate application of the sealing compound. The sealant shall also meet the requirements of the following table:

Composition	**Test Method**	**Minimum**	**Maximum**
Bitumen (Petroleum Plastic Content)	ASTM D4	50	70
Ash Inert Mineral Matter	AASHTO T11	30	50
Volatile Matter	ASTM D6	---	2.0
Property	**Test Method**	**Minimum**	**Maximum**
Specific Gravity at 77 degrees F	ASTM D71	1.2	1.3
Ductility at 77 degrees F(cm)	ASTM D113	5.0	---
Softening Point	ASTM D36	320 degrees F	---
Penetration 77 degrees F (150 gms) 5 sec.	ASTM D217	50	120

G. Pre cast Manholes

1. All components shall meet the requirements of the Standard Drawings, ASTM C478, and ASTM C76 Class III. The mix design shall be:

Type I Portland Cement Content	615 Pounds per Cubic Yard
Fly Ash Content	85 Pounds per Cubic Yard
Coarse Aggregate Content	1,600 Pounds per Cubic Yard
Fine Aggregate Content	1,250 Pounds per Cubic Yard
Maximum Water/Cement Ration	0.40
Superplasticizer shall be added to create a workable slump.	

2. All cone sections and transition sections shall be eccentric. Barrel sections shall be custom made with openings to meet indicated pipe alignment and invert elevations.

3. The circumferential reinforcement for the manhole sections shall consist of welded wire fabric per ASTM C478.

4. Manholes shall be constructed with the minimum number of sections possible that the precaster can provide, to minimize the number of joints in the manhole. Minimum manhole section shall be 16 inches deep.

5. Each joint shall be a tongue and groove with two layers of butyl mastic sealant.

6. Pipe Connections:

a. Pipe connections to precast concrete manholes shall be with A-LOK cast in-place gaskets for new and replacement manholes. Grout shall not be allowed to encase A-LOK gaskets. Pipe connections for cured in place or for existing pipe shall be KOR N SEAL flexible connectors. Proper torque shall be applied to KOR-N-SEAL flexible connectors with a torque wrench per manufacturer's specifications.

7. Channels and benches shall be factory grouted only. There shall be no field grouting of channels or benches.

8. Where possible a minimum line drop of 0.1 foot shall be provided across new manholes.

9. Where the difference in invert elevation of two intersecting sewers in a manhole is 2 feet or more, a drop connection shall be installed as directed by the Purchaser.

10. Where invert elevations are not shown on the Drawings, pipes of differing sizes enter and exit manholes, all pipe crowns shall be matched to the same elevation.

11. The bottom of all precast base sections 4 feet in diameter shall extend a minimum of 6-inches beyond the outside wall of the manhole riser. The bottom of all precast base sections and cast-in-place bases 5 feet in diameter shall extend a minimum of 7-inches beyond the outside wall of the manhole riser. The bottom of all precast base sections and cast-in-place bases 6 feet and larger in diameter shall extend a minimum of 8-inches beyond the outside wall of the manhole riser.

12. For manholes four to six feet in diameter and less than twenty feet deep, precast reinforced concrete manhole base sections shall be a minimum of 8 inches thick. For all others, base sections shall be a minimum of 12 inches thick. All precast manhole base sections shall be reinforced with Number 4 steel reinforcing bars placed 6 inches on center each way and at mid depth of the slab, unless shown otherwise on the Drawings.

13. The interior of the manhole sections shall be a smooth, cylindrical surface. Lifting holes, when provided, shall be filled with expanding grout, or other approved materials.

14. All precast reinforced concrete manhole sections specified herein shall be inspected by the Purchaser's Representative. All materials that fail to conform to these Specifications will be rejected. After delivery to the Site, any materials that have been damaged in transit or are otherwise unsuitable for use in the Work shall be rejected and removed from the Site by the Subcontractor at no cost to the Purchaser.

2.02 EQUIPMENT

A. The Subcontractor shall furnish in good condition all equipment and facilities as required for the proper execution and inspection of the work. All equipment and facilities will be on site and approved by the Purchaser before work will be permitted to begin.

PART 3 EXECUTION

3.01 SITE PREPARATION AND RESTORATION

A. Rights-of-Way and Easements

1. The Subcontractor shall confine his construction activities to City of Memphis Rights-of-Way and Easements. The Subcontractor shall be responsible for obtaining written agreements for use of private property outside City acquired rights-of-way/easements for such purposes as storage of material and equipment and access to the construction site.

The Subcontractor shall immediately provide a copy of all such written agreements to the City and Purchaser upon obtaining the same.

B. Clearing of Rights-of-Way and Easements

1. The Subcontractor shall confine his clearing of rights-of-way and easements to the least area necessary for construction of facilities shown on the Drawings. The Subcontractor shall protect as many trees and shrubs within the area as possible. Where necessary for construction, the Subcontractor shall clear all live and dead vegetation and growth, pole stubs, logs, and other objectionable material. Cleared material shall be removed to within 3 inches of existing ground. This work shall be done well before excavation operations but only after erosion controls have been placed.

C. Location of Existing Obstructions

1. Locations of obstructions shown on the Drawings are approximate and are not intended as an accurate location of such obstructions. Obstructions not shown on the Drawings but encountered by the Subcontractor shall be removed and replaced in their original state or protected by the Subcontractor at no additional cost to the Purchaser.

D. Removal of Obstructions

1. The Subcontractor shall demolish and remove all structures and structure foundations, abandoned vehicles, appliances, and rubbish within the right of way/easement limits necessary for the performance of the work.

E. Protection of Obstructions Outside Easement Limits

1. The Subcontractor shall protect and avoid damage to all trees, shrubs, plants, fences, structures, and all other objects outside the right of way/easement limits shown on the Drawings and/or Plats due to construction operations. All damage shall be repaired or restored at the Subcontractor's expense. Particular attention shall be paid to avoid damage to trees, shrubs, bushes, and private property located next to rights of way/easements. No trees, plants, or other objects may be removed outside such limits without written permission of the property owner.

F. Special Protection of Obstructions Inside Easement Limits

1. Wherever the underground installation of sanitary sewer facilities will go through surface improvements previously made by the City, other governmental bodies, or property owners, the Subcontractor will be responsible for their protection and preservation. This responsibility includes the removal and storage of such improvements to allow replacement and restoration as close as possible to the undisturbed condition.

G. Disposal of Debris

1. All trees, brush, logs, snags, leaves, sawdust, bark, and refuse shall be collected and disposed of according to the City Code of Ordinances at the expense of the Subcontractor. There will be no separate pay item for disposal of debris. Debris shall be removed from the site when practical and shall not be left until the completion of the contract. Burning of debris shall not be allowed. When material is to be disposed of outside the easement, the Subcontractor shall first obtain written permission from the property owner on whose property the disposal is to be made and will file a copy with the Purchaser. Unless otherwise provided in the Contract Documents, the Subcontractor will arrange for disposing of such material outside the right of way/easement. No debris will be deposited in wetlands.

H. Replacement of Fences

1. Any fences disturbed inside the right of way/easement limits will be replaced or restored to their original or better condition. Any fences removed will be replaced in their original location. Fences in such poor condition that they cannot be taken down and rebuilt with the same material shall be replaced with new fence material similar in original quality, size, construction, and appearance to the removed fence. Exceptions to this requirement shall be allowed if written releases are obtained from the property owners by the Subcontractor and submitted to the Purchaser.

I. Restoration of Turfed Areas

1. All areas shall be restored as nearly as practicable to their original condition. Finished lawn areas where soil has been deposited shall be cleared to the level of the existing sod and then raked and watered. Areas where sod has been damaged, destroyed, or ruts have been filled shall be resodded. After final restoration of the settled trench surfaces, trench areas and areas regraded as part of the construction shall be resodded, unless otherwise shown on the Drawings or directed by the Purchaser. Sod must be living at the time of final acceptance of the project.

3.02 BACKFILLING

A. General

1. After sanitary sewer facilities have been bedded and installed according to these Specifications and upon permission of the Purchaser, the backfill may be placed. Backfilling operations shall continue following as closely behind manhole installation as practical. All backfill shall be placed in uniform horizontal layers. Pushing backfill material down a ramp into excavated areas shall not be permitted. No trash shall be allowed to accumulate in the space to be backfilled. Particular care shall be taken to avoid allowing wood to be included in the backfill, other than sheeting and shoring that has been approved to be left in place.

2. The Subcontractor shall be responsible for the condition of the trenches and filled areas during the contract and warranty period. The Subcontractor shall maintain frequent inspection of the same. If anytime during the 12-month warranty period the trenches or filled areas settle or sunken places appear, the Subcontractor shall be required to refill these sunken places when they are discovered with suitable material and shall replace all damaged curb, gutter, and sidewalk. All soft or dangerous trenches shall be marked, barricaded and caution lighted for the protection of the public.

3. Property with an existing dwelling located on it or lots within a developed subdivision or planned development are considered improved property.

B. Street Right of Way and Improved Property

1. Backfill Material:

a. Backfill for manhole excavations through pavements in street or highway right of way or where the Purchaser orders, shall be made with pit run gravel or other acceptable material as approved by the Purchaser. The backfill shall be from the top of the pipe embedment material or manhole foundation to the subgrade elevation of the pavement. Pea gravel or similar granular material approximately uniform in size and without bonding properties shall not be used.

2. Backfill for manhole excavations beyond pavements in street or highway right of way or outside public right of way shall be made with select earth from the top level of the pipe embedment material or foundation to the subgrade elevation in paved area, or within 1 inch of the surface in areas to be sodded, or to the surface in all other areas.

3. Select material shall be free from debris, organic matter, perishable compressible material and shall contain no stones or lumps larger than 6 inches. Rocks and lumps smaller than 6 inches shall not exceed an amount that will interfere with the consolidating properties of the fill material. Care shall be taken that stones and lumps are kept separated and well distributed, and that all voids are completely filled with fine material. No rocks or lumps shall come in direct contact with the pipe. The upper 3 feet of backfill in sodded or planted areas shall be free of rocks or lumps larger than 1 inch in diameter.

4. Placement and Compaction:

   a. Backfill material shall be placed by hand in 6 inch loose layers and tamped to a point 2 feet above the outside top of the pipe. Backfill shall be compacted with suitable mechanical tamping equipment with special care being taken not to damage the pipe or joints. Use of compaction equipment directly above semi-rigid and flexible pipe should be avoided until sufficient backfill has been placed to ensure that the equipment will not damage the pipe. A minimum of 36 inches of compacted backfill above the top of semi-rigid and flexible pipe shall be in place before wheel loading and a minimum of 48 inches of compacted backfill before use of pneumatic tampers. From these elevations to the subgrade elevation of the pavement, bottom of the sod, or to the original ground surface, suitable backfill shall be mechanically placed in 9 inch, maximum, loose layers. All backfill material shall be compacted to 95 percent of maximum density at plus or minus 2 percent of optimum moisture content as determined by Laboratory Standard Proctor Test (ASTM D 698).

C. Open Areas and Unimproved Property

1. Backfill of excavations on unimproved property shall be made with select material from the top level of pipe embedment material or foundation to the surface. Non-granular select material to be used for backfill shall be free from debris, organic matter and perishable compressible material, and shall contain no stones or lumps or rock fragments larger than 6 inches. Rocks or lumps smaller than 6 inches in diameter shall not exceed an amount that will interfere with the consolidating properties of the fill material. No rocks or lumps shall come in direct contact with the pipe. Stones and lumps shall be kept separated and well distributed, and all voids shall be completely filled with fine material.

3.03 REMOVAL OF EXISTING MANHOLES

A. Existing manholes and structures to be removed shall be shown on the Drawings or as directed by the Purchaser. The City reserves the right to retain or reject salvage of any materials encountered. Unless otherwise specified, salvaged rims and covers remain the property of the City and shall be delivered by the Subcontractor to the City yard as directed by the Purchaser. All remaining materials become the property of the Subcontractor who shall be responsible for disposal.

3.04 GENERAL CONSTRUCTION REQUIREMENTS

A. New manholes and structures shall be constructed of plain or reinforced concrete. Where the top elevation is not shown on the Drawings, the manhole or structure shall be built to conform to the elevation of the existing final grade or as ordered by the Purchaser. Completion of the manhole shall include the installation of fittings, connections to pipes, placing of castings, testing, and other construction as shown on the Drawings.

B. Inlet and outlet pipes shall extend through the walls of manholes to allow for water tight connections with the manhole walls. The ends shall be cut off flush with the inside surface of the wall as shown on the Drawings, design standards, or otherwise directed by the Purchaser. The pipes shall intersect at the structures so the inlet pipe will be aligned in the direction of outlet pipe such that counter-flow is prevented. Inlet pipes shall be installed 180 to 120 degrees from outlet pipe. Water stops shall be installed around pipes as they pass through the sanitary manhole wall.

C. Inverts shall be of Class A concrete poured to conform to the shapes shown on the Plans or otherwise directed. The inverts shall be constructed as to cause the least possible resistance to flow. The shape of the inverts shall conform uniformly to inlet and outlet pipes. A smooth and uniform finish shall be required.

D. Dewatering

1. Subcontractor shall furnish, install and operate pumps, pipes, appurtenances, and all equipment of sufficient capacity required to remove any groundwater encountered in the excavation. Subcontractor shall conduct said groundwater away from the construction site in an approved manner. Generally, dewatering is considered to be incidental to the construction of sewer manholes.

E. Bypass Pumping

1. Subcontractor shall furnish, install, and operate pumps, pipes, appurtenances, and all equipment of sufficient capacity required to maintain sewage flow around the work area. Subcontractor shall conduct said bypass pumping in an approved manner. Generally, bypass pumping is considered to be incidental to the construction of sewer manholes.

F. Traffic Control

1. All traffic control shall be installed and maintained in accordance Section 01551 – Traffic Control for Work Zones. At a minimum, the Subcontractor must have two trucks with flashing yellow lights on the work site. Traffic cones must also be placed downstream of the construction site to divert cars into the adjacent lane(s) per MUTCD requirements. On roads with heavy traffic volume, a flagman may also be needed to assist with traffic control. For bidding purposes, the Subcontractor should assume that a flagman will be needed on 30 percent of the setups.

3.05 INSTALLATION – PRECAST MANHOLES

A. Manhole Foundations

1. Precast concrete manholes shall be built according to the Drawings or as directed by the Purchaser. All precast manholes shall use either a concrete slab constructed of Class A concrete on a 12-inch thick No. 67 crushed limestone foundation and will be cast integrally with the base section and the inlet and outlet pipes as shown on the Drawings or the precast manhole shall use a precast base section conforming to this Specification. The stone base shall be fully encapsulated in a geotextile fabric as indicated on the plans or as directed by the Purchaser. The Subcontractor shall dewater sufficiently to maintain the ground water level at or below the bottom of the manhole foundation prior to and during placement of the foundation.

B. Manhole Installation on Existing Lines

1. For all lines 12 inches in diameter or less, a section of pipe shall be removed and a

complete precast manhole installed. The existing pipes shall be joined by a flexible coupling to pipe extensions from the manhole. Minimum 4-foot pipe extension shall be required from manhole to connect to existing pipe.

C. Manhole Diameters

1. In general, the internal diameter of manholes shall be 4 feet.

2. Manhole diameter sizing, however, is contingent upon limitations of manufacturer due to pipe sizes and pipe deflections at manhole. Subcontractor shall verify proper manhole diameter is provided based on proposed manhole pipe configuration and pipe sizes indicated. Manhole sizing shall be approved by the Purchaser.

D. Frames and Covers

1. Cast iron frames and covers shall be set at the required elevation and properly bonded to the masonry with two rings of butyl mastic sealant and anchor bolts.

2. City Standard watertight frames and covers shall be used in flood prone areas, and areas where water ponds or could pond, including traffic areas.

   a. Where shown on the Drawings, vent stacks shall be installed in long runs of sewers, potentially with watertight frames and covers. Vents shall be designed and constructed to preclude water entering the sewer system during storm events through the vents.

3. City Standard frame and cover obtained from Universal Scaffolding shall be used in all other areas.

4. Manhole rim elevations shall be set at grade in traffic areas and finished landscaped areas (finished grade is at the top of mulch in finished landscape areas), shall be set at 3 inches above grade in non-finished landscaped areas, and to be set at 2 feet or more above finish grade in non-traffic and non-landscaped areas.

5. Wherever manholes are constructed in paved areas, the top surface of the frame and cover shall conform to the exact slope, crown, and grade of the existing adjacent pavement.

3.06 PROTECTION OF DOWNSTREAM FACILITIES

A. The Subcontractor must take all steps necessary to assure that no material is allowed to fall into the line during his installation process. The Subcontractor shall bear all cost of repairs resulting from any damages to downstream facilities resulting from failure to abide by this stipulation.

3.07 WASTEWATER SPILLS

A. Should the Subcontractor spill any wastewater, such that the sewage either immediately or ultimately enters the waters of the State of Tennessee, then the Subcontractor shall be completely responsible for any fines or penalties imposed on the Purchaser or the Subcontractor by the USEPA or the State of Tennessee. The Subcontractor shall immediately notify the Program Manager in the event of a spill.

PART 4 MEASUREMENT & PAYMENT

4.01 MEASUREMENT

A. Precast Manhole Replacement

1. Precast manhole replacement will be measured per vertical foot of manhole from the downstream invert up to the bottom of the frame casting.

B. Precast Manhole Installation

1. Precast manhole installation will be measured per vertical foot of manhole from the downstream invert to the bottom of the frame casting.

C. Pavement Backfill

1. Pit run gravel or other acceptable material used for backfill under pavements or other areas directed by the Purchaser will be measured by the cubic yard. The backfill will extend 12 inches around the outside of the masonry or concrete work to allow for proper placement. No payment will be made for additional backfill used outside of 12 inches unless approved prior to completion by the Purchaser.

D. Traffic Control

1. Traffic control will be measured as specified in Section 01551 – Traffic Control for Construction Work Zones.

E. Dewatering

1. Dewatering is considered to be an incidental to sewer manhole rehabilitation.

F. Bypass Pumping

1. Bypass pumping is considered to be an incidental to sewer manhole installation and replacement.

4.02 PAYMENT

A. Precast Manhole Replacement

1. Precast Manhole replacement will be paid at the contract unit price per vertical foot, which shall be full compensation for the base, precast sections, adjusting rings, as needed, gaskets, steps, cast-in or core drilled pipe openings, pipe connectors, grout, manhole rims, frames, and covers, and vacuum testing, and removal and approved offsite disposal of materials, including manhole being replaced.

B. Precast Manhole Installation

1. Precast Manhole installation will be paid at the contract unit price per vertical foot, which shall be full compensation for the base, precast sections, adjusting rings, as needed, gaskets, steps, cast-in or core drilled pipe openings, pipe connectors, grout, manhole rims, frames, and covers, and vacuum testing, and removal and approved offsite disposal of materials.

C. Pavement Backfill

1. Accepted quantities of pit run gravel or other acceptable material used for backfill under pavements or other areas designated by the Purchaser will be paid for at the contract unit price per cubic yard furnished and placed, which will be full compensation for furnishing, placing and compacting the selected material.

D. Traffic Control

1. Traffic control will be paid as specified in Section 01551 – Traffic Control for Construction Work Zones.

4.03 PAYMENT WILL BE MADE UNDER:

Item No.	Pay Item	Pay Unit
02531-4.01.A	PRECAST MANHOLE REPLACEMENT (96” DIA.)	VERTICAL FOOT
02531-4.01.B	PRECAST MANHOLE INSTALLATION (72” DIA.)	VERTICAL FOOT
02531-4.01.C	PRECAST MANHOLE INSTALLATION (60” DIA.)	VERTICAL FOOT
02531-4.01.D	PAVEMENT BACKFILL	CUBIC YARD
02531-4.01.E	PRECAST MANHOLE INSTALLATION (84” DIA.)	VERTICAL FOOT
02531-4.01.F	PRECAST MANHOLE INSTALLATION (120” DIA.)	VERTICAL FOOT

END OF SECTION 02531

SECTION 02534
COATING OF NEW MANHOLES ON INTERCEPTORS

PART 1 – SCOPE

1.01 This work consists of the coating of new interceptor manholes for sanitary sewers as shown on the Plans, stipulated in the Contract Documents, or as directed by the Purchaser. The construction will be accomplished by these Specifications and in conformity with the details shown on the Plans or established by the Purchaser. The Subcontractor shall perform all work necessary to complete the Contract with the best modern practice. Unless otherwise provided, the Subcontractor is required to furnish all labor, materials, equipment, and incidentals required to coat manholes as noted on the Drawings or directed by the Purchaser.

1.02 Accurately field measure and size each individual manhole. Each new sewer manhole designated to be coated may have a different configuration and varying field dimensions.

1.03 Each manhole to be coated shall be thoroughly cleaned and all loose or missing bricks, loose mortar, holes, etc. shall be repaired. All leaks shall be plugged prior to manhole coating.

1.04 The presence or absence of leakage through manhole walls may depend on the groundwater levels and conditions at the time of the inspections. High groundwater levels in the project area typically occur in the dormant season (December through May), but will vary with rainfall in any given year and sewer location. Be advised the groundwater currently entering any leaking sewer mains and laterals may migrate to the manholes after the sewer mains and laterals are rehabilitated or replaced. Reflect assumptions and judgments on leakage through manhole walls based on this information in the unit prices bid for coating manholes. All leakage shall be stopped prior to coating manholes. No additional payment will be made for repairing leaks not visible prior to bidding or sewer rehabilitation.

1.05 When applicable, the manhole coating system shall not be installed until all main sewer lining or installation and other manhole rehabilitation work is complete.

1.06 The Subcontractor will arrange his work so that sewage flow will be maintained during the construction period with no discharge of sewage into the open trench, and there will be no backup of sewage into the existing or new line. The subcontractor will provide necessary bypass pumping capacity to carry flow downstream of the manhole to be coated.

1.07 Definitions/Standards:

A. ASTM D-638: Test Method for Tensile Properties of Plastics.
B. ASTM D-695: Test Method for Compressive Properties of Rigid Plastics.
C. ASTM D-790: Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
D. ASTM D-4541: Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
E. ASTM D-412: Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension
F. ASTM D-2240: Standard Test Method for Rubber Property Durometer Hardness
G. ASTM D-522: Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings
H. ICRI 03732: Selecting and Specifying Concrete Surface Preparation for

Sealers, Coatings, and Polymer Overlays

1.08 Quality Assurance. Furnish materials of quality required by the American Society for Testing and Materials (ASTM) standards and industry approved standards and specifications. Provide guarantee against defective materials and workmanship in accordance with the requirements of these specifications.

1.09 Sequencing: All required interruptions of flow through manholes or any other portion of the sanitary sewer system shall be coordinated with the Purchaser, and approval must be received from the Purchaser prior to the interruption.

1.10 The material for stopping active leaks and repairing nonleaking holes, cracks, etc. in concrete and masonry manholes shall be compatible with the coating system used.

1.11 Substitutions: Should the Subcontractor wish to use any brand or type of material other than as specified herein, he shall so state in writing to the Purchaser naming the proposed substitution and manufacturer. This statement shall be accompanied by a certificate of compliance from an approved independent testing laboratory that the proposed substitute meets or exceeds the specified requirements and has been tested in accordance with the specified test standards. The statement shall also include documented proof that the proposed brand or type of material has a proven record of performance when used in the intended application as confirmed by actual field test or successful installations.

1.12 The Subcontractor shall apply the manhole coating system material on a sample area not less than four square feet (4 ft^2) in size. When approved, the sample area shall serve as a standard of acceptance for all further work.

1.13 All manholes shall be coated either in their entirety or to the water level as indicated on the maps and plans.

PART 2 - MATERIALS AND EQUIPMENT

2.01 MATERIALS

A. Submittals

1. Unless otherwise specified all sample submittals shall be delivered to the Purchaser within two weeks of the scheduled start of coating operations.

2. Site Subcontractor emergency phone numbers.

3. Schedules of work on a weekly basis that will be delivered no later than 2:00 PM on Thursday for the week following with daily AM email updates of approximate crew locations each day. Weekly schedule format shall contain a map, with sufficient streets labeled and identified at a scale to provide clarity, along with the nature and type of crew located by map area.

4. Product Data on the following:
   a. Crack and hole repair products.
   b. Cementitious plug material.
   c. Active Leak-Stop Material
   d. Frame and cover seals.
   e. Corrosion resistant coating system including application requirements and chemical resistance data.

f. Gasket Polymer Properties

5. Manufacturer's Certificate of Compliance for each type of product that product furnished meets requirements of this Section.

6. Manufacturer's written recommendations for product handling and installation.

7. Confined space entry plans.

8. Plan for diversion of flow during installation of manhole over existing piping.

9. Subcontractor shall submit to the Purchaser (when requested) evidence indicating that the proposed applicators are fully qualified to perform the work, and any proposed applicator found to be not qualified shall (at the written request of the Purchaser) be removed forthwith by the Subcontractor.

10. The coatings manufacturer shall warranty the entire project to include any and all aspects of the surface preparation, base material installation and protective coating applications for a period of TEN (10) YEARS from the date of acceptance by the Purchaser. The warranty shall make no distinction between installation practices and material performance and shall not be prorated with respect to elapsed time for the entire warranty period. Manufacturer shall, within a reasonable period of time after receipt of written notice thereof by the Purchaser [period not to exceed sixty (60) calendar days], repair defects in materials or workmanship during said TEN (10) year period, and any damage to other work caused by such defects or repairing of same at his own expense and without cost to the Purchaser. Submit certificate of warranty.

B. Manhole Coating System. Spray applied or centrifugally cast manhole coating system:

1. The material applied onto the surface of brick or concrete manholes shall be a coating system consisting of a base coat and/or top coat to provide corrosion resistance within a sanitary sewer environment. The thickness of the base coat and top coat shall meet the manufacturer's recommendation. Where applicable, the coating shall be applied to the roof, fillets, hatch frames, and underside of hatch surfaces. Subcontractor can request to not use a base coat but must provide to the Purchaser evidence of successful installations of the product without using a base coat and its capability to properly adhere to the manhole wall and form a smooth finish on the wall, bench, and invert. In cases where the base coat is not used, the thickness of the top coating will be increased by the base coat thickness listed above.

2. The top coat applied shall be an approved polymer based polyurethane, a geopolymer, or a high-build solvent free epoxy product in conjunction with a high- strength cementitious repair/patch/base coat. The following products are acceptable and approved: Spectrashield Liner Systems, Quadex QM-1s and Structure Guard, GeoKrete Geopolymer by Quadex, or EcoCast.

3. The installer shall warrant and save harmless the Owner and his Purchaser against all claims for patent infringement and any loss thereof. The Subcontractor shall handle and store all material and shall dispose of all wastes in accordance with applicable regulations.

4. Each system shall be designed for application over damp (but not active running water) surfaces without degradation of the final product and the bond between the product and the manhole surfaces. Active leaks shall be stopped

using a premixed fast-setting, volume-stable waterproof cement plug consisting of hydraulic cement, graded silica aggregates, special plasticizing and accelerating agents or urethane injection. It shall not contain chlorides, gypsum, plasters, iron particles, aluminum powder or gas-forming agents, or promote corrosion of steel it may come in contact with. Set time shall be approximately 1 minute. Ten-minute compressive strength shall be approximately 500 PSI.

5. All invert channels shall be coated with the protective top coat only to prevent infiltration and to build up the invert channel to the new sewer main invert elevations; to fill all voids, cracks, holes, etc.; and to form a smooth flow channel.

   The entire channel shall be coated. The coating thickness shall be in accordance with manufacturer's recommendations.

C. Mortar

1. Mortar shall be composed of one part Portland cement and two parts sand (volumetric measure) thoroughly mixed in a tight box, with water added gradually and mixed continually until mortar has attained the proper consistency for use in brick masonry; prepared only in such quantities as needed for immediate use; mortar mixed for more than 30 minutes, retempered, or previously set will not be allowed.

2.02 EQUIPMENT

A. The Subcontractor will furnish and maintain in good condition all equipment and facilities as required for the proper execution and inspection of the Work. All equipment and facilities will be on site and approved by the Purchaser before work will be permitted to begin.

PART 3 – CONSTRUCTION REQUIREMENTS

3.01 PRELIMINARY AND GENERAL ITEMS

A. Notify all property owners who discharge sewage directly to the manhole being rehabilitated that their service will be discontinued while the lining is being placed, cured, and active pipe and service connections reopened. The Subcontractor shall notify individual property owners at least 72 hours in advance, giving the date, start time, and estimated completion time for the work being conducted. This notification shall be coordinated with the door hanger distribution.

B. Traffic Control

1. All traffic control shall meet the requirements of Section 01551 – Traffic Control for Construction Work Zones. All traffic control shall be installed and maintained in accordance with the Manual on Uniform Traffic Control Devices (MUTCD). At a minimum, the Subcontractor must have two trucks with flashing yellow lights on the work site. Traffic cones must also be placed downstream of the construction site to divert cars into the adjacent lane(s) per MUTCD requirements. On roads with heavy traffic volume, a flagman may also be needed to assist with traffic control.

C. Fall Protection

1. Subcontractor shall install and maintain all fall protection measures in accordance with the SARP10 Loss Control Manual. The Subcontractor shall construct a controlled access zone around the manhole being adjusted. At a minimum, the fall protection zone shall include traffic cones encircled with pennant tape. The controlled access zone must have one point of access with an entrance log.

D. Cleaning/Surface Prep

1. All manholes to be coated shall be thoroughly cleaned before coating. All grease, oil, laitance, coatings, loose bricks, mortar, unsound concrete and other foreign materials shall be completely removed. Debris resulting from cleaning shall be removed from the manhole and not allowed to be carried downstream.

E. Flow Control:

1. The Subcontractor shall be responsible for plugging or diverting the flow of sewage as needed for repair and coating of manhole inverts and benches.

F. Bypass of Flow:

1. As required for acceptable completion of the work and/or to avoid damages due to sewer spills or overflows, the Subcontractor shall provide for sewer flow maintenance around the manholes designated for coating. The bypass shall typically be made by plugging the line at an existing upstream manhole and pumping the flow into a downstream manhole or adjacent sanitary sewer system. The pump and bypass lines shall be of adequate capacity and size to handle the anticipated flow. Bypassing of sanitary sewage into the storm water system will not be allowed. For all bypass pumping, pump noise shall be kept to a minimum to the satisfaction of the Purchaser. The Subcontractor shall be required to contact all residential and commercial customers whose service lines connect to the sewer main being bypassed and inform them that they will be temporarily out of service. The Subcontractor shall also advise those customers against water usage until the mainline is back in service. After completing the necessary work on the main line, the Subcontractor shall advise those customers that the sewer main is back in service.

2. Bypass pumping is defined as providing pumps, standby pumps, piping, elevated structural support for aerial crossings, manpower to operate, routine maintenance and repair capability, pipe plugs, fuel, route and pump site clearing and any other work necessary to provide a complete bypass pumping operation. Any structures proposed by the Subcontractor for construction over or penetration into the interceptor piping for the purpose of performing the bypass operations must be approved by the Purchaser prior to implementation. The Subcontractor shall submit design drawings and details that are signed and sealed by a professional engineer licensed in the State of Tennessee. All bypass pump schemes must be submitted to and approved by the Purchaser in advance.

3. Public advisory services will be required to notify all parties whose service laterals will be out of service and to advise against water usage until the mainline is back in service.

4. The Subcontractor will be required to provide businesses with temporary service, as needed, and will be responsible for all necessary bypass pumping flows.

G. Wastewater Spills

1. Should the Subcontractor spill any wastewater, such that the sewage either immediately or ultimately enters the waters of the State of Tennessee, then the Subcontractor will be completely responsible for any fines or penalties imposed on the Purchaser or the Subcontractor by the USEPA or the State of Tennessee. The Subcontractor shall immediately notify the Program Manager in the event of a spill.

H. Safety

1. The Subcontractor shall carry out his operations in strict accordance with all applicable OSHA and SARP10 standards. Particular attention is drawn to those safety requirements involving work on an elevated platform and entry into a confined space.

3.02 MANHOLE COATING SYSTEM

A. The surface prior to spraying shall be damp without noticeable water droplets or running water. Materials shall be spray applied to a minimum uniform thickness to ensure that all cracks, crevices, and voids are filled and a smooth surface remains after light troweling. Perform light troweling to compact the material into voids and to set the bond. All manhole steps shall be removed prior to the coating being applied.

B. Application procedures shall conform to the recommendations of the protective coating manufacturer, including handling, thickness, mixing, environmental controls during application, safety, and spray equipment.

C. The equipment shall be specifically designed to accurately ratio and apply the base coat and top coat materials and shall be well maintained and in proper working order for the duration of the Work.

D. The coating must be applied by a “Certified Applicator” of the protective coating manufacturer.

E. Specified surfaces shall be coated by moisture tolerant, solvent-free, protective coating exhibiting properties described in these specifications.

F. Equipment approved by the coating manufacturer shall be used to apply each coat of the protective coating.

G. If necessary, subsequent top-coating or additional coats of the protective coating shall occur as soon as the base coat becomes tack-free, ideally within twelve (12) hours but not later than the recoat window for the specified products. Additional surface preparation procedures shall be required if the recoat window is exceeded.

H. The bench covers used to catch debris shall be removed and the bench and invert sprayed such that a gradual slope is produced from the walls to the invert. The wall-

bench intersection shall be rounded to a uniform radius the full circumference of the intersection.

I. No application shall be made to frozen surfaces or if freezing is expected to occur within the manhole for 24 hours after application. If ambient temperatures are in excess of 95°F, precautions shall be taken to keep the mix temperature at time of application below 90°F, using ice if necessary.

J. The final application shall have a minimum of four (4) hours cure time before subjected to actual flow.

3.03 MANHOLE COATING ACCEPTANCE

A. After the manhole coating work has been completed, the manhole shall be visually inspected by the Subcontractor in the presence of the Purchaser's Representative and the work shall be accepted if found satisfactory to the Purchaser's Representative. The finished surface shall be free of blisters, "runs" or "sags" or other indications of uneven coating thickness. No evidence of visible leaks shall be allowed.

B. After the protective coating has set hard to the touch, it shall be inspected with high-voltage holiday detection equipment. The surface shall first be dried, an induced holiday shall then be made onto the coated concrete surface and shall serve to determine the minimum/maximum voltage to be used to test the coating for holidays at that particular area. The spark tester shall be initially set at 100 volts per 1 mil (25 microns) of film thickness applied but may be adjusted as necessary to detect the induced holiday. All detected holidays shall be marked and repaired by abrading the coating surface with grit disk paper or other hand tooling method. After abrading and cleaning, additional protective coating material can be hand applied to the repair area. All tough-up/repair procedures shall follow the protective coating manufacturer's recommendations.

1. The Purchaser reserves the right to reject any and all manholes that do not pass holiday testing requirements, and replacement shall be at the Subcontractor's expense. A significant number of leaks on a single manhole or significant number of manholes leaking shall be considered as a basis for rejection and replacementof manholes.

PART 4 – DELIVERABLES

4.01 Provide post-coating MACP inspection for each manhole. Refer to Section 00001 Manhole GPS & MACP Inspection.

PART 5 – MEASUREMENTS

5.01 STANDARD MANHOLE COATING

A. A protective coating system consisting of a base coat and top coat with thicknesses in accordance with manufacturer's recommendations shall be measured per vertical foot of manhole from the downstream invert or water level up to the bottom of the frame casting where specified on the maps and plans.

5.02 NON-STANDARD STRUCTURE MANHOLE COATING

A. Non-standard structure manhole coating will be measured per each non-standard structure.

5.03 ADDITIONAL LEAK-STOP GROUTING

A. Additional continuous leak-stop grouting beyond four hours per manhole structure shall be measured per hour.

5.04 BYPASS PUMPING

A. Bypass pumping shall be measured as a lump sum item.

5.05 DEWATERING

A. Dewatering is considered to be an incidental to sewer manhole coating.

PART 6 – PAYMENT

6.01 STANDARD MANHOLE COATING

A. A standard manhole coating shall be paid for per vertical foot and shall include consist of surface preparation, up to four hours of continuous leak-stop grouting, sprayed on lining, removal and disposal of manhole steps, and holiday testing.

6.02 NON-STANDARD STRUCTURE MANHOLE COATING

A. Non-standard structure manhole coating will be paid per each non-standard structure. This shall consist of surface preparation, up to four hours of continuous leak-stop grouting, sprayed on lining, removal and disposal of manhole steps, and holiday testing.

6.03 ADDITIONAL LEAK-STOP GROUTING

A. Additional continuous leak-stop grouting beyond four hours per manhole structure shall be paid for per hour. This item includes all materials and labor necessary to complete the grouting.

6.04 BYPASS PUMPING

A. This item shall be paid for under item 02530-6.06. No payment will be made for bypass pumping under this section.

PAYMENT WILL BE MADE UNDER:

Item No.	Pay Item	Pay Unit
02534-6.01	STANDARD MANHOLE COATING (96” DIA.)	VF
02534-6.02	STANDARD MANHOLE COATING (72” DIA.)	VF
02534-6.02A	STANDARD MANHOLE COATING (60” DIA.)	VF
02534-6.03	ADDITIONAL LEAK-STOP GROUTING	HOUR
02534-6.02B	STANDARD MANHOLE COATING (84” DIA.)	VF
02534-6.02C	STANDARD MANHOLE COATING (120” DIA.)	VF

END OF SECTION
02534

SECTION 02541
CLOSED CIRCUIT TELEVISION INSPECTION OF SEWER MAINS & CONNECTIONS

PART 1 General

1.01 SCOPE

A. This Work will consist of cleaning and Pipeline Assessment Certification Program (PACP) internal closed circuit television (CCTV) surveys to digitally inspect and record conditions of existing sanitary sewer mains and connections. Sewer pipes and connections to be inspected are located in both improved streets, arterial and primary roads, backyards and unimproved easements.

B. The Work covered by this section includes furnishing all labor, competent PACP certified technicians, equipment, tools, accessories, and materials required to clean and inspect the designated sanitary sewer lines.

1.02 SUBMITTALS

A. PACP Requirements

1. PACP compliant inspections, logs, data, and photos shall be delivered to the Program Manager (from hereon Program Manager shall be interpreted as “Program Manager or his designee”) on external hard drive(s) which will become property of the Program Manager. Data files shall be formatted to facilitate upload into a PACP compliant Exchange database or internet uploads formats to an FTP site approved by the Program Manager.

B. Unless otherwise specified all sample submittals shall be delivered to the Program Manager within two weeks of the NTP.

C. For rehabilitation work, only Post-Rehabilitation PACP submittals will be required by the Purchaser. All CCTV done prior to rehabilitation shall be at the expense of the Subcontractor to ensure conformance with the Specifications.

D. Traffic Control

1. Traffic Control Plan shall be submitted to the Program Manager, including the following items:

a. Outline of permit acquisition procedure for lane closures.

b. Methods for proper signing and barricades, which comply with City of Memphis requirements.

c. Major streets (e.g. Shelby County Principal Arterial & Minor Arterial) requiring a City approved permit if taking a lane for mobile operations, secured through Traffic Control Plan submittal to the City and signed by a TN P.E. The City requires two-week lead time for permit processing.

i. The Subcontractor will be required to deliver a sample primary/arterial road Traffic Control Plan for review by the City.

ii. If the City determines that the nature of the work operation or the type of road in which the Subcontractor is working requires a permit, the Subcontractor will be

required to modify the sample Traffic Control Plan to obtain a permit from the City.

d. For everywhere else where a permit is not required, the Subcontractor shall develop, provide, and implement a traffic control plan for all mobile operations in accordance with standard MUTCD specifications.

E. Permits

1. The Subcontractor is also responsible for acquiring all necessary disposal and/or landfill site permits as required to perform this work.

2. Railroad Rights of Way: The Subcontractor shall notify the Program Manager when work or access to manholes and sanitary sewers lie within the 25 feet railroad easement as measured by 25 feet outside the nearest rail of the tracks. To access sewer facilities within the 25 feet of the railroad right of way the Subcontractor shall contact the Program Manager 48 hours in advance who will alert the City's Zone Construction Inspector to coordinate individual railroad direction and guidance.

3. Permit required confined space entry plans in compliance with the Loss Control Manual.

F. Copies of National Association of Sewer Service Companies (NASSCO) certification for all field staff conducting PACP inspections.

G. Sample of PACP compliant television survey log in MS Access format.

H. Sample of PACP compliant video inspection in MP-4 (Web optimized) format.

I. Cleaning and CCTV vehicle, equipment, and cleaning supplies list.

J. Disposal site(s) and appropriate landfill permits for appropriate disposal of all waste materials removed from the sewer during the light and heavy cleaning operations.

1.03 DELIVERABLES

A. Records

1. Pipe Cleaning Record

a. The Subcontractor shall provide a dated manifest of the volume or weight of the dewatered sewer cleaning loads taken and dumped at the permitted landfill. Each waste load manifest shall be associated with a list of corresponding sewer segments from where the waste originated.

2. Digital Inspection Record

a. In the digital PACP V.6.0.1 compliant format, the Subcontractor shall provide the following information:

i. Digital CCTV survey inspection which shall be recorded and shall be continuous as the inspection proceeds through the manholes and sewer pipes. Inspection videos should be delivered in an MP-4 (Web optimized) format.

ii. Digital Recordings: The digital recording shall document the visual and audio record of the manhole and sewer pipe inspection and shall be the basis of measurement and payment. Digital recording playback shall be at the same

speed that it was recorded. Original digital recordings for the Project shall be forwarded to the Program Manager on clearly labeled external hard drive(s) in PACP ACCESS format with final report submittals and shall become the property of the Program Manager. Data for a single facility asset will not be split across multiple hard drives. Digital recordings shall be available to the Program Manager by the close of business on the Monday following a week after data acquisition. File naming must be consistent. Additional instructions, naming conventions, file structures, etc. will be provided after contract award.

(1) Picture Quality: The sewer inspection digital record shall be free of steam, fog, vapor, or other headspace distortion that degrades the quality of the picture from the intended purpose of evaluating the sewer for structural and watertight integrity. If necessary, the Subcontractor shall provide positive ventilation or other means through the sewer pipe to draw out steam, fog, and vapor that will degrade the recorded image of the pipe.

3. Inspection Documentation Logs

a. Observations made during television inspection shall be documented in an unmodified PACP compliant manner within an electronic inspection log form, supported by accompanying audio, digital photographs and MP-4 (Web optimized) format recording written to an external hard drive and submitted to the Program Manager. Hard copies of completed inspection log photographs shall be furnished to the Program Manager with invoicing.

