CERTIFICATIONS

The following licensed professionals are responsible for the various portions of the project manual by which their seal is affixed:

- 01560 Erosion and Sedimentation Control
- 01610 Basic Product Requirements
- 02230 Site Clearing
- 02370 Rip-rap
- 02371 Anchored Reinforced Vegetation System
- 02382 Articulating Concrete Block (ACB) Revetment System
- 02530 Sewer Pipe Installation
- 02531 Installation and Replacement of Manholes
- 02532 Sanitary Sewer Manhole Adjustments
- 02541 Memphis PACP/CCTV
- 02544 Manhole GPS and MACP Inspection
- 02630 Site Prep & Restoration
- 02631 Earthwork
- 02632 Storm Drain Pipe Installation
- 02920 Seeding
- 02950 Removal and Replacement of Pavements and Incidentals
- 03050 Portland Cement Concrete
- 03310 Concrete Structures
- **Special Instructions