4. Electronic & Hard Copy Records

a. Reports:

i. The Subcontractor shall prepare printed inspection log reports for each associated sewer pipes inspected during the actual field inspection activities. These field logs shall then be reviewed by the Subcontractor's technical staff, along with reviewing the associated digital video record, as a means of ensuring that no defects or entries are omitted or incorrect. Edited field logs shall then be used in the final project reports and submitted in pdf format.

b. Draft Report and Final Report:

i. The Draft Final Report will contain electronic and hard copies of each of the PACP CCTV log pipe segment inspection logs. Digital recordings of the inspections written to an external hard drive and the PACP compliant database of the inspections in ACCESS format shall also be submitted in electronic and pdf format.

ii. Draft Report shall be delivered to the Program Manager within fifteen working days the last or final inspection. The Program Manager will have two work weeks to review and comment. Subcontractor shall address all comments provided and submit a Final Report within one work week upon receipt of comments. At the Program Manager’s discretion a meeting will be held so the Subcontractor can explain the processes used to address the comments.

5. Quality

a. Rejection of deliverables will be submitted to the Subcontractor via the Program Team in a written communication discussing issues that must be addressed. The Subcontractor will be required to follow up with a response within three business days upon receipt of the written communication. Subcontractors will have seven (7)

calendar days from the rejection notice date to make the necessary corrections and resubmit the data deliverable in its entirety.

PART 2 PRODUCTS

2.01 EQUIPMENT

A. General

1. All equipment used for PACP compliant CCTV sewer segment inspections of existing sanitary sewer mains and connections shall be specifically designed and manufactured for the purpose intended under this Contract. The software and hardware for the electronic capture of the inspection defects and recorded observations must be Version 6.0.1NASSCO PACP compliant.

2. The Subcontractor shall submit an equipment list to the Program Manager for approval before the commencement of the Work and shall certify that back-up equipment is available and can be delivered to the worksite within 72 hours.

3. The Subcontractor shall provide equipment to perform inspections of sewer mains located in streets, street rights-of-way, backyards, easements and rights-of way that are off-road.

    a. Including but not limited to portable CCTV equipment, vehicles capable of transporting TV equipment and accessing remote easements, and adequate cleaning equipment rights of way or easement applications.

B. PACP Compliant Software & Data Logger Requirements

1. Data logger

    a. Internal inspection logs created and captured electronically during the television inspection through the use of commercially available electronic data loggers in the truck are required. NASSCO PACP protocols Version 6.0.1 shall be used for capturing and recording the observations. Audio commentary made during the inspection and captured on the digital video shall correspond with the PACP observations on the log.

    b. The data logger equipment and software shall allow the Program Manager access directly to the captured electronic data and provide for a non-proprietary export of the data into MS ACCESS databases in accordance with PACP standards for standalone database review.

2. Software must be compliant with the NASSCO PACP V.6.0.1 standards. Follow PACP protocol for recording of observations and defects for sewer mains.

    a. All software shall be capable of providing complete survey reports in compliance with PACP, and the software shall be the V.6.0.1 of the PACP compliant software.

    b. The Program Manager has no intent to specify which software the Subcontractor shall use, but requires the software and the submitted database to be fully compliant with PACP V.6.0.1 and capable of being exported to ACCESS databases. No payment will be rendered for improperly formatted data.

    c. Software and data logger must be capable of capturing sewer main and sewer lateral observations by PACP descriptions, record travel footage along pipeline, and video

time stamp the recorded observations to support hyper linking from the digital record to the event point or location within the digital inspection record. The same requirements apply to still photo images (if provided) which shall follow PACP guidelines and be hyperlinked to the inspection log.

C. Sewer Main CCTV

1. Sewer Main Digital Color Video Camera

a. All cameras used shall be digital format color CCTV units specifically designed and constructed for use in sewer pipe inspection work. The cameras shall be operable in 100 percent humidity conditions. The camera shall have a high-resolution, 360-degree pan and tilt or rotating head with a wide viewing angle lens and either automatic or remote focus and iris controls. Camera lighting shall be sufficient for use with digital color inspection cameras and for the manhole and pipe diameters identified in the contract.

i. Camera, Television Monitor, and Other Components shall be capable of producing a high resolution color digital inspection record.

ii. Video file to be in MP-4 (Web optimized) format

b. In all cases, the complete digital inspection system (camera, lens, lighting, cables, monitors, and recorders) shall be capable of providing a digital picture and digital video quality acceptable to the Program Manager. Inadequate lighting, image distortions, blurry or murky images, and dirty lenses will be a cause for rejection. No payment will be made for unsatisfactory inspections and the Subcontractor shall perform work until deliverable is of acceptable quality. Digital video cameras/digital recorders not specifically intended for use for internal television inspection of manholes and sewer lines shall not be permitted.

c. Pan and tilt type camera, capable of turning at right angles to pipe’s axis over an entire pipe wall perimeter shall be used.

i. The camera lens shall be capable of self-righting itself after a lateral view or connection view with a return view down the pipe with a “home" capability for the lens.

d. Lighting shall be suitable to allow clear picture of entire inner pipe wall extending at least 10 feet in front, including black High Density Polyethylene (HDPE) pipe.

e. Document header and observations shall be in accordance with PACP V.6.0.1protocols.

D. Cleaning Equipment

1. Hydraulic sewer pipe cleaners or combination hydraulic/vacuum cleaners shall be specifically designed and constructed for such cleaning.

2. Mechanical sewer pipe cleaners shall be specifically designed and constructed for such cleaning.

3. The Subcontractor shall possess equipment capable of hydraulically or mechanically cleaning a minimum of 1,000 linear feet of pipe from one direction and have a minimum 1,000 linear feet of hose or cable on-site during the cleaning execution.

4. Hydraulic sewer pipe cleaners shall be specifically designed and constructed for such cleaning. The sewer cleaner shall have a minimum usable water capacity of 600 gallons and a pump capable of delivering at least 30 gallons per minute at 1,500 psi at the nozzle.

   a. The hydraulic cleaning equipment shall have multiple hydraulic cleaner hose nozzles for a variety of sewer cleaning conditions, including grease, roots, debris and granular materials.

   b. Vacuum equipment shall be capable of lifting debris removed from the segment from the downstream manhole.

5. Mechanical sewer pipe cleaners (cable machines with buckets, brushes, swabs, root cutters, and power rodders with similar capability) shall be capable of controlled forward and reverse travel through the sewers without inflicting damage to the existing pipe in removing rocks, grit and other heavy debris and roots.

PART 3 EXECUTION

3.01 INSPECTIONS

A. CCTV Inspection of Sewer Mains

1. Cleaning

   a. Sewer pipe cleaners or combination hydraulic-vacuum cleaners must accompany CCTV units at all times. Ideally, sewers lines are to be cleaned and then followed immediately by CCTV inspection. All sewers must be cleaned in advance of CCTV during the same calendar day they are inspected.

   b. Light Cleaning

      i. Before CCTV work, the Subcontractor shall light clean the sewer line from manhole to manhole, from upstream to downstream direction unless an obstruction is encountered, one sewer section at a time and performed as efficiently as possible at the Subcontractor’s discretion.

      ii. Materials shall not be passed from one sewer segment to another but must be trapped and removed from each sewer segment prior to CCTV inspection.

   c. Heavy Cleaning

      i. If a camera is inserted and additional debris or impediments to inspection are observed following the required light cleaning, heavy cleaning shall be approved by the Program Manager. Sections of pipe containing significant roots, large areas of debris, and/or several inches of depth of sands and gravels that will require the use of additional hydraulic nozzles, cable/bucket machine, power rodders and root cutters is considered heavy cleaning.

      ii. Heavy cleaning will be proposed by the Subcontractor and approved by the Program Manager. The Subcontractor must obtain prior approval for heavy cleaning in each sewer segment in order to receive payment for heavy cleaning.

d. Cleaning Execution

i. No roots, grease or debris from light or heavy cleaning shall be passed from sewer segment to sewer segment during the cleaning operation. All debris flushed from the sewer must be collected, captured, and removed from the sewer at the downstream manhole.

ii. Roots shall be removed in the sections where root intrusion is a problem. Special precautions shall be exercised during the cleaning operation to assure complete removal of visible roots from the joint area and so as not to incur further damage to the pipe. Any visible roots that may impact rehabilitation efforts shall be removed. Fine roots are allowed if the Subcontractor made a heavy cleaning attempt to remove roots with proper root removal means. Procedures may include the use of mechanical devices such as rodding machines, expanding root cutters and porcupines, and hydraulic procedures such as high-pressure jet cleaners.

iii. The Subcontractor is responsible for safe, responsible and legal handling and disposal of all material and debris removed from the sewers. The Subcontractor is responsible for all permits and landfill fees associated with the disposal of debris collected and removed from the sewer.

i. Proper disposal arrangements are the exclusive responsibility of the Subcontractor. The Subcontractor shall provide a dated manifest of the volume and weight of the dewatered sewer cleaning loads taken and dumped at the permitted landfill. The Subcontractor shall not dispose of debris at a City of Memphis Wastewater Treatment Plant. Each waste load manifest shall be associated with a list of corresponding sewer segments from where the waste originated.

2. Sewer Flow Levels During Inspection Operations

a. Maintain low sewer flow during inspection by using sandbags or flow-through plugs or by inspecting during low flow times of day, evening, or early morning hours while camera is moving and recording observations in the sewer segment. Any items used to restrict flow shall be removed immediately after intended use.

i. Flow-through Plugs: If used, secure the plugs so as to remain in place during inspection. Use a fail-safe device at the downstream pipe connection to ensure the plug is not lost in the downstream sewer segment if it becomes dislodged from the upstream pipe connection.

ii. Conduct all cleaning and CCTV operations to prevent building backups and sewer overflows.

iii. Subcontractor shall be responsible for cleanup, repair, fines, property damage costs, and claims for any sewage backup, spillage or sanitary sewer overflow during or as a result of the cleaning and inspection operations.

b. Allowable Depth of Flow For Inspection Operations

i. For effective inspection, all flow shall be minimized in the segment being inspected. However, the depth of flow at the upstream manhole of the interceptor section being worked shall be within the specified limits provided herein.

c. Maximum Allowable Depth of Flow for CCTV Inspection

i. 6 - 10 inch diameter Pipe - 20% of pipe diameter

ii. 12 - 18 inch diameter Pipe - 25% of pipe diameter

iii. 24-inch diameter and Larger Pipe - 30% of pipe diameter

iv. Exceptions to these guidelines shall result in rejection, and non-payment, of the CCTV inspection unless approved in advance by the Program Manager.

3. Camera Operations

a. Using the pan/tilt feature, pan the interior of the manhole for record purposes in accordance with V.6.0.1 PACP protocols and begin and terminate the inspection in the starting and ending manholes.

i. Capture the inside of manhole walls, manhole channel, and pipe connection to wall at both upstream and downstream manhole and lateral connections using the digital mainline sewer camera and the pan/tilt feature.

b. Place the camera at center of manhole and commence video before entering pipe.

i. Start footage counter at manhole wall/pipe connection or at a short pre-measured distance down the pipe for the sewer segment inspection.

c. Connections: The digital camera shall be used to look at connections and up laterals from the connection in the main sewer pipe being inspected. The camera shall pause, pan, and record all connections. Conditions noted in these sidelines and laterals shall be noted on the inspection logs.

d. Mainline camera operations:

i. Move through line at speed no greater than 30 feet per minute stopping for minimum 10 seconds to record lateral connections, mainline connections, defects, and features and points of interest.

ii. Do not float camera.

iii. Maintain technical quality, sharp focus, and distortion free picture with the camera lens centered in the pipe for the different diameters inspected.

(1) Eliminate steam in line for duration of inspection.

(2) Utilize blower as needed to defog sewer line.

iv. Digitally record a complete sewer segment in its entirety with no breaks, “blink-outs,” or interruptions from manhole to manhole according to PACP V.6.0.1 formats.

v. Pan, tilt, and rotate as necessary to best view and evaluate lateral connections, pipe defects, features, obstructions, and points of interest.

vi. Use power winches, powered rewinds, self-propelled tractors, or other devices that do not obstruct camera view or interfere with proper documentation of sewer conditions to move camera through sewer.

(1) Whenever non-remote powered and controlled winches are used, set up telephones or other suitable means of communication between manholes to insure good communication.

vii. Use hydraulic jet nozzle pressure and flow to remove standing water from depressions or sags in the sewer, if necessary, for complete inspection of the sag portion of the sewer segment.

viii. Measurement for location of defects and service laterals:

(1) At ground level by means of Program Manager-approved footage counter or metering device.

(2) Electronic display measurement meters: Accurate to PACP standards over length of section being televised.

(3) Do not pull unnecessary length of slack camera cable if it impacts the footage counter.

ix. Stop camera at service connections and inspect lateral with pan and tilt camera.

(1) Identify building connection in PACP compliant terms as active, capped, or abandoned.

(2) If no wastewater flows are being discharged from building, consider steady, clear observed flow as infiltration/inflow.

x. Identification of Defects

(1) If roots, sludge, or sediment material impedes inspection after the light cleaning, withdraw camera and perform heavy cleaning at the direction of the Program Manager.

(2) Upon completion of heavy cleaning operation, resume internal inspection.

(3) Furnish media confirmation for heavy cleaning (more than three passes with jet cleaner) to Program Manager.

(4) If protruding tap impedes inspection trim protruding tap to 1/2 inch.

xi. If obstructions are not passable and cannot be removed by sewer cleaning, withdraw CCTV equipment and perform a reverse inspection from opposite end of the sewer segment in accordance with PACP protocols.

(1) Subcontractor shall be responsible for costs associated for reverse set-ups when an obstruction is encountered that cannot be passed.

(2) Subcontractor shall be responsible for all judgments and impacts as to whether an obstruction in the sewer main can be passed. Costs involved in extracting a stuck camera in the sewer main will be borne by the Subcontractor and at no additional cost to the Program Manager.

(3) When additional obstructions are encountered after reversal of equipment and no means are available for passing a second obstruction in order to complete the sewer main inspection, remand the segment inspection to the

Program Manager for resolution. The portion of the main inspected will be paid for as prescribed.

xii. Undocumented facilities

(1) If undocumented manholes or sewer mains (facilities not on the field updated GIS sewer maps) are encountered during the inspection, the Subcontractor needs to complete the documentation requirements per PACP requirements and capture on the video the following:

(a) Approximate horizontal distance from the upstream or reference manhole.

(b) Approximate depth of the undocumented manhole by turning the pan/tilt camera vertically and estimating the height of the cover from the invert.

(c) A provisional manhole asset ID number shall be used by the Subcontractor by adding a dash and two-character number to the closest upstream manhole ID.

xiii. Retrieval of Stuck Equipment

(1) The Subcontractor is responsible for hiring a licensed sub-Subcontractor to retrieve any equipment/foreign objects that get stuck in the sewer system through the execution of the scope of work (fallen cameras, jet nozzles, inflatable plugs, sandbags etc.) at the Subcontractor's own cost. Such retrieval by an appropriately licensed sub-Subcontractor shall be made within 72 hours to avoid interfering with the City of Memphis sewer system operations. Any and all impacts and related costs due to the Subcontractor's equipment in the line shall be the responsibility of the Subcontractor. Subcontractor shall follow SARP10 sewer point repair specifications outlined in "Section 02540 Sanitary Sewer Point Repairs" and "Section 02950 Removal and Replacement of Pavements and Incidentals" during retrieval of equipment. Also per "00585.2.2 Safety, Health, and Accident Prevention Program," Purchaser must approve sub-tier Subcontractors prior to mobilization to the jobsite.

4. Quality Assurance

a. With each monthly invoice the Subcontractor shall provide a QA/QC memo documenting that 10% of the previous month's CCTV data has undergone a random, independent review by a PACP certified reviewer using NASSCO standards for Television Inspection of Main Sewer and PACP Quality control as the basis for the QA/QC procedures. The independent reviewer shall be a Tennessee P.E. or is a P.E. in another state and has a Tennessee P.E. license pending. Each line segment which has been randomly reviewed shall be identified in the QA/QC memo as well as any subsequent findings or recommendations. Internal independent QA/QC is acceptable, as long as the person is a Tennessee P.E. or is a P.E. in another state and has a Tennessee P.E. license pending. Failure to submit the QA/QC memo shall delay payment of the current month's invoice.

b. For all new Subcontractors and Operators who begin PACP coding, an initial review of CCTV data will consist of reviewing, at a minimum, 20 of the first 100 PACP inspection records submitted. Subsequent reviews will be based on the results of the initial reviews as explained below.

c. Auditing Procedures:

i. Header Information: As explained in the NASSCO PACP Quality Control Standards each audited inspection record is given an accuracy level for the header information and the detailed observation records. It is expected that the accuracy of the header record exceed 90% because the majority of the contents are based upon facts and not subject to operator judgment. To assess the accuracy level of the header, record the number of errors as compared to the total number of header fields using the following formula:

ii. Detailed Observations: Determining the accuracy level for the detailed observation records is similar to the method for assessing the header record. The main difference being that a defect observation has multiple data entries that must also be counted towards the total number of entry fields. In the event that a defect is not coded all of the required entries for coding the missed defect are counted towards the total error count. The following formula is used to calculate the accuracy level of the detailed observation records:

iii. Review Scoring and Results

(1) Satisfactory Review, No changes required. Accuracy Level of 90% or above for both the Header Record and Observation Detail with no major errors or omissions found.

(2) Unsatisfactory Review (below levels of acceptance) will not be accepted by the Program Manager and will not be considered payable items in the Subcontractor's Request for Payment.

5. Deliverable Documentation

a. Mainline Sewer

i. Submit V.6.0.1 PACP compliant records, logs, and electronic inspection data for sewer line inspection to Program Manager by the close of business on the Monday following a week after data acquisition.

ii. Monthly QA/QC memo submittal listing which segments have been randomly reviewed, as well as any subsequent findings or recommendations.

iii. Digital videos, data, and photos shall be delivered to the Program Manager on external hard drives which will become property of the Program Manager.

iv. Data files shall be formatted to facilitate upload into a PACP Exchange Database with the approval of the Program Manager.

v. Inspections displaying poor digital video/audio quality will be rejected. Quality refers to, but is not limited to, grease or debris on lens, camera under water, image too dark or light, image washed-out, distorted image, out of focus images, lines improperly cleaned, and poor/no audio.

vi. Subcontractor will re-televise rejected inspections and resubmit inspections at no additional cost to the Program Manager.

b. Map changes/undocumented manholes:

i. For map changes identifying undocumented manholes and network changes which were found as a result of field inspections or observations, a Map Edit Form shall also be prepared and supplied by the Subcontractor with a drawing or sketch and shall indicate special details, field measurement or distances, or locations about an observed undocumented manhole or a change to the sewer network. The Map Edit Form should also identify buried manholes and siphons that have been encountered.

ii. Subcontractor shall indicate all buried manholes identified in the field via CCTV using the provided Buried Manhole Form. Any additional manholes that have not been located or verified via CCTV but are impeding the completion of required CCTV work should be designated as unable to locate (UTL) and be included on the form.

c. Incident observation and data collection:

i. The Subcontractor shall report all buried manholes, pipe collapses, large void, utility conflicts, Unable to Complete line segments, and heavy cleaning requests to the Program Manager through the program-defined reporting application (Teamworx) and shall fill out all required fields and attach picture documentation as necessary. At least one picture shall be included showing the incident or condition of the sewer line encountered that required it to be recorded. All reported incident observations will be monitored by the Program Manager and inadequate reporting will result in a meeting between the Program Manager and Subcontractor.

6. Easement or Turf Operation

a. The Subcontractor will restore the work area to its original condition as quickly as possible after the inspection is complete. The Subcontractor will not be allowed to postpone restoration of the site until the end of the project.

PART 4 MEASUREMENT & PAYMENT

4.01 MEASUREMENT

A. Light Cleaning & CCTV Inspection

1. Light cleaning and mainline CCTV inspection shall be measured by linear foot by each diameter of mainline sewer inspected and documented in accordance with the specification.

B. Heavy Cleaning

1. Heavy cleaning shall be measured by linear foot of each diameter of heavy cleaning approved by the Program Manager and documented.

C. Remote Trimming of Protruding Service Lateral

1. Remote trimming of protruding service lateral that prevent a thorough inspection of the pipe will be measured per each.

4.02 PAYMENT

A. Mainline CCTV Inspection

1. Light cleaning and mainline CCTV inspection shall be paid for at the unit price for each linear foot of each diameter inspected and documented in accordance with the specification.

2. The unit price for Light Cleaning and Mainline CCTV inspection shall cover the entire cost of the required light cleaning and CCTV inspection and reporting in accordance with PACP V 6.0.1 format, including but not limited to labor, mobilization and access, CCTV equipment, recording media, traffic control, light cleaning of mainline sewer, documenting results in PACP records and logs, digital format recordings, photo equipment, power supply for equipment, interim and final reports and all other appurtenant work.

3. No additional payment will be made for:

   a. Re-inspection due to rejected inspection and/or records for any reason.

   b. Reversals.

   c. Performing excavation and associated sewer point repair to retrieve a stuck CCTV camera or hydraulic cleaning hose/nozzle.

   d. Incomplete electronic logs.

   e. Unapproved duplication of inspections: The Subcontractor is responsible to ensure duplications do not occur.

B. Heavy Cleaning

1. Heavy Cleaning shall be paid for at the unit price for each linear foot of each diameter of heavy cleaned sewers at the direction of the Program Manager and in accordance with the specification.

2. The unit price for Heavy Cleaning shall include the entire cost including but not limited to labor, mobilization and access, traffic control, appropriate disposal of sewer debris removed from sewer at permitted site and all other appurtenant work. Payment includes non-hydraulic jet efforts such as porcupines, cutters, power rodding, clam buckets, and other mechanical means, traffic control, and re-cleaning with hydraulic jet, labor, materials, and equipment necessary to clean mainline sufficiently to allow video reviewers a clear picture of pipe conditions.

3. No additional payment will be made for:

   a. Additional passes of heavy cleaning if the inspection observation reveals roots, grease or other debris remaining in the sewer after the heavy cleaning passes.

C. Remote Trimming of Protruding Service Lateral

1. Remote trimming of protruding service lateral that prevent a thorough inspection of the pipe will be measured per each.

4.03 PAYMENT WILL BE MADE UNDER:

Item No.	Pay Item	Pay Unit
02541-4.01.A	LIGHT CLEANING & MAINLINE CCTV INSPECTION FOR 42” DIAMETER PIPE	LF

END OF SECTION 02541

SECTION 02543
CLOSED CIRCUIT TELEVISION & SONAR INSPECTION OF LARGE DIAMETER SEWER MAINS

PART 1 GENERAL

1.01 SCOPE

A. This Work will consist of assessment, Pipeline Assessment Certification Program (PACP) internal closed circuit television (CCTV), and Sonar surveys to digitally inspect and record conditions of existing sanitary sewer mains and connections in 24-inch and larger diameter sanitary sewer pipe and siphons. Larger diameter sewer pipes to be inspected are located in both improved streets, arterial and primary roads, backyards and unimproved easements. Subcontractor shall have appropriate all-terrain vehicles necessary to access the work. No cleaning of the sanitary sewer is required prior to CCTV and Sonar inspection unless otherwise specified by the Program Manager.

B. The Work covered by this section includes furnishing all labor, competent PACP certified technicians, equipment, tools, accessories, and materials required to CCTV and Sonar inspect the designated 24-inch diameter and larger sanitary sewer lines.

1.02 SUBMITTALS

A. PACP Requirements

1. PACP compliant inspections, logs, data, and photos shall be delivered to the Program Manager (from hereon Program Manager shall be interpreted as “Program Manager or his designee”) on external hard drives which will become property of the Program Manager. Data files shall be formatted to facilitate upload into a PACP compliant exchange database or internet uploads formats to an FTP site approved by the Program Manager.

B. Unless otherwise specified all sample submittals shall be delivered to the Program Manager within two weeks of the NTP.

C. Traffic Control

1. Traffic Control Plan shall be submitted to the Program Manager, including the following items:

   a. Outline of permit acquisition procedure for lane closures.

   b. Methods for proper signing and barricades, which comply with City of Memphis requirements.

   c. Major streets (e.g. Shelby County Principal Arterial & Minor Arterial) requiring a City approved permit if taking a lane for mobile operations, secured through Traffic Control Plan submittal to the City and signed by a TN P.E. The City requires two-week lead time for permit processing.

      i. The Contractor will be required to deliver a sample primary/arterial road Traffic Control Plan for review by the City.
      ii. If the City determines that the nature of the work operation or the type of road in which the Contractor is working requires a permit, the Contractor will be required to modify the sample Traffic Control Plan to obtain a permit from the City.

d. For everywhere else where a permit is not required, the Contractor shall develop, provide, and implement a traffic control plan for all mobile operations in accordance with standard MUTCD specifications.

D. Permits

1. The Contractor is also responsible for acquiring all necessary disposal and/or landfill site permits as required to perform this work.

2. Railroad Rights of Way: The Contractor shall notify the Program Manager when work or access to manholes and sanitary sewers lie within the 25 feet of railroad easement as measured by 25 feet outside the nearest rail of the tracks. To access sewer facilities within the 25 feet of the railroad right of way the Contractor shall contact the Program Manager 48 hours in advance who will alert the City's Zone Construction Inspector to coordinate individual railroad direction and guidance.

3. Schedules of work on a weekly basis that will be delivered no later than 2:00 PM on Thursday for the week following with daily AM email updates of approximate crew locations each day.

   a. Weekly schedule format shall contain the following elements:
      i. Map format.
      ii. Sufficient streets labeled and identified at a scale to provide clarity.
      iii. Nature and type of crew location by map area.

4. Permit required confined space entry plans in compliance with the Loss Control Manual.

E. Copies of National Association of Sewer Service Companies (NASSCO) certification for all field staff conducting PACP inspections.

F. Sample of PACP compliant television survey log in MS Access format.

G. Sample of PACP compliant video inspection in MP-4 format.

H. CCTV and Sonar inspection vehicle and equipment supplies list.

I. Sample of combined CCTV & Sonar inspection report.

1.03 DELIVERABLES

A. Records

1. Digital Inspection Record

   a. In the digital PACP V.6.0.1 compliant format, the Contractor shall provide the following information:

      i. Digital CCTV survey and Sonar inspection which shall be recorded and shall be continuous as the inspection proceeds through the manholes and sewer pipes.

      ii. Digital Recordings: The digital recording shall document the visual and audio record of the sewer pipe inspection and shall be the basis of measurement and payment. Digital recording playback shall be at the same speed that it was recorded. Original digital recordings for the Project shall be forwarded to the Program Manager on clearly labeled external hard drive(s) in PACP ACCESS format with final report submittals and shall become the property of the Program Manager. Data for a single facility asset will not be split across multiple hard

drives. Digital recordings shall be available to the Program Manager by the close of business on the Monday following a week after data acquisition. File naming must be consistent. Additional instructions, naming conventions, file structures, etc. will be provided after contract award.

(1) Picture Quality: The sewer inspection digital record shall be free of steam, fog, vapor, or other headspace distortion that degrades the quality of the picture from the intended purpose of evaluating the sewer for structural and watertight integrity. If necessary, the Contractor shall provide positive ventilation or other means through the sewer pipe to draw out steam, fog, and vapor that will degrade the recorded image of the pipe.

2. Inspection Documentation Logs

a. CCTV Records

i. Observations made during television inspection shall be documented in an unmodified PACP compliant manner within an electronic inspection log form, supported by accompanying audio, digital photographs and MP-4 (web optimized) format recording written to an external hard drive and submitted to the Program Manager. Hard copies of completed inspection log photographs shall be furnished to the Program Manager with invoicing.

b. Sonar Records

i. Where combined CCTV and Sonar inspections are performed, the display in the viewing area shall show the combined CCTV and Sonar images of the sewer being inspected. The Sonar image shall be superimposed on the real CCTV image, and continuously recorded, as a combined operation at the time of the inspection resulting in a single combined video file in MP-4 (Web optimized) format for each inspection.

ii. The Sonar Inspection shall include a comprehensive final report on the findings concerning major defects including fractures, displaced joints, deformation, corrosion, lateral intrusions, dominant surface features, encrustation, and debris/silt depths.

3. Electronic & Hard Copy Records

a. Reports: The Contractor shall prepare printed inspection log reports for each associated sewer pipe inspected during the actual field inspection activities. These field logs shall then be reviewed by the Contractor's technical staff, along with reviewing the associated digital video record, as a means of ensuring that no defects or entries are omitted or incorrect. Edited field logs shall then be used in the final project reports and submitted in pdf format.

b. Draft Report and Final Report: The Draft Final Report will contain electronic and hard copies of each of the PACP CCTV log pipe segment inspection logs. Digital recordings of the inspections written to an external hard drive and the PACP compliant database of the inspections in ACCESS format shall also be submitted in electronic and pdf format.

i. Draft Report shall be delivered to the Program Manager within fifteen working days of oldest inspection. The Program Manager will have two workweeks to review and comment. The Contractor shall address all comments provided and submit a Final Report within one workweek upon receipt of comments. At the

Program Manager's discretion a meeting will be held so the Contractor can explain the processes used to address the comments.

4. Meetings

   a. The Program Team will arrange bi-weekly meetings (every other week) with the contractor to discuss data management and field issues.

5. Quality

   a. Rejection of deliverables will be submitted to the Contractor via the Program Team in a written communication discussing issues that must be addressed. The Contractor will be required to follow up with a response within three business days upon receipt of the written communication. Contractors will have seven (7) calendar days from the rejection notice date to make the necessary corrections and resubmit the data deliverable in its entirety.

PART 2 PRODUCTS

2.01 EQUIPMENT

A. General

1. Subcontractor shall have appropriate all-terrain vehicles necessary to access the work. Expected terrain may require the use of four-wheel drive vehicles, ATVs, tracked vehicles, or other appropriate off-road vehicles.

2. All equipment used for PACP compliant CCTV sewer segment inspections of existing larger diameter sanitary sewer mains shall be specifically designed and manufactured for the purpose intended under this Contract. The software and hardware for the electronic capture of the inspection defects and recorded observations must be Version 6.0.1 NASSCO PACP compliant.

3. All CCTV equipment requirements contained in Section 00003 – Closed Circuit Television Inspection of Sewer Mains & Connections, Paragraph 2.02 are applicable, except 2.02.D. Cleaning Equipment since pre-cleaning of the larger diameter sewers is not required.

PART 3 EXECUTION

3.01 INSPECTIONS

A. CCTV & Sonar Inspection of Sewer Mains

1. Sewer Flow Levels During Inspection Operations

   a. Maintain low sewer flow during inspection by using sandbags or flow-through plugs or by inspecting during low flow times of day, evening or early morning hours while camera is moving and recording observations in the sewer segment. Any items used to restrict flow shall be removed immediately after intended use.

      i. Flow-through Plugs: If used, secure the plugs so as to remain in place during inspection. Use a fail-safe device at the downstream pipe connection to ensure the plug is not lost in the downstream sewer segment if it becomes dislodged from the upstream pipe connection.

ii. Conduct all cleaning and CCTV operations to prevent building backups and sewer overflows.

iii. Contractor shall be responsible for cleanup, repair, fines, property damage costs, and claims for any sewage backup, spillage or sanitary sewer overflow during or as a result of the cleaning and inspection operations.

b. Allowable Depth of Flow For Inspection Operations:

i. For effective inspection, all flow shall be minimized in the segment being inspected. However, the depth of flow at the upstream manhole of the interceptor section being worked shall be within the specified limits provided herein.

c. Maximum Allowable Depth of Flow for CCTV Inspection

i. 24-inch diameter and Larger Pipe - 30% of pipe diameter. Flow in excess of the 30% depth of flow limitation shall include the provision for Sonar inspection for below the water surface level in addition to a raft mounted CCTV inspection for above the water level.

ii. Exceptions to these guidelines shall result in rejection, and non-payment, of the CCTV inspection unless approved in advance by the Program Manager.

2. Camera Operations

a. When flow is in excess of the 30% depth of flow limitation, the Contractor shall include the provision for Sonar inspection for below the water surface level in addition to a raft/float mounted CCTV inspection for above the water level.

b. Raft/float supports shall be collapsible to fit through existing manhole frames associated with 24-inch diameter and larger sewers.

c. Camera Operations requirements shall be as contained in Section 00003 – Closed Circuit Television Inspection of Sewer Mains & Connections, Paragraph 3.01 are applicable for the execution of the CCTV operations with the camera mounted on a raft or float, except as modified below.

d. Contractor shall be responsible for all judgments and impacts as to whether an obstruction in the sewer main can be passed. Costs involved in extracting a stuck camera in the sewer main will be borne by the Contractor and at no additional cost to the Program Manager.

3. Camera & Sonar Combined Operations

a. The combination CCTV and Sonar equipment shall be capable of inspecting a length of sewer up to at least 1,500 linear feet when entry into the sewer may be obtained at each end and up to 750 feet where a self-propelled unit is used and where entry is possible from one end only.

b. Each inspection unit shall contain a means of transporting the CCTV camera or Sonar equipment in a stable condition through the sewer under inspection. Such equipment shall ensure the maintained location of the CCTV camera and Sonar equipment when used independently on or near to the central axis of a circular shaped sewer. The maximum allowable flow depth that is permissible for the

combination Sonar/CCTV is equal to 75% of the pipe diameter. A Sonar only unit shall be used when flow is greater than 75% of the pipe diameter.

c. Where the CCTV camera or Sonar head are towed through the sewer, all winches shall be stable with either lockable or ratcheted drums. All connection shall be steel or of an equally non-elastic material to ensure the smooth and steady progress of the CCTV camera or Sonar equipment through the surcharged sewer. All winches shall be inherently stable under loaded conditions.

d. Each inspection unit shall carry sufficient numbers of guides and rollers such that, when inspecting, all connecting materials are supported away from pipe and manhole structures and all CCTV & Sonar lines used to measure the CCTV camera and the Sonar head location within the sewer are maintained in a taut manner and set a right angles where possible, to run through or over the measuring equipment.

e. The CCTV Camera and Sonar head shall be positioned to reduce the risk of picture distortion. In circular sewers the CCTV camera lens and/or Sonar head shall be positioned, when possible, centrally within the “dry” area for the CCTV and centrally within the “wet” area for the Sonar head. In non-circular sewers, picture/sonar image orientation shall be taken at mid-height, unless otherwise agreed, and centered horizontally. In all instances the camera/sonar lens shall be positioned looking along the axis of the sewer. A positioning tolerance of + 10% of the vertical sewer dimension shall be allowed.

f. When the scanning Sonar is deployed, either stand alone or combined with CCTV, the speed or travel shall be limited to 4 inches per second or 20 feet per minute.

g. A General Condition 360° CCTV rotational scan must be implemented at every 50 feet interval (min) along sewers, and at all manholes and all salient, specified, defect features. More frequent scans must be made should the condition of the pipe differ from the previous scan. The tilt must not be less than 225°.

h. The color palette shall have a minimum of 16 colors with text. The Sonar image, inside the viewing area shall be in color.

i. The picture update speed shall not result in unsatisfactory picture resolution. The range of resolution shall be 1/10 inch.

j. The maximum beam width of Sonar energy pulse shall be no greater than two degrees from the center of the transducer.

k. The transducer shall be of the continuous scanning type, the speed of which shall be 1 second per 360° scan.

l. The Contractor is responsible for hiring a licensed sub-contractor to retrieve any equipment/foreign objects that get stuck in the sewer system through the execution of the scope of work (fallen cameras, jet nozzles, inflatable plugs, sandbags etc.) at the Contractor’s own cost. Such retrieval by an appropriately licensed sub-contractor shall be made within 72 hours to avoid interfering with the City of Memphis sewer system operations. Any and all impacts and related costs due to the Contractor’s equipment in the line shall be the responsibility of the Contractor. Contractor shall follow SARP10 sewer point repair specifications outlined in “Section 02540 Sanitary Sewer Point Repairs” and “Section 02950 Removal and Replacement of Pavements and Incidentals” during retrieval of equipment. Also per “00585.2.2 Safety, Health, and Accident Prevention Program”, Purchaser must approve sub-tier contractors prior to mobilization to the jobsite.

4. Coordination with Other Subcontractors

    a. The Program Manager has an existing contract with a construction subcontractor to handle all clearing, grubbing, access road building, and easement coordination and acquisition. The SSES Subcontractor shall be responsible for notifying the Program Manager of access needs in a timely manner to allow the construction subcontractor to perform the work without impacting the SSES Subcontractor's schedule. SSES Subcontractor shall also coordinate directly with the construction subcontractor in instances where both entities must work on the same site simultaneously.

5. Quality Assurance

    a. QA/QC shall be as contained in Section 00003 - Closed Circuit Television Inspection of Sewer Mains & Connections, Paragraph 3.01.D. Quality Assurance.

6. Deliverable Documentation

    a. Mainline Sewer:

        i. Submit V.6.0.1 PACP compliant records, logs, and electronic inspection data for sewer line inspection to Program Manager by the close of business on the Monday following a week after data acquisition

        ii. Digital videos, data, and photos shall be delivered to the Program Manager on external hard drives which will become property of the Program Manager.

        iii. Data files shall be formatted to facilitate upload into a PACP Database with the approval of the Program Manager.

        iv. Inspections displaying poor digital video/audio quality will be rejected. Quality refers to, but is not limited to, grease or debris on lens, camera under water, image too dark, image washed-out, distorted image, or out of focus images, lines improperly cleaned, and poor/no audio.
            (1) Contractor will re-televise rejected inspections and resubmit inspections at no additional cost to the Program Manager.

    b. Map changes/undocumented manholes:

        i. For map changes identifying undocumented manholes and network changes which were found as a result of field inspections or observations, a Map Edit Form shall also be prepared and supplied by the Contractor with a drawing or sketch and shall indicate special details, field measurement or distances, or locations about an observed undocumented manhole or a change to the sewer network. The Map Edit Form should also identify buried manholes and siphons that have been encountered.

        ii. Contractor shall indicate all buried manholes identified in the field via Sonar/CCTV using the provided Buried Manhole Form. Any additional manholes that have not been located or verified via Sonar/CCTV but are impeding the completion of required Sonar/CCTV work should be designated as unable to locate (UTL) and be included on the form.

c. Sonar Reports

i. The Contractor shall submit two hard copies of all details, i.e. a typed “Full Detail” report for each inspection, showing the position and full text of each defect encountered and their grades. The Contractor shall also supply an overall Summary Report detailing major defects and those inspections that require attention along with a statistical report showing lengths of sewers inspected and a breakdown of sizes and lengths inspected.

ii. The Contractor shall supply a MS ACCESS database and free issue software for both the viewing of the media files and the Sonar images from within the database.

iii. The Sonar Inspection shall include complete structural and service assessment to the equivalent PACP standard as that obtained through conventional CCTV imagery.

iv. The Sonar inspection shall include measurement of flow depth and debris/silt depth.

v. A Color High Resolution Sonar image of cross sections of the sewer must be taken (saved) every 50 feet or more frequently should the internal profile or debris/silt depth of the sewer change from the previously saved image.

vi. These images are to be cross-referenced to the reports and database(s) for ease of retrieval.

PART 4 MEASUREMENT & PAYMENT

4.01 MEASUREMENT

A. CCTV & SONAR INSPECTION

1. CCTV & Sonar inspection shall be measured by linear foot by each diameter of mainline sewer inspected and documented in accordance with the specification.

4.02 PAYMENT

A. CCTV & SONAR INSPECTION

1. CCTV & Sonar inspection shall be paid for at the unit price for each linear foot of each diameter inspected and documented in accordance with the specification.

2. The unit price for CCTV & Sonar inspection shall cover the entire cost of the required CCTV & Sonar inspection and reporting in accordance with PACP V 6.0.1 format, including but not limited to labor, mobilization and access, CCTV equipment, recording media, traffic control, light cleaning of mainline sewer, documenting results in PACP records and logs, digital format recordings, photo equipment, power supply for equipment, interim and final reports, and all other appurtenant work.

3. No additional payment will be made for:

4. Re-inspection due to rejected inspection and/or records for any reason
5. Incomplete electronic logs for either CCTV or Sonar digital records

4.03 PAYMENT WILL BE MADE UNDER:

Item No.	Pay Item	Pay Unit
02543-4.01.A	CCTV & SONAR INSPECTION FOR EACH DIAMETER	LF

END OF SECTION 02543

SECTION 02544
MANHOLE GPS & MACP INSPECTION

PART 1 GENERAL

1.01 SCOPE

A. This Work shall consist of locating sanitary sewer system facilities, gathering sub-meter grade GPS coordinates of manhole (including lamphole) covers, Manhole Assessment Certification Program (MACP) protocol Level 1 and Level 2 manhole inspections using the National Association of Sewer Service Companies (NASSCO) MACP Version 6.0.1 protocols, associated photographs, camera inspection of manholes and the associated pipe connections, and documentation of manholes not found, not on grade and/or not showing. The work shall also consist of completing an internal 3D manhole scan for each manhole with a depth greater than 25 feet or associated with large-diameter sanitary sewer interceptors (36-inch diameter and larger). Manholes to be located, documented and inspected are in both improved streets, arterial and primary roads, backyards and unimproved easements. Manholes may be elevated significantly above the existing ground level. Subcontractor shall have appropriate all-terrain vehicles necessary to access the work, in addition to any equipment necessary to access all elevated manholes while remaining in compliance with The Loss Control Manual. Once new manhole coordinates are obtained, the updated source GIS map data shall be delivered to Program Manager in order to reflect the actual sewer system network.

B. The Work covered by this section includes furnishing all labor, competent MACP certified technicians/crew leads, equipment, tools, accessories, and materials required to GPS, perform MACP Level 1 and Level 2 inspections, conduct 3D scan camera inspections where applicable and document the specified manholes.

C. Selected Subcontractor(s) will be provided two Geo-databases; one will have supporting records (aerial photo overlays, outfall and block maps and as-builts, as available), and a maiden database which will include the asset ID for each manhole.

1.02 SUBMITTALS

A. GPS Requirements

1. Sub-meter GPS coordinates, updated GIS map data, Levels 1 and 2 MACP data and records, and camera inspection photos and 3D scan of the manholes shall be delivered to the Program Manager on clearly labeled external hard drive(s) which will become property of the Program Manager. Inspection data for any one asset shall not be delivered on multiple drives. MACP data files shall be formatted to facilitate upload into a MACP Exchange Database or internet upload to an FTP site as approved by the Program Manager.

B. Unless otherwise specified, all sample submittals shall be delivered to the Program Manager within two weeks of the NTP.

C. For rehabilitation jobs, only Post-Rehabilitation MACP submittals will be required by the Purchaser.

D. Traffic Control

1. A Traffic Control Plan shall be submitted to the Program Manager, including the following items:

a. Outline of permit acquisition procedure for lane closures.

b. Methods for proper signing and barricades, which comply with local requirements and the City.

c. Major streets (e.g. Shelby County Principal Arterial & Minor Arterial) requiring a City approved permit if taking a lane for mobile operations, secured through Traffic Control Plan submittal to the City and signed by a TN P.E. The City requires a two-week lead time for permit processing.

i. The Subcontractor will be required to deliver a sample primary/arterial road Traffic Control Plan for review by the City.

ii. If the City determines that the nature of the work operation or the type of road in which the Subcontractor is working requires a permit, the Subcontractor will be required to modify the sample Traffic Control Plan to obtain a permit from the City.

d. For everywhere else where a permit is not required, the Subcontractor shall develop, provide, and implement a Traffic Control Plan for all mobile operations in accordance with standard MUTCD specifications.

E. Permits

1. The Subcontractor is also responsible for acquiring all necessary disposal and/or landfill site permits required to perform this work.

2. Railroad Rights of Way: The Subcontractor shall notify the Program Manager when work or access to manholes and sanitary sewers lie within the 25 feet railroad easement, as measured by 25 feet outside the nearest rail of the tracks. To access sewer facilities within the 25 feet of the railroad right of way, the Subcontractor shall contact 48 hours in advance the Program Manager, who will alert the City's Zone Construction Inspector to coordinate individual railroad direction and guidance.

3. Permit required confined space entry plans in compliance with the Loss Control Manual.

F. GPS calibration standards, including frequency, are to be followed in the field; specify which available base stations will be used for the work.

G. Sample of sub-meter GPS coordinates delivered in electronic and pdf format.

H. Copies of NASSCO certifications for all field staff conducting MACP Levels 1 and 2 inspections.

I. Sample of MACP Level 1 and Level 2 documentation logs (with photo documentation comments and photos properly referenced) in MACP formats, in both electronic and pdf format.

J. Equipment list, including GPS and 3D camera manufacturer and model equipment to be used.

K. Sample of the GPS coordinate delivery in an ESRI ArcPAD .axf file format.

L. Sample of the digital inspection data delivery in MS ACCESS database format.

M. Sample of 3D manhole inspection and all software necessary to view inspections.

1.03 DELIVERABLES

A. Records

1. GPS Manhole Cover Coordinates

a. Subcontractor's Level 1 Lamphole and Level 2 Manhole GPS coordinate delivery to the Program Manager shall be in an ESRI ArcPAD .axf file format. The updated GIS source map data reflecting the actual sewer system network shall also be delivered. Inspection data is to be delivered to the Program Manager by the close of business on the Monday following a week after data acquisition. Subsequent data will not be accepted if GPS data is not obtained and delivered at the same time as inspection is conducted. The requested GPS control check file (MS EXCEL) shall also be delivered at this time.

2. Level 1 and Level 2 Inspection Documentation

a. Deliver complete MACP Level 1 for lampholes and Level 2 inspections for manholes in MACP electronic database and pdf electronic formats on an external hard drive. Delivery will be in MS ACCESS database format unless otherwise preapproved by the Program Manager. Inspection data is to be delivered to the Program Manager by the close of business on the Monday following a week after data acquisition.

3. 3D Camera Inspection

a. For manholes greater than 25-feet in depth or associated with lines 36-inches or greater in diameter, the Subcontractor shall provide the Program Team with the software required to view the digital film file in the way the Subcontractor can view it, including full control of the virtual pan and tilt. The digital files must include the following:

i. An unfolded view of the manhole with a minimum of 3,000 lines of vertical resolution.

ii. The capability to produce three-dimensional representation of the manhole structure.

iii. A distortion-free virtual pan and tilt allowing the review of the manhole structure from any angle at any depth. The virtual pan and tilt must consist of view from the bottom and top camera, any virtual pan and tilt that artificially creates this view from a single camera will be deemed unacceptable due to distorted images on the direct side view.

2. Camera Inspection Documentation

a. Include specified camera photo documentation of defects, leaks and pipe connections in the MACP Image reference field as appropriate, for the Level 2 documentation. Inspection data is to be delivered to the Program Manager by the close of business on the Monday following a week after data acquisition.

3. Manhole Reports

a. Deliver a summary report in PDF format of each manhole inspected. The report will include all MACP Level 1 & Level 2 data collected for the manhole. The report shall include the surface view photo of the manhole with the outlet pipe facing 6 o'clock as

well as a downhole photo of the channel with the outlet pipe at 6 o'clock. Any defects noted in the manhole shall also have an accompanying photo in the report.

4. Draft Report and Final Report

    a. In addition to the electronic database and pdf format reports, three copies of the Draft Report will contain hard copies of each of the MACP inspections with camera manhole defect and pipe connection photographs. The MACP compliant database of the inspections in ACCESS format shall also be submitted to the Program Manager electronically on an external hard drive.

    b. Draft Report shall be delivered to Program Manager within fifteen working days of the last or final inspection. The Program Manager will have a two workweek period to review and provide comments to the Subcontractor. The Subcontractor shall address all comments and submit the Final Report within one workweek from receipt of comments. At the Program Manager's discretion, a meeting will be held upon submittal of the Final Report to have the Subcontractor go over the processes used to address comments.

5. Quality

    a. Rejection of deliverables will be submitted to the Subcontractor via the Program Team in a written communication discussing issues that must be addressed. The Subcontractor will be required to follow up with a response within three business days upon receipt of the written communication. Subcontractors will have seven (7) calendar days from the rejection notice date to make the necessary corrections and resubmit the data deliverable in its entirety.

PART 2 PRODUCTS

2.01 EQUIPMENT

A. Subcontractor shall have appropriate all-terrain vehicles necessary to access the work. Expected terrain may require the use of four-wheel drive vehicles, ATVs, tracked vehicles, or other appropriate off-road vehicles. Additionally, the Subcontractor shall have all equipment necessary to access elevated manholes in accordance with the Loss Control Manual.

B. All equipment used for the gathering of GPS coordinates, collection of condition assessment information, and digital 3D camera inspection of manholes shall be specifically designed and manufactured for the purpose intended under this Contract. The software and hardware for the electronic capture of the inspection defect observations must be consistent with NASSCO's MACP Level 1 and Level 2 requirements for the collection of data. ESRI ArcPad 10.1 is required for GPS data collection and GIS map updates for manhole / lamphole facility locations. Export of the electronic inspection data to an MACP format Microsoft ACCESS database for analysis is required.

C. The Subcontractor shall submit an equipment list to the Program Manager for approval before the commencement of the Work and shall certify that back-up equipment is available and can be delivered to the worksite in 72 hours.

1. GPS Equipment

    a. GPS Equipment shall be sub-meter grade, Trimble Pro Series Receivers with Floodlight technology capability, Top Con GRS-1 Series equipment or equal (to be approved by Program Manager prior to mobilization). GPS coordinates to be real-time or post-processed to achieve sub-meter accuracy. Equipment must have ESRI ArcPad 10.1 installed for use in data acquisition.

2. Camera

   a. All camera systems used shall be digital format. The camera must have two independently or simultaneously controlled digital cameras, one facing in the downward direction and one facing in the upward direction. Each camera must have a minimum of 185 degree field of view. The inspection camera system must illuminate the interior of the manhole using a xenon strobe light. The light shall be positioned 360 degrees around the camera lens to distribute the light evenly onto the structure walls. The lighting must be able to illuminate manholes up to 120” in diameter without the need of any auxiliary lighting.

   b. A camera must also be able to obtain still images of the following specified pictures: Photo 1- surface view photos taken of the manhole should include a whiteboard (or similar) with the manhole ID number identified on it. The photographer should be standing with the outlet pipe facing their 6 o’clock position. Photo 2 - the downhole photo of the manhole channel should be taken with the outlet pipe facing their 6 o’clock position. Additional photos as specified by MACP guidance. The camera used for these images must be minimum 5 megapixel .jpg format for sufficient clarity and detail in the photos, and photos of at least 2 MB shall be submitted. If the 3D scan camera system cannot obtain photos of sufficient quality, a pole-mounted digital camera with lighting shall be used for the specified pictures in this paragraph.

   c. The 3D camera system shall produce individual images or frames with no more than 0.001 inches of movement during image or frame exposure to produce crisp, clear images. The inspection camera must provide a minimum of 3,000 lines of vertical resolution in the side view and a minimum of 500 lines in the perspective view.

   d. Inadequate lighting, image distortions, blurry or murky images, low resolution, dirty lens and/or other quality issues will be a cause for rejection. If unsatisfactory, Subcontractor shall perform work until deliverable is of acceptable quality. No payment will be made for unsatisfactory inspections or until submittal is accepted.

3. Data Logger and Software

   a. MACP inspections and logs created and captured electronically during the MACP inspection of the manhole through the use of commercially available electronic data loggers are required. Paper records for data collection in the field shall not be used. NASSCO MACP protocols shall be used for capturing and recording the observations.

   b. The data logger equipment and software shall allow Program Manager direct access to the captured electronic data, and provide for export of the data in accordance with MACP formats and standards.

4. Retrieval of Stuck Equipment

   a. The Subcontractor is responsible for hiring a licensed sub-Subcontractor to retrieve any equipment that becomes lodged in the sewer system through the execution of the scope of work (fallen cameras, jet nozzles, inflatable plugs, sandbags etc.) at the Subcontractor’s own cost. Such retrieval by an appropriately licensed sub-Subcontractor shall be made within 72 hours to avoid interfering with the City of Memphis sewer system operations. Any and all impacts and related costs due to the Subcontractor’s equipment in the line shall be the responsibility of the Subcontractor.

PART 3 EXECUTION

3.01 INSPECTION

A. GPS Coordinates of Manhole Cover

1. Program Manager will provide Subcontractor with a digital copy of the original GIS source map indicating the sewer system network compiled from existing City records.

2. The Subcontractor shall capture and record sub-meter grade x, y and z coordinates of each manhole cover identified in the original GIS maiden data map provided with a unique asset identification (ID) number. Additional sanitary sewer lamphole and manholes found in the field in the course of the inspection work that are not provided in current mapping nor identified with a current unique asset ID shall be documented and GPS coordinates shall be recorded. A provisional manhole asset ID number shall be used by the Subcontractor by adding a dash and a two-character number to the closest upstream manhole ID.

3. Record sub-meter GPS coordinates in NAD83 TN State Plane Coordinates horizontal, NAVD88 vertical in US Survey feet using properly-calibrated GPS equipment. If GPS coordinates cannot be obtained due to buildings, trees or cloud cover, Subcontractor shall note this on the inspection form and return at least one additional time at a different time of day or under different sky cover. If both attempts fail at securing the sub-meter coordinates, this is to be documented and reported in the submittal. Land surveying shall not be required where GPS is not available.

4. The Subcontractor shall be expected to use all reasonable means to locate the lampholes and manholes in the field. This includes walking the pipeline alignment, using measuring tapes or wheels from the last found manhole, using metal detectors, or other means. If manholes are not able to be found and documented or unknown manholes are found, record the reasons for not locating or not opening the manhole or the specifics of the new manhole found, and submit with supporting MACP documentation to the Program Manager daily.

5. Once GPS coordinates are obtained for known and newly discovered facilities, the original GIS map data shall be delivered to the Program Manager to reflect the actual sewer system network for the assigned inspection area.

6. The Subcontractor shall revisit predefined GPS control locations near project area at least one time per day per each GPS unit used as a quality control check on GPS accuracy. Subcontractor is to document these checks on a single log, which shall be kept on file for the duration of the project, and shall be released to Program Manager on a weekly basis.

B. MACP MH Inspection

1. The Subcontractor shall document and record each sanitary sewer manhole inspection in MACP Level 1 format for lampholes and Level 2 format for manholes with supporting completed MACP format database. The complete NASSCO MACP Levels 1 and Level 2 protocols must be utilized for the lamphole and manhole inspections respectively, and must be associated in the electronic database and pdf documentation with the unique asset ID provided.

2. The Subcontractor shall mark the direction of wastewater flow (one arrow per pipe) in and out of the manhole around the perimeter of the manhole cover on the street with discrete

green arrows spray painted onto the road surface using a guide or template for the arrows. The arrows shall be a minimum of 12 inches and a maximum of 18 inches in length.

3. The Subcontractor shall follow the prescribed MACP Level 1 and Level 2 procedures and use the required nomenclature and formats to document the manhole interior and exterior conditions and defects.

4. Subcontractor shall be responsible for cleanup, repair, fines, property damage costs, and claims for any sewage backup, spillage or sanitary sewer overflow during or as a result of the field operations.

C. Camera Inspection of Manholes and Associated Pipe Connections

1. For manholes greater than 25-feet in depth and manholes associated with lines 36-inches and larger in diameter, a 3D manhole scan shall be completed in conjunction with Level 2 manhole inspections of defects and include each sewer pipe connection in the manhole. The photo record of the inspection shall document defects and leaks and shall include a photo record of the connecting pipes in each manhole. Abbreviations, naming conventions, and numbering conventions shall be documented in MACP formats.

2. File naming must be consistent. Additional instructions, naming conventions, file structures, etc. will be provided after contract award.

D. Incident Observation and Data Collection

1. The Subcontractor shall report all Unable to Complete and surcharged manholes to the Program Manager through the program-defined reporting application (Teamworx) and shall fill out all required fields and attach picture documentation as necessary. For a surcharged manhole, at least one picture shall be included to document the level of surcharge. All reported incident observations will be monitored by the Program Manager and inadequate reporting will result in a meeting between the Program Manager and Subcontractor.

PART 4 MEASUREMENT and PAYMENT

4.01 MEASUREMENT

A. GPS Coordinates of Manhole Cover

1. The capture and associated documentation of sub-meter GPS x, y and z coordinates for each lamphole and manhole cover will be measured for payment per each lamphole and manhole located by GPS and its coordinates recorded in accordance with the specification, provided that documentation meets QA/QC standards.

B. MACP Level 1 for Lamphole Inspections

1. The inspection and recording of all lamphole observations in a MACP compliant fashion will be measured for payment per each lamphole inspected in accordance with the specification.

C. MACP Level 2 for Manhole Inspections

1. The inspection and recording of all manhole observations in a MACP compliant fashion will be measured for payment per each manhole inspected in accordance with the specification. For manholes greater than 25-feet in depth or associated with lines 36-

inches in diameter or greater, a 3D manhole scan shall be included as part of the MACP Level 2 inspection.

4.02 PAYMENT

A. Post GPS Coordinates of Cleanout or Manhole Cover

1. The capture and associated documentation of sub-meter GPS x, y and z coordinates for each manhole cover shall be paid for at the unit price bid for each cleanout and manhole cover coordinates documented and recorded in accordance with the specification provided that QA/QC standards are met.

2. The unit price for each manhole cover GPS set of coordinates shall cover the entire cost of the GPS equipment and time necessary to gather the coordinates, including but not limited to calibrating the equipment; setup and access; traffic control; documenting results in prescribed MACP electronic formats, records and logs; power supply for equipment; interim and final reports; and all other appurtenant work.

3. No additional payment will be made for:

   a. Location or re-inspection due to cars parked over manholes or other impediments to on grade and showing manhole covers.

   b. Additional visit(s) to secure the proper GPS coordinates due to lack of adequate satellite coverage or reception.

B. Post MACP Level 2 for Manhole Inspections

1. The inspection and recording of all manhole observations in a MACP format shall be paid for at the unit price bid per each MACP Level 2 inspection performed in accordance with the specification, provided that QA/QC standards are met.

2. The unit price for each MACP manhole inspection shall cover the entire cost of the inspection and reporting, including but not limited to setup and access, documenting results in records and logs, digital photos, power supply for equipment, interim and final reports, and all other appurtenant work. This also includes the materials and labor to complete 3D scan of the manhole with all associated deliverables where applicable.

4.03 PAYMENT WILL BE MADE UNDER

Item No.	Pay Item	Pay Unit
02544-4.01.A	POST GPS COORDINATES OF CLEANOUT OR MANHOLE COVER	EACH
02544-4.01.B	POST MACP LEVEL 2 MANHOLE INSPECTIONS-NO 3D SCAN	EACH

END OF SECTION 02544

SECTION 02630
SITE PREPARATION AND RESTORATION

PART 1 GENERAL

1.01 SCOPE

A. This Work shall consist of the removal of brush, rubbish, fences, structures, abandoned appliances, building foundations, all trees, shrubs and plants not to be protected, and all other obstacles within the right-of-way / easement limits shown on the Plans and/or in the Special Instructions; the disposal of debris; and the restoration and/or protection of trees, shrubs, plants, fences, turfed areas, and structures after construction of drainage facilities is completed.

PART 2 PRODUCTS

2.01 EQUIPMENT

A. All equipment for the satisfactory performance of the work shall be on the project and approved before the work will be permitted to begin.

PART 3 EXECUTION

3.01 RIGHT-OF-WAY AND EASEMENT

A. The Subcontractor shall confine his construction activities within the rights-of-way and/or easements as shown on the Plans and easement/rights-of-way plats provided by the owner. The Subcontractor shall be responsible for obtaining written agreements for use of private property outside of City of Memphis acquired rights-of-way/easements for such purposes as storage of material and equipment and access to the construction site. The Subcontractor shall provide a copy of all such written agreements to the Purchaser immediately upon obtaining the necessary documentation.

3.02 EXISTING OBSTRUCTIONS

A. Where applicable, locations of obstructions shown on the Plans are approximate and are shown only for information purposes and are not intended as an accurate location of such obstructions. Obstructions not shown on the Plans but encountered by the Subcontractor shall be removed as necessary and, if directed by the Owner, replaced in their original state or protected by the Subcontractor at no additional cost to the Purchaser.

3.03 REMOVAL OF VEGETATION

A. The rights-of-way/permanent easements shown on the Plans and right-of-way/easement plats shall be cleared of all dead trees, living trees, stumps, brush, projecting roots, hedge, weeds, pole stubs, logs, and other objectionable material, vegetation and growth. This work shall include the removal of all trees, shrubs, and plants not suitable for moving and replanting as determined by the Owner. All trees, stumps, roots, pole stubs, brush, hedge, and other protruding obstructions within the rights-of-way/easements shall be removed to within 3 inches of existing ground. This work shall be done well in advance of excavation operations. Trees and shrubs to be replanted shall be extracted with an ample ball of earth around roots so that transplanting may be successful. The root ball shall be wrapped in burlap. Vegetation stored for replanting shall be watered sufficiently to protect the root system from dehydration.

B. Low hanging branches and unsound branches on trees or shrubs designated to remain, shall be removed. All trimming shall be done by skilled workmen and in accordance with good tree surgery practices.

3.04 REMOVAL OF OBSTRUCTIONS

A. Existing fence material and posts within the rights-of-way/easement limits shown on the Plans and right-of-way/easement plats shall be moved from the construction area and stored in such a manner as to protect them against damage. The Subcontractor shall be responsible for the condition of the removed fence material and posts. The Subcontractor shall demolish and remove all structures and structure foundations within the rights-of-way/easement limits unless otherwise instructed by the Purchaser. Such structures and foundations shall be removed to 12 inches below the subgrade elevation or as directed by the Purchaser. If permitted by the Purchaser, the Subcontractor shall backfill basements, cisterns, and the like in an approved manner. The Subcontractor shall remove all abandoned vehicles, appliances and rubbish within the rights-of-way/easement limits.

3.05 PROTECTION OF OBSTRUCTIONS OUTSIDE RIGHT-OF-WAY/EASEMENT LIMITS

A. The Subcontractor shall protect and avoid damage to all trees, shrubs, plants, fences, turfed areas, structures, and all other objects outside of the right-of-way/easement limits shown on the Plans and right-of-way/easement plats from damage due to construction operations. Damage caused by the Subcontractor shall be repaired or restored at no cost to the Purchaser. Particular care shall be used to avoid damage to trees, shrubs, bushes, turfed areas, and private property located adjacent to rights-of-way/easements on private property. No trees, plants, turfed areas, or other objects outside such limits shall be disturbed or damaged without the written permission of the property owner.

3.06 SPECIAL PROTECTION OF OBSTRUCTIONS INSIDE EASEMENT LIMITS

A. Wherever the underground installation of drainage facilities conflicts with other improvements previously made by the Purchaser, other governmental bodies, or adjacent property owners, the Contractor shall be responsible for their protection and preservation, including necessary removal and storage of such improvements, and subsequent replacement to obtain, to the fullest extent possible, the undisturbed condition.

3.07 DISPOSAL OF DEBRIS

A. All trees, brush, logs, snags, leaves, sawdust, bark, construction debris, and refuse shall be collected and disposed of in accordance with all applicable City codes and ordinances. Debris shall be removed from the site as soon as practical and shall not be left until the completion of the contract. If burning of debris is allowed by the Purchaser, the Subcontractor must obtain and pay for a permit from the City of Memphis Department of Fire Prevention and all precautions necessary shall be exercised to prevent the spread of fire and such burning shall be in accordance with Division 1, “General Requirements” of these Specifications. Burning shall be done only at approved locations and in conformity with the laws, ordinances, and requirements of agencies and officials having jurisdiction. When materials are to be disposed of, the Subcontractor shall obtain written permission before hand from the property owner on whose property the disposal is to be made and shall file a copy of such permit with the Purchaser. Unless otherwise provided in the Contract Documents, the Subcontractor shall make his own arrangements for disposing of such materials off site.

3.08 REPLACEMENT OF VEGETATION

A. As soon as backfill operations permit, the Contractor shall replace transplanted trees, shrubs, and plants. The Contractor shall properly water the transplanted vegetation immediately upon replanting and at suitable intervals thereafter. If shrubs, plants, or trees die after transplanting and before final acceptance of the Work, the Contractor shall at his expensed replace same with equal shrubbery, plants, or trees.

3.09 REPLACEMENT OF FENCES

A. Any fences disturbed within the rights-of-way/easement limits shall be replaced to the satisfaction of the Purchaser. Fences in such poor condition that they cannot be removed and replaced shall be replaced with new fence material similar in original quality, size, and appearance to the removed fence or a written release shall be obtained from the property owners. For chain link fence, new fence materials and construction methods shall conform to the requirements of Specification Section 02820. For box culvert or pipe construction, any fences removed shall be replaced in their original location. Any fence damaged during construction shall be restored to original or better condition. For channel lining construction, removal of fences shall be performed with care and the fence rolled up or stacked and stored on the owner's property. All side yard fences within the easement shall be replaced or extended to the new channel with in-kind fence material.

3.10 ESTABLISHMENT OF TURFED AREAS

A. After final restoration of settled trench surfaces, all areas within the right-of-way or permanent easement limits which were established turfed areas prior to construction will be sodded in accordance with Specification Section 02921. All cut or fill slopes constructed for new drainage facilities will be sodded in accordance with Specification Section 02921 and in conformity with City cross-sections.

3.11 RESTORATION OF OTHER TURFED AREAS

A. All areas outside the right-of-way, permanent easement, or cut and fill slopes shall be restored as nearly as practical to their original condition at the Contractor's expense. Finished lawn areas upon which earth has been deposited shall be cleared to the level of the existing sod and then raked and watered. Areas where sod has been damaged, destroyed, or ruts have been filled in shall be resodded. Areas where sod is only slightly damaged may be lightly reseeded, if so permitted by the Purchaser. Sodding and seeding materials and construction methods shall conform to the requirements of Specification Section 02921.

PART 4 MEASUREMENT & PAYMENT

4.01 MEASUREMENT

A. Site Preparation and Restoration

1. No measurement of area will be made. When changes in the Contract Documents affect the rights-of-way/easement area, a proportionate adjustment for the increased or decreased area will be made.

2. When the Proposal Sheet(s) does not contain an item for Site Preparation and Restoration, this work will be required within the construction limits and will not be paid for directly but will be considered as a subsidiary obligation of the Subcontractor under other contract items.

4.02 PAYMENT

A. Site Preparation and Restoration

1. Payment will be made for Site Preparation and Restoration at the contract lump sum price, which price will be full compensation for removal and/or protection of trees, shrubs, plants, brush, rubbish, fences, man-made obstructions including but not limited to structures,

abandoned appliances, building foundations, and all other obstructions as may directed by the Owner; the disposal of debris and obstructions removed; and the restoration of trees, shrubs, plants, fences; restoration of turfed areas outside of right-of-way, permanent easement and cut and fill slopes, and all other items as shall be specified in the Plans and Contract Documents or directed by the Owner.

4.03 PAYMENT WILL BE MADE UNDER:

Item No.	Pay Item	Pay Unit
02630-4.01.A	SITE PREPARATION AND RESTORATION	LUMP SUM

END OF SECTION 02630

SECTION 02631
EARTHWORK FOR DRAINAGE SYSTEMS

PART 1 – SCOPE

1.01 This work shall consist of all types of excavation, special protection, protection of existing utilities, backfilling, and grading for all types of drainage facilities including such labor, material and equipment, and all other items as may be necessary to complete the earthwork as shown on the Plans, stipulated in the Contract Documents, or directed by the Purchaser.

PART 2 – MATERIALS AND EQUIPMENT

2.01 MATERIAL

A. Lumber.
Lumber to be used for bracing trenches shall be no less than 2 inch thick rough cut oak.

B. Pit Run Gravel.
Pit run gravel shall consist of one of the three gradations shown in the table below.

1. Total Percent, by Dry Weight, Passing Each Sieve (U.S. Standard)

Size No.	2 ½ "	2"	1 ½ "	1"	3/8"	No. 40	Clay*
1	100	95-100			35-65	10-30	1-12
2		100	95-100		40-65	10-30	1-12
3			100	90-100	45-65	10-35	2-12

* Clay content shall be determined by the Hydrometer Test – AASHTO T 88. Clay content up to 15 percent may be used with the approval of the Purchaser.

2. That portion passing the No. 40 sieve shall be known as the binder. The binder aggregate shall consist of hard durable particles of limestone or a sound silicious material. Shale aggregate or pipe clay binder will not be acceptable, and in no case shall the percent of silt exceed the percent of clay by more than 25 percent.

3. If the binder material is insufficient to properly bond the aggregate, a satisfactory binding material may be incorporated, as approved by the Purchaser, so that the resultant mixture will comply with these Specifications. The mixing shall be done uniformly, and blending of materials on stockpiles or in the pits by bulldozers, clamshells, draglines, or similar equipment will not be permitted.

C. Backfill Material.
Material for backfill shall be fine compactible soil selected from site excavation if approved by the Purchaser as being suitable. Additional material needed shall be obtained from borrow excavation.

2.02 EQUIPMENT
All equipment necessary for the satisfactory performance of this work shall be on the Project and approved before work will be permitted to begin.

PART 3 – CONSTRUCTION REQUIREMENTS

3.01 EXCAVATION

A. General.
All excavation performed under this Section including trench excavation, structure excavation, and channel excavation but excluding undercut will be considered unclassified excavation regardless

of the nature of the material and objects excavated and will not be measured or paid for separately except as specifically noted herein. Pavement removal and replacement shall be accomplished as specified in Specification Section 02950.

1. Undercut Excavation.

a. Undercut excavation shall consist of removing and disposing of soft, spongy earth, muck, mud, unconsolidated fill, organic matter, and any other unsatisfactory materials below the grade established on the Plans for storm drains, structures, and channels where determined necessary by the Purchaser. No undercut excavation shall be performed without prior authorization of the Purchaser in writing. The limits of undercut excavation will be determined by the Purchaser, who will be present during the undercut operations.

b. Undercut areas shall be backfilled with suitable material to the grade established on the Plans. The backfill shall be placed in 6 inch maximum lifts and compacted by use of a bulldozer.

2. Unauthorized Excavation Below Subgrade or Outside of Limits.

All unauthorized excavation carried beyond or below the lines and grades given by the Plans or Contract Documents, together with the removal of such excess excavated materials, and the cost of refilling the space of such over dig or unauthorized excavation, shall be at the Contractor's expense. The excess space between the undisturbed bottom and sides of the excavation and subgrade limits shown on the Plans for storm drain pipe shall be refilled with suitable material and compacted per Specification Section 02631, Paragraph 3.01.A.1a unless otherwise directed by the Purchaser. The excess space between the undisturbed bottom of the excavation and subgrade elevations shown on the Plans for box culverts and concrete channel lining shall be refilled with suitable material and compacted per Specification Section 02631, Paragraph 3.01.A.1a. The unauthorized excavation outside of side excavation limits shall be backfilled with select material unless otherwise directed by the Purchaser. The backfill shall be compacted in accordance with Specification Section 02631, Paragraph 3.01.A.1a.

3. Change in Excavation Location or Grade.

If the Purchaser orders in writing that the location or grade of a proposed drainage facility be changed from that shown on the Plans, the following provisions will apply.

a. If the change is made before excavation work has begun and the facility being constructed is covered in the Proposal Sheet(s) by pay items with appropriate depth classifications (pipes, manholes, and similar items), the appropriate pay item will apply to the new depth measurements along the changed centerline. If the changed location or grade introduces a new depth classification not included in the Proposal Sheet(s), a Change Order or Construction Change Order will be prepared in accordance with Specification Section 00710 Article 9 "Changes". If the facility being constructed is not covered in the Proposal Sheet(s) by pay items with depths classifications (box culverts, concrete channel lining, unlined channel, inlets, junction structures, etc.) and if the average depth of excavation per linear foot at the changed location or grade is within 10 percent of the original Plan quantity, there will be no change in the unit price for this work and no additional compensation (or reduced compensation) will be allowed for the change. If the average depth of excavation per linear foot at the changed location is more than 10 percent above or below original Plan quantities, a new unit price for the actual excavation depth will be established. For purposes of comparing changed quantities to Plan quantities, a 1 foot wide strip will be assumed from natural ground line to invert along both the revised and original locations; quantities will then be calculated for the 1 foot wide strip along both conditions and then divided by the proper lengths.

b. If the change is made after excavation has already begun on the original Plan location, the procedures described above will apply to payment for work along the changed location.

If abandonment of an existing excavation or a portion of an existing excavation is required due to a change by the Purchaser, the Contractor will be compensated for the backfilling and restoration of the abandoned excavation. Backfilling and restoration of the abandoned excavation will be accomplished in accordance with the appropriate section of these Specifications.

c. Filling a portion of existing excavation to meet changed grades will be accomplished in accordance with Specification Section 02631 Paragraph 3.01.A.1a.

d. If a change in location and/or grade is authorized in writing by the Purchaser at the written request of the Contractor; whether before or after excavation work has begun; the Contractor will not receive and additional compensation whatsoever for the changed work even though lengths and/or depth of excavation may be greater than original Plan quantities. Backfilling and restoration of abandoned excavation work will be accomplished totally at the Contractor's expense. If changes requested by the Contractor result in reduced lengths and/or depth of excavation, the revised quantities using Proposal unit prices or Change Orders/Construction Change Orders as appropriate will be used to develop payment.

4. Disposition of Excavated Material.

a. Excavated materials suitable for backfill shall be stored no closer than 2 feet from the edge of the excavation to allow free passage of the Purchaser and permit the Purchaser to perform his work in an expeditious and safe manner. Excavated material shall not obstruct crosswalks, sidewalks, street intersections, nor interfere unreasonably with travel on streets by occupants of adjoining property. Gutters or other surface drainage facilities shall not be obstructed. When clear access to fire hydrants, mail boxes, sewer and conduit manholes, and similar utility or municipal service facilities is required, the Contractor must provide such access. Excavated material intended for backfill shall be stored in such a manner as to minimize loss of excavated material due to erosion.

b. All materials excavated, disturbed, damaged, or removed by the Contractor and not to be used for refilling trenches, channels, or structure excavations or to be used in restoration of subsurface or surface facilities or conditions, shall be removed from the site and disposed of by the Contractor, unless otherwise directed. The City reserves the right to retain excess excavation material and direct the Contractor to deliver it to a site specified by the Purchaser at the Contractor's expense. If the Contractor proposes to store or place such excess excavated material upon any property, written consent of the property owner or owners must be secured in advance and a certified copy thereof be filed with the Purchaser. No surplus or excess materials shall be deposited in any stream channel nor in any place where preconstruction surface drainage would be changed, without written permission of the Purchaser.

5. Control of Storm Water.

a. The Contractor shall keep all excavations free of water. He shall provide all dams, flumes, channels, sumps, or other works necessary to keep the excavation entirely clear of water and shall provide and operate pumps or other suitable equipment of adequate capacity for dewatering the excavations. He shall avoid producing mud in the trench or channel bottom by his operations. If necessary or so ordered by the Purchaser, the Contractor shall place pit run gravel at his own expense to maintain a firm, dry excavation bottom and base. Pipe bedding, laying, jointing, and the placing of concrete or masonry shall be done in a water free trench or excavation, which shall be kept clear of water until pipe joints, concrete and masonry have set and are resistant to water damage. The water shall be disposed of at the Contractor's expense.

b. All gutters, pipes, drains, conduits, culverts, catch basins, inlets, ditches, creeks, and other storm water facilities shall be kept in operation, or their flows shall be satisfactorily diverted and provided for during construction. Any facilities disturbed during construction shall be restored to the satisfaction of the Purchaser.

6. Excavation Around Obstructions.

a. The Contractor shall perform all excavation by hand where excavation by machinery would endanger trees, structures, or utilities which otherwise might be saved by the use of hand excavation.

b. The Contractor shall cautiously excavate test holes to locate the limits of underground obstructions anticipated within the excavation. When a water pipe, gas pipe, sewer, or similar utility comes within the limits of the trench, such facilities shall be properly supported.

B. Trench Excavation.

1. All trenches shall be open cut unless otherwise shown on the Plans. Tunneling, boring, or jacking will be allowed only on permission of the Purchaser, unless otherwise shown on the Plans, and a complete record thereof shall be kept in the Contractor's project diary.

2. The Contractor shall be responsible for prosecuting the work in accordance with the grades and lines shown on the Plans or as directed by the Purchaser. Trenches may be excavated by machinery to a depth that will not disturb the finished subgrade. The remaining material shall be hand excavated so that the pipe may be laid on a firm, undisturbed subgrade.

3. No more than 300 feet of trench shall be opened at any time in advance of the completed storm drain, nor shall more than 100 feet be left unfilled except by written permission from the Purchaser. In special cases the Purchaser may limit the distance to which the trench may be opened by notifying the Contractor in writing.

4. The width of trenches below a level 1 foot above the outside top of pipe shall be such as to leave not less than 6 inches on each side of the outside of the pipe for all sizes up to and including 15 inch diameter pipe. Maximum trench width dimension for these pipe sizes shall be 36 inches. For 18 inch diameter pipe, the width of trenches below a level 1 foot above the outside top of pipes shall be such as to allow not less than 6 inches one each side of the pipe, with a maximum trench width of 42 inches. For pipes sizes over 18 inches, the width of trenches below a level 1 foot above the outside top of the pipe shall be such as to allow not less than 12 nor more than 15 inches on each side of the outside top of the pipe. If the trench width at or below that level 1 foot above the outside top of pipe exceeds the widths specified, provision shall be made for the additional load upon the pipe at the Contractor's expense. For pipes other than circular, trench width shall be adjusted to provide for the additional pipe width along the along the horizontal axis.

5. The sides of the trench shall be as nearly vertical as possible. The bottom of the trench shall be carefully graded, formed, and aligned according to the Plans and to the satisfaction of the Purchaser before storm drains are laid thereon.

6. The bottom of the trench shall be excavated at each joint of bell and spigot pipe to allow the body of the pipe a uniform contact and support throughout its entire length. When mortar joints are specified, bell holes shall be excavated at each joint in the pipe line to provide space underneath the pipe in which to properly build up mortar joints.

C. Excavation For Drainage Structures.

1. The Contractor shall be responsible for prosecuting the Work in accordance with the lines and elevations shown on the Plans or as directed by the Purchaser. The Contractor shall excavate as required for all structures with foundations carried to firm, undisturbed earth at the elevation of the underside of the structure.

2. The outside dimensions of all manholes, inlets, box culverts, channel lining, and other drainage structure excavations shall be at least 12 inches greater than the outside of the masonry or concrete work to permit backfilling around structure.

3. Where structures are to be built in street right-of-way or paved areas, the excavation shall not exceed 2 feet from the outside of the masonry or concrete work. In the event that the excavation exceeds this limit, the Contractor will be required, at his expense, to backfill the entire space around the structure with suitable material compacted as specified in Specification Section 02631 Paragraph 4.0.

4. For drainage facilities to be constructed in fill areas, the fill shall first be placed and compacted in accordance with these Specifications. The excavation for the drainage facilities shall then commence following the placement of fill.

D. Unlined Channel Excavation.

The Contractor shall be responsible for prosecuting the Work in accordance with the grades and lines shown on the Plans or as directed by the Purchaser. The sides and bottom of the channel shall be excavated and shaped so as to conform with the cross-sections shown on the Plans or as directed by the Purchaser.

3.02 SPECIAL PROTECTION

A. Treacherous Ground.

When running sand, quicksand, or other treacherous ground is encountered, the work shall be carried on with the utmost vigor and shall be prosecuted day and night should the Purchaser so direct.

B. Sheeting and Shoring.

1. The Contractor shall furnish, place, and maintain such sheeting and shoring as may be required to support the sides of any excavation to prevent earth movement that could endanger the work or workmen; or to prevent any earth movement which might in any way delay the Work, change the required width of the excavation, or endanger adjacent pavement, utilities, sewers, buildings, or other structures above or below the ground surface; or to contain the construction within a specified area such as an easement or street right-of-way. The Contractor shall place this sheeting and shoring for such protective purposes without the Purchaser's instructions.

2. During the extraction of sheeting, care shall be exercised to prevent damage due to settlement or movement of new drainage facilities. The sheeted trench width, as measured between those faces of the sheeting in contact with the earth trench wall, shall not exceed the maximum width of trench specified in Specification Section 02631 paragraph 3.01.B. below an elevation 1 foot above the top of the pipe. Walers and struts shall be designed and installed to present no obstructions to proper placement of the pipe, bedding, cradle or encasement, nor shall they interfere with the satisfactory laying and jointing of the pipe.

3. Sheeting, bracing, and shoring shall be withdrawn and removed as the backfilling is being done, except where and to such extent as the Purchaser shall order that sheeting, bracing, and shoring be left in place, or where the Purchaser will permit the same to be left in place at the Contractor's request. The Contractor shall cut off any such sheeting at least 2 feet below the surface and shall remove the cutoff material from the excavation.

4. All sheeting, bracing, and shoring which is not left in place under the foregoing provisions shall be removed in a manner which will not endanger the completed work or other structures, utilities, sewers, or property whether public or private. The Contractor shall exercise care to prevent the opening of voids during the extraction process.

5. Steel drag shields or trench boxes may be used in lieu of sheeting, shoring, and bracing unless the Purchaser directs otherwise.

C. Excess Width Of Trench.

If the Contractor is permitted to use equipment that results in wider trenches than hereinbefore specified, concrete cradle or additional concrete cradle shall be used around pipe if required to resist the additional load caused by the extra width. The dimensions of this cradle will be specified by the Purchaser, and no extra compensation will be allowed for the additional material or work.

D. Blasting.

1. Blasting shall be under taken only after the Contractor has received written authorization from the Purchaser. With respect to the use of explosives in blasting, the Contractor shall apply for and receive all necessary permits and comply with all federal and state laws, rules, ordinances and regulations and requirements of the insurer governing the keeping, storage, use, manufacture, sale, handling, transportation, or other disposition of explosives. The Contractor shall provide additional liability insurance to the City, with limits and coverages as specified by the Purchaser, covering blasting operations in advance of any blasting. All operations involving the handling, storage, and use of explosives shall be conducted with every precaution under the supervision of a properly licensed individual. The Contractor shall take special precautions for the proper use of explosives both at or near the top of the excavation and in the excavation in order to prevent harm to human life and damage to surface structures, utilities, sewers, or other subsurface structures. The Contractor shall advise the Purchaser in advance when charges are to be set off. Blasts shall not be fired until all persons in the vicinity have had ample notice and have reached positions of safety.

2. Storm drains shall be carefully protected from all blasts, and all excavations requiring blasting shall be fully completed at least 30 feet in advance of the laying of the pipe. In all cases, the mouth of the pipe shall be provided with a board or other stopper carefully fitted to the pipe to prevent all earth or other substances from entering.

3. After a blast is fired, the Contractor shall thoroughly scale the excavation. All loose shattered rock or other loose material which may be dangerous to the workmen, pipe, or structure shall be removed and the excavation made safe before proceeding with the Work. The fact that the removal of loose, shattered rock or other loose material may enlarge the excavation beyond the required width will not relieve the Contractor from making such removal and filling the extra space. The Contractor shall not be entitled to extra compensation therefore.

E. Wellpoints.

The Contractor shall use wellpoints, sump pumps, or any other method of dewatering as required to lower the water table below the bottom of the excavation. He shall make a request to the Purchaser and receive approval of the use of special dewatering equipment other than well points or sum pumps. Dewatering operations are considered incidental to the Work and no additional compensation shall be made to the Contractor.

F. Underpinning.

When excavations require underpinning of existing structures, the Contractor shall submit shop drawings of underpinning details to the Purchaser prior to commencement of excavation below the foundation of the structure. Review of underpinning details by the Purchaser shall not relieve the Contractor of his responsibility for protection of the structure and its contents.

3.03 EXISTING UTILITIES

A. Location.

The Plans indicate the available records of location of existing structures and facilities, both above and below the ground, but the City assumes no responsibility for the accuracy or completeness of this information. Utility service connections are not shown on the Plans, but can be encountered at any location on the Project. If it is necessary to adjust or relocate any utility, it shall be the Contractor's responsibility to coordinate the work with the appropriate utility. Any cost or delays incurred by the Contractor in this activity shall be incidental and no additional compensation will be made.

B. Protection.

1. If the construction of the storm drains, structures, or channel requires the removal and replacement or protection of any overhead wires or poles, the Contractor shall make satisfactory arrangements for such work with the owner or owners of such wires and poles and no additional payment will be made by the City.

2. The Contractor shall protect any sewer or utility within the limits of the construction. The Contractor shall proceed with caution in any excavation and shall use every means to determine the exact location of underground structures, pipe lines, conduits, and similar obstructions prior to excavation in the vicinity thereof. The City will not be responsible for the cost of protection or repair or replacement of any structure, pipe line, conduit, service connection, or similar facility above and below ground which may be broken or otherwise damaged by the Contractor's operations. All water and gas pipes and other conduits adjacent to or crossing the excavation shall be properly supported and protected by the Contractor.

C. Service Connections.

1. Sewer and utility services between mains and buildings shall be maintained and adjusted as necessary by the Contractor so as to provide as nearly a continuous operation as reasonably can be expected. This shall be accomplished in any way that the Contractor may desire, provided that the individual service not be inoperative more than two consecutive hours. The occupants shall be notified by the Contractor at least six hours in advance of such service interruptions. When a break occurs, the Contractor shall notify the affected occupant(s) of the probable length of time that the service will be interrupted.

2. If existing underground facilities or utilities require removal and replacement for the prosecution of this Work, all replacements of such underground construction or parts thereof shall be made with new materials conforming to the requirements of these Specifications or, if not specified, as approved by the Purchaser.

3. The removal and replacement of water services to accommodate new construction shall be the Contractor's responsibility within the limits where the new service line grade blends smoothly with the existing service line grade. This work will be incidental to the construction of the drainage facility and no additional compensation will be made.

4. The removal and replacement of sewer services to accommodate new construction shall be the Contractor's responsibility from the sewer main to a point where the new grade and existing grade can be matched. Payment will be made in accordance with Specification Section 02631 Paragraph 5.05.

5. The Contractor shall be responsible for any damage to the service as a result of his operations. The City does not guarantee the number, size, condition, nor length of adjustment necessary to bring a service to a new grade.

3.04 BACKFILLING

A. General.

1. Bedding for drainage facilities shall be constructed in accordance with the following specifications for the various type facilities:
   a. Storm Drain Pipe: Specification Section 02632 Paragraph 3.02.B
   b. Manholes, Inlets and Special Structures: Specification Section 02640 Paragraph 3.02
   c. Reinforced Concrete Box Culverts: Specification Section 02641 Paragraphs 3.02.B and 3.01.B

After drainage facilities have been bedded and installed in accordance with appropriate specifications and upon permission of the Purchaser, the backfill may be placed. No trash will be allowed to accumulate in the space to be backfilled. Particular care shall be taken to avoid allowing wood to be included in the backfill, other than sheeting and shoring that has been approved to be left in place.

2. The Contractor shall at all times be responsible for the condition of the trenches and filled areas. He shall maintain frequent inspection of same and at any time before the final acceptance of the work by the City the trenches or filled areas settle and sunken places appear, he shall be required to refill these sunken places with suitable material as soon as they are discovered. All trenches shall be barricaded and caution lighted at all times for the protection of the public.

3. Backfilling shall be accomplished as soon as practicable after underground work is completed and inspected. Backfilling operations shall proceed in an orderly fashion following as closely behind construction operations as practical.

4. All backfill shall be placed in uniform horizontal layer. “Ramping,” that is pushing backfill material down a ramp into excavated areas, will not be permitted unless authorized in writing by the Purchaser.

B. Backfill in Street Right-Of-Way and Improved Property

1. Backfill Material in Pavement Areas.

Backfill in excavations through pavement in street right-of-way or wherever prevention of backfill settlement is considered essential such as driveways and paved parking areas on private property, and where the Plans require or the Purchaser orders, shall be made with pit run gravel or other acceptable material from the top of the bedding material or foundation to the subgrade elevation of the pavement. Pea gravel, sand or similar granular materials approximately uniform in size and without bonding properties shall not be used.

2. Backfill Material Outside of Pavement Areas.

a. Backfill in excavations outside of pavement in street right-of-way or outside of public right-of-way shall be made with select, job-excavated earth from the top level of the bedding material or foundation to the subgrade elevation in paved area, or to within 1 inch of the surface in areas to be sodded, or to the surface in all other areas.

b. Nongranular, job-excavated material shall be free from debris, organic matter, perishable compressible materials, and shall contain no stones or lumps or rock fragments larger than 6 inches in dimension, nor be in such amount that will interfere with the consolidating properties of the fill material. Care shall be taken that stones and lumps are kept separated and will distributed, and that all voids are completely filled with fine materials. The upper 3 feet of backfill in sodded or planted areas shall be free of such rocks or lumps larger than 1 inch in diameter.

3. Placement and Compaction.

a. Storm Drain Trenches.
As soon as the pipe has been bedded, laid, jointed, and inspected by the Purchaser, backfilling shall continue in the following manner. Backfill shall be placed by hand in 6 inch loose layers above the bedding and tamped with heavy tampers or pneumatic tampers, special care being taken not to damage the pipe or joints, to a point 2 feet above the outside top of the pipe. From this point to the subgrade elevation of the pavement, or to the bottom of the sod, or to the original ground surface in all other areas, suitable backfill shall be placed in 12 inch loose layers and compacted to 95 percent of maximum density at plus or minus 2 percent of optimum moisture content as determined by Laboratory Standard Proctor Test (ASTM D 698).

b. Structure and Box Culvert Excavations.
As soon as the masonry or concrete work has set sufficiently to withstand compaction, and the Purchaser has inspected it, suitable backfill shall be placed in 6 inch loose layers concurrently and uniformly on all sides and compacted with heavy tampers or pneumatic tampers to 95 percent of maximum density at plus or minus 2 percent of optimum moisture content as determined by Laboratory Standard Proctor Test (ASTM D 698). Suitable backfill shall be placed in this manner concurrently on all sides from the foundation of the structure or culvert to the subgrade elevation of the pavement, or to the bottom of the sod or to the original ground surface in all other areas.

c. Concrete Channel Lining Excavations.
As soon as concrete work has set sufficiently to withstand backfilling and has been inspected by the Purchaser, select backfill material shall be placed by methods other than ramping and compacted by jetting or flooding from the foundation of the channel lining to 3 inches above the top of the wall. Backfill will be rounded slightly adjacent to the top of wall to an elevation 1 inch above the top of the wall to assure positive surface drainage over the top of the wall. Backfill operations shall be coordinated with placement of the weep hole drainage system behind the channel lining wall. Special care shall be exercised during backfilling operations to prevent settlement behind channel lining walls.

C. Backfill in Open Areas and Unimproved Property

1. Backfill Material. Backfill for storm drain pipe excavations in open areas and unimproved property shall be made with select earth material from the top level of the bedding material or foundation to the surface. Backfilling for structures, box culverts, and concrete channel lining excavations in open areas and unimproved property shall be performed in accordance with Specification Section 02631 Paragraph 3.04.B. Nongranular, job-excavated material to be used for backfill shall be free from debris, organic matter and perishable compressible materials, and shall contain no stones or lumps or rock fragments larger than 6 inches in dimension or in such amount that will interfere with the consolidating properties of the fill material. Stones and lumps shall be kept separated and well distributed, and all voids shall be completely filled with fine materials.

2. Placement of Backfill. Backfill procedures specified for improved areas shall apply from the trench bottom to a point 2 feet above the outside of the pipe. From this point to slightly above the surrounding surface elevation, suitable backfill may be placed by bulldozer or other mechanical means.

D. Drainage Facilities Placed on Fill

1. Fill material placed in areas over which drainage facilities will be constructed shall be select earth material from the elevation of suitable subgrade to the bottom elevation for bedding or foundation of the drainage facility.

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

3.05 FINAL GRADING

A. Final grading around and above drainage facilities shall be shaped to the slope of adjacent undisturbed ground. Sufficient grading operations shall be performed to provide natural surface drainage from adjacent properties into drainage facilities.

B. Grading above the top of concrete channel lining walls shall be accomplished in accordance with proposed cross-sections supplied by the City at the preconstruction conference or as directed by the Purchaser. Grading shall provide adequate drainage over the top of channel walls. Side slopes shall be graded to provide a minimum slope of ½ inch per foot beginning 3 inches above the top of channel walls. Side slopes shall be rounded off near the channel wall to an elevation of 1 inch above the top of wall. The addition of sod will provide a final side slope elevation 2 inches above the top of wall.

PART 4 – MEASUREMENT

4.01 UNDERCUT BACKFILL
Undercut backfill will be measured by the ton of suitable material.

4.02 SHEETING AND SHORING DIRECTED TO REMAIN IN PLACE
Sheeting and shoring directed to remain in place will be measured by the 1,000 board feet, in place prior to being cut off below grade. Sheeting and shoring placed and removed by the Contractor will not be measured for payment.

4.03 PAVEMENT BACKFILL
Pit run gravel or other suitable materials used for backfill as determined by Specification Section 02631 Paragraph 3.04.B will be measured by the ton and will be paid for at the contract unit price per ton furnished and placed, which price will be full compensation for furnishing, placing and compacting the selected fill.

4.04 UNLINED CHANNEL
Unlined channel will be measured per linear foot along the centerline for various channel cross-sections, complete in place.

4.05 SEWER BUILDING (HOUSE) CONNECTION REMOVAL AND REPLACEMENT
Sewer building connection removal and replacement for construction of drainage facilities shall be measured per each, complete in place. Sewer building connections damaged by the Contractor which do not require removal and replacement for construction of drainage facilities will not be measured for payment.

4.06 GENERAL
All work for excavation, blasting, drainage of trench and dewatering, backfilling of excavation, compaction, grading, protection of existing utilities, water service connection adjustments, disposal of excess materials, and all other similar items included in this section of the Specifications but not covered by a Pay Item herein will be considered as a subsidiary obligation of the Contractor under other Pay Items of the Contract.

4.07 COMPACTION TESTING
Soil test as required by the Purchaser will be paid for by the test as performed by a testing agency which meets the approval of the Purchaser.

PART 5 – PAYMENT

5.01 UNDERCUT BACKFILL
Accepted quantities of undercut backfill will be paid for at the contract unit price per ton of backfill material furnished and placed, which price will be full compensation for undercut excavation, special protection, protection of existing utilities, and backfilling to bottom of facility subgrade elevations, complete in place.

5.02 SHEETING AND SHORING DIRECTED TO REMAIN IN PLACE
Accepted quantities of sheeting and shoring directed by the Purchaser to remain in place will be paid for at the contract unit price per 1,000 board feet in place prior to being cut off below grade, which will be full compensation for material only. The cost of placing sheeting and shoring to remain in place shall be incidental to the work. No payment will be made for sheeting and shoring placed and removed by the Contractor.

5.03 COMPACTION TESTING
Accepted quantities of compaction tests as required by the Purchaser will be paid for at the contract unit price per test.

5.04 UNLINED CHANNEL
Accepted quantities of unlined channel will be paid for at the contract unit price per linear foot for various channel cross-sections, which price will be full compensation for excavation, removal, and disposal of excavated material and grading, complete in place.

5.05 SEWER BUILDING (HOUSE) CONNECTION REMOVAL AND REPLACEMENT
Accepted quantities of sanitary sewer building connections removed and replaced will be paid for at the contract unit price per each connection, which price will be full compensation for excavation, removal of old connection line and appurtenances, materials and construction of new connection, joining to existing connection line, and backfilling, complete in place.

5.06 PAYMENT WILL BE MADE UNDER:

Item No.	Pay Item	Pay Unit
02631-01	Undercut Backfill	Ton
02631-02	Sheeting and Shoring Directed to Remain In Place	1,000 Board Feet
02631-03	Soil Compaction Test	Each
02631-04	Unlined Channel	Linear Foot
02631-04.____	Description	Linear Foot
02631-05	Sewer Building (House) Connection Removal and Replacement	Each
02631-06	Pavement Backfill	Ton

END OF SECTION 02631

SECTION 02820
CHAIN LINK FENCE

PART 1 GENERAL

1.01 SCOPE

A. This work shall consist of the construction of chain link fences and gates in accordance with these Specifications and at the locations and in conformity with the lines, grades, and dimensions shown on the Plans or as directed by the Owner. Chain link fence may be located atop concrete channel lining walls, retaining wall or similar structure, or may be located independently of structures.

PART 2 PRODUCTS

2.01 MATERIALS.

A. Materials used throughout the project shall be of constant design and manufacture in respect to individual items or parts, excepting where the proposed fence will be an extension of an existing fence, in which case the new fence shall be constructed of materials similar in appearance to those in the existing fence and continued until broken by cross street, railroad, fence ditch, or other physical feature. Unless otherwise directed, new materials shall be as described hereinafter.

B. Fabric.

1. The fabric shall be zinc coated steel chain link type meeting the requirements of AASHTO M 181 for Type I, Class B fabric (zinc coating = 2 oz/ft^2). All chain link fabric shall be manufactured of No. 9 gauge wire pickets, forming a uniform 2 inch mesh, and shall be of the height shown on the Plans or specified in the Contract Documents. Fabric up to and including 60 inches high shall be knuckled at the top and bottom selvage and fabric over 60 inches high shall be twisted on the top selvage and knuckled on the bottom selvage.

C. Line Posts.

1. Line posts shall be zinc coated steel pipe or H-sections of the following dimensions and of the lengths shown on the Plans or specified herein:

				H - Section	
Fence Height (pounds)	Nominal Size (inch)	Outside Diameter (inch)	Weight Per Foot (Pounds)	Dimension (inches)	Weight Per Foot
6 feet or less	1 ½	1.9	2.72	1.875 x 1.625	2.70
6 feet to 8 feet	2	2.375	3.65	2.25 x 1.95	4.10

2. Steel pipe shall conform to ASTM A 120 or AASHTO M181-85I Grade 2 and H-Sections shall be produced from ASTM A 570 and ASTM A 572, Grade 45. The weight of zinc coating shall be a minimum of 1.8 oz/square foot. The weight of zinc coating and weight per foot for steel post meeting the requirements of AASHTO M181-85I grade 2 may vary from the above noted valves.

D. End Posts, Corner And Pull Posts, And Braces.

E. End posts, corner posts, and pull posts shall be zinc coated steel pipe or square sections of the following dimensions and of the lengths shown on the Plans or specified herein:

	Steel Pipe			Square Section	
Fence Height (pounds)	Nominal Size (inch)	Outside Diameter (inch)	Weight Per Foot (Pounds)	Outside Dimension (inches)	Weight Per Foot
6 feet or less	2	2.375	3.65	2.0	3.60
6 feet to 8 feet	2 ½	2.875	5.79	2.5	5.70

1. Diagonal braces shall be 1 ¼ inch (1.660 inch O.D.) galvanized steel pipe, weighing 2.27 pounds per foot. Steel pipe and square sections shall conform to ASTM A 120 or AASHTO M181-85I Grade 2. The weight of zinc coating and weight of pipe per foot for steel post meeting the requirements of the AASHTO M181-85I grade 2 may vary from the above noted valves.

F. Top Rail:

1. Top rail shall be used when specified on the Plans in lieu of top tension wire. The top rail shall be 1 ¼ inch (1.660 inch O.D.) galvanized steel pipe, weighing 2.27 pounds per foot, meeting the requirements of ASTM A 120 or AASHTO M181-85I Grade 2. Top rails in random lengths shall be fitted with expansion sleeves for connecting lengths into a continuous run or shall have a 3 inch swagged end. Suitable fittings shall be provided for securing top rail to each gate, corner, and end post.

G. Barbed Wire:

1. Barbed wire shall consist of two No. 12 ½ gauge, twisted steel strands with No. 14 gauge four-point barbs spaced not more than 5 inches apart. The galvanized strands shall meet the requirements of ASTM A 121, Class II coating.

H. Miscellaneous Fittings And Hardware:

1. Zinc coated miscellaneous fittings and hardware shall be commercial grade steel or better quality, pressed, wrought, or cast as appropriate to the article, and sufficient in strength to provide a balanced design when used in conjunction with fabric, posts, and wires of the quality specified herein. All steel fittings and hardware shall be galvanized in accordance with AASHTO M 111.

I. Barbed Wire Support Arms:

1. Barbed wire support arms shall be single arms for carrying 3 barbed wire strands. Barbed wire support arms for line posts shall be at an angle of 45 degrees (plus or minus 5 degrees) and shall be fitted with clips or other suitable means for attaching three lines of barbed wire, with the top strand of barbed wire 12 inches (plus or minus 1 inch) above and horizontally from the fence line, and the remaining two strands of barbed wire spaced uniformly between the top of the fence fabric and top strand of barbed wire. Support arms

shall be capable of withstanding a load of 250 pounds when the base is clamped securely and the vertical load applied from where the outer strand of barbed wire passes over the arm.

J. Wire Ties:

1. Wire ties shall be No. 9 gauge and shall be either zinc coated steel, aluminum coated steel or aluminum alloy and sufficient in strength and other properties to provide a balanced design when used in conjunction with fabric, posts, and wire of the qualities specified herein. When tension wire is used, wire ties and clips for fastening fabric to tension wire shall be No. 11 gauge.

K. Tension Wire:

1. Tension wire shall be used at the bottom of fencing fabric when not otherwise secured and used at the top unless a top rail is specified. Tension wire shall be No. 6 gauge, spring rolled, aluminized steel wire.

L. Truss Rods and Turnbuckle:

1. Truss rods shall be 3/8 inch diameter steel rods and shall be equipped with a turnbuckle having a take-up of not less than four inches and shall be galvanized in accordance with AASHTO M 111.

M. Fence Gates:

1. Fence gates shall be of the kinds and sizes shown on the Plans or specified in the Contract Documents. They shall be of the swing type, complete with latches, stops, keepers, hinges, and fabric. The latch shall have provision for fastening with a padlock. The gates shall be covered with fabric matching the fence. The hinges shall be of adequate strength to support the gate and shall not twist or turn under action of the gate. The gates, gate posts, and braces shall be of the same material and finish as the adjoining fence. All gate posts and rails shall be furnished complete with ball caps and rail ends.

2. Posts, braces, and framing members for chain link fence gates shall be zinc coated steel pipe meeting the requirements of Specification Section 02820 Paragraph 2.01.C. Gate post shall be 2 ½ inch (2.875 inch O.D.) pipe weighing 5.79 pounds per foot for gate widths of 5 feet or less; and 3 ½ inch (4.0 inch O.D.) pipe weighing 9.10 pounds per foot for gate widths between 5 feet and 13 feet.

3. Framing members and interior bracing shall be of the following minimum dimensions:

Framing and Bracing

Fence Height	Nominal Size	Outside Diameter	Weight Per Foot
6 feet or less	1 ¼	1.66	2.27
6 feet to 8 feet	1 ½	1.90	2.72

a. Gate frames shall be welded at all corners or assembled with corner fittings. When corner fittings are used, gates shall have truss rods as specified in Specification Section 02820 Paragraph 2.01.J to prevent sag or twist. All welded joints shall receive

a shop applied zinc coating equivalent in thickness to that of the members being joined.

4. Fabric shall meet the requirements of Specification Section 02820 Paragraph 2.01.A.

5. Barbed wire shall meet the requirements of Specification Section 02820 Paragraph 2.01.E.

6. Miscellaneous fittings and accessories shall meet the applicable requirements of Specification Section 02820 Paragraphs 2.01 F, G, H, and J. The hinges shall be of such design to allow the gate to swing back 180 degrees, parallel with the fence line.

N. Concrete.

1. Concrete for post footings shall be Class A as specified in Specification Section 03050.

O. General.

1. Posts shall be fitted with ornamental tops or extension arms as stipulated in the Plans or in the Contract Documents. Caps or ornamental tops for tubular posts shall have a base fitting into the post with a flange extending over the top of the posts to protect against moisture. When a top rail is provided, all posts shall be provided with caps having a ring or hole suitable for the through passage of the top rail. Rail and brace ends, or other suitable means of connection, shall be provided when top rail or braces are required.

2. Fabrication of all materials shall be in conformity to the sizes, shapes, and other factors set out in these Specifications or shown on the Plans, and shall show careful, finished craftsmanship in all respects.

3. The weights specified for steel posts, braces, and rails are nominal weights, and a plus or minus tolerance of 5 percent will be permitted. All posts located on the top of concrete channel lining walls or similar structure shall be of sufficient length to be set fully 12 inches into the wall or structure.

4. All line posts located on the ground shall be of sufficient length to be set fully 24 inches deep into concrete footings, and all end, corner, and pull posts shall be of sufficient length to be set 30 inches deep into concrete footings.

2.02 EQUIPMENT

A. All equipment necessary for the satisfactory performance of the work shall be on hand and inspected by the Owner before construction work will be permitted to begin.

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS.

A. Fencing shall be placed atop concrete structures, such as concrete channel linings, in accordance with Plans and Design Standards. Fence post inserts will normally have been set into the concrete walls prior to fence construction activities. Inserts shall be 12 inch ling solid wall PVC pipe conforming to ASTM D2241, thin wall metal conduit conforming to ANSI C 80.3 and sealed at one end or other material approved by the Owner. Cans, bottles and the like shall not be used as inserts. Alternatively, posts may be set directly into the structure concrete as the concrete is poured, making sure that all posts are plumbed and held securely in the proper position until the concrete has set.

B. The inside diameter of the inserts shall be sufficient to provide a minimum of ¼ inch clear space between the outside surface of the post and the inside surface of the insert. Inside of inserts

shall be cleaned of debris and other foreign matter, insert space filled full of nonshrinking grout, the posts set into place in the insert and plumbed, and the post held plumb until the grout has set. All excess grout shall be removed before it sets. Where inserts have not been provided in the concrete structure, post holes of the same diameter and depth as required for inserts shall be cored in the concrete. Posts shall be set in cored holes in the same manner as posts set in inserts.

3.02 FENCING SET INDEPENDENTLY OF STRUCTURES.

A. Before beginning construction or placing of fences, all necessary work for clearing and grubbing, removal of structures and obstructions, and site preparation shall be performed in accordance with the applicable Sections of these Specifications. Clearing for fence construction shall not extend beyond the construction easements without written approval of the property owner. Living trees and shrubs one foot or more each side of the fence line shall remain undisturbed unless otherwise directed by the Owner. Any rock protruding above the ground surface and in the line of the fence shall be removed to ground surface.

B. Posts for chain link fence shall be set at intervals not to exceed 10 feet. The interval between posts shall be measured parallel to the bottom of the fabric of the proposed fence and in line of fence from center to center of post.

C. All line posts located on the ground shall be set fully 24 inches deep in concrete footings; end, corner and pull post shall be set 30 inches deep in concrete footings. Diameters of footing shall be : for line post not less than 8 inches; for end, corner or pull post not less than 10 inches. Footings for gate post shall be designed to support the cantilever load of the gate. Concrete for embedment of posts and for anchors shall be Class A and shall be crowned to shed water. Concrete shall be cured a minimum of 3 days prior to installation of fabric.

3.03 ERECTING FENCE.

A. For fence heights less than 6 feet a top and bottom tension wire shall be installed, unless specified otherwise. For fence heights 6 feet or greater a top rail and bottom tension wire shall be installed. When a top rail is specified, the top rail shall be connected with expansion sleeves to form a continuous rail.

B. Bracing assemblies consisting of the specified bracing pipe as the compression member and specified truss rod as the tension member shall be installed and securely tightened prior to installation of fabric. One brace assembly shall be provided for end post and two brace assemblies for corner and pull posts. When fence alignment changes abruptly by more than 30^0 a corner brace assembly shall be installed. When the internal angle of a curved fence alignment exceeds 30^0 one brace assembly shall be installed at each point of curvature. Pull post shall be installed at abrupt changes in grade or at the midpoint of a straight fence alignment exceeding 500 feet in length.

C. The fabric shall be placed on the side of the post as directed by the Owner and 2” above ground or concrete structure. Fabric shall be secured at one end and sufficient tension applied to remove all slack before making attachment elsewhere. The fabric shall be fastened to the posts with wire ties at intervals not exceeding 14 inches. Fabric shall be fastened to the tension wire or rail with wire ties at intervals not exceeding 24 inches. When specified, barbed wire shall be installed and pulled taut before being permanently attached to a post or arm. Fence gates shall be constructed in accordance with the Plans, Specifications and manufacturer’s standards and instructions, or as directed by the Owner.

3.04 TEST

A. Before any fencing is installed, manufacturer’s certificates stating that the fabric, post, rails,

braces, barbed wire, tension wire, ties and hardware are made in accordance with applicable standards as specified herein shall be filed with the Owner. At the option of the Owner, test samples of any materials to be furnished shall be furnished at the job site before work commences.

PART 4 PAYMENT

4.01 MEASUREMENT

A. Chain Link Fence

1. Fences will be measured for payment by the linear foot along the bottom of the fabric and from end to end of fence, complete and in place, deducting the width of gates and openings, for each type and height of fence provided.

B. Fence Gates

1. Gates will be measured for payment by the unit, per each, complete and in place, for the kinds and dimensions as shown on the Plans.

4.02 PAYMENT

A. Chain Link Fence

1. The accepted quantities of chain link fence will be paid for at the contract unit price per linear foot, complete and in place, for each type and height of fence, which price will be full compensation for fabric, posts, rails, tension wire, miscellaneous hardware, post hole excavation, concrete footings, concrete coring and grouting.

B. Fence Gates

1. The accepted quantities of gates will be paid for at the contract unit price per each, complete and in place, for the kinds and dimensions of gates stipulated or shown on the Plans.

4.03 Payment will be made under:

Item No.	Pay Item	Pay Unit
02820-4.01.A	CHAIN LINK FENCE HEIGHT x DESCRIPTION	LINEAR FOOT
02820-4.01.B	FENCE GATES HEIGHT x WIDTH OF OPENING	EACH

END OF SECTION 02820

SECTION 02920
SEEDING

PART 1 - SCOPE

This work shall consist of furnishing and placing seed, commercial fertilizer, agricultural limestone, erosion control fabric, and mulch material when specified, and of caring for such areas until acceptance, all in accordance with these Specifications, on all newly graded earthen areas that are not to be paved, stabilized, or sodded, unless otherwise indicated on the plans or directed by the Purchaser.

PART 2 - MATERIALS AND EQUIPMENT

2.01 MATERIALS.

A. Grass Seed.

1. The seed shall meet the requirements of the Tennessee Department of Agriculture and no “Below Standard” seed will be accepted. Grass seed furnished under these Specifications shall be packed in new bags or bags that are sound and not mended.

2. The Contractor shall furnish the Purchaser a certified laboratory report from an accredited commercial seed laboratory or from a State seed laboratory showing the analysis of the seed to be furnished and approving the seed for purity and germination. The report from an accredited commercial seed laboratory shall be signed by a Senior Member of the Society of Commercial Seed Technologists. At the discretion of the Purchaser, samples of the seed may be taken for a check against the certified laboratory report. Sampling and testing will be in accordance with the requirements of the Tennessee Department of Agriculture.

3. When a seed group is used, the percentages forming the group shall be as set out below, unless otherwise specified.

Name	Quantity, Percent by Weight
Group A	
Lespedeza (Common or Korean)	20
Sericea Lespedeza	15
Ky. 31 Fescue	40
English Rye	15
White Dutch Clover	5
Weeping Love Grass	5
Group B	
Ky. 31 Fescue	55
Redtop	15
English Rye	20
White Dutch Clover	5
Weeping Love Grass	5
Group C	
Sericea Lespedeza	50
Ky. 31 Fescue	30
English Rye	15
White Dutch Clover	5

4. In mixing or forming “Groups” of seed, they shall be uniformly mixed. “Group” seed shall not be mixed until after each type seed that is used to form the “Group” has been tested and inspected separately and approved for purity and germination. Seed mixed before tests and inspection are made will not be accepted.

B. Fertilizer.

Manufactured fertilizer shall be a standard commercial fertilizer containing the specified percentages by weight of nitrogen (N), phosphoric acid (P_2O_5) and potash (K_2O). The fertilizer shall be furnished in standard containers with the name, weight, and guaranteed analysis of the contents clearly marked. The containers shall insure proper protection in handling and transporting the fertilizer. All commercial fertilizer shall comply with local, state, and federal fertilizer laws.

C. Agricultural Limestone.

Agricultural limestone shall contain not less than eighty-five (85%) of calcium carbonate and magnesium carbonate combined and shall be crushed so that at least 85 percent will pass the No. 10 mesh sieve and 100 percent will pass the 3/8 inch sieve.

D. Mulch Material.

All mulch material shall be air dried and virtually free of noxious weeds and weed seeds or other materials detrimental to plant growth on the work site or on adjacent agricultural lands. Hay shall be stalks of approved grasses, sedges, or legumes seasoned before baling or loading. Straw shall be stalks of rye, oats, wheat, or other approved grain crops. Both hay and straw shall be suitable for spreading with standard mulch blower equipment. Biodegradable fabric as specified in this section may be used as an alternate to mulch material at the Contractor’s option.

E. Inoculants for Legumes.

Inoculants for treating legume seed shall be standard cultures of nitrogen fixing bacteria that are adapted to the particular kind of seed to be treated. The inoculant shall be supplied in convenient containers of a size sufficient to treat the amount of seed to be planted. The label on the container shall indicate the specified legume seed to be inoculated and the date period to be used.

F. Mulch Binder.

Cut back asphalt, Grade RC-70 or RC-250 conforming to AASHTO Specifications shall be used.

G. Water.

Water shall be free from any harmful or objectionable qualities or organisms.

H. Biodegradable Fabric.

1. Biodegradable fabric shall consist of a knitted or bonded construction of yarn with uniform openings interwoven with strips of biodegradable paper. The fabric shall be degradable by exposure to ultraviolet light. The fabric shall be “Hold/Gro” as manufactured by Gulf States Paper Corporation of Tuscaloosa, Alabama, or equal. The fabric shall be furnished in rolls and shall conform to the following requirements:

   a. Roll Widths: 5 feet minimum and 10 feet maximum.

   b. Roll Length: Approximately 360 feet.

   c. Weight: Approximately 0.2 pounds per square yard of fabric.

2. Fabric shall be secured in a place with wood pegs or other biodegradable materials.

3. The manufacturer shall provide moisture proof bags comparable to 4 to 6 mil opaque polyethylene bags for protection of the fabric prior to installation.

2.02 EQUIPMENT.
All equipment necessary for the satisfactory performance of this construction shall be on the project and inspected before work will be permitted to begin.

PART 3 - CONSTRUCTION REQUIREMENTS

3.01 GENERAL
The Contractor shall notify the Purchaser at least 48 hours in advance of the time he intends to begin sowing seed and shall not proceed with such work until permission to do so has been granted by the Purchaser. Before starting seeding operations on any area, final dressing and the placing of topsoil shall have been completed in accordance with the project requirements. All seeding and related operations shall be continuous operations.

3.02 PREPARING THE SEEDBED.
Each area to be seeded shall be scarified, disked, harrowed, raked, or otherwise worked until it has been loosened and pulverized to a depth of not less than one inch. This operation shall be performed only when the soil is in a tillable and workable condition. Fertilizer, at the rate of not less than 23 pounds of Grade 6- 12-12 or equivalent, per 1,000 square feet, and agricultural limestone, at the rate of not less than 100 pounds per 1,000 square feet, shall be distributed evenly over the seedbed, unless other are specified on the plans or in the Contract Documents. The limestone and fertilizer shall be lightly harrowed, raked, or otherwise incorporated into the soil as specified above when mixed with seed in water and applied with power sprayer equipment.

3.03 TIME OF SEEDING.
Group “A” seed shall be used for seeding from February 1 to August 1, and Group “B” seed shall be used from August 1 to December 1, except that either Group “A” or “B” may be used during the month of August. Group “C” seed shall be used from February 1 to December 1 and only when specified on the Plans or in the Contract Documents. Seeding shall be performed only when the soil is in a tillable and workable condition, and no seeding shall be performed between December 1 and February 1, unless otherwise permitted.

3.04 SEEDING.
Seed of the specified group shall be sown as soon as preparation of the seedbed has been completed and thoroughly watered after seeding. Care shall be exercised to not wash seeding by over watering. Seed shall be sown uniformly by means of a rotary seeder, wheelbarrow seeders, hydraulic equipment, or other satisfactory means, and unless otherwise specified on the Plans or in the Contract Documents, at the rate of 1 ½ pounds per 1,000 square feet. Group “C” seed and seeds of legumes when sown alone shall be inoculated before sowing in accordance with the recommendations of the manufacturer of the inoculant and as directed by the Purchaser. No seeding shall be done during windy weather, or when the ground surface is frozen, wet, or otherwise nontillable.

3.05 BIODEGRADABLE FABRIC.

A. When biodegradable fabric is specified, the fabric shall be loosely draped over the seeded area. The seed bed to be covered shall be prepared, fertilized, limed, seeded, and watered prior t installation of the fabric. If the slope is greater than 3 to 1, fabric shall be applied vertically with paper strips oriented parallel to the slope.

B. The Contractor shall dig a 4 inch deep check ditch 1 foot back from the slope crown, then fold, place and peg fabric every 9 inches in the check ditch, and cover with soil. An identical check ditch shall be provided 1 foot away from the bottom of the slope. When 2 or more lengths of fabric are required to be installed side by side to cover an area, they shall overlap

4 inches minimum. Fabric installed end to end shall overlap 4 inches minimum with the upgrade section on top of the lower grade section. End to end overlaps of adjacent rows of fabric shall be staggered a minimum of 5 feet. Each length of fabric shall be pegged in 3 rows, each edge and the center, with pegs placed on 3 foot centers maximum. Overlapped ends shall be pegged on 9 inch centers across the fabric overlap. Pegs shall be driven flush with the ground. The Contractor shall strictly adhere to the installation directions provided by the manufacturer of the fabric.

C. The Contractor shall maintain and protect the biodegradable fabric until Final Acceptance or until the Purchaser has determined that the fabric has served its useful life, whichever occurs first. Maintenance shall consist of watering as required, repairs made necessary by erosion, wind, fire, or any other cause until Final Acceptance. Following the restoration of damaged areas under plant establishment requirements for applicable underlying items, the fabric shall be repaired or replaced to meet the original requirements and maintained until Final Acceptance of the Project.

3.06 MULCHING.

When seeding with mulch is specified, the mulch material shall be spread evenly over the seeded areas at an approximate rate of 75 pounds per 1,000 square feet immediately following the seeding operations. This rate may be varied by the Purchaser, depending on the texture and condition of the mulch material and the characteristics of the area seeded. All portions of the seeded areas shall be covered with a uniform layer of mulch, so that approximately 25 percent of the ground is visible. The mulch shall be held in place by the use of an approved mulch binder. Cutback asphalt or emulsified asphalt shall be applied at the approximate rate of 4 gallons per 1,000 square feet as required to hold the mulch in place. Mulch in medians and other areas affected by traffic shall be held in place by applying asphalt binder at the approximate rate of 11 gallons per unit. The Contractor shall cover exposed structures, guardrails, signs, and appurtenances, if the mulch binder is applied in such a way that it would come in contact with or discolor the structures.

3.07 MAINTENANCE AND REPAIR.

All seeded areas shall be cared for and maintained properly to the Purchaser's satisfaction until Final Acceptance of the Work and for the duration of the warranty period. Such care shall include, but not be limited to watering as necessary, fertilizing, and mowing the seeded areas when required by the Purchaser. When mowing is required, mower blades shall be set at sufficient height to protect the vitality of the growth. Areas which have been previously seeded and mulched in accordance with this Specification Section but which have been eroded, damaged or failed to successfully establish a stand of grasses or legumes shall be repaired as directed by the Purchaser. All material and labor required to maintain and repair seeded areas shall be furnished by the Contractor at no cost to the City. If the Purchaser directs the Contractor to place additional fertilizer on the area to be reseeded, and additional 4 pounds of agricultural limestone will be required for each additional pound of fertilizer.

PART 4 – MEASUREMENT

The furnishing of seeding as specified herein may be incidental to the work of the Contract, or may be measured and payment made under the Pay Items described herein, as defined by the Pay Items in the Proposal Sheet(s) and/or as included in the Plans and Contract Documents. If payment is made separately, measurement for the work of this Specification will be as described below.

4.01 SEEDING (WITH MULCH).

The area of seeding (with mulch) to measured for payment will be the number of seeding units, with mulch, in accordance with these Specifications. Each unit will consist of 1,000 square feet measured along the surface.

4.02 SEEDING (WITHOUT MULCH).

The area of seeding (without mulch) to be measured for payment will be the number of seeding units in accordance with these Specifications. Each unit will consist of 1,000 square feet measured along the surface.

4.03 BIODEGRADABLE FABRIC.
Biodegradable fabric to be measured for payment will be the number of 1,000 square foot units for which biodegradable fabric has been applied over seeded areas. Measurement will be along the surface.

4.04 GENERAL.
All work and materials for seed bed preparation, application of fertilizer and limestone, application of mulch binder, watering and maintenance and repair of work, and all other similar items included in this section of the Specifications but not covered by a Pay Item herein will be considered as a subsidiary obligation of the Contractor under other items of the Contract.

PART 5 – PAYMENT

5.01 SEEDING (WITH MULCH).
Seeding (with mulch) will be paid for at the contract unit price per unit (1,000 square feet), for the accepted quantities, which price will be full payment for preparing the seedbed, and for furnishing and placing all materials including fertilizer, water, agricultural limestone, seed, mulch materials, mulch binder and inoculant, complete in place; and for maintenance and repair of the seeded and grassed area.

5.02 SEEDING (WITHOUT MULCH).
Seeding (without mulch) will be paid for at the contract unit price per unit (1,000 square feet) for the accepted quantities, which price will be full payment for preparing the seedbed, and for furnishing and placing all materials including fertilizer, water, agricultural limestone, seed, and inoculant, complete in place; and for maintenance and repair of the seeded and grassed areas.

5.03 BIODEGRADABLE FABRIC.
Biodegradable fabric will be paid for at the contract unit price per unit (1,000 square feet) for furnishing, installing, maintaining, and protecting the fabric, which price will be full payment for accomplishing the above.

5.04 PAYMENT WILL BE MADE UNDER:

Item No.	Pay Item	Pay Unit
02920-5.01	SEEDING (WITH MULCH)	Unit of 1,000 SF
02920-5.02	SEEDING (WITHOUT MULCH)	Unit of 1,000 SF
02920-5.03	BIODEGRADABLE FABRIC	Unit of 1,000 SF

END OF SECTION
02920

SECTION 02921
SODDING

PART 1 - SCOPE

1.01 This work shall consist of furnishing and placing sod at all locations shown on the Plans or where directed by the Purchaser, and in conformity with these Specifications. Ordinarily, the work will consist of the furnishing and placing of new sod originating from sources outside the rights-of-way and easement limits. In some cases, however, the work will include removing sod from areas where the requirements of the project would destroy existing sod, storing the sod so removed, and resetting it in areas shown on the Plans or designated by the Purchaser.

PART 2 - MATERIALS AND EQUIPMENT

2.01 MATERIALS

A. Sod

1. New sod shall consist of live, dense, well rooted growth of Bermuda grass, free from Johnson grass, nutgrass, and other obnoxious grasses or weeds, well suited for the intended purpose and for the soil in which it is to be planted. All sod shall be cleanly cut in strips having a reasonably uniform thickness of not less than 2 inches and cut in 16” x 24” rectangles.

2. The sale or movement of sod for propagation is controlled by Tennessee Plant Pest Act of 1955, TCA 43-55 et. Seq., and the Contractor shall be responsible for obtaining all inspections, authorizations, and permits which may be required by such law and the Tennessee Department of Agriculture.

B. Fertilizer

1. Manufactured fertilizer shall meet the requirements of Specification Section 02920 Paragraph 2.01.B and shall be Grade 15-15-15 unless otherwise specified on the Plans or in the Contract Documents.

C. Ammonium Nitrate

1. Ammonium nitrate shall be a standard commercial product, shall conform to the requirements for other commercial fertilizers as specified in Specification Section 02920 Paragraph 2.01.B, and shall have a minimum of 33 ½ percent nitrogen.
2. Quantity and placement of ammonium nitrate shall be so that it is entirely absorbed into the soil, with no amount reaching any waterways or waterbodies.

D. Agricultural Limestone

1. Agricultural limestone shall meet the requirements of Specification Section 02920 Paragraph 2.01.C.

2.02 EQUIPMENT

A. All equipment necessary for the satisfactory performance of this work shall be on the project and approved before work will be permitted to begin.

PART 3 - CONSTRUCTION REQUIREMENTS

3.01 WEATHER LIMITATIONS

A. Sod shall be set or reset only when the soil is moist and favorable for growth. No setting or resetting shall be done between December 1 and February 1, unless weather and soil conditions are considered favorable and permission is granted by the Purchaser.

3.02 REMOVING AND STORING SOD FOR RESETTING

A. If specified, sod removed from such areas as lawns, yards, and lots shall be so cut, handled, and stored that the sod can be reset in the same locations from which it was removed. No exchange of sod will be permitted unless approved by the Purchaser. Unless reset immediately after cutting, sod shall be stacked in piles and kept moist until reset. Sod shall be reset within 7 days after removal, unless otherwise specifically permitted by the Purchaser. Reset sod shall show vitality and growth at the time of acceptance by the City and for duration of the warranty period.

3.03 SODDING

A. The area to be sodded shall be brought to the lines and grades shown on the Plans or as directed by the Purchaser. The surface of the ground to be sodded shall be loosened to a depth of not less than one inch with a rake or other device. If necessary, it shall be sprinkled until saturated for a minimum depth of one inch and kept moist until the sod is placed. Immediately before placing the sod, fertilizer and lime shall be applied uniformly to the prepared surface of the ground. Fertilizer shall be applied at the rate of 8 pounds of Grade 15-15-15, or equivalent per 1,000 square feet. Agricultural limestone shall be applied at the rate of 100 pounds per 1,000 square feet.

B. Sod shall be placed as soon as practical after removal from the point of origin and shall be kept in a moist condition during the interim. The sod shall be carefully placed by hand on the prepared ground surface with the edges in close contact and, as far as possible, in a position to break joints. Each strip of sod laid shall be fitted and rolled using a roller of sufficient size and weight to fix the sod into place. Immediately after placing, the sod shall be thoroughly wetted and rolled with an approved roller or hand tamped, as approved by the Purchaser. Pinning or pegging shall be required on slopes greater than 2 to 1 to hold the sod in place or in other instances at the direction of the Purchaser.

3.03 MAINTENANCE AND REPAIR

A. The sod shall be watered as frequently as necessary for a period of two weeks, after which, ammonium nitrate shall be applied at the rate of 3.5 pounds per 1,000 square feet, and the sod given an additional watering. The Contractor shall not allow any equipment or material placed on any planted area and shall erect suitable barricades and guards to prevent his equipment, labor, or the public from traveling on or over any area planted with sod. Care shall include periodic watering, fertilizing and mowing necessary to maintain the vitality and appearance of the sod. When mowing is required, mower blades shall be set at sufficient height to protect the vitality of the growth. Sodded areas that become eroded, damaged or fail to successfully establish a stand of grass shall be repaired and/or replaced as directed by the Purchaser. All material and labor required to maintain and repair seeded areas shall be furnished by the Contractor at no cost to the City. Sod must be living at the time of final acceptance of the project and through the duration of the warranty period.

3.04 DISPOSAL OF SURPLUS MATERIAL

A. All surplus material shall be disposed of off-site.

PART 4 – MEASUREMENT

4.01 The furnishing and setting of sodding as specified herein may be incidental to the work of the Contract, or may be measured and payment made under the Pay Items described herein, as defined by the Pay Items in the Proposal Sheet(s), and/or as included in the Plans and Contract Documents. If payment is made separately, measurement for the work of this Specification shall be as described below.

4.02 SODDING

A. Sod will be measured for payment by the square yard of surface upon which the sod has been set.

4.03 REMOVING, STORING, AND RESETTING SOD

A. Sod to be removed, stored, and reset will be measured for payment by the square yard of surface upon which the removed sod has been reset.

PART 5 – PAYMENT

5.01 SODDING

A. Sodding will be paid for at the contract unit price per square yard for the accepted quantities, which price will be full payment for furnishing, setting, pinning and pegging if required, fertilizing, watering, mowing, providing and placing agricultural limestone, and for the maintenance and repair of the sodded area.

5.02 REMOVING, STORING, AND RESETTING SOD

A. This work will be paid for at the contract unit price per square yard for the accepted quantities, which price will be full payment for removing and storing the sod or turf, setting, pinning and pegging if required, fertilizing, watering, mowing, providing and placing agricultural limestone, and for the maintenance and repair of the sodded area.

5.03 PAYMENT WILL BE MADE UNDER:

Item No.	Pay Item	Pay Unit
02921-5.01	SODDING (NEW SOD)	Square Yard
02921-5.02	REMOVING, STORING, AND RESETTING SOD	Square Yard

END OF SECTION
02921

SECTION 02950
REMOVAL AND REPLACEMENT OF PAVEMENTS AND INCIDENTALS

PART 1 GENERAL

1.01 SCOPE

A. This Work shall consist of the removal and replacement of pavements, sidewalks, driveway aprons, curbs and gutters, driveways, paved areas, and curbs made necessary by the improvement of sanitary sewer infrastructure, and other items of construction that require temporary cuts. Such replacement shall be to a condition at least equal to the condition existing prior to removal and of in-kind material and shall be compliance with the Drawings, these Specifications, or as directed by the Purchaser. The Work which will be included in the Subcontract and for which the Subcontractor shall be compensated therefore is limited to that area within the rights-of-way and construction easements for the Project. The Subcontractor will not be compensated for the removal and replacement of facilities outside the rights-of-way, easements, and limits of construction of the Project.

PART 2 PRODUCTS

2.01 MATERIALS

A. Concrete:

1. Portland cement concrete shall be in accordance with Section 03050 Portland Cement Concrete.

B. Asphaltic Concrete Pavement:

1. Asphaltic concrete surface courses shall meet the requirements of Mix No. 1 and bases courses shall meet the requirements of Mix No. 2 as described below.

2. The composition of the mixes shall be as follows:

Total Percent Passing by Weight

Sieve Size	Mix No. 1	Mix No. 2
2”	100	100
1-1/2”	100	100
3/4”	100	100
3/8”	76-96	65-95
No. 4	51-76	45-70
No. 8	36-60	25-50
No. 30	16-40	12-30
No. 100	3-12	2-12
No. 200	2-8	1-6

3. The proportions of the total mixture, in percent by weight, shall be as follows:

Courses	Combined Mineral Aggregate	Asphalt Cement
Mix No. 1, Surface	92.0 – 96.0	4.0 – 8.0
Mix No. 2, Binder	93.0 – 97.5	2.5 – 7.0

4. It is the intent of this Section of the Specifications that the above described mixes shall conform to the following mixtures specified in the Tennessee Department of Transportation Standard Specifications for Road and Bridge construction.

   a. Mix No. 1 – Section 411, Asphaltic Concrete Surface (Hot Mix), Grading E.

   b. Mix No. 2 – Section 307, Bituminous Plant Mix Base (Hot Mix), Aggregate Grading C.

5. For multiple layer construction, succeeding layers shall not be laid until the previous layer has cooled sufficiently to support the construction equipment

6. When Mix No. 1 is to be used as a surface for traffic lanes, the mineral aggregate shall be composed of not less than 50 percent nor more than 55 percent crushed limestone and not more than 50 percent nor less than 45 percent natural sand. When Mix No. 1 is used for surfacing of shoulders or other non-traffic lane construction, the mineral aggregate may be composed entirely of limestone, including screening and manufactured sand, but in no case shall the mineral aggregate for this construction consist of less than 50 percent limestone. The natural sand shall be so graded that not more than 5 percent will be retained on the No. 4 sieve.

C. Expansion Joint Filler:

1. Preformed expansion joint filler shall be of the bituminous type, shall conform to the requirements of AASHTO M 213 and shall not be more than 1 inch or less than 1/2 inch in thickness. The filler shall be cut to the full depth of pavement, curb and gutter, sidewalk, or driveway being replaced.

D. Gravel Pavement or Base:

1. Crushed limestone with such material as manufactured sand or other fine materials naturally contained or added thereto as needed to match existing conditions and conform to the gradations shown below:

Grading Table for Graded Aggregate Base Course
Total Percent, by Dry Weight, Passing Each Sieve (U.S. Standard)

Size No.	2 ½ "	2"	1 ½"	1"	3/8"	No. 40
1	100	95-100			35-65	10-30

2.02 EQUIPMENT

A. Equipment and tools necessary for cutting, removal, and hauling of existing items; handling and placement of new material; and all equipment necessary to perform all parts of the Work shall be at the job site sufficiently ahead of the start of construction operations to be examined and approved by the Purchaser.

B. When saws are used to cut pavement, the Subcontractor shall provide sawing equipment adequate in power to complete the sawing to a minimum of 1-1/2 inches below the pavement surface in one pass. An ample supply of saw blades shall be maintained at the site of the Work at all times during sawing operations.

C. Other types of pavement cutting equipment shall be capable of cutting the pavement to a neat straight line of 1-1/2 inch minimum depth below the pavement surface in one pass.

D. The Subcontractor shall provide equipment capable of removal of pavements, sidewalks, driveway aprons, curbs and gutters, driveways, paved areas, and curbs without disturbance of adjacent items to remain in place.

PART 3 EXECUTION

3.01 REMOVAL OF ASPHALT PAVEMENT

A. Asphalt pavement shall be removed to a clean straight line as shown on the drawing details. Pavement shall be cut by saw or other equipment approved by the Purchaser in advance. Edges of existing asphalt pavement adjacent to trenches, where damaged, shall be recut in a clean straight line within the limits of damaged pavement only. Such recuts shall be parallel to the original cuts and perpendicular to the pavement surface.

3.02 REMOVAL OF CONCRETE PAVEMENT

A. Concrete pavement shall be removed to a neat straight line as shown on the drawing details. Care shall be used to avoid damage to pavements and to the pavement base remaining in place.

3.03 REMOVAL OF CONCRETE SIDEWALK, CURB AND GUTTER, AND DRIVEWAY

A. Concrete sidewalks, curbs and gutters, and driveways shall be removed to the nearest contraction or expansion joint. Care shall be used to avoid damage to sidewalks, curbs and gutters, and driveways remaining in place.

3.04 REMOVAL OF GRAVEL PAVEMENT

A. Gravel surfaces encountered in construction shall be removed as needed to allow for the adjustment of the manhole frame and cover.

3.05 REPLACEMENT OF PAVEMENT

A. Asphalt Pavements

1. Replace asphalt paving courses to match existing thickness. The minimum surface course thickness shall be 2 inches. Asphalt pavement and base replacement shall be constructed for the entire cross-section of pavement removal area including all areas where pavement was re-cut subsequent to the initial pavement removal.

B. Concrete Pavements

1. Concrete pavement shall be replaced with Class A concrete pavement equal in thickness to the pavement removed but not less than 4 inches thick. Concrete pavement and base replacement shall be constructed for the entire cross-section of pavement removal area including all areas where pavement was re-cut subsequent to the initial pavement removal.

2. Reasonable efforts shall be made to avoid contrast in the color and texture of existing and restored surfaces.

C. Placing, Curing, and Protection of Concrete

1. After the backfill in the trench has been brought to the appropriate subgrade elevation shown on the Plans, compacted to the specified density, and permission has been given by the Purchaser, a concrete slab of the appropriate thickness shall be placed within the entire disturbed area.

2. Any loose or disturbed pavement or base shall be removed prior to placement of the concrete. Concrete shall be placed only on a moist subgrade and shall not be placed unless the ambient temperature is 35° F and rising. In no case shall concrete be placed on a frozen or frosty subgrade. After the concrete is placed, it shall be struck off in an approved manner to the appropriate grade as shown on the Plans and shall be finished with floats and straight edges until the required surface texture has been obtained.

3. No vehicles or loads shall be permitted on any concrete until the Purchaser has determined that the concrete has obtained sufficient strength for such loads. The Subcontractor shall construct and place such barricades and protection devices as are necessary to protect the concrete.

3.06 REPLACEMENT OF SIDEWALKS, DRIVEWAY APRONS, CURBS AND GUTTERS, DRIVEWAYS AND OTHER PAVED AREAS, AND CURBS

A. Concrete sidewalks and driveway aprons shall be replaced in accordance with the City of Memphis Standard Construction Specifications.

B. Unless otherwise directed, curb and gutter shall be replaced with new concrete curb and gutter of the same cross-section and at the same top of curb elevation and flow line as that removed. Where curb and gutter of a different type than existing is to be used for replacement, the replacement flow line shall match existing and a transitions section provided between the existing and replacement cross-sections. Curb heights shall be transitioned at a rate of 1 inch in 5 feet. Granite curb shall be replaced with new concrete curb whose height matches existing adjacent curb top elevations. Any expansion joint material removed shall be replaced at the original locations. Existing concrete edges shall be cleaned prior to placement of concrete. The finished curb and gutter cross-section, elevations, texture, and color shall conform to the adjacent concrete surfaces.

C. Replacement of paved areas other than street pavement; concrete, asphalt, or gravel driveways; and asphalt or concrete curb within the right-of-way or construction easement limits shall be in kind for those cross-sections removed, unless directed otherwise by the Purchaser.

3.07 DAMAGE DUE TO SETTLEMENT

A. The Subcontractor shall be responsible for any damage caused by settlement of backfill placed beneath pavements, sidewalks, driveway aprons, curbs, curbs and gutters, driveways, paved areas other than street pavement, and asphalt or concrete curb within the right-of-way or construction easement limits. This includes any damage which may occur at any time prior to, and during a period of one year from the date of Final Completion of the Work covered by the Subcontract.

B. During such period, the Subcontractor shall at his own cost and expense refill all excavations where settlement damage has occurred and replace damaged pavements, sidewalks, driveway aprons, curbs, curbs and gutters, paved areas, driveways, and all other damaged items to the satisfaction of the Purchaser. Should the Subcontractor fail to repair settlement damage which may occur as described above within 5 days after being given notice thereof, the Purchaser shall have the right to repair such settlement and charge the cost of such repairs to the Subcontractor.

3.08 DAMAGE OUTSIDE CONSTRUCTION EASEMENT LIMITS

A. The Subcontractor will be held responsible for all damage to roads, highways, shoulders, curbs and gutters, ditches, embankments, bridges, culverts, and other property, caused by him or any of this Sub-subcontractors in hauling or otherwise transporting materials to and from the several sites of Work, regardless of the location of such damage. The Subcontractor shall make arrangements relative to the payment for, or repair or replacement of, such damage or damaged surfaces or structures which are satisfactory and acceptable to the Purchaser, at the Subcontractor's cost and expense.

PART 4 MEASUREMENT & PAYMENT

4.01 MEASUREMENT

A. Pavement Removal and Replacement

1. Pavement removal and replacement shall be measured for payment by the square yard, complete in place.

B. Concrete Sidewalk Removal and Replacement

1. Sidewalk removal and replacement shall be measured for payment by the square foot, complete in place.

C. Concrete Curb and Gutter Removal and Replacement

1. Curb and gutter removal and replacement shall be measured for payment by the linear foot, complete in place.

D. Gravel Driveway and Gravel Area Removal and Replacement

1. Gravel driveways and gravel area removal and replacement shall be measured for payment by the ton of crushed limestone, complete in place.

4.02 PAYMENT

A. Pavement Removal and Replacement

1. The accepted quantities of pavement removal and replacement shall be paid for at the Subcontract unit price per square yard for the type specified, which price will be full compensation for cutting and recutting pavement; removal and disposal of pavement and base; preparing the subgrade; placing, finishing, curing, and protection of concrete; and placing and compacting asphaltic concrete wearing surfaces, complete in place.

B. Concrete Sidewalk Removal and Replacement

1. The accepted quantities of sidewalk removal and replacement shall be paid for at the contract unit price per square foot, which price will be full compensation for removal and disposal of sidewalk; preparing the subgrade; and placing, finishing, curing and protection of concrete, complete in place.

C. Concrete Curb and Gutter Removal and Replacement

1. The accepted quantities of curb and gutter removal and replacement shall be paid for at the Subcontract unit price per linear foot for the type specified, which price will be full compensation for removal and disposal of curb and gutter; preparing the subgrade; and placing, finishing, curing and protection of concrete, complete in place.

D. Gravel Driveway and Gravel Area Removal and Replacement

1. The accepted quantities of gravel driveway and gravel area removal and replacement shall be paid for at the Subcontract unit price per ton of crushed limestone, which price will be full compensation for preparing the subgrade and replacing the gravel, complete in place.

4.03 PAYMENT WILL BE MADE UNDER:

Item No.	Pay Item	Pay Unit
02950-4.01.A-1	ASPHALTIC CONCRETE PAVEMENT REMOVAL AND REPLACEMENT	SQUARE YARD
02950-4.01.A-2	CONCRETE PAVEMENT REMOVAL AND REPLACEMENT	SQUARE YARD
02950-4.01.B	CONCRETE SIDEWALK REMOVAL AND REPLACEMENT	SQUARE YARD
02950-4.01.C	CONCRETE CURB AND GUTTER REMOVAL AND REPLACEMENT	SQUARE YARD
02950-4.01.D	GRAVEL DRIVEWAY AND GRAVEL AREA REMOVAL AND REPLACEMENT WITH CRUSHED STONE	TON

END OF SECTION 02950

SECTION 03050
PORTLAND CEMENT CONCRETE

PART 1 GENERAL

1.01 SCOPE

A. This specification covers the classification, materials, proportioning of materials, equipment, mixing requirements, and testing for Portland cement concrete to be used for construction of streets, bridges, and miscellaneous structures and facilities as defined in Division 2 – Site Construction of these Specifications. The classification requirements, forming, curing, measurement, and payment for specific uses of concrete are specified and defined in the appropriate sections of Division 2.

PART 2 PRODUCTS

2.01 CONCRETE CLASSIFICATION

A. Portland cement concrete used for construction of the various items covered in Division 2 of these Specifications shall be classified by usage as follows

1. Class A

    a. Class A concrete shall be used as specified for such items as concrete curb, curb and gutter, sidewalks, drainage and sewer structures other than box culverts, ditch paving, bridges (other than superstructure) and similar uses.

2. Class A S

    a. Class A S concrete shall be used for bridge superstructures and channel lining of ditches.

3. Class B

    a. Class B concrete shall be used for roadway base and pavement.

4. Class C

    a. Class C concrete shall be used as specified for such items as concrete cradles, encasements, embankment slope paving at bridge abutments, and other low strength applications.

5. Class P

    a. Class P concrete shall be used for cast-in-place box culverts and precast and precast-prestressed concrete structures or structural members. High-early-strength concrete shall be as specified in Specification Section 03050 Paragraph 6.05.

2.02 HIGH-EARLY-STRENGTH CONCRETE

A. High-early-strength concrete may be required in the Plans and Specifications or substituted at the request of the Subcontractor, subject to the approval of the Purchaser. When high-early-strength cement concrete is authorized, it shall conform to the requirements of Table 03050.2 except that the 28 day strength (or 14 day strength for Class B concrete) shall be obtained in 7 days. The use of Type I or Type III cement for high-early-strength concrete in lieu of using Type III cement. When type I cement is used, the concrete shall have a

minimum of 7.6 sacks (714 pounds) of cement per cubic yard of concrete. If admixtures are used to obtain high-early-strength concrete, such admixtures may only be used if previously approved by the Tennessee Department of Transportation for similar uses of the concrete and if specifically approved for the project by the Purchaser.

B. The gradation of fine and coarse aggregates shall be the same as that approved for the concrete for which the high-early-strength concrete is substituted. All materials entering into the high-early-strength concrete shall be of the same kind and class as the materials entering into the other part or parts of the facility constructed of the class of concrete for which high-early-strength is being substituted.

C. No additional compensation will be made if the Subcontractor elects to substitute high-early-strength concrete for any class of concrete. The unit price for the class for which the substitution is made shall be full compensation for the concrete.

2.03 MATERIALS

A. Materials used in the production of Portland cement concrete of the various classifications specified herein shall meet the following requirements.

2.04 PORTLAND CEMENT

1. Portland cement shall be Type I cement conforming to the requirements of AASHTO M 85, except that for high-early-strength concrete, Type III cement may be used.

2.05 FINE AGGREGATE.

A. Fine aggregate shall consist of natural sand, clean and free from any surface film or coating and graded from fine to coarse. Fine aggregate shall conform to the requirements of ASTM C 33 and the specifications included herein. The amount of deleterious substance shall not exceed the following percentage by weight:

1.	Removed by decantation……	3 percent
2.	Coal or lignite……	1 percent
3.	Clay lumps……..	1 percent
4.	Other local deleterious substances (such as shale, alkali, Mica, coated grains, soft and flaky particles)……	1 percent
5.	Total coal, clay lumps, shale, soft fragments and other local deleterious substances ……..	5 percent

B. All fine aggregate shall be free from amounts of organic impurities that would be detrimental to concrete strength and durability. Aggregate shall be subjected to the colorimetric test made in the field as follows:

1. Fill a 12 oz. graduated bottle to the 4 ½ oz. mark with the sand to be tested. Add a 3% solution of sodium hydroxide until the volume, after shaking, amounts to 7 ounces. Shake thoroughly and let stand for 24 hours. The sample shall then show a practically colorless solution, or at least, a solution not darker than straw color.

C. Fine aggregate shall be well graded from coarse to fine and, when tested by means of laboratory sieves, shall conform to the following requirements:

Passing	Percent
3/8 in. Sieve……	100
No. 4 Sieve……	95 to 100
No. 16 Sieve……..	50 to 90
No. 50 Sieve……..	10 to 30
No. 100 Sieve……	0 to 10
No. 200 Sieve……	0 to 3

a. Note: Not more than 45% should be retained between any two consecutive sieves.

D. Fine aggregate shall be of such quality that mortar composed one (1) part Portland cement and three (3) parts fine aggregate, by weight when made into briquets or cylinders, shall show a tensile or compressive strength at seven (7) and twenty-eight (28) days at least equal to the strength of briquets or cylinders composed of one (1) part of the same cement and three (3) parts standard Ottawa sand by weight. The percentage of water used in making the test specimens of cement and fine aggregate shall be such as to produce a mortar of the same consistency as that of the Ottawa sand test specimens of standard consistency.

2.06 COARSE AGGREGATE

A. Coarse aggregate for any class of Portland cement concrete shall consist of crushed stone or crushed or uncrushed gravel unless otherwise specified.

B. Coarse aggregate for Class A, Class B, or Class C concrete shall be furnished in two sizes: Size No. 4 and Size No. 67 as shown hereinafter in Table 03050.1, Coarse Aggregate Gradation Table. The two sizes shall be manufactured, within the specified limits, to produce Size No. 467 when combined in the proper proportions at the batching plant. If the supplier provides a proper stockpile to prevent segregation, then a combined Size No. 467 can be used in lieu of blending Size No. 4 and Size No. 67.

C. Coarse aggregate for Class AS concrete shall be Size No. 57. Only limestone coarse aggregate will be used for Class AS concrete; gravel coarse aggregate will not be permitted.

D. Coarse aggregate for Class P concrete shall be size No. 57 or Size No. 67 as may be specified or directed. Only limestone coarse aggregate shall be used for Class P concrete; gravel coarse aggregate will not be permitted.

E. Coarse aggregate for concrete curbing placed by machine extrusion methods shall be Size No. 57 or Size No. 67.

F. The coarse aggregates shall otherwise conform to the requirements of AASHTO M 80 and ASTM C 33 with the following exceptions and stipulations:

1. Deleterious Substances: The amount of deleterious substances shall not exceed the following limits:

		Maximum Percent by Weight
a.	Soft or nondurable fragments (fragments which are structurally weak such as shale, soft sandstone, limonite concretions, gypsum, weathered schist or cemented gravel) ……..	3.0
b.	Coal and lignite ……	1.0
c.	Clay lumps ……	0.25
d.	Material passing the No. 200 sieve ……..	1.00
e.	Thin or elongated pieces (length greater than 5 times average thickness)	10.00
f.	Other local deleterious substances	1.00

i. Notes:

(1) In the case of crushed aggregate, if all the material finer than the 200 mesh sieve consists of the dust of fracture essentially free of clay or shale, Item 4, Maximum Per Cent by Weight, may be increased to 1.5.

(2) The sum of the percentages of Items No. a, b, c, d, and f shall not exceed 5.0.

(3) When the coarse aggregate is subjected to five alternations of the sodium sulfate soundness test, the weighted percentage of loss shall be not more than nine.

(4) Alternate freeze/thaw tests for soundness will not be performed.

(5) The percentage of wear as determined by AASHTO T 96 shall not exceed 40.

COARSE AGGREGATE GRADATION TABLE
Table 03 05 00.1

Size Number	Amounts Finer Than Each Lab. Sieve (Sq. Openings), % By Weight							
	2”	1-1/2”	1”	¾”	½”	3/8”	No. 4	No.8
4	100	90-100	20-55	0-15	----	0-5	----	----
467	100	95-100	----	35-70	----	10-30	0-5	----
57	----	100	95-100	----	25-60	----	0-10	0-5
67	----	----	100	90-100	----	20-55	0-10	0-5

2.07 WATER

A. The water used in mixing concrete shall be clean, free from oil, acid, strong alkalis, organic or vegetable matter.

2.08 AIR-ENTRAINING ADMIXTURES

A. Air-Entraining Admixtures shall conform to the requirements of AASHTO M 154, except that the tests for bleeding, bond strength and volume change will not be required.

B. The Purchaser will maintain a list of qualified products. The Subcontractor shall be required to furnish a material that appears on this list.

C. A product may become approved by furnishing test data from a recognized laboratory showing that the air-entraining admixture proposed for use conforms to the requirements of these Specifications. A recognized laboratory is defined as one of the following: A State Transportation Department Laboratory; a Federal Highway Administration Laboratory; or other laboratories which are approved by the Purchaser.

2.09 CHEMICAL ADDITIVES

A. For Portland cement concrete mixtures, these additives shall conform to the requirements of AASHTO M 194 covering the following five types:

1. Type A – Water reducing admixtures

2. Type B – Retarding admixtures

3. Type C – Accelerating admixtures

4. Type D – Water reducing and retarding admixtures

5. Type E – Water reducing and accelerating admixtures

B. Additionally, admixtures for increasing the flowable characteristics of concrete (super plasticizers) may be used, subject to the approval of the Purchaser for each class and intended use of the concrete. Such admixtures shall meet the applicable requirements of ASTM C 494. The use of a plasticizer shall not change the maximum water requirements for the approved design mix. When approved for use, the admixture shall be introduced into the mix in the manner and quantities recommended by the manufacturer.

C. Additives listed in items A through E above and super plasticizers may only be used with the written approval of the Purchaser. Before any admixture is approved, the manufacturer of the admixture or the Subcontractor shall furnish the Purchaser documentary evidence that the material proposed for use has been tested in accordance with the methods of test specified in AASHTO M 194 (or ASTM C 494 for super plasticizers) and meets the requirements of the Specification. Documentary evidence for all additives shall be the results of tests conducted by a testing laboratory inspected at regular intervals by the National Bureau of Standards. The Purchaser may require a notarized certification from the manufacturer of any additives used stating that the material is identical with that originally approved and has in no way been changed or altered. Even through additives have been approved by the Purchaser, the Subcontractor shall be responsible for the successful use of the additives. No reduction in the cement content of the concrete as designed without chemical additives will be made when additives are permitted.

D. Calcium chloride additives will not be permitted.

2.10 CURING MATERIALS

A. Curing materials shall be as specified in the various Specification Sections of Division 2 and as specified below:

B. Water

1. Water used in curing Portland cement concrete shall be free from any substance which may be injurious to concrete when applied on the surface as a curing agent.

C. Burlap

1. Burlap shall conform to AASHTO M 182, Class 3 or Class 4. If Class 1 or Class 2 burlap is permitted, at least two layers shall be use.

D. Liquid Membrane-Forming Compounds

1. These compounds shall conform to AASHTO M 148. Where applied texture finish is specified, a Type 1-D, Class B, membrane which is compatible with the texture finish shall be used. Type 2 (white pigmented) membrane shall be used in all other applications, unless otherwise specified.

E. White Polyethylene Sheeting

1. This material shall conform to AASHTO M 171.

2.11 FLY ASH

A. Class C fly ash conforming to the requirements of ASTM C 618-84 may be used as a replacement for Portland cement if approved in writing by the Purchaser. The maximum amount of cement being replaced by fly ash shall not exceed 15 percent. Before any fly ash will be approved for use, the Subcontractor shall furnish the Purchaser documentary evidence that the fly ash proposed for use has been tested in accordance with ASTM C 311-7 and meets the requirements of that specification. Documentary evidence shall be the results of tests conducted by a testing laboratory inspected at regular intervals by the National Bureau of Standards. Even though the fly ash has been approved by the Purchaser, the Subcontractor shall be responsible for its successful use. When a specific air content has been required and fly ash is being used, the air content shall be tested on each truck load of concrete at the batch plant and the tested value shall be indicated on the ticket.

2.12 EQUIPMENT

A. General

1. Equipment and tools necessary for handling materials and performing all parts of the Work shall be subject to the approval of the Purchaser. The equipment shall be at the job site sufficiently ahead of the start of construction operations to be examined thoroughly and approved. The equipment and organization shall be of sufficient capacity to accomplish the maximum continuous concrete placement, as governed by the construction joints shown on the Plans and Design Standards or as directed by the Purchaser.

2.13 BATCHING PLANT AND EQUIPMENT

A. General

1. The batching plant shall include bins, weighing hoppers, and scales. If cement is used in bulk, a bin, hopper, and separate scale for cement shall be included. The Subcontractor shall provide adequate means for cement cut off checks. The weighing hoppers shall be properly sealed and vented to preclude dusting during operation. The bulk cement

storage bin or hopper shall be provided with adequate means for sampling the cement in storage.

B. Bins and Hoppers

1. Bins with adequate separate compartments for fine aggregates, each size of coarse aggregate, and cement shall be provided in the batching plant. Each compartment shall discharge efficiently and freely into the weighing hopper. Means of control shall be provided so that as the quantity desired in the weighing hopper is being approached, the material may be added slowly and shut off with precision. A port or other opening shall be provided for removing an overload of any one of the several materials from the hopper. Weighing hoppers shall be constructed so as to eliminate accumulations of tare materials and to discharge fully without jarring the scales. Partitions between compartments, both in bins and in hoppers, shall be ample to prevent spilling under any working conditions.

C. Scales

1. The scales for weighing aggregates and cement shall be of either the beam type or the springless-dial type. They shall be accurate within 0.5 percent throughout the range of use. The value of the minimum graduation on the scale for weighing cement shall not be greater than 5 pounds. The value of the minimum graduation on the scale for weighing amounts of aggregates up to 10,000 pounds or more shall be not greater than 10 pounds. The value of the minimum graduation of scales used in weighing amounts of aggregate 10,000 pounds or more shall be not greater than 0.1 per cent of the nominal capacity of the scales but shall not exceed 50 pounds. When beam type scales are used, provision, such as a “tell-tale” dial, shall be made for indicating to the operator that the required load in the weighing hopper is being approached. The “tell-tale” device on weighing beams shall indicate critical position clearly. Poises shall be designed so that they cannot be easily removed from the beam and can be held firmly in place. The weigh beams and “tell-tale” device shall be in full view of the operator while charging the hopper, and he shall have convenient access to all controls.

2. Scales shall be tested no less than once monthly by a certified scale testing company. Testing shall meet the requirements of applicable City ordinances and State law. The Subcontractor shall have available not less than 10 standard 50 pound weights meeting the requirements of the U.S. Bureau of Standards for calibrating and testing weighing equipment. The person dispensing weighed material shall certify that the amounts of materials used is in accordance with quantities shown on the delivery ticket.

D. Equipment for Structural Concrete

1. The requirements for batching plants shall be as prescribed above, except that when approved by the Purchaser, the requirement for storage compartments in addition to weigh bins, for fine and coarse aggregates may be waived, provided the batching tolerances specified in Specification Section 03050 Paragraph 5.02.A are maintained.

2. Ample and satisfactory equipment for conveying concrete from the mixer to final position in the forms shall be provided. Closed chutes or pipes shall be used when concrete is to be dumped or dropped for a distance greater than 5 feet. Where steep slopes are required, the chutes shall be equipped with baffle boards or shall be in short lengths that will enable the direction of movement to be reversed. Tremies for placing seal concrete under water shall consist of a water tight tube 10 inches to 14 inches in diameter. It shall be constructed so that the bottom can be sealed and opened after it is in place and fully charged with concrete. It shall be supported so that it can be easily moved horizontally to cover all the work area and vertically to control the concrete flow.

2.14 MIXERS

A. General

1. Concrete may be mixed at a central point or wholly or in part in truck mixers. Each mixer shall have attached in a prominent place a manufacturer's plate showing the capacity of the drum, in terms of mixing and agitating capacity, and the speed of rotation of the mixing drum or blades for both mixing and agitation.

2. Mixers shall be capable of combining the aggregates, cement, additives when specified, and water into a thoroughly mixed and uniform mass within the specified mixing period. They shall have a minimum capacity sufficient to comply with minimum production requirements.

3. Mixers shall be equipped with an approved device for accurately measuring water within a range of error of not more than one percent. The amount of water used in each batch shall be shown by an indicator which is accurately calibrated and easily read.

4. Central plant mixers shall be equipped with an approved batch meter and timing device which will automatically lock the discharge lever during the full time of mixing and release it at the end of the mixing period. This device shall be equipped with a bell or other suitable warning device that will give a clearly audible signal each time the lock is released. In case of failure of the timing device, the mixer may be used for the balance of the day while it is being repaired, providing the Subcontractor furnishes a satisfactory means of determining the mixing time.

B. Mixers at Site of Construction

1. Mixers at the site of construction will not be permitted, unless permitted by the Purchaser.

C. Truck Mixers and Truck Agitators

1. Truck mixers used for mixing and hauling concrete and truck agitators used for hauling central-mixed concrete shall meet all the applicable requirements under Paragraph A above, and in addition, the manufacturer's plate shall indicate the various uses for which the equipment is designed, the gross volume of the drum, and the minimum and maximum speed of rotation of the drum or blades for charging, mixing and agitating. Trucks equipped for mixing shall be equipped with an approved device for recording the number of revolutions of the drum or blades. Mixers or agitators used to mix and transport paving concrete shall be of the hydraulic drum lift type or other especially designed types which will discharge low slump concrete (1 – 2 ½ inch) at a satisfactory rate without segregation.

D. Non-agitator Trucks

1. Bodies of nonagitator hauling equipment for concrete shall be smooth, mortar tight, metal containers, and shall be capable of discharging the concrete at a satisfactorily controlled rate without segregation. Covers shall be provided when needed for protection of the concrete. Nonagitator trucks may be used only with approval of the Purchaser.

E. Admixture Induction

1. A satisfactory method and equipment for setting the dosage for admixtures must be furnished and if admixtures other than air entraining agents are used, they shall be added in the manner and in the dosage recommended by the manufacturer.

F. Vibrators

1. Vibrators shall be of an approved type and design, and shall operate under load at the rate as recommended by the manufacturer and approved by the Purchaser. For concrete structures, all concrete to be vibrated shall be compacted by means of approved high frequency internal vibrators or other approved types of vibrators immediately after being deposited in the forms. At least two vibrators in good operating condition and tow sources of power shall be available at the site where more than 25 cubic yards of concrete are to be poured. The use of external vibrators for compacting concrete will be permitted where the concrete is inaccessible for adequate compaction, provided the forms are sufficiently rigid to prevent displacement or damage from external vibration and approved by the Purchaser. For concrete pavement, the frequency of surface vibrators shall not be less than 3,500 impulses per minute and the frequency of the internal type shall not be less than 5,000 impulses per minute for tube vibrators and not less than 7,000 impulses per minute for spud vibrators. When spud type internal vibrators, either hand operated or attached to spreader or finishing machines, are used adjacent to forms, they shall have a frequency not less than 7,000 impulses per minute. For prestressed concrete, all concrete shall be thoroughly compacted with approved high frequency vibrators operating at a minimum of 7,000 vibrations per minute.

PART 3 EXECUTION

3.01 HANDLING BATCHING AND MIXING

A. Stockpiling Aggregates

1. Sites for aggregate stockpiles shall be grubbed and cleaned prior to storing aggregates, and the ground shall be firm and smooth and well drained. A cover of at least three inches of aggregate shall be maintained in order to avoid the inclusion of soil or foreign material. The stockpiles shall be built in layers not exceeding four feet in height, and each layer shall be completely in place before the next layer is started so as to prevent segregation. The material shall be deposited in such manner as to prevent coning, except in the case of aggregate composed essentially of material finer than the No. 4 sieve and base material.

2. Dumping, casting or pushing over sides of stockpiles will be prohibited, except in the case of aggregate for base material and fine aggregate materials.

3. Unless otherwise authorized, aggregates from different sources, different gradings or differing in specific gravity by more than 0.03 shall not be stockpiled together. Stockpiles of different types or sizes of aggregates shall be spaced far enough apart, or separated by suitable walls or partitions, to prevent the mixing of the aggregates.

4. When it is necessary to operate trucks or other equipment on a stockpile in the process of building the stockpiles, it shall be done in a manner approved by the Purchaser. Any method of stockpiling aggregate which allows the stockpile to become contaminated with foreign matter or causes excessive degradation of the aggregate will not be permitted. Excessive degradation will be determined by sieve tests of samples taken from any portion of the stockpile over which equipment has operated, and failure of such samples to meet all grading requirements for the aggregate shall be considered cause for discontinuance of such stockpiling procedure.

5. Stockpiles shall be maintained in a saturated surface dry condition to the extent possible.

3.02 HANDLING, MEASURING AND BATCHING MATERIAL

A. General

1. The batch plant site, layout, equipment and provisions for transporting material shall be such as to assure a continuous supply of material to the Work.

2. Aggregates shall be handled from stockpiles or other sources to the batching plant in such manner as to maintain a uniform grading of the material. Aggregates that have become segregated, or mixed with earth or foreign material, shall not be used. All aggregates produced or handled by hydraulic methods, and washed aggregates, shall be stockpiled or binned for draining at least 12 hours before being batched. Rail shipment requiring more than 12 hours will be accepted as adequate binning only if the car bodies permit free drainage. In case the aggregates contain high or non-uniform moisture content, storage or stockpile periods in excess of 12 hours may be required by the Purchaser. The Purchaser may require sprinkling of aggregate that has dried to the extent that it absorbs mixing water.

3. The fine aggregate and each size of coarse aggregate shall be separately weighed into the hopper or hoppers in the respective amounts set by the Subcontractor and approved by the Purchaser. Cement shall be measured by the sack or weight. Separate scales and hoppers shall be used for weighing the cement. The scales shall be equipped with a device to indicate positively the complete discharge of the batch of cement into the batch box or container. Ninety-four pounds of bulk cement shall be considered one sack. Batches involving fractional sacks will not be allowed except when bulk cement is used.

4. Batching plants equipped to proportion aggregates and bulk cement by weight by means of automatic and interlocked proportioning devices of approved type may be used.

5. Batching shall be so conducted as to result in the required weights of each material being within a tolerance of 1.0 percent for cement and 1.5 percent for aggregates.

6. Water may be measured either by volume or by weight. The accuracy of measuring the water shall be within a range of error of not over 1.0 percent. Unless otherwise permitted, calibrated tanks for measuring water shall include an auxiliary tank from which the measuring tank shall be filled. The measuring tank shall be equipped with an outside tap and valve to provide for checking the setting unless other means are provided for readily and accurately determining the amount of water in the tank. The volume of the auxiliary tank shall be at least equal to that of the measuring tank.

7. The use of chemical additives shall be as prescribed under Paragraph 3.06 of this Specification and they shall be added to the mix using the methods and at the time and in the manner recommended by the manufacturer of the additive, subject to approval by the Purchaser.

8. Unless specifically provided in the contract, the furnishing and use of approved additives or admixtures and the other precautions necessary to provide satisfactory concrete and concrete products shall be considered subsidiary to the furnishing and placement of the concrete and any and all additional costs related thereto and risks resulting there from shall be borne by the Subcontractor.

9. Different types of cement shall not be mixed, nor shall they be used alternately. Where it is necessary for the color of the concrete to be uniform, only those cements which will produce similar color in concrete may be used alternately. The Purchaser shall designate which cements may be used alternately.

10. Air entraining agents shall be added to the mix by an approved procedure and by the use

of an approved dispenser to assure an accurate proportioning of the agent.

11. All admixtures shall be measured with an accuracy of plus or minus 3.0 percent.

B. Limitations on Concrete Operations

1. Mixing of concrete shall be discontinued in time to allow finishing to be completed in daylight hours, unless an adequate and approved artificial lighting system is provided and operated.

2. When concrete is being placed during hot weather, appropriate measures shall be taken to reduce the hazards of increased rate of cement hydration and high concrete temperatures. The temperature of the concrete at point of discharge shall not exceed 90^0 F. The Purchaser may require any or all, but not limited to, the following precautions to reduce the temperature of the concrete:

   a. Sprinkle coarse aggregate stockpiles in a manner so as to distribute the water evenly and to prevent a variation of moisture within the stockpile.

   b. Use crushed or chipped ice as a portion of the mixing water, or use water cooled by refrigeration or other means. If ice is used, it shall be substituted on a pound for pound basis for water and completely melted before the concrete is discharged from the mixer.

   c. The Subcontractor may employ other means which he may have at his disposal if approved by the Purchaser. In order to minimize the number and extent of precautions as indicated during the production and use of concrete during hot weather, the Subcontractor may use approved chemical admixtures for set-retarding purposes, with the Purchaser's approval. However, the use of such approved set-retarding admixtures shall not relieve the Subcontractor of the necessity for other precautions deemed necessary to minimize variability of the physical characteristics, strength, and other requirements of the green concrete.

   d. Unless authorized in writing by the Purchaser, mixing and concreting operations shall be discontinued when a descending air temperature in the shade and away from artificial heat reaches 40^0F (if the temperature is expected to reach 35^0F or below), and not resumed until an ascending air temperature in the shade and away from artificial heat reaches 35^0F.

   e. When concreting at temperatures above 35^0F, the aggregates or water shall be heated or cooled if necessary prior to being placed in the mixer so that the temperature of the resultant mixture will be not less than 50^0F nor more than 90^0F at the time of placement. If heating is required, the apparatus used shall heat the mass uniformly and shall be so arranged as to preclude the possible occurrence of overheated areas which might injure the concrete.

   f. When concreting is authorized at temperatures 35^0F or less, the Purchaser will require the water or the aggregates or both to be heated to not less than 70^0F nor more than 150^0F. The temperature of the mixed, heated concrete shall be not less than 50^0F nor more than 100^0F at the time of placement. No concrete shall be placed on frozen grade nor shall frozen aggregates be used in the concrete.

   g. When it is expected that the ambient temperature will drop below 35^0F, the Subcontractor shall provide sufficient canvas and framework, other types of housing, or to enclose and protect the concrete in such a way that the air surrounding the fresh concrete can be maintained at a temperature of not less than 45^0F and the

temperature of the concrete shall not exceed 80^0F. The above conditions shall be maintained for a period of 120 hours after the concrete is placed. The Subcontractor shall be responsible for the quality of concrete placed during cold weather, and any concrete injured by frost action or freezing shall be removed and replaced at the Subcontractor's expense. When impending weather conditions indicate the possibility of the need for such temperature protection, all necessary heating and covering material shall be on hand ready for use before the Purchaser's permission is granted to begin placement.

3.03 MIXING CONCRETE

A. General

1. The concrete may be mixed in a central mix plant or in truck mixers. The mixer shall be of an approved type and capacity, and shall comply with the applicable requirements of Paragraph 4.03 of this Specification Section. Mixers shall be cleaned at suitable intervals. Equipment having components made of aluminum or magnesium alloys which would have contact with plastic concrete during mixing, transporting or pumping of Portland cement concrete, shall not be used.

2. The batch shall be so charged into the drum that a portion of the mixing water shall enter in advance of the cement and aggregates. Mixing time shall be measured from the time all materials except water are in the drum. The flow of water shall be uniform, and all water shall be in the drum buy the end of the first 15 seconds of the mixing period. The throat of the drum shall be kept free of such accumulations as may restrict the flow of materials into the drum.

3. When mixed in a central mixing plant, the mixing time shall not be less than 60 seconds nor more than 90 seconds. Mixing time ends when the discharge chute opens. Transfer time in multiple drum mixers shall be included in the mixing time. The contents of an individual mixer drum shall be removed before a succeeding batch is emptied therein.

4. The mixer shall be operated at the drum speed recommended by the manufacturer. Any concrete mixed less than the specified time shall be discarded and disposed of by the Subcontractor at his expense. Mixers for central mix plants shall not be operated at a capacity greater than the manufacturer's guaranteed mixing capacity.

5. Mixed concrete from the central mixing plant shall be transported in truck mixers, truck agitators or nonagitating trucks having special bodies. The time elapsing from the time water is added to the mix until the concrete is deposited in place at the site of the Work shall not exceed 30 minutes when the concrete is hauled in nonagitating trucks, nor 60 minutes when hauled in truck mixers or truck agitators. When high early strength concrete is used, agitator trucks only shall be used and the concrete shall be deposited in place at the site of the Work within 30 minutes from the time water is added to the mix, regardless of the method of transportation, unless otherwise approved by the Purchaser.

6. Truck mixers and truck agitators used to transport concrete from a central mixing plant and truck mixers used to mix concrete in transit from a central batching plant shall meet all applicable requirements of Paragraph 4.03 of the Specification Section, and in addition, the mixing speed and agitating speed shall be those recommended by the manufacturer of the mixer and the total revolutions at mixing speed shall not be less than 70 nor more than 100. Truck mixers and truck agitators shall be operated within the capacity recommended by the manufacturer.

7. Retempering concrete by adding water or by other means will not be permitted. Concrete that is not within the specified slump limits at time of placement shall not be used.

Admixtures for increasing the workability or for accelerating the set will be used only when provided for in the Contract, or permitted by the Purchaser. The addition of admixtures to the mix shall be in accordance with the provisions of Paragraph 5.02.A of this Specification Section.

8. Tests for air content shall be made on samples of fresh concrete when and as directed. The air content shall be that specified under Part 6 of this Specification Section and shall be determined in accordance with AASHTO T 152, T 196 or T 199.

B. Ready Mixed Concrete

1. Ready mixed concrete shall fully comply with ASTM C 94 for Ready Mixed Concrete and to the requirements of these Specifications. Ready mixed concrete shall be discharged from the mixer within 1 hour after the introduction of water, provided the air temperature or the concrete temperature does not exceed 70^0F. When the air temperature or concrete temperature exceeds 70^0F, the elapsed time between the addition of water to the mix and discharge shall not exceed 30 minutes. The 30 minute time limit for temperatures exceeding 70^0F may be extended to 1 hour, provided an approved admixture is used. The admixture shall be a water reducing and retarding agent meeting the requirements of Paragraph 3.06, Type D of this Specification Section and shall be used in accordance with the provisions of Paragraph 5.02.A of this Specification Section. The ready-mix plant furnishing the concrete shall have been inspected and approved for use as provided for in Part 4 of this Specification Section.

2. The delivery ticket accompanying each load of concrete shall show the class and quantity of concrete, the quantity of cement, aggregates, water, and additive used in the batch, and the time of batching. Materials used in the concrete shall be tested and approved.

3.04 MIX DESIGN AND PROPORTIONING

A. GENERAL

1. A Concrete Classification Table, Table 03050.2 is provided hereinafter to indicate to the Subcontractor the five classes of concrete to be use. The table contains certain criteria to be met in the design of job mixes for the different classifications of concrete. Data included are the minimum 28 day compressive strength of the concrete (14 day strength for Class B concrete), the range of slump allowed, the minimum cement content of the concrete, and the maximum water allowed. The Subcontractor shall be responsible for design of the concrete mix to be used for each classification of concrete within the limits of Table 03050.2, and for providing concrete to the Purchaser in accordance with the approved design mixes.

2. Unless otherwise specified in the Contract Documents all concrete shall contain an air entraining admixture. The concrete shall contain between 5 percent and 8 percent entrained air. Other admixtures may be used if specifically approved by the Purchaser. The use of calcium chloride will not be allowed.

3. The Purchaser may specify differing compressive strengths for the several classifications by notation on the Plans or in the Special Provisions, and those values shall govern over the values of these Specifications.

CONCRETE CLASSIFICATION TABLE

Table 03 05 00.2

Minimum #/CY Class Of Concrete	28-Day Limestone Compressive Strength (psi)	Slump In Inches	(i) (3) Min. Cement Factor-Sacks/CY Gravel Course Aggregate	Limestone Course Aggregate	(3) Min. Cement Factor-#/CY Gravel Course Aggregate	Limestone Course Aggregate	(3) Net Water Max. Gals./CY Gravel Course Aggregate	Limestone Course Aggregate	(3) Net Water Max-# Gravel Course Aggregate	
A 3,000	3-5	6.0	5.5	564	517	36	33	300	275	
AS	4,000	3-5	**(2)**	6.2	**(2)**	583	**(2)**	37.2	**(2)**	310
B 3,500 **(1)**	1-2 ½	6.2	5.8	583	545	34.1	31.9	284	266	
C 2,500	2-4	5.0	4.5	470	423	34	30.6	283	255	
P 5,000	1-3	**(2)**	7.0	**(2)**	658	**(2)**	35.0	**(2)**	292	

(2) Minimum compressive strength @ 14 days. Minimum flexural strength @ 14 days of 550 psi per AASHTO T 22.
(3) Gravel Coarse Aggregate no permitted.
(4) Tabulated valves are for Type I cement conforming to the requirements of AASHTO M 85 only.

3.05 MIX DESIGN

A. Prior to mixing any concrete for the project, the Subcontractor shall submit his proposed design mix and reports of tests for each classification of concrete to the Purchaser for approval. The design mix shall be submitted on a form that indicates the supplier and type of the concrete and materials to be used as well as the amounts of materials per cubic yard for at least the following items and units (based upon saturated surface dry aggregate):

1. Cement-Pounds
2. Coarse Aggregate-Pounds
3. Fine Aggregate-Pounds
4. Air Entraining Admixture – Ounces
5. Other Admixtures (if allowed) – Ounces
6. Water – Pounds
7. Fly Ash (if allowed) – Pounds

3.06 PROPORTIONING

A. Each class of concrete shall be manufactured by combining the several materials prescribed in the design mix in the proportions necessary to obtain the specified compressive strength for each class. Proportioning shall be based upon the specified cement content, and the amount of water for each class of concrete shall not exceed the quantity shown in Table 03050.2. Below this limit, the quantity of water shall be adjusted to meet the slump requirements. Aggregate weights shown in the Subcontractor's mix design(s) shall be based on saturated surface dry aggregate; batch weights shall be corrected to compensate for surface moisture on the aggregate in order to determine the amount of water to be added at the mixer.

B. In addition to the requirements specified herein and on Table 03050.2, Portland cement concrete for pavement, Class B, (Specification Section 02750) shall have a flexural strength at 14 days of not less than 550 pounds per square inch when tested in accordance with AASHTO T 22.

3.07 CHANGES IN MIX

A. When approved by the Purchaser, the ration of coarse and fine aggregate may be adjusted in order to assure better workability or to accommodate placement by pumping. However, in no case shall the fine aggregate exceed 44 percent of the total aggregate.

B. If during the progress of the Work, the specific gravity of one or both of the aggregates change more than plus or minus 0.03 from those shown on the concrete design, the design weights shall be adjusted by a design change to conform to the new specific gravity.

3.08 TESTING

A. Test Samples

1. The Purchaser shall provide for all test cylinders. All samples shall be cast, cured and tested by the Purchaser at its expense. The Subcontractor will be required to assist the Purchaser in securing necessary materials for casting the required number of cylinders.

Testing ages will be 7 days and 28 days unless otherwise determined by the Purchaser. Laboratory cylinders shall be used to determine the quality of concrete produced. The number of cylinders to be cast daily for any quantity of concrete and laboratory tested, shall be specified by the Purchaser. With prior consent of the Purchaser, the Subcontractor may prepare field cylinders. These cylinders may be used as a gauge for early safe removal of forms where the Subcontractor requests earlier removal than set out in the Specifications.

B. Cement Testing

1. All cement used in the Work shall be pre-tested before use. Cement may be used upon completion of a satisfactory 3 day physical test made in accordance with current ASTM Specifications. Cement shall be tested by an approved commercial testing laboratory at the Subcontractor's expense.

C. Core Samples

1. If the Purchaser's testing of cylinders indicates compressive strength less than required in Table 03050.2 for the class of concrete specified, the Subcontractor may, at his option, elect to drill core samples from the actual concrete placed. If the Subcontractor elects to drill (or is instructed by the Purchaser to drill) core samples from the hardened concrete, the costs of obtaining the cores and of repairing the core holes with non-shrinking grout shall be borne by the Subcontractor.

2. The cores shall be drilled as directed by the Purchaser, at the same approximate locations from which the test cylinder concrete was obtained. The locations of the drilled cores shall be selected so that the remaining structure will not be impaired or sustain permanent damage after the holes are repaired by the Subcontractor. The drilled samples shall be tested for compressive strength by the Purchaser, and the equivalent 28 day strength of the concrete placed and represented by the drilled core samples shall be determined. The Purchaser shall use the test results of the drilled cores to determine the acceptability of the concrete.

3.09 METHODS OF SAMPLING AND TESTING

A. Test cylinders cast to determine acceptability for minimum AASHTO strength requirements shall be made and cured in accordance with AASHTO T 23 and tested in accordance with AASHTO T 22. Test cylinders cast to determine when a precast unit or a structure may be put into service or to determine when a tensioning load may be transferred shall be cured by methods identical to those used in curing the concrete member, and tested in accordance with AASHTO T 22.

B. Drilled core samples shall be taken and tested in accordance with AASHTO T 24. Due to possible fracturing effect of the coring operation, drilled core samples having a compressive strength of 85 per cent or more of specified strength will be considered acceptable.

C. Slump shall be determined in accordance with AASHTO T 119 on the job site during each placement.

D. The amount of air entrained shall be determined by pressure or volumetric meters of approved design and in accordance with AASHTO Method T 152 or AASHTO Method T 196, except that AASHTO Method T 199 may be used after the accuracy of the Chace Air Indicator has been determined by comparison tests.

3.10 CONCRETE FAILING TO MEET STRENGTH REQUIREMENTS

A. Concrete which has been mixed and placed in accordance with these Specifications, and which fails to meet the minimum 28 day strength requirements shall be removed and disposed of by the Subcontractor, at his expense, unless specifically authorized by the Purchaser, in writing, to remain in place. The removal shall be in such manner as will not cause damage to the remaining concrete or to other structural units or other facilities and property.

B. The Purchaser may, at his discretion, allow concrete which fails to meet the minimum strength requirement to remain in place. Payment for this concrete will be at a reduced price, to compensate the Purchaser for loss of durability. The amount of the reduction shall be determined by the Purchaser and shall be based on the particular circumstances.

3.11 MISCELLANEOUS

A. Concrete Mixed and/or Batched Off Project Site

1. Concrete may be mixed and/or batched off the immediate project site, subject to specific approval of the Purchaser and under the direct supervision of the Subcontractor. A delivery ticket (certified by the batch plant) showing mix, quantity of cement, quantity of fine and coarse aggregate, moisture content, total water and gallons per cubic yard of concrete shall be furnished to the Purchaser with each delivery of concrete and the Subcontractor shall show to the satisfaction of the Purchaser that the plant is so located and equipped as to produce and deliver concrete fully meeting the specification requirements.

PART 4 MEASUREMENT AND PAYMENT

The methods of measurement and payment for concrete shall be as specified in Divisions 2 and 3 of these Specifications for each particular item constructed by the Subcontractor.

END OF SECTION 03050

SECTION 03310
CONCRETE STRUCTURES

PART 1 GENERAL

1.01 SCOPE

A. This work shall consist of the construction of all structures, or parts of structures, composed of Portland cement concrete whether plain, reinforced, or a combination of both. Concrete structures shall be constructed of Class A Concrete, unless otherwise specified. They shall be constructed on prepared foundations, at the locations indicated or directed in conformity with the dimensions, lines and grades shown on the Plans or as directed by the Purchaser and in accordance with these Specifications.

B. The concrete used in this construction shall be composed of a mixture or mixtures of Portland cement, aggregates, air-entraining agents, water, and chemical additives when approved, combined by the methods an in the proportions defined for the particular class of concrete designated as shown in Specification Section 03050.

C. Parts of a structure, or structures, indicated to be constructed with materials other than Portland cement concrete and concrete reinforcement steel shall be constructed in accordance with the provisions set out in the Specification Section covering the particular type of construction.

PART 2 PRODUCTS

2.01 MATERIALS

Materials used in this construction shall meet the requirements of the applicable Sections or Paragraphs of Specification Section 03 05 00, “Portland Cement Concrete” and the following:

A. Waterstops

1. Waterstops shall be of the type, shape, and dimension shown on the Plans.

2. Metallic: Metallic waterstops shall be sheet copper conforming to the requirements as specified in the current Specifications for Copper Sheet, Strip, Plate, and Rolled Bar, Type ETP, ASTM Designation B 152. The weight per square foot shall be as specified on the Plans.

3. Nonmetallic:

a. Nonmetallic waterstops shall be manufactured from either natural rubber, synthetic rubber, or polyvinylchloride (PVC) at the option of the Subcontractor. Waterstops shall be produced by such a process that, as supplied for use, they will be dense, homogeneous, and free from holes and other imperfections. The cross-section of the waterstop shall be uniform along its length and transversely symmetrical so that the thickness at any given distance from either edge of the waterstop will be uniform.

b. Rubber Waterstop:

i. The waterstop shall be fabricated from a high grade thread-type compound. The basic polymer shall be natural rubber or a copolymer of butadiene and styrene, or a blend of both. The compound shall contain no less than 70 percent by volume of the basic polymer, and remainder shall consist of reinforcing carbon black, zinc oxide, accelerators, antioxidants, vulcanizing agents and plasticizers, but shall contain no factice.

ii. Samples taken from the finished waterstop shall meet the following requirements when tested in accordance with the current specified ASTM method of test.

Title	ASTM Requirement	Method of Test
Tensile Strength (Die “C”)	2500 psi. min.	D 412
Ultimate Elongation (Die “C”)	450 percent, min.	D 412
Shore Durometer Hardness	60-70	D 2240
Specific Gravity (Sec. 17)	1.15 + 0.03	D 297
Water Absorption (% by Wt.)	5 percent, max.	D 570
Tensile Strength after accelerated Aging, oxygen-pressure method	80 percent, min.	D 572

a. Polyvinylchloride Waterstop

i. This waterstop shall be extruded from an elastomeric plastic material. The material shall be a plastic compound, the basic resin of which shall be polyvinylchloride. The compound shall contain any additional resins, plasticizers, stabilizers, or other materials needed to insure that when the material is compounded it will meet the performance requirements of this Specification. No reclaimed polyvinylchloride shall be used.

Title	ASTM Requirement	Method of Test
Tensile Strength (Die “C”)		
Sheet Material	2,000 psi	D 412
Finished Waterstop	1,700 psi	D 412
Ultimate Elongation (Die “C”)		
Sheet Material	350% Min.	D 412
Finished Waterstop	300% Min.	D 412
Stiffness in Flexure	750 psi Min.	D 747
Accelerated Extraction		CRD C 572
Tensile Strength (Die “C”)	1,750 psi	D 412
Elongation (Die “C”)	300%	D 412
Effect of Alkali (After 7 Days)		
Change in Weight	-0.1 to +0.25%	
Change in Hardness, Shore Durometer	+ or – 5%	
Low Temperature Brittleness	-35^{o}	D 746
Specific Gravity	1.3	D 792

ii. For polyvinylchloride waterstops, the supplier shall submit a certificate stating that all of the performance requirements specified for the sheet material under Polyvinylchloride Waterstops have been complied with. Field splices for Polyvinylchloride waterstops shall be performed by heat sealing the adjacent surfaces in accordance with the manufacturer’s recommendations. Waterstops shall be manufactured with an integral cross-section which shall be uniform within plus or minus 1/8 inch in width, and the web thickness or bulb diameter within plus 1/16 inch and minus 1/32 inch.

iii. The Subcontractor shall furnish the Purchaser at this request and at no cost to the Purchaser a certified test report from an approved laboratory covering each lot or

unit of finished waterstops. These test reports shall contain the numerical laboratory test data of the required test.

B. Epoxy Resin Systems

1. Two Component epoxy resin systems shall conform to the requirements of the appropriate class designation of AASHTO M 200, M 234, M 235, unless otherwise designated on the Plans or in the Contract. The appropriate class designation is determined by the proposed use of the material.

2. Requirements for Specific Uses:

a. Bonding fresh concrete to cured concrete.
Requirements: The material shall meet the compositional specification of AASHTO M 235, Class I and applicable requirements of the Class III performance specification.

b. Bonding cured concrete to cured concrete.
Requirements: The material shall meet the compositional specification of AASHTO M 235, Class II and the applicable requirements of the Class III performance specification.

c. Binder in epoxy resin concrete and mortar for repairing spalls and other defects in concrete.
Requirements: The material shall meet the compositional specification of AASHTO M 235, Class II and the applicable requirements of the Class III performance specification.

C. Bar Reinforcement

1. Unless otherwise specified, all steel reinforcement for concrete shall be billet steel bars conforming to the requirements of ASTM A 615.

D. Dowel Bars

1. Dowel bars shall be plain and shall conform to the requirements of ASTM A 306, Grade 55, 60, 65, or 70.

E. Welded Wire Fabric

1. Fabric for reinforcement shall conform to ASTM A 185, or as indicated on the Plans, and shall be supplied in mats of the size, design and weight shown on the Plans.

1.02 EQUIPMENT

A. Equipment and tools necessary for handling materials and performing all parts of the Work shall be subject to approval by the Purchaser as to design, capacity, and mechanical condition. Equipment shall be on hand sufficiently ahead of the start of construction operations to be examined and approved. The equipment and organization shall be of sufficient capacity to accomplish the maximum continuous concrete placement, as governed by the construction joints shown on the Plans or as directed by the Purchaser.

B. The requirements for batching plant and mixers shall be as prescribed in Specification Section 03 05 00.

C. Ample and satisfactory equipment for conveying concrete from the mixer to final position in the forms shall be provided. Closed chutes or pipes shall be used when concrete is to be dumped

or dropped for a distance greater than 5 feet. Where steep slopes are required, the chutes shall be equipped with baffle boards or shall be in short lengths that will enable the direction of movement to be reversed.

D. Vibrators shall be of an approved type and design and shall operate under load at a rate as recommended by the manufacturer and approved by the Purchaser.

PART 3 EXECUTION

3.01 FORMS

A. Construction

1. Forms shall be mortar-tight and sufficiently rigid to prevent distortion due to the pressure of the concrete and other stresses incidental to the construction operations, including vibration. Forms shall be so constructed and maintained as to prevent the opening of joints due to shrinkage of the lumber.

2. The forms shall be built true to line and grade and shall be held in place by means of studs or uprights, and waling, which shall be sufficiently and substantially braced and tied.

3. All forms and studding shall be cut off and capped with not less than a 2 inch by 4 inch piece so that the top of the cap will be at the elevation of the finished exposed surface of the concrete.

4. All edges shall be chamfered with ¾ inch material, unless otherwise specified. All chamfer strips shall be straight, of uniform width, and dressed.

5. Wood devices of any kind used to separate forms shall be removed before placing concrete within 4 inches of such devices.

B. Form Lumber

1. Form lumber for all exposed concrete surfaces shall be dressed at least on one side and two edges and shall be so constructed as to produce mortar-tight joints and smooth, even concrete surfaces.

2. Plywood forms, or forms face-lined with plywood, masonite, or other approved similar material may be used, provided the plywood forms and form linings are substantial, of uniform thickness, and are mortar-tight when in position.

C. Metal Ties

1. Metal ties or anchorages within the forms shall be so constructed as to permit their removal to a depth of at least one inch from the face without injury to the concrete. In case wire ties are permitted, the wires shall be cut back at leas ¼ inch from the surface of the concrete, and the surface left sound, smooth, even, and uniform in color.

D. Walls

1. Sufficient openings shall be provided at intervals along the bottom of wall forms to permit thorough cleaning prior to concrete placement. Such openings shall be closed before placing concrete in the forms.

E. Surface Treatment

1. Prior to placing reinforcement, all forms shall be treated to prevent the adherence of concrete. Forms not provided with a special treatment shall be treated with an approved oil. Any material that will adhere to or discolor the concrete shall not be used.

F. Metal Forms

1. The specifications for forms, as regards design, mortar tightness, filleted corner, beveled projections, bracing, alignment, removal, and reuse and oiling apply to metal forms. The metal used for forms shall be of such thickness that the forms will remain true to shape. All bolt and revet heads shall be countersunk on the face forming the concrete surface. Clamps, pins, or other connecting devices shall be designed to hold the forms rigidly together and to allow removal without injury to the concrete. Metal forms which do not present a smooth surface or do not line up properly shall not be used. Care shall be exercised to keep metal forms free from rust, grease, or other foreign matter.

2. When the Subcontractor wishes to utilize a special forming system not specifically authorized in this Specification, he shall submit his design and calculation to the Purchaser for review and approval.

3.02 FALSEWORK

A. The falsework used to support the forms and concrete for concrete structures shall be supported on sills resting on rigid foundations composed of piles driven until the bearing capacity of each pile is sufficient to support the load to which it will be subjected, or earth-borne footings as hereinafter provided.

B. Earth-borne footings will be permitted only when, in the opinion of the Purchaser, the soil can adequately support the superimposed loads and the following conditions are met:

1. Spread footings will only be permitted on stable ground, capable of supporting the superimposed load.

2. The site is graded and so maintained to prohibit ponding of water or erosion of soil in the proximity of the spread footings.

3. The falsework system shall be designed and constructed to preclude exceeding the bearing capacity of the soil but in no case shall exceed 3,000 pounds per square foot.

4. The footings shall be designed and constructed to carry the superimposed loads.

5. All footings shall be constructed on a level plane.

C. The falsework shall be designed and constructed to support the required loading without distortion or settlement of the forms.

D. The Subcontractor shall place “tell-tales” for observation of the amount of falsework settlement at locations designated by the Purchaser.

E. The Purchaser may require the Subcontractor to submit detailed falsework plans, together with a soils report, design calculations or any other information necessary for a thorough review. The Subcontractor is totally responsible for the design and construction of the falsework system and shall repair, or remove and replace, as directed and at his expense, any concrete, other material or portions of the structure which are damaged or destroyed due to failure of the falsework.

3.03 REINFORCEMENT

A. All reinforcement shall consist of deformed steel bars, unless otherwise indicated or directed. Deformed steel bars shall have a net area at all sections equivalent to that of plain round or square bars of the corresponding nominal size.

B. Structural steel shapes shall conform strictly to the shapes indicated or required.

C. Steel wire fabric may be furnished in rolls or sheets.

D. Reinforcing steel shall be stored above the ground surface upon platforms, skids or other supports located without the scope of the active construction operations and shall be protected at all times from injury and damage. All brush and weeds shall be removed from the area immediately prior to storing reinforcing steel thereon.

E. Reinforcing steel, where indicated, shall be accurately bent, without heating, to the forms and dimensions indicated on the Plans. Minimum bend diameters shall be in accordance with the requirements of the American Concrete Institute. Unless otherwise indicated, all bends shall be in one plane. Bars of ¾ inch or less which have only hooks or a single bend may be bent in the field, provided satisfactory equipment for proper and accurate work is used and provided the bending is accomplished true to form and dimensions without damage to the bars. All other bending shall be done in the shop before shipment.

F. Substitution of bars of different sizes from those indicated on the Plans may only be made with the written permission of the Purchaser. If substitution is permitted, the following shall apply:

1. The total area of steel in any one linear foot in each direction shall not be reduced.

2. For cast-in-place concrete the clear distance between parallel bars in a layer shall not be less than 1.5 bar diameters, 1.5 times the maximum size of the coarse aggregate, nor 1-1/2 inches.

3. Where positive or negative reinforcement is placed in two or more layers, bars in the upper layers shall be placed directly above those in the bottom layer with the clear distance between layers not less than 1 inch.

4. Clear distance limitation between bars shall also apply to the clear distance between a contact lap splice and adjacent splices or bars.

5. Groups of parallel reinforcing bars bundled in contact to act as a unit shall be limited to 4 in any one bundle. Bars larger than #11 shall be limited to two in any one bundle in beams. Bundled bars shall be located within stirrups or ties. Individual bars in a bundle cut off within the span of a member shall terminate at different points with at least 40 bar diameters stagger. Where spacing limitations are based on bar diameter, a unit of bundled bars shall be treated as a single bar of a diameter derived from the equivalent total area.

6. In walls and slabs, the primary flexural reinforcement shall be spaced not farther apart than 1.5 times the wall or slab thickness, nor 18 inches.

G. All reinforcement shall be furnished in the full lengths shown on the Plans, unless otherwise approved in writing by the Purchaser. No splices shall be made unless indicated on the Plans or authorized by the Purchaser. Splices shall be so arranged and manipulated as to provide a minimum of 2 inches net clearance between the splices and the surface of the complete concrete work, unless otherwise indicated or directed. Splices of tension reinforcement at points of maximum stress shall be avoided. The members at all splices shall be rigidly clamped by means of at least two approved metal clips located approximately 3 inches from the ends of the bars and bolted around them or securely wired in a manner satisfactory to the Purchaser.

H. Steel shapes shall be spliced only as indicated on the Plans.

I. Steel fabric shall be spliced by overlapping of the sheets by not less than 12 inches; by matching at least three transverse member; and by securely wiring the overlapped sections in a manner satisfactory to the Purchaser.

J. All reinforcing steel before being placed shall be thoroughly cleaned of mill scale, rust, dirt, paint, oil, or other foreign substances or coating of any character that will reduce the bond. If reinforcement which has been placed becomes dirty, rusty, or spattered with mortar which dries before concrete is placed around it, such reinforcement, or part affected, shall be thoroughly cleaned before being covered with concrete.

K. Reinforcement shall be accurately placed and firmly held in position as indicated on the Plans. Steel bars shall be securely fastened together with metal clips or wire at each intersection, except where spacing is less than on 1 foot in each direction then alternate intersections shall be fastened. All reinforcing steel shall be securely spaced from the forms and between adjacent reinforcement by means of precast mortar blocks, metal spacers or other approved devices or methods, and where possible, all spacer devices shall be so arranged that their use cannot be detected in the completed structure. Spacer blocks shall be cast of mortar mixed in the same proportions as that in the concrete mixture and shall not have a length or width greater than the depth required for proper spacing from the forms or between adjacent reinforcement. The use of gravel, concrete, brick, or wooden blocks is prohibited.

L. All the reinforcing steel necessary for a section of a concrete structure shall be accurately and securely placed and the placement approved by the Purchaser before any concrete is deposited in the section, and care shall be observed not to disturb it during the placing of the concrete.

M. All dimensions relating to reinforcing bars are to the centers of the bars, unless otherwise indicated.

N. Tolerances for bending and cutting during fabrication shall be in accordance with the “Manual of Standard Practice” published by the Concrete Reinforcing Steel Institute.

3.04 DRAINAGE AND WEEP HOLES

A. Drainage openings and weep holes shall be constructed using materials in the manner and at the locations shown on the Plans or established by the Purchaser. Ports or vents for equalizing hydrostatic pressure, when required, shall be placed as directed.

3.05 PLACING PIPES, CONDUITS, ANCHORS, CASTING, AND OTHER APPURTENANCES

A. Pipes, conduits, anchors, castings, bolts, plates, grillage, and other appurtenances which are necessary or desirable to be placed in the concrete of a structure, whether indicated on the Plans or not, shall be placed by the Subcontractor during construction, as directed.

B. No compensation will be allowed for placing such pipes, conduits, and other appurtenances, except that no deductions will be made for the volume of concrete displaced by those items.

3.06 EXPANSION JOINTS

A. Expansion devices shall be as indicated on the Plans. The devices shall be securely anchored in correct position. All sliding surfaces shall be true and smooth and shall form complete contact throughout. Movement shall not be impeded by the concrete in which they are embedded.

B. Unless otherwise provided, where portions of concrete bridge superstructure rest on the substructure, the contact area shall be separated by at least two layers of three-ply bituminous-saturated paper.

C. Open joints shall be constructed using forms which will permit removal without injury to the concrete. After removal of the forms, the joints shall be cleaned thoroughly. Filled joints shall be constructed with premolded filler, unless otherwise indicated. Joints requiring a sealant shall be thoroughly cleaned and sealed with one of the specified joint sealing materials before the structure is opened to traffic. Edges of open and filled joints shall be chamfered or edged, as directed. Mortised joints shall be constructed as shown on the Plans or as directed.

3.07 PLACING CONCRETE

A. General

1. Concrete shall not be placed until forms and reinforcing steel have been checked and approved. The forms shall be clean of all debris and kept wet immediately before concrete is placed. The method and sequence of placing concrete shall be approved by the Purchaser. Unless otherwise permitted, all concrete shall be placed in daylight, and the placing of concrete in any portion of the structure shall not be started unless it can be entirely completed in daylight. When the placing of concrete is permitted during other than daylight hours, an adequate and approved artificial lighting system shall be provided and operated.

2. All concrete shall be thoroughly worked during the placing by means of tools of approved type. The working shall be such as to force all coarse aggregate from the surface and to bring mortar against the forms to produce a smooth finish, substantially free from water and air pockets or honeycomb.

3. If the forms show bulging or settlement while concrete is being placed, the placing shall be stopped until correction has been made.

4. T-beam girders, slabs, arch rings, and all horizontal sections of bridges except curbs and sidewalks shall be constructed monolithically and continuously, unless otherwise permitted. Curbs and sidewalks shall be constructed after the bridge deck is completed, unless otherwise indicated on the Plans.

5. After initial set and prior to final set of the concrete, the forms shall not be jarred, and no strain shall be placed on the ends of the projecting reinforcement. Piles shall not be driven closer than 20 feet to footings less than 7 days old nor to foundations supporting concrete less than 7 days old.

B. Railings and Curbing

1. When constructing curb, careful attention shall be given to the installation of railing steel or anchoring devices.

2. Concrete railings shall not be constructed on any structure until the falsework has been struck.

C. Chutes and Troughs

1. Concrete shall be placed so as to avoid segregation of the materials and the displacement of the reinforcement.

2. All chutes, troughs, and pipes shall be kept clean and free from coatings of hardened concrete by thoroughly flushing with water after each run. The water used for flushing shall be discharged clear of the concrete already in place.

3. Care shall be taken to fill each part of the form by depositing the concrete as near final position as possible. The coarse aggregate shall be worked back from the forms and around the reinforcement without displacing the bars. After initial set of the concrete, the forms shall not be jarred and no strain shall be placed on the ends of projecting reinforcement.

D. Vibrating

1. Unless otherwise directed, the concrete shall be compacted with suitable mechanical vibrators operating within the concrete. When required, vibrating shall be supplemented by hand spading with suitable tools to assure proper and adequate compaction.

2. Vibrators shall be so manipulated as to work the concrete thoroughly around the reinforcement and embedded fixtures and into corners and angles of the forms. Vibrators shall not be used as a means to cause concrete to flow or run into position in lieu of placing. The vibration at any point shall be of sufficient duration to accomplish compaction but shall not be prolonged to the point where segregation occurs.

3. At least one additional standby vibrating unit shall be available for all individual pours in excess of 10 cubic yards.

E. Joints

1. Feather-edge construction joints will not be permitted. Transverse or longitudinal joints through spans will not be permitted, except where specified.

2. In no case shall the concreting of any section or layer be stopped or temporarily discontinued within 18 inches of any finished surface, unless the details of the structure provide for a coping having a thickness of less than 18 inches, in which case, at the option of the Purchaser, the construction joint may be made at the underside of the coping.

3. Layers completing a day’s work or placed just prior to temporarily discontinuing operations shall be cleaned of all laitance or other objectionable material as soon as the surface has become sufficiently firm to retain its form.

3.08 BONDING CONSTRUCTION JOINTS

A. Where dowels, reinforcing bars, or other adequate ties are not indicated on the Plans, keys of a directed size shall be made by constructing projections above the concrete and monolithically with the concrete.

B. In resuming work, the forms shall be drawn tightly against the face of the concrete. The entire surface of the concrete to be bonded shall be cleaned thoroughly and roughened with a steel tool. In addition, if directed, the surface to be bonded shall be cleaned and roughened by sandblasting. The surface shall then be soaked with clean water, after which concreting may proceed.

3.09 REMOVAL OF FORMS AND FALSEWORK.

A. Forms for ornamental work, railings, parapets, columns, and vertical surfaces that do not carry loads shall be removed in from 12 to 48 hours, unless otherwise directed by the Purchaser. In cold, damp, or freezing weather, all vertical forms shall remain in place until the concrete has

set sufficiently to withstand damage when the forms are removed. In removing forms, care shall be exercised not to mar the surface of the concrete nor to subject it to any undue pressure.

B. Projecting wires or other metal devices used for holding forms in place and which pass through the body of the concrete shall be removed or cut as specified in Specification Section 03310 Paragraph 3.01.A, and the holes or depressions thus made and all other holes, depressions, and small voids which show upon the removal of the forms shall be filled with cement mortar mixed in the same proportions as that which was used in the body of the concrete which is being repaired.

C. Falsework and supports under slab or girder spans, any length, may be released and removed when representative specimens of the concrete in the spans, cured by the methods and in the manner the concrete which the test specimens represent is cured, attain a compressive strength of 3,000 pounds per square inch. In addition to the above requirement, the concrete shall have been placed a minimum of 10 days, not counting the days of 24 hours each in which the temperature falls below 40^{o} F., or 21 calendar days, whichever occurs first.

D. For continuous concrete girder or slab units, any length, the falsework and supports shall not be released or removed from any span in the continuous unit until the concrete in all spans in the unit has been placed a sufficient length of time to meet all requirements for the removal of falsework and supports as set forth above.

E. Forms supporting bridge decks between girders and outside curb overhangs may be removed after seven days.

3.10 DEFECTIVE CONCRETE

A. Any defective concrete discovered after the forms have been removed shall be removed immediately and replaced. If the surface of the concrete is bulged, uneven, or shows honeycombing which cannot be repaired satisfactorily, the entire section shall be removed and replaced.

B. Concrete having a 28 day strength of less than the minimum specified shall be removed and disposed of by the Subcontractor, at his expense, unless specifically authorized by the Purchaser, in writing, to remain in place. The removal shall be in such a manner as will not cause damage to the remaining concrete or to other structural units or other facilities and property.

3.11 FINISHING CONCRETE SURFACES

A. Unless otherwise authorized, the surface of the concrete shall be finished immediately after form removal.

B. All concrete surfaces shall be given a Class 1 finish. The following surfaces of all structures shall be given a Class 2 Finish: roadway face and top of curb, vertical outside face of curb overhang or sidewalk slab, bottom surface of slab overhang, bridge railings, barrier railings, all vertical surfaces of the superstructure of dual bridges exposed to view from either structure, and all surfaces of retaining walls, wingwalls, and end walls which are visible from passing vehicles.

1. Class 1, Ordinary Surface Finish

a. Immediately following the removal of the forms, all fins and irregular projections shall be removed from all surfaces which are to be exposed or waterproofed. On all surfaces, the cavities produced by form ties and all other holes, honeycomb spots, broken corners or edges, and other defects, shall be thoroughly cleaned, saturated

with water, and carefully pointed and trued with a mortar of cement and fine aggregate mixed in the proportions used in the Class of the concrete being finished. Mortar used in pointing shall not be more than 30 minutes old. All construction and expansion joints in the completed work shall be left carefully tooled and free of all mortar and concrete. The joint filler shall be left exposed for its full length with clean and true edges.

b. All surfaces which cannot be repaired to the satisfaction of the Purchaser shall be "rubbed" as specified for a Class 2 finish.

2. Class 2, Rubbed Finish.

a. After removal of forms, the rubbing of concrete shall be started as soon as its condition will permit. Immediately before starting this work, the concrete shall be kept thoroughly saturated with water. Sufficient time shall have elapsed before the wetting down to allow the mortar used in the pointing to thoroughly set. Surfaces to be finished shall be rubbed with a wetted wooden block or a medium coarse carborundum stone. The carborundum stone shall not be used until the concrete has hardened to the state where the sand will grind, rather than ravel or roll. Rubbing shall be continued until all form marks, projections, and irregularities have been removed; all voids filled; and a uniform surface has been obtained. The paste produced by this rubbing shall be left in place. A brush finish or painting with grout will not be permitted.

b. After all concrete above the surface being finished has been cast, the final finish shall be obtained by rubbing with a fine carborundum stone and water. This rubbing shall be continued until the entire surface is of a smooth texture and uniform color.

c. After the final rubbing is completed and the surface has dried, it shall be rubbed with burlap to remove loose powder and shall be left free from all unsound patches, paste, powder, and objectionable marks.

3. Class 3, Float Finish

a. This finish, for unformed surfaces, except slab surfaces for pavements or bases, shall be achieved by placing an excess of material in the form and removing or striking off the excess with a template, forcing the coarse aggregate below the mortar surface. Creation of concave surfaces shall be avoided after the concrete has been struck off, the surface shall be thoroughly worked and floated with a suitable floating tool of wood, canvas, or cork. Before the finish has set, the surface cement film shall be removed with a fine brush in order to have a fine-grained, smooth but sanded texture.

3.12 FINISHING SLAB SURFACES FOR PAVEMENTS OR BASES.

A. Bridge floors or top slabs of structures serving as finished pavements or bases shall be finished either by hand methods or approved mechanical finishing machines.

B. When the hand method is used, the bridge floors or slabs shall be struck off with a screed which is parallel to the centerline of the roadway, resting on bulkheads or screed strips cut or set to the required cross-section of the roadway. This screed shall be so constructed as to have sufficient strength to retain its shape and that the cutting edge may be adjusted to conform to the profile of the roadway. Screeds shall be of sufficient length to finish the full length of spans 40 feet or less in length. Spans over 40 feet in length shall be finished in two or more sections, but no section shall be less than 20 feet in length. Screed strips or headers shall be accurately set to the specified grades, checked, and adjusted as necessary prior to the final screeding operation. The screed shall be worked back and forth over the surface until the proper profile and cross-section is obtained.

C. When mechanical finishing machines are used, they shall be approved power driven machines, traveling on rails adjusted to conform to the profile of the roadway. The machines shall be equipped with oscillating or vibrating transverse or longitudinal screeds that may be adjusted to conform to the profile or the required cross-section of the roadway. The screeds shall have sufficient strength to retain their shape after adjustment. The finishing machine shall go over each area of the bridge floor as many times as is required to obtain the required profile and cross-section.

D. Regardless of the method of finishing, the Subcontractor shall maintain a minimum rate of placement of 20 linear feet of bridge deck per hour when concrete is placed in a longitudinal section.

E. After finishing as described above, the surface shall be checked with a 12 foot straightedge and shall show no deviation is excess of 1/8 inch from the testing edge of the straightedge when placed parallel to the centerline. Deviations in excess of this requirement shall be corrected before the concrete sets.

F. The surface shall be finished by dragging a seamless strip of damp burlap over the full width of the surface. The burlap drag shall consist of sufficient layers of burlap to slightly groove the surface and shall be moved forward with minimum bow of the lead edge. The drag shall be kept damp, clean, and free of particles of hardened concrete. A light broom or brush herring bone finish that leaves a texture similar to that obtained by the burlap drag may be used when permitted by the Purchaser. For bases, the surface shall be finished by grooving lightly with a wire broom at an angle of 60^{o} with the centerline. All strokes shall begin at the center and end at the edge. After the slab has been finished by the burlap drag, surfaces which will become traffic lanes shall be textured by the formation of transverse grooves. The grooves shall be formed in the surface at an appropriate time during the stiffening of the concrete, so that in the hardened concrete the grooves will be between 0.09 inch and 0.13 inch in width; between 0.12 inch to 0.19 inch in depth; and spaced at random intervals between 0.3 inch and 1.0 inch. The grooves shall terminate approximately 18 inches from curbs, parapets, barrier walls, and other vertical walls. The grooves shall be relatively smooth and uniform; shall be formed without tearing the surface and without bringing pieces of coarse aggregate to the top of the surface; and shall be formed to drain transversely. All areas which do not conform to these requirements shall be corrected at the Subcontractor's expense by approved methods.

G. As soon as the surface has set sufficiently to withstand damage when walking on it and not later than the morning following the placing of the concrete, it shall be straightedged with the 12 foot straightedge and all variations exceeding 1/8 inch shall be plainly marked. The Subcontractor shall correct a seal such variations in the same manner as specified for Portland Cement Concrete Pavement.

3.13 CURING CONCRETE

A. All concrete surfaces, except those surfaces protected by forms that remain in place seven days or longer as required under the provisions of Specification Section 03310 Paragraph 3.09, "Removal of Forms and Falsework", shall be cured as specified below. Curing shall begin as soon as the concrete has hardened sufficiently to withstand surface damage to unformed surfaces and immediately after the forms have been removed from formed surfaces.

B. When the temperature is expected to fall below 35^{O} F., the concrete shall be protected in accordance with the provisions of Specification Section 03310 Paragraph 3.14.

C. The initial curing period for concrete surfaces shall be by the "Water Method" for a period of not less than 24 hours, or until the concrete surfaces have been prepared for the application of curing compound, in accordance with the provisions under B below. During the initial curing

period, the concrete shall be protected from the sun by burlap mats or other approved materials and kept completely and continuously moist.

D. The “Water Method” and membrane-forming compound method of curing will be required for all bridge decks, and on all concrete slabs when the temperature exceeds 90^{O} F during placement.

1. Water Method

a. All concrete slabs shall be covered immediately with material suitable for use with the water cure and kept thoroughly wet for at least 120 hours from the beginning of the initial curing period. All surfaces other than slabs shall be protected from the sun and shall be kept wet for a period of at least 72 hours from the beginning of the initial curing period. Curbs, walls, handrails, and other surfaces requiring a Class 2 finish may have the covering temporarily removed for finishing, but the covering shall be restored as soon as possible.

2. Membrane-Forming Compound Method

a. All surfaces shall be given the required surface finish prior to application of the curing compound. Prior to the application of curing compound, the surface shall be kept moist.

b. The rate of application of curing compound shall be as recommended by the manufacturer but shall not be less than one gallon for 150 square feet of concrete surface. The curing compound shall be applied, under pressure, immediately after completion of the initial curing period or acceptance of the concrete finish. If the surface is dry, the concrete shall be thoroughly wet with water and the curing compound applied just as the surface film of water disappears. At the time of use, the compound shall be in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle. If the application of the compound results in a streaked or blotchy appearance, the method shall be stopped and water curing, as set out above, applied until the cause of the defective appearance is corrected. The coating shall be protected against marring for a period of seven days from date of application. Any coating marred or otherwise disturbed within the seven day period shall be replaced at once.

3.14 PROTECTION OF CONCRETE IN COLD WEATHER

A. Concrete shall be protected in cold weather a specified in Specification Section 03050.

3.15 WATERPROOFING AND WATERSTOPS

A. Waterproofing shall be applied as indicated in the Division 2 Specifications.

B. Metallic or nonmetallic waterstops, as specified, shall be installed in accordance with the details shown on the Plans and in conformity with the requirements of these Specifications.

C. Metallic waterstops shall be spliced, welded or soldered, as necessary, to form continuous, watertight joints.

D. Nonmetallic waterstops shall be installed in continuous strips without splices, except that splices will be permitted at changes in direction when necessary to avoid buckling or distortion of the web or flange. All splices of nonmetallic waterstops shall be performed in accordance with the manufacturer’s recommendations and in the case of polyvinylchloride waterstops, the heat used shall be sufficient to melt but not char the plastic.

E. Adequate provisions shall be made to support the waterstops during the progress of work and to insure their proper embedment in the concrete. The concrete shall be thoroughly worked in the vicinity of the joints to insure maximum density and imperviousness. Forms shall be so designed that they can be removed without damaging the waterstops. Suitable guards shall be provided to protect exposed projecting edges and ends of partially embedded waterstops from mechanical damage.

PART 4 MEASUREMENT & PAYMENT

4.01 MEASUREMENT

A. All concrete will be measured for payment as stipulated under the Specification Section specifying each individual type of construction.

B. No allowance will be made for furnishing the material and the construction of drainage openings and weep holes as indicated or as directed, provided such openings are 6 inches in diameter or less, except that no deduction will be made for such openings in the computation of concrete quantities. Allowance will be made for other openings as indicated.

C. No allowance will be made for additional cement used in depositing concrete underwater; for use of calcium chloride or chemical additives; for fillers, sealer, and tar paper used in expansion joints; for dowels or other materials used in bonding construction joints; for waterstops; and for painting metals.

D. No allowance will be made for concrete placed below the foundation elevation shown on the Plans or as directed by the Purchaser.

E. No additional compensation will be made for high-early-strength concrete substituted by the Subcontractor.

4.02 PAYMENT

A. All concrete will be paid for as stipulated under the Specification Section specifying each individual type of construction.

END OF SECTION 03310

SECTION 01050

FIELD ENGINEERING

PART 1 - GENERAL

1.01 REQUIREMENTS INCLUDED

A. Provide and pay for field engineering services required for the Project.
   1. Survey work required in execution of Project.
   2. Civil, structural, or other professional engineering services specified, or required to execute contractor's construction methods.

B. Owner's Representative will identify existing control points and property line corner stakes indicated on the drawings, as required.

1.02 RELATED REQUIREMENTS

A. Section 00700: General Conditions

B. Section 00800: Supplementary Conditions

C. Permit and Easement Documentation

1.03 QUALIFICATIONS OF SURVEYOR OR ENGINEER

A. Qualified engineer or registered land surveyor, acceptable to Contractor and Owner.

B. Registered Professional Engineer of the discipline required for the specific service on the Project, if required, licensed in the State in which the project is located.

1.04 SURVEY REFERENCE POINTS

A. Existing basic horizontal and vertical control points for the Project are those designated on drawings.

B. Locate and protect control points prior to starting site work and reserve all permanent reference points during construction.
   1. Make no changes or relocations without proper written notice to Engineer.
   2. Report to Engineer when any reference point is lost or destroyed or requires relocation because of necessary changes in grades or locations.

   3. Require surveyor to replace project control points which may be lost or destroyed.

a. Establish replacements based on original survey control.

1.05 PROJECT SURVEY REQUIREMENTS

A. Establish a minimum of two (2) permanent benchmarks on site, when not present, referenced to data established by survey control points.
   1. Record locations with horizontal and vertical data, on Project Record Documents.

B. Establish lines and levels, locate and lay out, by instrumentation and similar appropriate means:
   1. Site improvements;
      a. Stakes for grading, fill and topsoil placement.
      b. Utility slopes and invert elevations.
   2. Batter boards for structures.

C. Clearly delineate property boundaries, and permanent and temporary easements on the ground as indicated on the drawings

C. From time to time, verify layouts and replace delineation markers by same methods.

D. Replace property corners and other monuments disturbed during construction operations.

1.06 RECORDS

A. Maintain a complete, accurate log of all control and survey work, if required, as it progresses.

1.07 SUBMITTALS

A. Submit name and address of Surveyor and Professional Engineer to Engineer.

B. On request of Engineer, submit documentation to verify accuracy of field engineer work.

C. Submit certificate signed by Registered Engineer or Surveyor certifying that elevations and locations of improvements are in conformance, or non-conformance, with Contract Documents.

PART 2 - PRODUCTS

(NOT USED)

PART 3 - EXECUTION

(NOT USED)

END OF SECTION

SECTION 01150

MEASUREMENT AND PAYMENT

PART 1 - GENERAL

1.01 GENERAL

A. For the information and guidance of bidders, the following explanation of the Bid Form items is made. The omission of reference to any item in this description shall not, however, alter the intent of the Bid Form or relieve the Contractor of the necessity of furnishing such as part of the Contract(s). The quantities set forth in the Bid Form are approximate and are given to establish a uniform basis for the comparison of Bids. The Owner reserves the right to increase or decrease the quantity of any class or portion of the work during the progress of construction in accordance with the terms of the Contract. Lump Sum prices are used as a means of computing the final figures for Bid and Contract purposes, for periodic payments for work performed, for determining value of additions or deletions and wherever else as is reasonable.

B. Payment will be made on the basis of Work actually performed completing each item in the Contract, such work including, but not limited to, the furnishing of all necessary labor, materials, equipment, transportation, clean up, and all other appurtenances to complete the construction, installation, testing and start-up of the work to the configuration and extent as shown on the Project Plans and as described in the Specifications.

C. Notwithstanding any other Sections, paragraphs, sentences, or words in the Contract Documents, payments shall not be made for work not performed, materials not supplied and/or any other item/items for which the Owner does not receive the benefit described or intended.

D. CLEANUP AND SEEDING

1. Contractor shall cleanup all areas of the Work and fine grade and seed all appropriate disturbed areas with seeding types as listed in the Specifications for the areas and seasons as appropriate as the Work progresses. All areas where poor vegetation cover has been noted by April 1st of the year following the initial seeding shall be fine graded and re-seeded.
2. This work is included in a Unit Price line item (Item 20) payment.

PART 2 - MEASUREMENT AND BASIS OF PAYMENT

Division A – Conveyance –Payment Items

2.02 Unit Price Items

A. Whenever units of measure are mentioned in this Section, it shall be interpreted to mean the unit installed in accordance with the Contract plans and specifications and ready for use. Include in prices all costs for labor, materials, tools, equipment, supervision, testing, excavation, and other incidentals to complete the work.

B. The Purchaser's Representative, in conjunction with the project superintendent, will verify all measurements and quantities for payment

C. The prices for those items that involve excavation shall include compensation for the disposal of surplus excavated material, handling water, trench protection and the installation of all necessary sheeting, shoring, and bracing.

D. The work/components outlined in Section 2.02 shall be paid at the Unit Price in accordance with the applicable Specification Section for the work/components. This work shall include, but not be limited to, the following major components:

Item No.	Spec Item No.	Pay Item	Pay Unit
1	02530-6.02	Undercut Backfill	Ton
2	02530-6.04	Service Connection Removal and Replacement	EA
3	02530-6.03.6.01	6" PVC Pipe, all depths	LF
4	02530-6.03.42.01	42" Fiber Reinforced (FRP) Pipe, 14.1-16 feet deep	LF
5	02530-6.03.42.02	42" Fiber Reinforced (FRP) Pipe, 16.1-18 feet deep	LF
6	02530-6.03.42.03	42" Fiber Reinforced (FRP) Pipe, 18.1-20 feet deep	LF
7	02530-6.09.42	Jack & Bore - 42" FRP	LF
8	02530-6.05	Pavement Backfill	CY
9	02530-6.08	42" Pipe HydroExcavation/Hand Digging	LF
10	02531-4.01.B	Precast Manhole Installation (72" DIA.)	VF

Item No.	Spec Item No.	Pay Item	Pay Unit
11	02534-6.02	Standard Manhole Coating (72" DIA.)	VF
12	02531-4.01E	Precast Manhole Installation (84” DIA.)	VF
13	02534-6.02B	Standard Manhole Coating (84" DIA.)	VF
14	02531-4.01A	Precast Manhole Installation (96” DIA.)	VF
15	02534-6.01	Standard Manhole Coating (96" DIA.)	VF
16	02531-4.01F	Precast Manhole Installation (120” DIA.)	VF
17	02534-6.02C	Standard Manhole Coating (120" DIA.)	VF
18	02541-4.01.A	Post Light Cleaning & Mainline CCTV Inspection for 42" Pipe	LF
19	02544-4.01.A	Post GPS Coordinates of Cleanout or Manhole Cover	EA
20	02544-4.01.B	Post MACP Level 2 Manhole Inspection	EA
21	2100	Silt Fence	LF
22	02920-5.01	Seeding (With Mulch)	1000SF
23	02950-4.01.A-1	Asphaltic Concrete Pavement Removal and Replacement	SY
24	See 2.04 Below	Abandon Existing Sewer Structure	EA
25	02370-01.01	Grade C Rip Rap - Bank Stabilization	TON

2.03 Lump Sum Items

A. The Lump Sum work outlined in 24, 25, 26, 27 below shall be paid at the Contract Lump Sum Prices in accordance with their applicable specification sections. Payment shall be made for percentage of work completed for these items, based on a Schedule of Values for the work breakdown as agreed to by the Contractor, Engineer, and Purchaser’s Representative.

Item No.	Spec Item No.	Pay Item	Pay Unit
26	02230-01	Clearing and Grubbing	LS
27	See 2.03 Below	Mobilization (Conveyance)	LS
28	01551-5.01	Traffic control for construction work zones	LS
29	02530-6.06	Bypass pumping	LS

B. Reference the Specification Sections pertaining to these items for specific payment conditions.

2.03 Mobilization Item-25

A. Mobilization to the job site shall be paid at the Lump Sum Bid price. Price shall include all contractor-incurred mobilization and demobilization costs associated with the

Project. Payment under this item is limited to the Unit Price Bid or 3.00% of the Project Bid Total, whichever is less. Payment shall be made at one-half the Bid price for mobilization and one-half of the Bid price for demobilization.

B. If the contractor is required to pull all personnel and equipment off the job at the request of the Owner and is subsequently required to re-mobilize, then he would be paid the lump sum price for mobilization a second time in two payments as outlined in "Item 25" above.

2.04 Abandon Existing Sewer Structure Item-22

A. Payment to the Contractor for lowering, filling, and abandoning existing manholes shall be made at the appropriate Contract Unit Price per manhole. The price shall include furnishing all labor, materials, and equipment required to complete the construction, including all excavation, backfilling, sheeting, shoring, bracing, removal of water, manhole fill and stone, furnishing and installing plugs, sealing existing sewers, and proper disposal of all unsuitable material, vegetation, and debris.

B. The Contract Unit Price shall be considered payment for:

I. If manhole has salvageable cast iron frame and cover, remove cast iron frame and cover and deliver to the Owner. If cover is not salvageable, dispose of the cover in accordance with applicable regulations.
II. Permanently plug all incoming and outgoing pipes from inside manhole in accordance with the typical pipe plug detail with 3,000 psi.
III. Remove manhole to an elevation not less than twenty-four (24") inches below finished grade or top section if precast.
IV. Fill manhole with compacted sand.
V. Use compacted T.D.O.T base grading "D" stone cap remaining excavation over existing manhole.
VI. Backfill to finished grade with suitable soil material for manholes in non-paved areas or backfill to required sub-grade with compacted T.D.O.T. base grading "D" stone in paved areas.

C. The Contract Unit Price shall be considered payment for all necessary fine grading, clean up, seeding and landscaping required to restore all areas disturbed by the construction. Concrete and pavement restorations are paid for under other bid items.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

(Not Used)

END OF SECTION

SECTION 01340

SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

PART 1 - GENERAL

1.01 REQUIREMENTS INCLUDED

A. Submit Shop Drawings, Product Data, and Samples required by Contract Documents.

1.02 RELATED REQUIREMENTS

A. Section 01720: Project Record Documents

B. Purchaser Requirements

1.03 SHOP DRAWINGS

A. Drawings shall be presented in a clear and thorough manner.
   1. Details shall be identified by reference to sheet and detail, schedule or room numbers shown on Contract Drawings.

B. Providing shop drawings and other submittals in electronic **(color .pdf)** format is required.

1.04 PRODUCT DATA

A. Preparation:
   1. Clearly mark each submittal to identify pertinent products or models.
   2. Show performance characteristics and capacities.
   3. Show dimensions and clearances required.
   4. Show wiring or piping diagrams and controls.

B. Manufacturer's standard schematic drawings and diagrams:
   1. Modify drawings and diagrams to delete information that is not applicable to the work.
   2. Supplement standard information to provide information specifically applicable to the Work.

1.05 SAMPLES

A. Office samples shall be of sufficient size and quantity to clearly illustrate:
   1. Functional characteristics of the product, with integrally related parts and attachment devices.
   2. Full range of color, texture, and pattern.

1.06 CONTRACTOR RESPONSIBILITIES

A. Review Shop Drawings, Product Data, and Samples prior to submission.

B. Determine and verify:
   1. Field measurements,
   2. Field construction criteria,
   3. Catalog numbers and similar data, and
   4. Conformance with specifications.

C. Coordinate each submittal with requirements of the Work and of the Contract Documents.

D. Notify the Engineer in writing, at time of submission, of any deviations in the submittals from requirements of the Contract Documents.

E. Begin no fabrication or work which requires submittals until return of submittals with Engineer approval.

1.07 SUBMISSION REQUIREMENTS

A. Make submittals promptly in accordance with the approved schedule, and in such sequence as to cause no delay in the work, or in the work of any other contractor.

B. Number of submittals required:
   1. Shop Drawings: Submit electronic (color .pdf) submissions via the project portal established by the Purchaser.
   2. Samples: Submit the number stated in each specification section for products requiring sample submissions.

C. Submittals shall contain:
   1. The date of submission and the dates of any previous submissions.
   2. The project title and number.
   3. Contract identification.
   4. The names of:
      a. Contractor
      b. Supplier
      c. Manufacturer
   5. Identification of the project, with the specification section number.
   6. Field dimensions clearly identified as such.
   7. Relation to adjacent or critical features of Work or materials.
   8. Applicable standards, such as AWWA, ASTM, TDOT, local, or Federal Specification numbers.
   9. Identification of deviations from Contract Documents.
   10. Identification of revisions on resubmittals.
   11. An 8" x 3" blank space for Contractor and Engineer stamps.

12. Contractor's stamp, initialed or signed, certifying to review of submittal, verification of products, field measurements and field construction criteria, and coordination of the information within the submittal with requirements of the Work.

1.08 RESUBMISSION REQUIREMENTS

A. Make any corrections or changes in the submittals required by the Engineer and resubmit until approved.

B. Shop Drawings and Product Data:
   1. Revise initial drawings or data and resubmit as specified for the initial submittal.
   2. Indicate any changes which have been made other than those requested by the Engineer.

C. Samples: Submit new samples as required for initial submittal.

1.09 DISTRIBUTION

A. Distribute Shop Drawings and copies of Product Data which carry the Engineer stamp of approval to:
   1. Job site file
   2. Record documents file
   3. Other affected contractors
   4. Subcontractors
   5. Supplier or fabricator

B. Distribute samples which carry the Engineer stamp of approval as directed by Engineer.

1.10 ENGINEER DUTIES

A. Review submittals with reasonable promptness and in accordance with schedule.

B. Affix stamp and initials or signature, and indicate requirements for resubmittal, or approval of submittal.

C. Return submittals to Contractor for distribution, or for resubmission.

PART 2 - PRODUCTS

(NOT USED)

PART 3 - EXECUTION

(NOT USED)

END OF SECTION

SECTION 01410

TESTING LABORATORY SERVICES

PART 1 - GENERAL

1.01 LABORATORY SERVICES

A. Purchaser will employ and pay for services of an Independent Testing Laboratory, acceptable to the Engineer, to perform specified services. See respective specification sections for required services.

B. Inspection, Sampling, and Testing are required for:
   1. Concrete mixing and placing.
   2. Steel erection.
   3. Site grading and foundation excavation.
   4. Other areas as specified elsewhere.

1.02 QUALIFICATION OF LABORATORIES

A. Meet "Recommended Requirements for Independent Laboratory Qualifications", edition which is current when Agreement is signed by Purchaser and Contractor, published by American Council of Independent Laboratories.

B. Meet basic requirements of ASTM E329-77 "Standards for Recommended Practice for Inspection and Testing Agencies for Concrete, Steel, and Bituminous Materials as Used in Construction."

C. Be licensed to operate in the State of the project.

D. Have properly calibrated equipment, calibrated within the past twelve (12) months by devices of accuracy traceable to either:
   1. National Bureau of Standards.
   2. Accepted values of natural physical constants.

1.03 LABORATORY DUTIES

A. Cooperate with Purchaser, Engineer, and Contractor and provide qualified personnel promptly on notice.

B. Perform specified inspections, sampling and testing of materials, and methods of construction.

C. Comply with specified standards, ASTM, other recognized authorities, and as specified.

D. Ascertain compliance with requirements of Contract Documents.

E. Promptly notify Purchaser, Engineer, and Contractor of irregularities or deficiencies in Work which are observed during performance of duties.

F. Promptly submit reports (.pdf format) of inspections and tests to Purchaser and Engineer, and submit reports to Contractor at the project site, including:
   1. Date issued.
   2. Project title, number, and location.
   3. Testing laboratory name and address.
   4. Name and signature of inspector.
   5. Date of inspection and sampling.
   6. Date of test.
   7. Identification of product and specifications section.
   8. Type of inspection or test.
   9. Observations regarding compliance with Contract Documents.

1.04 LIMITATIONS OF AUTHORITY

A. Laboratory is not authorized to:
   1. Release, revoke, alter, or enlarge on requirements of Contract Documents.
   2. Approve or accept any portion of Work.
   3. Perform any duties of the Contractor.

1.05 CONTRACTOR'S RESPONSIBILITIES

A. Cooperate with Laboratory personnel and provide access to Work.

B. Provide to Laboratory, representative samples of materials to be tested, in required quantities.

C. Furnish copies of mill test reports.

D. Furnish casual labor and facilities:
   1. To provide access to Work to be tested.
   2. To obtain and handle samples at the site.
   3. To facilitate inspections and tests.
   4. For Laboratory's exclusive use for storage and curing of test samples.

E. Notify Laboratory sufficiently in advance of operations to allow for assignment of personnel and scheduling of tests.

F. Pay Laboratory travel and labor costs when Laboratory is notified that Work to be sampled will be in progress, and Laboratory personnel come to the site to perform their duties and that phase of the Work is not performed within a reasonable time.

G. Pay for additional tests when initial tests indicate Work does not comply with Contract Documents.

PART 2 - PRODUCTS

(NOT USED)

PART 3 - EXECUTION

(NOT USED)

END OF SECTION

SECTION 01710

CLEANING

PART 1 - GENERAL

1.01 REQUIREMENTS INCLUDED

A. Execute cleaning, during progress of the Work, and at completion of the Work, as required by General Conditions.

1.02 RELATED REQUIREMENTS

A. Conditions of the Contract

B. Each Specification Section: Cleaning for specific Products or Work.

1.03 DISPOSAL REQUIREMENTS

A. Conduct cleaning and disposal operations to comply with codes, ordinances, regulations, and anti-pollution laws.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Use only those cleaning materials which will not create hazards to health or property, and which will not damage surfaces.

B. Use only those cleaning materials and methods recommended by the manufacturer of the surface material to be cleaned.

C. Use cleaning materials only on surfaces recommended by cleaning material manufacturer.

PART 3 - EXECUTION

3.01 DURING CONSTRUCTION

A. Execute periodic cleaning to keep the Work, the site, and adjacent properties free from accumulations of waste materials, rubbish, and windblown debris, resulting from construction operations.

B. Provide on-site containers for the collection of waste materials, debris, and rubbish.

C. Remove waste materials, debris, and rubbish from the site periodically and dispose of at legal disposal areas away from the site.

3.02 DUST CONTROL

A. Clean interior spaces prior to the start of finish painting and continue cleaning on an as-needed basis until painting is finished.

B. Schedule operations so that dust and other contaminants resulting from the cleaning process will not fall on wet or newly-coated surfaces.

3.03 FINAL CLEANING

A. Employ skilled workmen for final cleaning.

B. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from sight-exposed interior and exterior surfaces.

C. Broom clean exterior paved surfaces; rake clean other surfaces of the grounds.

D. Prior to final completion, or Owner occupancy, Contractor shall conduct an inspection of sight-exposed surfaces, and all work areas, to verify that the entire Work is clean.

END OF SECTION

SECTION 02100

EROSION CONTROL

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 01050: Field Engineering

B. Section 02221: Trenching, Backfilling, and Compacting

C. Section 02921: Seeding

1.02 JOB CONDITIONS

A. Excavation, trenching, backfilling, and grading operations to elevations as needed to meet the requirements shown on the Contract Documents, shall be done in such a manner as to cause the least amount of soil erosion and siltation.

B. Appropriate management practices and control structures shall be in place prior to clearing of vegetation for necessary construction activities near streams, rivers, and lakes.

C. Provisions required to maintain uninterrupted surface water flow shall be maintained during the work. Storm water flow in existing gutters, surface drains, and swales shall not be interrupted.

D. The Engineer shall be notified of any unexpected subsurface or other unforeseen conditions. Work shall be discontinued until the Engineer provides notification to resume work.

1.03 PERMITS

A. All conditions set forth in the Corps of Engineers 404 Permit, Tennessee Valley Authority 26A Permit (if applicable), and the Tennessee Department of Environment and Conservation Notice of Coverage (and Storm Water Pollution Prevention Plan (SWPPP)) shall be strictly adhered to. The Owner shall obtain the appropriate permit.

B. If applicable, the Contractor and his/her subcontractors will be required to sign the SWPPP and the Notice of Intent (NOI), thus binding them to the conditions outlined in the SWPPP and the Notice of Cover (NOC). The contractor shall be responsible for all fines and penalties arising from failure to adhere to the SWPPP, NOC, or proper erosion control practices.

PART 2 - PRODUCTS

2.01 PROTECTIVE MATERIALS

A. Straw Bale Barriers

B. Silt Fence and Stakes

C. Sand Bags

D. Stone Rip Rap

E. Floating Boom

F. Burlap

G. Temporary Diversion Dike or Berm

H. Diversion

I. Temporary Sediment Trap

J. Temporary Sediment Basin

K. Check Dams

L. Riprap

M. Construction Road Stabilization

N. Stream Crossings

O. Permanent & Temporary Vegetation

P. Storm Drain Inlet Protection

Q. Culvert Inlet Protection

PART 3 - EXECUTION

3.01 PREPARATION

A. Erosion and sediment control shall be in accordance with the Tennessee Water Quality Control Act of 1977, as amended, and the Federal Act Pl 92-59.

B. The Tennessee Department of Conservation Publication, Tennessee Erosion & Sediment Control Handbook, latest revision, shall be used as a guide for construction of projects that require erosion and sediment controls to protect adjoining property and waters of the state.

3.02 PERFORMANCE

A. Whenever possible, a buffer strip of vegetation cover shall be kept adjacent to grading operations.

B. Control measures shall be in place and functional before earth moving operations begin and must be properly constructed and maintained during the construction period.

C. Staked and entrenched straw bales or silt fence shall be installed along the base of all sloped cuts and fills, on the downhill sides of stockpiled soil, and along stream banks.

D. All surface water flowing toward the construction area shall be diverted around the area as much as possible to reduce erosion potential by using beams, channels, and/or sediment traps as necessary.

E. Maintenance of erosion and sediment control methods shall be performed on a regular basis throughout the construction period and until a good vegetative cover is established over the entire disturbed area.

F. A vegetation buffer strip shall be maintained between any stream and pipe trenching. Excavated material from the trench shall not be placed between the trench and stream.

G. Trenches or pits shall be backfilled as soon as practicable to reduce erosion potential.

H. Erosion control measures shall be removed when they have served their useful purpose. The disturbed soil shall be fine graded, top soiled, and planted with permanent vegetation as soon as the construction sequence allows to prevent further potential erosion and sedimentation. Any seeded areas which are eroded shall be reworked as soon as possible.

3.03 INSPECTION

A. The erosion and sediment control measures shall protect adjacent properties, shall be in accordance with the Tennessee Erosion and Sediment Control Handbook and local ordinances, and shall be approved by the Engineer. All measures shall be sized and designed in accordance with the criteria specified in the handbook. All erosion control measures shall be placed prior to commencement of grading.

B. Temporary measures shall be applied throughout the construction of the project to control erosion and to minimize siltation of drainage ditches, storm drains, and waterways. The Contractor, as a minimum, shall employ all erosion control measures indicated on the drawings and specified herein.

C. Limit grading to areas of workable size to limit the duration of exposure of disturbed and unprotected area. All appropriate conservation practices should be applied in sequence of work. Disturbed areas that are to be left unfinished for more than 30 days shall be stabilized with seed and mulch, or any other necessary temporary or permanent measures.

D. Protect stockpiling material with mulch, temporary vegetation, or sediment barrier at base. Slopes of stockpiled material shall not exceed 2:1.

E. Stabilize all streets and parking areas, within fifteen (15) days of final grading, with base coarse-crushed stone.

F. Allow no water to enter the storm drainage system prior to settlement or screening of excess siltation.

G. No more than five hundred (500′) feet of trench shall be open at any one time.

H. Synthetic filter fabric fencing shall be used for sediment control when land disturbing activities are within twenty-five (25′) feet of a live creek or stream.

I. No excavated material shall be placed in streambeds.

J. On disturbed short, steep slopes, where erosion hazard is high, or in vegetated channels or ditches, contractor shall provide soil stabilization blankets and matting as directed by Owner or Engineer.

3.04 FAILURE TO EXECUTE

A. In the event the Contractor repeatedly fails to satisfactorily control erosion or siltation, the Owner reserves the right to employ outside assistance or to use his own forces to provide the erosion and sediment control indicated and specified. The cost of such work, plus related engineering costs, will be deducted from monies due to the Contractor for other work.

END OF SECTION

SECTION 02210

SITE GRADING AND FILLING

PART 1 - GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE:

A. Section 01050: Field Engineering

B. Section 01710: Cleaning

C. Section 02230: Site Clearing

D. Section 02100: Erosion Control

E. Section 02630: Site Prep & Restoration

F. Section 02631: Earthwork

G. Section 02950: Removal and Replacement of Pavements and Incidentals

H. Project Drawings

1.02 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies:

1. Comply with requirements of the authority having jurisdiction for work done on controlled property.
2. Obtain permits and notices, as required, for removal of walks and drives on controlled property.

B. Testing Laboratory and Geotechnical Engineer:

1. The Geotechnical Engineer's and Testing Laboratory's fee will be paid for by Owner except when the Geotechnical Engineer or Testing Laboratory personnel are notified by Contractor that work will be in progress, and they come to job site and work is not in progress. In that case, the Contractor shall pay for Geotechnical Engineer's or Testing Laboratory personnel's time and mileage. Contractor shall pay for retesting as specified below.
2. Have earth borrow fill tested and approved by design Testing Laboratory before moving it to the job site.
3. Soil compaction testing of in-place soil, and filled and compacted areas will be performed by Testing Laboratory in accordance with ASTM D698-78 Standard Proctor as specified below.

1.03 PROTECTION

A. Protect excavations and grounds from water ponding and water damage. Construct and maintain temporary drainage. Pump, if required, to keep excavations free of water. Maintain site in well drained condition at all times.

B. Protect, maintain, and restore benchmarks, monuments, and other reference points affected by this work. If benchmarks, monuments, or other permanent reference points are displaced or destroyed, points shall be re-established and markers reset under supervision of a licensed surveyor who shall furnish Engineer with certification of his work.

C. Protect Utilities and other construction designated to remain in place.

D. Protect trees to remain in place.

1.04 LINES AND GRADES

A. It is imperative that lines and grades established on drawings, except for allowance for installation of fill aggregate, concrete, and topsoil established below, be met when this work is completed.

1.05 SUBMITTALS TO ENGINEER

A. Submit one (1) copy of permits and notices obtained from authority having jurisdiction before commencing work.

B. Obtain and submit certification of adequacy of site grading and filling from Testing Laboratory, signed and sealed by a qualified Geotechnical Engineer, stating that work is in accordance with Contract Documents, and that soils are capable of supporting the structure to be constructed under the Contract.

C. If benchmarks and other permanent reference points are displaced, obtain and submit certification, signed and sealed by a licensed surveyor, of proper re-establishment of benchmarks and reference points.

PART 2 - PRODUCTS

2.01 GRANULAR FILL

A. Crushed or natural stone conforming to ASTM D448, Size 57, or well graded, dense mineral aggregate meeting Tennessee D.O.T. Specification 303 Class A, Grading D.

B. Granular fill shall have less than 10% passing the No. 200 sieve.

2.02 EARTH FILL

A. Earthen fill shall be free from organic material and debris and shall meet one of the following parameters:

1. Plasticity index between ten (10) and twenty-five (25), a liquid limit less than forty-five (45), and more than 60% passing the No. 200 sieve.

2. Plasticity index less than twenty-five (25), a liquid limit less than forty-five (45), and more than 10% passing the No. 200 sieve.

B. On-site earth removed during cutting operations may be used if it meets the above requirements and is approved by the Geotechnical Engineer.

C. Cobbles are not suitable for reuse as engineered fill. Frozen material should not be used. Fill shall not be placed on a frozen subgrade.

2.03 OFF-SITE BORROW

A. Off-site borrow may be utilized provided the Geotechnical Engineer approves its use.

PART 3 - EXECUTION

3.01 REMOVAL OF OBSTRUCTIONS

A. Clean out cellars, wells, cisterns, septic tanks and drain fields, cesspools, catch basins, manholes, and similar items to solid subgrade and break up masonry and/or concrete bottoms so that no pieces remain which are over twelve (12") inches in their largest dimension. Break out masonry and concrete sides of such construction to a depth of at least two (2') feet below bottoms of footings to be installed as part of this project or subgrade, as applicable.

B. Fill basements, cellars, walls, and other items enumerated above with specified granular fill and compact to 98 percent Standard Proctor Density.

3.02 DISPOSITION OF ABANDONED UTILITIES

A. If abandoned underground utility lines or electric or communication conduits are uncovered while grading, then that part uncovered shall be removed and capped off at points of removal and at property lines.

3.03 REMOVAL AND STORAGE OF TOPSOIL

A. Remove topsoil to its entire depth from areas within structure lines and for a distance of ten (10') feet beyond, under pavements, or other areas to be excavated, filled, or graded.

B. Mow grass, weeds and other annual-type growth, and brush close to ground.

C. Scrape or rake area to remove brush, roots, loose grass, weeds, and rocks before stripping topsoil.

D. Topsoil to be stored for reuse shall meet requirements established above.

E. Store topsoil in area designated by Engineer. Store to prevent erosion and mixture with debris and other materials.

3.04 SITE EXCAVATION AND PROOF-ROLLING

A. After this stripping is done, proof-roll these areas with a heavily-loaded rubber-tired tandem axle dump truck. Operate the truck at a normal walking speed so that the Geotechnical Engineer may observe the ground while walking beside the truck.

B. The Geotechnical Engineer will inspect the areas for soft spots and direct remediation efforts.

3.05 REMEDIAL WORK

A. During the course of proof-rolling and inspection, as the Geotechnical Engineer finds soft spots, he shall direct cutting out of soft spots and backfilling with specified, compacted earth fill or granular material.

3.06 GENERAL SITEWORK

A. Before depositing fill material, remove vegetation and other unsuitable materials. Do not place fill on a subgrade that contains frost, is muddy or frozen.

B. Fill and grade to attain elevations indicated +/- 0.1' less allowance for placement of aggregate, concrete, walks, drives and parking areas, and topsoil.

C. Outside of structures, in areas designated to receive topsoil, grade, or fill and compact specified earth, to bring areas to finished grade +/- 0.1' less six (6") inches for placing topsoil.

D. Where drives are indicated to join the building, allow for placement of aggregated base and asphalt.

3.07 GRADING

A. Grade to uniform levels and slopes, without abrupt changes. Make transitions from levels to slopes smooth and with large radius cuts.

B. Finish areas to a reasonably true and even plane at required elevations, less allowances for items specified above.

C. Along the lines indicating the limits of work, taper finish grade to the existing grade at a slope matching the natural contour. Perform all of this work within the limit lines.

3.08 FILLING

A. Where soft spots are taken out at the direction of the Geotechnical Engineer, backfill with specified fill approved by the Geotechnical Engineer. Deposit fill in loose lifts not to exceed six (6") inches and thoroughly compact each lift before placing succeeding lifts.

B. Within the structure lines and for a distance of ten (10') feet outside of structure lines, place specified earth fill in loose lifts not to exceed eight (6") inches and thoroughly compact each lift before placing succeeding lifts.

3.09 COMPACTION DENSITIES

A. For all compaction, except those areas where there will be no construction or pavement:
   1. If earth is used for filling, compact to a density of 98 percent at optimum moisture condition ASTM D698-78 Standard Proctor.
   2. If granular fill is a coarse sand or gravel, or of a uniform size, or has low fines content, granular materials should be compacted to at least 85% relative density (ASTM D 4253 and D 4254).
   3. If granular fill with high fines content is used, such as TDOT Mineral Aggregate Base Type A Grading D, compact to a density of 98 percent at optimum moisture condition ASTM D698-78 Standard Proctor.

B. For areas where no construction will be placed, compact to a density of 95 percent at optimum moisture condition ASTM D698-78 Standard Proctor.

3.10 COMPACTION TESTING

A. While filling and compacting operations are in progress, Geotechnical Engineer will make density tests at random depths and at random locations to determine adequacy of compaction. If compaction tests do not meet specified densities, take action to compact to require densities and pay for retesting to prove compaction densities.

3.11 PLACING OF TOPSOIL

A. Place topsoil in areas disturbed by construction and not covered by paving, buildings, and other hard-surfaced materials.

B. Scarify sub-grade to a depth of three (3") inches and spread topsoil uniformly to bring finished grade to elevations indicated after topsoil has been lightly compacted with roller. Topsoil shall be four (4") to six (6") inches thick.

C. Level and slope topsoil as indicated so that finished grades are +/- 0.1' elevations indicated.

3.12 CLEAN-UP

A. After all other work of this section is completed, leave area clean and free of any debris.

END OF SECTION

SECTION 02221

TRENCHING, BACKFILLING, AND COMPACTING FOR PRESSURE PIPE

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 01025: Measurement and Payment

B. Section 01050: Field Engineering

C. Section 02100: Erosion Control

E. Section 02921: Seeding

F. Section 15060: Pressure Pipes, Valves, and Appurtenances

1.02 JOB CONDITIONS

A. Provide for uninterrupted surface water flow during the work. Provide means whereby storm water can be uninterrupted in existing gutters and surface drains, or temporary drains.

B. All pipe shall be installed in a dry trench. No extra compensation shall be allowed for trench dewatering.

C. Immediately notify the Engineer of any unexpected subsurface or other unforeseen conditions. Discontinue work in area until Engineer provides notification to resume work.

D. Existing utilities, poles, service lines, fences, structures, trees, shrubs, or other improvements encountered during the construction, whether above or below ground, shall be protected by the Contractor. Any item damaged or removed by the Contractor shall be repaired or replaced at the Contractor's expense to at least its original condition and to the satisfaction of the Owner. It shall be the Contractor's responsibility to locate any existing utilities in the path of construction.

E. Adjacent structures which may be damaged by excavation work shall be underpinned or supported by other means.

F. Excavations shall be protected by shoring, bracing, sheet piling, underpinning, or other methods required to prevent cave in or loose dirt from falling into excavation.

1.03 PERMITS

A. Permits shall be obtained from authorities having jurisdiction prior to any explosives being brought to the site. The Contractor shall be responsible for providing such insurance that is required to hold the Owner harmless from any claims that may arise due to blasting operations at the site. The minimum insurance requirement will be that which is outlined in the General and Supplemental Conditions.

B. All conditions set forth in the Corps of Engineers 404 Permit and Tennessee Valley Authority 26A Permit (if applicable), and the SWPPP (if applicable), shall be strictly adhered to. The Owner shall obtain the appropriate permit.

1.04 QUALITY ASSURANCE

A. Adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for the proper performance of the work in this section shall be used.

B. Equipment adequate in size, capacity, and numbers to accomplish the work in a timely manner shall be used.

PART 2 - PRODUCTS

2.01 FORCE MAINS AND WATER LINES

A. BEDDING MATERIAL

1. Angular gravel, crushed gravel, or crushed limestone meeting the following gradation requirements set forth in ASTM 33 shall be used:

SIEVE SIZE	PERCENT PASSING
1"	100
3/4"	90 - 100
1/2"	20 - 55
3/8"	0 - 15
#4	0 - 5

2. Shall be used for bedding, haunching, and initial backfill of PVC and ductile iron pipe.
3. Frozen materials shall not be used.
4. In areas where rock excavation is required, undercut the trench six (6”) inches and place flowable fill prior to placing backfill material.

B. BACKFILL MATERIALS

1. Material excavated from the trench, free from large stones, clods, debris, or frozen lumps shall be used for final and backfill of PVC and ductile iron pipe.
2. For all pipe under paved areas or “heavy-duty stone,” backfill shall be

TDOT Mineral Aggregate Base, Type A, Grading D, compacted in 8” lifts to a density of 98% standard proctor.

PART 3 - EXECUTION

3.01 PREPARATION

A. Line and grade for trench shall be established.

B. Location of all underground utilities, existing and proposed shall be located.

C. Location of existing sewer laterals, manholes and service connections shall be located prior to commencement of trenching.

D. Location of existing water services, meters, and appurtenances shall be located prior to commencement of trenching.

3.02 PERFORMANCE

A. All earthwork and trenching operations shall comply with the requirements of OSHA Construction Standards for the construction industry (29 CFR part 1926).

B. Unless otherwise shown on the drawings or required by the specifications or authorized by the Engineer, all work shall be done in open, vertical trenches. Any sheeting driven below the level of the top of the pipe shall not be disturbed or removed. The responsibility for assessing the need for sheeting and analyzing the stresses induced shall be the total responsibility of the Contractor.

1. Trench sheeting left in place shall be backfilled to a level of twelve (12") inches above the top of the pipe. It shall then be cut off and the upper portion removed.
2. Sheeting for structures shall be left in place until backfill has been brought to a level of twelve (12") inches above the top of the bottom footing. It shall then be cut off and removed.

C. Clearing, including removal of surfacing and pavement, shall be done as necessary to carry on the construction in the proper manner. Material shall be removed only to minimum width necessary to allow adequate construction area. Concrete and asphalt shall be saw cut.

D. Trenches shall be excavated to such depth as required by the drawings. Trenches for force mains and water lines shall be excavated to such depth as required to provide a minimum of thirty (30") inches cover in all directions from the pipe wall, unless otherwise indicated. Maximum width of the trench at and below the top of the pipe shall not exceed the following widths.

PIPE SIZE	MAXIMUM WIDTH
4”	2’6”
6"	2' 6"
8"	2' 6"
10"	2' 6"
12"	2' 8"
15"	2' 10"
18"	3' 0"
21"	3' 3"
24"	3' 6"

E. If rock is encountered in the trench, it shall be excavated in a manner approved by the Owner and as specified below:

1. No separate payment for trench rock excavation will be made. Trench excavation shall be considered unclassified.
2. Trench shall be undercut one (1') foot where rock is in the trench and backfilled with crushed stone.
3. Drilling and blasting operations shall be conducted with due regard for the safety of persons and property in the vicinity and in strict conformity with requirements of all ordinances, laws, and regulations governing blasting and the use of explosives. Rock excavation near existing pipelines or other structures shall be conducted with the utmost of care to avoid damage.
4. All drilling, blasting, and use of explosives shall be in strict accordance with OSHA standards for the construction industry (29 CFR part 1926).

F. Excavated material suitable for backfilling shall be stockpiled no closer than two (2') feet from the edge of the trench and shall not obstruct crosswalks, sidewalks, or street intersections, and shall not cause unreasonable interference with travel on the streets by occupants of adjacent property. Gutters and other drainage facilities shall not be obstructed. Free access shall also be maintained to fire hydrants, mailboxes, sewer and water manholes, gas meters, or other municipal facilities.

3.03 BEDDING, HAUNCHING, AND BACKFILLING

A. Pipe shall be installed as shown on the drawings.

B. Bedding shall be shaped and compacted to 60 percent relative density, ASTM D2049, to provide uniform bearing of the pipe. Bell holes shall be excavated to allow for unobstructed assembly of the joint. Bell holes shall be made as small as practical. After the joint has been made, bell holes shall be filled with bedding material.

C. After pipe is jointed and aligned, haunching material shall be installed and compacted to 60 percent relative density, ASTM D2049. Ensure material is worked under the haunch of the pipe to provide adequate side support. Precautions shall be taken to prevent movement of the pipe during placement and compaction of haunching material.

D. Initial backfill shall be hand placed and compacted to provide cover over the pipe as detailed. Pipe shall be protected from large particles of backfill material.

E. Balance of backfill shall be placed by a method which will not damage or displace the pipe, nor cause bridging action in the trench. Backfill material shall be compacted with earthmoving equipment as material is placed so that excessive settlement of the trench material will not occur. Material shall be neatly mounded over the trench. Trench and settled areas shall be maintained as they occur. Finish grade shall be completed to eliminate uneven areas.

F. Where pavement or "heavy-duty stone" is to be placed over the backfilled trench as indicated on the drawings, bedding shall be #57 stone up to one foot above the top of the pipe (see typical detail) and the backfill shall be TDOT mineral aggregate base, Type A, Grading D, compacted in 8" lifts to a density of 98% standard proctor.

3.04 CREEK AND DITCH CROSSINGS

A. Construct pipe encasement as shown on typical details. Concrete shall be placed in the dry. Concrete: ASTM C94, 2500 psi, at twenty-eight (28) days.

B. Construction methods that will minimize siltation and erosion shall be utilized.

C. All backfill shall be granular material as specified for embedment material or crusher run stone.

D. Clean up, grading, seeding, and other restoration work shall begin immediately, and exposed areas shall not remain unprotected for more than seven (7) days.

3.05 TESTING OF BACKFILL

A. A testing laboratory or the Owner's Representative shall verify compaction of the bedding and haunching material after placement and compaction.

END OF SECTION

SECTION 02540

SEWER FLOW CONTROL AND BYPASS PUMPING

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Sewer flow control required to perform sewer line replacement, television inspection, sewer line testing, and sewer line sealing. Flow control is required for all sewer line replacements and when sewer line flow is greater than one-third of the pipe diameter when inspecting pipe.

1.02 RELATED DOCUMENTS

A. Section 01570: Traffic Regulations

B. Section 01710: Cleaning

C. Section 15060: Pipe, Valves, and Appurtenances

1.03 SUBMITTALS

A. A Flow Control Plan shall be submitted a minimum of five(5) business days prior to controlling flow. The Plan shall include, at a minimum:

1. Estimate of peak flow.
2. Detailed procedure for handling peak estimated flow.
3. Schedule.
4. Listing and informational drawings of proposed equipment including plugs, bypass pump(s), hoses, pipes, including sizes, capacities, power requirements, and material types.
5. Detailed plan showing pumps, suction and discharge piping, valves, traffic control, and other required items.
6. Plan for notifying sewer customers.
7. Operation plan.
8. Emergency procedures.

B. Owner's Representative and Engineer will review the plan and either approve or comment on its contents. Contractor shall address comments and satisfy Owner and Engineer that the plan is sound and, that it will adequately address both low flows and peak flows within the portion of the collection system being affected by the work.

1.04 JOB CONDITIONS

A. Notify the Engineer immediately if unusual or unexpected conditions are encountered. Discontinue Work until Engineer provides notification to resume Work.

B. All Work in streets and roadways shall be conducted in strict accordance with provisions of Section 01551.

C. Contractor shall plan the Work and arrange the Work schedules to minimize the length of the time sewer service is interrupted.

1.05 QUALITY ASSURANCE

A. Adequate numbers of skilled workman who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specific requirements and the methods needed for proper performance of the Work in this section shall be provided and used to complete the work. Equipment adequate in size, capacity, and numbers to accomplish the Work in a timely manner shall be provided and used to complete the Work.

B. Contractor shall provide an adequate on-the-job supervisor of all Work and workmen to assure the Work meets all requirements of the Contract.

PART 2 - PRODUCTS

2.01 FLOW CONTROL SYSTEMS

A. Provide adequate capacity and sized equipment to handle estimated flows. Equipment shall be capable of handling a minimum of 150 percent of the estimated peak flow.

B. Plugs shall include connections for pressure gauges and air hoses and shall include flow through capability. For pipe sizes less than twenty-four (24") inches, plugs shall be mechanical type with rubber gaskets or, shall be pneumatic type with rubber boots. For pipe sizes twenty-four (24") inches or greater, plugs shall be two-piece inflatable bag stoppers.

C. Discharge piping shall be HDPE or DIP and shall be leak free, with butt-fused (HDPE) or rubber gasketed (DIP) joints. Discharge piping may be reused on subsequent placements if approved by the Owner.

D. Flexible discharge piping may be used for low pressure flow control and low flow conditions, as determined by the Contractor. Flexible discharge hoses may not be used for controlling flow from existing sewer pipe sizes in excess of ten (10") inches.

E. Bypass pumps shall be fully automatic self-priming units. Pumps shall be designed to handle a minimum of three (3") inch diameter solid and shall be capable of running dry for long periods of time without pump/ motor failure. Engines shall be low noise type (max ninety (90) decibels at fifty (50') feet). Provide one stand-by pump of each type utilized for the work.

PART 3 – EXECUTION

3.01 GENERAL

A. Secure approval of "Traffic Control Plan" prior to working in roadways.

B. Install barriers, signs and other devices to identify and protect the work site and all adjacent areas.

C. Notify all properties that will or potentially have sewer service disruptions due to the planned work activities.

D. Notify Owner a minimum of forty-eight (48) hours prior to implementing system.

E. Operate and maintain the system seven (7) days per week and twenty-four (24) hours per day, no exceptions.

F. Eliminate all flow from sewer line sections where point repairs, service connections, manhole construction, pipe replacement or rehabilitation are to occur.

G. Remove flow control equipment and accessories after work is completed and pipe section is placed back into service, with approval of the Owner.

3.02 PLUGGING AND BLOCKING

A. A sewer line plug shall be inserted into the lines upstream of the line section being worked. Secondary plugs are required where pipe diameters exceed ten (10") inches.

B. Plugs shall be so designed that all or any portion of the sewage can be released. During TV inspection, testing and sealing operations, flow shall be reduced to within the limits specified above.

C. After the Work has been completed, flow shall be restored to normal in controlled, gradual manner such that downstream surcharging is prevented.

D. Temporary plugs shall be removed at the end of each day **if** the downstream pipe sections are capable of handling the restored flow and removal is approved by the Owner's Representative.

3.03 PUMPING AND BYPASSING

A. When pumping and bypassing is required the Contractor shall supply the pumps, conduits, and other equipment to divert the flow of sewage around the line section in which Work is to be performed.

B. Bypass pumping shall be performed in a manner that will not damage public or private property or create a nuisance.

C. Provide a minimum of 72 hours notice to customers whose sanitary sewer service will potentially be interrupted.

D. Dumping or spilling sewage on private or public property in any form or fashion is strictly prohibited. Contractor shall be responsible for cleanup, site restoration, and any and all fines associated with the spill.

E. Contractor is responsible for all power requirements for bypass pumps and standby units.

F. Service for disconnected sewer service connections shall be maintained in a manner approved by the Owner.

3.04 FLOW CONTROL PRECAUTIONS

A. When flow in a sewer line is plugged, blocked, or bypassed; sufficient precautions

must be taken to protect the sewer lines from damage that might result from sewer surcharging.

B. Contractor is solely responsible for any damage to public or private property and any claims resulting from the damage, which are a result of a failure of the flow control system.

C. Precautions must also be taken to ensure that sewer flow control operations do not cause flooding or damage to public or private property being served by the sewers involved.

3.05 QUALITY CONTROL AND MAINTENANCE OF SYSTEMS

A. General:
   1. Contractor shall perform pressure and leakage tests of the system using clean water prior to bypass operations. Tests shall be performed at a minimum of 1.5 times the maximum working pressure of the system.
   2. Pressure and leakage tests shall be witnessed by the Owner.

B. Inspection and Maintenance:
   1. Contractor shall inspect bypass system a minimum of every two (2) hours to insure that it is operating correctly.
   2. Contractor shall insure that the system is properly maintained and, that an operator is on hand at all times when pumping operations are occurring. Contractor may submit a monitoring/ alarm/ communication system in lieu of 24-hour monitoring. Owner and Engineer will review the submittal and notify Contractor of their decision relative to the proposed system.

C. Cleaning:
   1. Prior to tearing down and moving the system to a different location, all sewage within the system must be flushed to an existing operable sanitary sewer main.
   2. Areas disturbed by the operation must be cleaned and restored, including pavements, to a condition as good as or better than prior to the operation taking place.

3.06 ADDITIONAL RESPONSIBILITIES OF THE CONTRACTOR

1. In the event of any Contractor-related overflow or interruption/backup of customer service, the Contractor shall immediately notify the Engineer and Owner's Representative. The Contractor shall contain and eliminate the overflow/interruption.

2. The Contractor shall be responsible for any fines levied by others, reimbursement of any agency incurred costs, damage, cleanup, restoration of flow and any disruption of service costs to customers as a result of the Contractor's work. This in addition to any and all costs incurred by the customer.

3. The Contractor shall respect the rights of property owners, and not enter upon private property without obtaining written permission from the owner of the

property.

4. For manholes located in easements of private property, the Contractor shall provide the residents with 24-hour advanced notice for easement access prior to entering the property, unless the resident provides immediate permission.

3.07 CLEAN-UP

A. Clean-up and final completion of Work.

1. Upon acceptance of the Work, the Contractor shall reinstate the Project areas affected by the operations.
2. Removal and replacement of fences, damage repair to yards, lawns, sidewalks, driveways, roads, other utilities, etc. due to movement of by-pass pumping equipment, excavating or other equipment and/or erection of equipment and/or any other activities associated with the Work shall be the sole responsibility and the sole cost of the Contractor unless specifically designated for payment under the Contract Unit Price Schedule.

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 SCOPE

A. This section includes all materials, labor, equipment, and services required for the installation of all plain and reinforced cast-in-place concrete (including formwork, reinforcement, reinforcement supports, embedded items detailed on the concrete drawings, joint fillers, joint sealers, and waterstops), and all related activities in accordance with the drawings, construction specifications, General Conditions, and other contract documents.

1.02 PUBLICATIONS REFERENCED HEREIN

A. American Concrete Institute (ACI) as listed:
   1. ACI 116R - Cement and Concrete Terminology.
   2. ACI 301 - Specifications for Structural Concrete for Buildings.
   3. ACI 305R - Hot Weather Concreting.
   4. ACI 306R - Cold Weather Concreting.
   5. ACI 315 - Details and Detailing of Concrete Reinforcement.
   6. ACI 350R - Environmental Engineering Concrete Structures.

B. American Society for Test and Materials (ASTM) standards:
   1. CRD-C 48 - Method of Test for Water Permeability of Concrete.
   2. Concrete Reinforcing Steel Institute, Manual of Standard Practice.
   3. Federal Specifications, TT-S-00227E (COM-NBS)-70, Sealing Compound, Elastomeric Type, Multi-Component.
   4. American Association of State Highway and Transportation Officials (AASHTO), Standard Specifications - Part II, T 260 Sampling and Testing for Total Chloride Ion in Concrete and Concrete Raw Materials.
   5. American Welding Society, Structural Welding Code - Reinforcing Steel (AWSD 1.4).

1.03 DEFINITIONS

A. Embedded Items: All bolts, inserts, sleeves, conduit, fixtures, and other material placed so as to become anchored in cast-in-place concrete, as indicated and specified elsewhere in the contract documents.

B. Testing Laboratory: An independent engineering testing laboratory engaged by the Owner (or as otherwise specified in the contract documents) to perform testing services required in this section not otherwise assigned.

C. Concrete Design Mix: A concrete design mix in the quantities of specific ingredients which, when mixed, will yield one (1) cubic yard of concrete of a given strength, slump, and air content. Any variation in admixtures, cement or water content, or of any other ingredient, shall constitute a different design mix.

D. Hydraulic Structures: Cast-in-place structures which have as their primary purpose the containment, conveyance or processing of liquids without other materials to provide water

tightness and are designed in accordance with ACI 350.

E. Definitions of other terms used in this specification, not defined where used or elsewhere in the contract documents, shall be as given in ACI 116R.

1.04 SUBMITTALS

A. General: All submittals required by this specification shall be to the persons or parties identified in the contract documents.

B. Concrete Design Mix Reports: Design mix reports for each proposed concrete design mix shall be submitted. These submittals shall include the results of all tests performed to qualify the materials (including determination of chloride ion concentration) and to establish each design mix. No concrete shall be placed until the design mix for that concrete is accepted and approved by the Engineer.

C. Concrete Permeability: Certified test results, showing that the water permeability of concrete proposed for use in any hydraulic structure designed to contain liquids satisfies the requirements of Paragraph 3.16, shall be submitted prior to the placement of any such concrete.

D. Mill Test Reports: Certified test reports, showing compliance with the required standards, shall be submitted for any or all materials proposed for use on the project, as required by the Engineer. When so required, such test reports shall certify that the material tested is of the same quality as that proposed for use on this project.

E. Reinforcing Steel Shop Drawings: Reinforcing steel shop drawings shall be submitted for review prior to fabrication. They shall conform to the requirements of ACI 315 and shall include placement plans, bar details, and bills of materials. Fabrication shall not be started until the submitted shop drawings have been reviewed and marked "Released for Production" by the Engineer.

F. Formwork Shoring: The Contractor shall specify the type of forms that are to be used for the job and provide detailed drawings of formwork to ensure compliance with ACI 301, Section 2. No concrete pours will be made prior to approval of the proposed formwork and rebar placement.

G. Production Concrete Testing

1. The Contractor and the Testing Laboratory shall report the results of all tests and inspections immediately after they are performed. Reports on strength tests shall include, in addition to the information required by ASTM C 39, the following:
    a. Project name and project number.
    b. Air temperature and temperature of concrete at time of sampling.
    c. Slump of sample.
    d. Air content of sample, percent.
    e. Location where the concrete represented by the sample was deposited.
    f. Name of person who molded the test cylinders.
    g. Description of storage and curing conditions prior to testing.
    h. Batching information (amount of concrete, time loaded or mixed, concrete design mix designation, type and brand of cement and any admixtures, total mixing water, maximum aggregate size, weights of ingredients, and

amount of added water).

PART 2 - PRODUCTS

2.01 QUALITY OF MATERIALS

A. When selecting materials, the contractor shall confirm the availability of certified test reports showing compliance with all required standards. See Submittals, Paragraph D.1.

2.02 CEMENT

A. All cement shall be Portland Cement conforming to ASTM C 150, Type I or Type II (normal or moderately sulfate resistant, respectively), and shall all be of one brand produced at a single cement manufacturing plant.

2.03 ADMIXTURES

A. All admixtures shall be compatible with all other concrete mix ingredients and reinforcing steel, and with the intended use of the concrete. No admixtures shall be used without the consent of the Owner's representative.

B. Admixtures to be used in concrete, when permitted, shall conform to the following specifications:
   1. Air entraining admixtures, ASTM C 260.
   2. Water-reducing, retarding, and accelerating admixtures, ASTM C 494.
   3. Pozzolanic admixtures (including fly ash), ASTM C 618, including the supplementary optional physical requirements.

2.04 WATER

A. Mixing water shall meet the requirements of ASTM C 94 (subject to chloride limitations in Paragraph 2.06).

2.05 AGGREGATES

A. Aggregates shall conform to the requirements of Section 4.2 of ACI 301.

2.06 CHLORIDE ION CONCENTRATION

A. Unless otherwise specified, the maximum water soluble chloride ion concentration in hardened concrete at ages twenty-eight (28) to forty-two (42) days contributed from the ingredients of the concrete including water, aggregates, cement, and admixtures shall not exceed 0.10% by weight of the cement. The water soluble chloride ion concentration in each proposed concrete design mix shall be determined by testing in accordance with AASHTO T260.

2.07 STORAGE OF MATERIALS

A. The storage of cement, aggregates, and admixture materials shall conform with Section 4.1 of ACI 301. Reinforcing shall be stored clear of the ground and protected from formation of rust and other damage.

2.08 FORMWORK

A. All formwork shall conform to the requirements of Section 2 of ACI 301.

2.09 REINFORCEMENT

A. Reinforcement material shall conform to the requirements of Section 3 of ACI 301 (all reinforcing bars shall be Grade 60 unless noted otherwise on the drawings). No coated bars shall be accepted unless otherwise noted or approved in writing by the Engineer.

2.10 WIRE BAR SUPPORTS

A. Wire bar supports shall be plastic coated when in contact with forms for concrete that is to be left exposed. Such bar supports shall be in accordance with Class 1, maximum protection, in Chapter 3 of Manual of Standard Practice by the Concrete Reinforcing Steel Institute. All other wire bar supports shall conform to Class 2, moderate protection (or to Class 1).

2.11 PRE-MOLDED EXPANSION JOINT FILLER

A. Pre-molded expansion joint filler material shall conform to ASTM D 1752, Type I or II, or to ASTM D 1751.

NOTE: If ASTM D 1751 joint filler material is used, backer material compatible with the joint sealer shall be used between the joint sealer and the joint filler material. Such backer material must provide a complete permanent separation of the joint filler and the joint sealer.

2.12 JOINT SEALER

A. Joint sealer shall be a self-leveling two (2) component polysulfide material conforming to Federal Specification TT-S-00227E, Type 1, Class A.

2.13 WATERSTOPS

A. Waterstops shall be "Waterstop RX" as manufactured by American Colloid Company or approved equal.

B. Products proposed as an equal to those specified shall be submitted to the Engineer for review. Submittals shall include sample, specifications, and list of various installations of similar applications.

2.14 CURING MATERIALS

A. Waterproof sheet material (such as polyethylene film) shall conform to ASTM C 171.

B. Membrane curing compound material shall conform to ASTM C 309, Type I-D with fugitive dye. Materials containing wax, silicones, or other ingredients detrimental to subsequent floor finishes, are not acceptable.

C. Other suitable materials, which when saturated over a period of time will not stain the concrete or otherwise be detrimental to the work may be used if approved by the Owner's representative.

2.15 GROUT

A. All grout shall be one (1) of the following non-shrink grouts and shall be in accordance with ASTM C827, ASTM C191 and ASTM C109: Crystex (L & M Construction Chemicals), Five Star (US Grout Corporation), or Masterflow 713 (Master Builders). The installation

and curing of all grout shall be in accordance with the manufacturer's recommendations. All grout shall be submitted to the Engineer for approval prior to placement.

PART 3 - EXECUTION

3.01 GENERAL

A. All concrete shall be of the specified quality and capable of being placed without excessive segregation. When hardened, concrete shall develop all characteristics required by these specifications and the contract documents.

3.02 STRENGTH

A. The specified compressive strength of the concrete, f'c, shall be 4000 psi unless otherwise specified. Strength requirements shall be based on a twenty-eight (28) day compressive strength unless a different test age is specified.

3.03 WEIGHT

A. Unless otherwise specified, the concrete shall be regular weight. When lightweight concrete is specified, the concrete proportions shall be selected to meet the specified limit on maximum air-dry unit weight as measured in accordance with ASTM C 567.

3.04 DURABILITY

A. Air-entrainment and air content measurement for all concrete shall conform with ACI 301 (Section 4.2.2.4) requirements for concrete subject to potentially destructive exposure as follows:

Aggregate Size	Percent Air Content by Volume
#7 (1/2" max.)	5 to 9
#67 (3/4" max.)	4 to 8
#57 (1" max.)	3.5 to 6.5

B. Measurement of air content shall conform to ASTM C 138, C 173, or C 231. Unless otherwise specified, ASTM C231 shall be used.

3.05 WATER-CEMENT RATIO

A. Unless otherwise specified, all concrete for structures designated as hydraulic structures and or designed to contain liquids (such as chests), shall have a water-cementing material (cement plus any accepted pozzolans) ratio not to exceed 0.45 by weight. All other concrete shall have a water-cementing material ratio not to exceed 0.50 by weight.

3.06 MINIMUM CEMENT

A. Unless otherwise specified, the minimum cementing material (cement plus accepted pozzolans) content per cubic yard for all concrete shall be as follows (from ACI 301, Table 4.2.2.1):

Nominal Maximum Aggregate Size	Minimum Cement*
1" (#57 stone)	520 pounds/cubic yard (5.5 Bags/cu.yd.)
3/4" (#67 stone)	540 pounds/cubic yard (5.7 Bags/cu.yd.)

1/2" (#7 stone)	590 pounds/cubic yard (6.3 Bags/cu.yd.)

*Maximum 20% pozzolan by weight.

3.07 MINIMUM CEMENT FOR HYDRAULIC STRUCTURES

A. Unless noted otherwise, the minimum cementing material (cement plus any accepted pozzolans) content per cubic yard for hydraulic structures shall be as follows (from ACI 350, Section 3.5.1, and ACI 301, Table 4.2.2.1):

Nominal Maximum Aggregate Size	Minimum Cement*
1" (#57 stone)	536 pounds/cubic yard (5.7 Bags/cu.yd.)
3/4" (#67 stone)	564 pounds/cubic yard (6.0 Bags/cu.yd.)
1/2" (#7 stone)	590 pounds/cubic yard (6.3 Bags/cu.yd.)

*Maximum 20% pozzolan by weight (fly ash).

3.08 SLUMP

A. Unless otherwise specified, all concrete, except floor slabs with specified f'c of 4000 psi or greater, shall be proportioned and produced to have a slump of four (4") inches or less. Concrete for floor slabs with specified f'c of 4000 psi or greater shall be proportioned and produced to have a slump of three (3") inches or less.

B. A tolerance of up to one (1") inch above the maximum is allowed for one (1) batch in any five (5) consecutive batches tested. Concrete of lower than usual slump may be used only if it is properly placed and consolidated. The slump shall be determined in accordance with ASTM C 143.

3.09 MAXIMUM SIZES OF COARSE AGGREGATE

A. Unless noted otherwise, the maximum nominal size of the coarse aggregate shall not be more than that of #57 stone (one (1") inch), 1/5 of the narrowest width of beams or walls, 1/3 of the depth of slabs, nor 3/4 of the minimum clear spacing between reinforcing bars. Additionally, the maximum nominal size of the coarse aggregate shall not be less than that of #7 stone (1/2").

3.10 ADMIXTURES

A. Admixtures used shall conform to the requirements in Paragraph 2.03 and shall be subject to the following limitations.

B. Admixtures containing calcium chloride shall not be used.

C. All admixtures shall be used in accordance with the manufacturer's instructions.

3.11 SELECTION OF PROPORTIONS

A. Each concrete design mix (see Definitions, Paragraph C.1.) shall be proportioned in accordance with ACI 301 (Section 4 on the basis of previous field experience or laboratory trial mixtures).

3.12 PROPORTIONING ON THE BASIS OF PREVIOUS FIELD EXPERIENCE OR TRIAL MIXTURES

A. Determination of the standard deviation shall be in accordance with ACI 301 (Section 4).

B. The determination of the required average compressive strength shall be in accordance with ACI 301 (Section 4).

C. The documentation of the average strength shall be in accordance with ACI 301 (Section 4). See Submittals, Paragraph A.1.

3.13 PROPORTIONING BASED ON EMPIRICAL DATA

A. Unless otherwise specified, concrete shall not be proportioned based on empirical data.

3.14 REDUCTION OF THE REQUIRED AVERAGE STRENGTH

A. After sufficient data becomes available during construction, the amount by which the average strength must exceed the specified minimum strength f'c may be reduced, subject to approval by the Owner's representative, in accordance with ACI 301 (Section 4.2).

3.15 LIGHTWEIGHT CONCRETE

A. The ability of the selected proportions to meet the specified limits for air-dry weight shall be verified by tests made in accordance with ASTM C 567. The air-dry unit weight shall be correlated with the fresh unit weight of the same concrete to permit use of the latter as the basis for acceptance during construction.

3.16 HYDRAULIC STRUCTURE WATER PERMEABILITY

A. The permeability of trial batch concrete proposed for use in any watertight structure indicated on the drawings shall not exceed ten (10) by ten (10) to the minus of twelve (12) when tested in accordance with CRD-C 48 (Method of Test for Water Permeability of Concrete).

PART 4 - PERFORMANCE OF WORK

4.01 FORMWORK

A. The design and installation of all formwork shall be in accordance with ACI 301 (Section 2) except as otherwise specified (see Paragraph 4.13 for requirements for removal of forms).

B. Chamfer strips, 3/4" x 45 degrees in size, shall be used at all edges of formed concrete to be left exposed, unless otherwise specified.

C. Tolerances: Unless otherwise specified, formwork shall be constructed so that the concrete surfaces will conform to the tolerances given to ACI 301 (Section 2.3).

D. The preparation of form surfaces shall be in accordance with ACI 301 (Section 2.2) except as otherwise specified.

E. The portion of the forms in contact with concrete surfaces to receive joint sealer shall be free of any substance which will remain on these surfaces and cause the adhesion between the surfaces and the sealer to be weakened.

F. Form tie assemblies for hydraulic structures shall be of such type as to leave no metal or other material within 1 1/2" of the surface. The assembly shall provide a cone-shaped depression at the surface of the concrete at least one (1") inch in diameter and 1 1/2" deep to allow filling and patching.

G. When a portion of single rod ties are to remain in a liquid retaining structure, the portion

that is to remain shall be provided with a tightly fitted washer at midpoint.

4.02 REINFORCEMENT

A. Reinforcing shall not be welded unless otherwise specified. When welding of reinforcement is specified all such welding shall conform to AWS D 1.4.

B. If welding is specified for zinc-coated or epoxy-coated reinforcement, zinc coatings shall be repaired afterwards with a zinc-rich formulation conforming to ASTM A 767 and epoxy coatings shall be repaired with a patching material conforming to ASTM A 775. Such repairs shall conform to the material manufacturer's recommendations. All welds, and all steel splice members used to splice reinforcing bars, shall be coated with the material used for repair of coating damage.

C. The fabrication of reinforcing steel shall conform to the requirements of ACI 301 (all reinforcement shall be cold bent unless otherwise specified).

NOTE: Fabrication shall not be started until the reinforcing steel shop drawings have been reviewed and marked "Released for Production," by the Engineer. See Submittals, Paragraph E.1.

D. Tolerances for the fabrication of reinforcing steel shall conform to Figures 4 and 5 of ACI 315.

E. Tolerances for the placing of reinforcing steel shall conform to the requirements of ACI 301 (Section 3.3).

F. The placing of reinforcing steel shall conform to the requirements of ACI 301 (Section 3.3), except as otherwise specified.

G. Positioning of wire mesh shall be done in a manner that will allow lifting it off of the subgrade at least as indicated, but not closer to the surface of the concrete than one (1") inch or closer than 1 1/2" to the ground.

H. Bond structural steel and reinforcing steel in foundation footing to grounding electrode conductor. Bond steel together.

4.03 CONSTRUCTION AND CONTROL JOINTS

A. Joints allowed, but not indicated on the contract documents, shall be located and constructed to minimize the impact on the strength of the structure. All locations shall be approved by the Owner's representative. In general, joints, when necessary, shall be located as near as possible to the middle of the spans of slabs, beams, and girders. Joints, when necessary in columns and walls, shall be at the underside of beams, and girders, and at the top of footings. Beams, girders, brackets, column capitals, haunches, and deep panels shall be placed at the same time as slabs.

B. In floor slabs on grade, unless otherwise indicated on the drawings, provide construction or control joints continuously on maximum spacing of fifteen (15') feet, unless otherwise specified, in a grid pattern which coincides with column centerlines whenever feasible, and as approved by the Owner's representative.

C. Unless otherwise specified, control joints shall be completed while the concrete is still in the plastic state.

4.04 EXPANSION AND ISOLATION JOINTS

A. Reinforcement or other embedded metal items bonded to the concrete (except dowels in slabs on grade, bonded on only one (1) side of the joint) shall not be permitted to extend continuously through any expansion joint.

B. Provide 1/2" wide expansion joints continuously at edges of slabs on grade abutting walls, columns, foundations, and other construction, unless otherwise indicated. Joint filler material shall extend full depth of joint except for space at top required for joint sealer, and shall be securely positioned.

C. Exposed corners with rough edges shall be smoothed with an abrasive tool prior to sealer installation. Immediately prior to sealer installation, concrete surfaces to receive the sealer shall be clean and dry.

4.05 WATERSTOPS

A. The design and location of waterstops shall be as shown on the drawings. See Paragraph 2.13 for waterstop material (unless specified otherwise).

B. Each piece of pre-molded waterstop shall be of the maximum practical length in order to reduce the number of required splices.

C. Waterstop material shall be butted at all joints to form a continuous barrier. Joints shall develop water tightness equal to that of continuous waterstop material.

4.06 OTHER EMBEDDED ITEMS

A. All trades whose work is related to the concrete or must be supported by it shall be given ample notice and opportunity to set and/or furnish embedded items before the concrete is placed.

B. Embedded Items

1. All embedded items in any section or area in concrete which is scheduled to be placed, including anchor bolts (free of oil and other foreign matter), shall be set true within 1/8" of position shown on the drawings or as otherwise indicated, securely installed, and shall be thoroughly checked by the Contractor before concreting for that section or area is started. Voids in these items shall be filled temporarily with readily removable material to prevent the entry of concrete into these voids.

4.07 PRODUCTION OF CONCRETE

A. The production of all concrete shall conform to the requirements of ACI 301 (Section 4).

B. The control of admixtures shall conform to the requirements of ACI 301 (Section 4.3).

4.08 TEMPERING AND CONTROL OF MIXING WATER

A. Concrete shall be mixed only in quantities for immediate use. Concrete which has started to harden shall be discarded and shall not be re-tempered.

B. When concrete arrives at the job site with slump below that suitable for placing, as indicated by the specifications, water may be added only as follows:

1. If approved by the concrete manufacturer and the Owner's representative, water may be added, but only once at the rate of one (1) gallon per cubic yard, and only if neither the design mix water-cement ratio nor the maximum slump for the concrete mix is exceeded. If allowed, an addition of water above that permitted by the water-cement ratio limitation shall be accompanied by addition of a quantity of cement sufficient to maintain the proper water-cement ratio.
2. The additional water shall be incorporated into the mixture by mixing for a minimum of an additional thirty (30) drum revolutions in accordance with ASTM C 94. Immediately after such additional mixing, representative samples shall be taken for separate strength tests.

4.09 EXTREME WEATHER CONDITIONS

A. During Hot Weather

1. Whenever the job temperature is over, or likely to be over, 80° F, all mixing, placement, and finishing procedures shall be directed to keeping the concrete at a temperature not in excess of 85° F maintained reasonably uniform, and to maintain uniform moist conditions. Refer to ACI 305R Hot Weather Concreting.

B. During Cold Weather

1. When daily temperatures are generally below 40° F, the temperature of the concrete at the time of placing shall be above 50° F, but not higher than 85° F. Provisions shall be made for maintaining the placed concrete at a temperature above 50° F for a period of at least six (6) days. Refer to ACI 306R Cold Weather Concreting.

4.10 PREPARATION BEFORE PLACING CONCRETE

A. General

1. Immediately prior to concreting, the place of deposit and all mixing, transporting, conveying, and placing equipment shall be available for inspection. The Contractor shall give the Owner's representative twenty-four (24) hours notice before placing concrete. Access shall be provided by the Contractor to top and bottom of forms prior to inspection.

B. The inner surfaces of conveying equipment shall be free of hardened concrete and foreign materials.

C. Preparation of previously cast construction joint surfaces shall be completed. All laitance, soft mortar, dirt, form oil, or other foreign materials shall be removed. Except as otherwise specified, the preparation shall be as follows:

1. The previously cast concrete shall be moistened thoroughly (damp but completely free of standing water or free moisture).
2. The surfaces of all vertical construction joints cast against bulkheads shall be roughened to uniformly expose the aggregate, and then washed with clean water to remove all dust and loose particles.
3. The surfaces of all horizontal construction joints in work designed to contain liquids (such as chests) shall be dampened (but not saturated) and then thoroughly covered with a two (2") inch thick (minimum) coat of cement grout of similar

proportions to the mortar in the concrete. The fresh concrete shall be placed before the grout has attained its initial set.

4. Surfaces specified to receive an adhesive (see Paragraph 2.16) shall be prepared and the adhesive applied in accordance with the manufacturer's recommendations.

D. Formwork shall be completed; snow, ice, and water shall be removed; reinforcement shall be secured in place; expansion joint material, anchor bolts, and other embedded items shall be properly positioned.

E. Reinforcement shall be free of dirt, loose scale, oil, ice, kinks, or bends not shown on the details, and free of rust which could be removed by moderate hand wiping.

F. Preventing Cave-Ins

1. Adequate means of preventing cave-ins of earth during placement of concrete shall be provided. All work shall conform to OSHA Standards.

G. Preventing Absorption of Water

1. Earth, against which concrete is placed, shall be sufficiently damp to prevent absorption of water from the concrete, without allowing water to stand.

H. Grade under slabs shall conform to line and grade of slab bottom indicated.

I. Concrete shall not be placed on frozen ground.

J. The readiness of each place to receive concrete shall be approved by the Owner's representative before concreting is begun.

4.11 CONVEYING AND DEPOSITING CONCRETE

A. General

1. Conveying and depositing of concrete shall be in accordance with ACI 301 (Section 5) and the following additional requirements:

B. Concrete shall be conveyed and deposited in such a manner as to prevent separation of ingredients and to minimize re-handling and flowing. In depositing concrete, the following requirements shall be observed:

1. At free-fall heights of six (6') feet or less, concrete may be deposited without the use of a dropchute, if apparent separation of ingredients does not occur.
2. For free-fall heights greater than six (6') feet, a dropchute shall be used.
3. For hydraulic structures, the free-fall height shall not exceed four (4') feet.

C. When concrete is placed against earth, care shall be taken to prevent mixing of earth and concrete during placing and consolidation.

D. Concrete shall be properly consolidated at or near the place of deposit. Vibrators shall not be used to move the concrete to other parts of the form. Adequate reserve vibration equipment shall be on hand to ensure continuous consolidation of all freshly placed concrete.

E. All concrete surfaces to receive grout, or an additional concrete pour, shall be roughened with a rake or coarse broom before the fresh concrete obtains final set.

F. Unless otherwise specified, concrete shall not be deposited under water. If so specified,

procedures for placing such concrete shall ensure that concrete enters the mass of previously placed concrete from within, causing water to be displaced with minimum disturbance at the surface of the concrete. Placing procedures and the concrete mix design shall be approved by the Engineer.

4.12 CURING AND PROTECTION

A. Beginning immediately after placement, concrete shall be cured and protected in accordance with ACI 301 (Section 5) and as follows:

1. Concrete surfaces to receive joint sealer shall be kept free of any substance which might cause the adhesion between these surfaces and the joint sealer to be weakened.
2. After the concrete has been placed, anchor bolts shall be protected from corrosion by daubing the threads with grease, wrapping with burlap, and then covering bolts with wooden boxes or plastic protectors.
3. Extra attention to water curing shall be given to concrete slabs exposed to the sun's rays throughout the curing period, especially on any day when the surface temperature reaches 80° F. Each surface shall be kept wet.
4. Curing of floor hardened surfaces shall be in accordance with the recommendations of the manufacturer of the floor hardener.
5. Housing, covering, or other protection used to maintain elevated temperature shall remain in place for at least twenty-four (24) hours after artificial heating is discontinued.

NOTE: ACI 301 requires that the curing of all concrete be continued for at least seven (7) days, except for high-early-strength concrete for which the minimum period is three (3) days. Alternately, ACI 301 permits terminating proper moisture retention measures when properly field-cured cylinders reach 70% of f'c, or when laboratory-cured cylinders reach 85% of f'c.

4.13 REMOVAL OF FORMS AND RESHORING

A. The removal of forms and reshoring shall conform to ACI 301 (Section 2) and the following additional requirements.

B. Unless otherwise specified, forms and shoring supporting the weight of elevated slabs, beams, columns, and load bearing walls shall remain in place until the concrete attains at least seventy-five (75%) percent of the specified compressive strength, f'c, but not less than 3000 psi.

C. Unless otherwise specified, forms and shoring supporting the weight of all other concrete shall remain in place until the concrete attains at least fifty (50%) percent of the specified compressive strength, f'c, but not less than 2000 psi.

D. Unless otherwise specified, construction loads plus dead load on elevated slabs, beams, columns, and walls shall not exceed fifty (50%) percent of the design live load and dead load until the specified compressive strength is attained, unless shoring, designed to carry the total load is in place.

E. For the purpose of determining when form removal is allowed, the concrete will be

presumed to have reached the specified strength when either of the following conditions have been met:

1. When test cylinders, field cured along with the concrete they represent, have reached the strength specified for form removal. The cylinders shall be molded and tested in accordance with Paragraph 4.22 (Testing).
2. When the concrete has been cured in accordance with Paragraph 4.12 (Curing and Protection), for the same length of time as the age at test of laboratory-cured cylinders which reach the strength specified for form removal. The length of time the concrete in the structure has cured shall be taken to be the cumulative time that the concrete has been dampened or thoroughly sealed against moisture loss and the temperature has been maintained above 50° F.

F. Forms to be reused shall be cleaned immediately after removal.

G. **No form shall be removed prior to 48 hours after completion of a concrete pour**.

4.14 REPAIR OF SURFACE DEFECTS

A. Surface defects, including tie holes shall be repaired immediately after form removal in accordance with ACI 301 (Section 5), except as otherwise specified.

B. Unless otherwise specified, all tie holes shall be plugged.

4.15 FINISHING OF FORMED SURFACES

A. In cases of exposed concrete, all formed surfaces shall be rubbed locally to remove loosened surface particles, to reduce misalignments of forms to not over 1/16", and to provide a uniform surface texture, immediately after removal of forms and subsequent removal of any concrete fins and after completion of any patching,.

B. In liquid retaining structures, concrete shall be rubbed to one (1') foot below the minimum liquid level (as specified by the Engineer).

C. In cases of unexposed concrete, no further work is required after the patching is completed.

4.16 FINISHING OF UNFORMED (TOP) SURFACES

A. All unformed surfaces shown on the plans as level or sloping planes shall be finished to a Class B finishing tolerance (1/4" in ten (10') feet as determined by a ten (10') foot straightedge placed anywhere on the slab in any direction), unless otherwise indicated (see definition of each Class of Finishing Tolerances in ACI 301, Section 5).

B. Any depressed surface shall be struck off to elevations noted on plans.

C. Unless otherwise indicated, one (1) of the following finishes shall be provided, depending upon the use to which the surface will be subjected:

1. Float Finish - Provide an even, level, dense surface by mechanical and/or hand floating to establish finished grades.
2. Soft-Textured Broom Finish - The surface shall be thoroughly hand or mechanically floated as required for Float Finish. Following any trowelling required to meet the specified finishing tolerance, the surface shall be lightly brushed with a soft bristled broom to produce a uniform, slightly textured surface,

with grooves at right angles to the direction of greater traffic.

3. Rough-Textured Broom Finish - The surface shall be thoroughly hand or mechanically floated as required for Float Finish. Following any trowelling required to meet specified finishing tolerance, the surface shall be lightly brushed with a coarse bristled broom to produce a uniform roughly textured surface, with grooves at right angles to the direction of greater traffic.
4. Trowel Finish - After thorough hand or mechanical floating, when no additional mortar or moisture can be drawn to the surface, and when the concrete is sufficiently hardened to bear a man's weight without imprint, the surface shall be steel trowelled smooth. Final trowelling by hand shall produce a ringing sound when the trowel is drawn across the surface. This requires a Class A finishing tolerance (1/8" in ten (10') feet as determined by a ten (10') foot straightedge placed anywhere on the slab in any direction).

4.17 METALLIC FLOOR HARDENER APPLICATION

A. When application of a metallic floor hardener is specified on the drawings, the hardener material shall be applied to a float finished surface at the rate recommended by the manufacturer for the particular type of service to which the floor will be subjected, in accordance with procedure demonstrated in the preparation of a Floor Slab Test Panel. The finish shall match the texture and density of the Floor Slab Test Panel finish selected by the Owner's representative as the model for this work.

4.18 ARCHITECTURAL CONCRETE

A. All concrete designated as architectural concrete on the drawings or elsewhere in the contract documents shall conform to the requirements of ACI 301 (Section 6) for architectural concrete.

4.19 MASSIVE CONCRETE

A. All concrete with a least dimension greater than six (6') feet, or when designated on the drawings, shall be treated as mass concrete and the requirements of ACI 301 (Section 8) for massive concrete shall be satisfied.

4.20 PRECAST - PRESTRESSED CONCRETE

A. Precast - Prestressed concrete shall be in accordance with Section 03413, Precast - Prestressed Concrete, of the construction specifications.

4.21 JOB-CAST, POST-TENSIONED, PRESTRESSED CONCRETE

A. Job-cast, post-tensioned, prestressed concrete shall conform to the special provisions of Section 9 of ACI 301 in addition to all other applicable portions of the Cast-In-Place Concrete section of the specification.

4.22 TESTING

A. Concrete testing procedures, except as otherwise provided, shall be as follows:
   1. Determining Air Content - ASTM C 173 (Test for Air Content of Freshly Mixes Concrete by the Volummetric Method), or other suitable method approved by the Owner's representative.

2. Determining Slump - ASTM C 143 (Test for Slump of Portland Cement Concrete).
3. Making, curing, and Shipment of Test Specimens - ASTM C 31 (Making and Curing Concrete Compressive and Flexural Test Specimens in the Field), with special attention to consolidation, prevention of water evaporation, temperature control and handling.
4. Compression Testing of Strength Test Specimens - ASTM C 39 (Test for Compressive Strength of Cylindrical Concrete Specimens).

B. Unused Concrete
1. Concrete in samples removed from concrete trucks for testing purposes shall be wasted on the site as directed by the Owner's representative.

4.23 EVALUATION AND ACCEPTANCE OF CONCRETE STRENGTH AND STRUCTURE

A. General
1. The evaluation of test results, acceptance of concrete, core tests (if required), and acceptance of structure shall be in accordance with ACI 301 (Section 1.6 and 1.7), and the contract documents.

B. Embedded Items
1. Embedded anchor bolts shall be installed per Section 4.06 of this specification and the Contract Documents. Anchor bolts shall be secured in place at the time of inspection with markings to identify grade and size per ASTM.

END OF SECTION

SECTION 140002
FIBERGLASS GRAVITY JACKING PIPE (FRPM)

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fiberglass Reinforced Polymer Mortar (FRPM) Pipe

1.02 REFERENCES

A. ASTM D3262 – Standard Specification for "Fiberglass" (Glass-Fiber Reinforced Thermosetting-Resin) Sewer Pipe

B. ASTM D4161 – Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals

C. ASTM D2412 – Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading

D. ASTM D3681 – Standard Test Method for Chemical Resistance of "Fiberglass" Pipe in a Deflected Condition

E. ASTM D695 – Standard Test Method for Compressive Properties of Rigid Plastics

PART 2 PRODUCTS

2.01 MATERIALS

A. Resin Systems: The manufacturer shall only use polyester resin systems with a proven history of performance in this particular application. The historical data shall have been acquired from a composite material of similar construction and composition as the proposed product.

B. Glass Reinforcements: The reinforcing glass fibers used to manufacture the components shall be of highest quality commercial grade E-CR glass (corrosion resistant and boron free E-glass) filaments with binder and sizing compatible with impregnating resins. No other glass type is allowed.

C. Silica Sand: Sand shall be minimum 98% silica with a maximum moisture content of 0.2%.

D. Additives: Resin additives, such as curing agents, pigments, dyes, fillers, thixotropic agents, etc., when used, shall not detrimentally affect the performance of the product.

E. Elastomeric Gaskets: Gaskets shall meet ASTM F477 and be supplied by qualified gasket manufacturers and be suitable for the service intended.

2.02 MANUFACTURE AND CONSTRUCTION

A. Pipes: Manufacture pipe by the filament wound process to result in a dense, nonporous, corrosion-resistant, consistent composite structure. Pipes shall be Type 1, Liner 1, and Grade 1 per ASTM D3262.

1. Interior Surface: The interior surface shall be 40 mils thick and shall provide crack resistance and abrasion resistance. The interior liner shall be manufactured using resin and fiber reinforcements.

2. Exterior Surface: The exterior surface shall provide UV protection. The exterior surface shall be manufactured using resin and fiber reinforcements.

B. Joints: Unless otherwise specified, the pipe shall be field connected with fiberglass sleeve couplings or bell-spigot joints that utilize elastomeric sealing gaskets as the sole means to maintain joint water tightness. The joints must meet the performance requirements of ASTM D4161. The joint shall have approximately the same O.D. as the pipe, so when the pipes are assembled, the joints are essentially flush with the pipe outside surface. Joints at tie-ins, when needed, may utilize gasket-sealed closure couplings.

C. Fittings: Flanges, elbows, reducers, tees, wyes, laterals and other fittings shall be capable of withstanding all operating conditions when installed. They may be contact molded or manufactured from mitered sections of pipe joined by glass-fiber-reinforced overlays. Properly protected standard ductile iron, fusion-bonded epoxy-coated steel and stainless steel fittings may also be used.

D. Acceptable Product: Thompson Pipe Group or approved equal. Fiberglass pipe and fittings shall have at least 5 years of experience in the United States with more than 50,000 linear feet of the proposed product installed in the United States within the last 10 years in municipal applications Manufacturer shall have field services and technical support with at least 10 years of experience in municipal applications in the United States.

2.03 DIMENSIONS

A. Diameters: The actual outside diameter of the pipes shall be in accordance with ASTM D3262 Table 3. For unlisted diameters, OD's shall be per manufacturer's literature unless otherwise agreed to between manufacturer and owner.

B. Lengths: Pipe shall be supplied in nominal lengths of 6 to 24 feet. Actual laying length shall be nominal +1, -1 inches. At least 90% of the total footage of each size and class of pipe, excluding special order lengths, shall be furnished in nominal length sections.

C. Wall Thickness: The minimum wall thickness, measured at the bottom of the spigot gasket groove where the wall cross-section has been reduced, is determined from the maximum jacking load. Minimum factor of safety against jacking force is 2.5 based on straight alignment.

D. End Squareness: Pipe ends shall be square to the pipe axis with a maximum tolerance of 1/16" for diameters through 36", 1/8" for diameters through 102" and 3/16" for diameters larger than 102".

2.04 TESTING

A. Pipes: Pipes shall be manufactured and tested in accordance with ASTM D3262.

B. Joints: Joints shall meet the requirements of ASTM D4161.

C. Stiffness: Minimum pipe stiffness when tested in accordance with ASTM D2412 shall normally be 140 psi.

D. Strain Corrosion: Pipe shall meet or exceed the requirements of Table 4 in ASTM D3262 when tested in accordance with ASTM D3681.

2.05 CUSTOMER INSPECTION

A. The Owner or other designated representative shall be entitled to inspect pipes or witness the pipe manufacturing.

B. Manufacturer's Notification to Customer: Should the Owner request to see specific pipes during any phase of the manufacturing process, the manufacturer must provide the Owner with adequate advance notice of when and where the production of those pipes will take place.

2.06 PACKAGING, HANDLING, AND SHIPPING

A. Packaging, handling, and shipping shall be done in accordance with the manufacturer's instructions.

PART 3 EXECUTION

3.01 INSTALLATION

A. Installation: The installation of pipe and fittings shall be in accordance with the project plans and specifications and the manufacturer's requirements.

B. Pipe Handling: Use textile slings, other suitable materials or a forklift. Use of chains or cables is not recommended.

C. Jointing:

1. Clean ends of pipe and joint components.

2. Apply joint lubricant to the bell interior surface and the elastomeric seals. Use only lubricants approved by the pipe manufacturer.

3. Use suitable equipment and end protection to push the pipes together.

4. Do not exceed forces recommended by the manufacturer for joining or pushing pipe. Jacking direction should be bell-trailing.

D. Field Tests:

1. Infiltration / Exfiltration Test: Maximum allowable leakage shall be per local specification requirements.

2. Low Pressure Air Test: Each reach may be tested with air pressure (max 5 psi). The system passes the test if the pressure drop due to leakage through the pipe or pipe joints is less than or equal to the specified amount over the prescribed time period.

3. Individual Joint Testing: For pipes large enough to enter, individual joints may be pressure tested with a portable tester to 5 psi max. with air or water in lieu of line infiltration, exfiltration or air testing.

4. Deflection: Maximum allowable long-term deflection is typically 3% of the internal diameter.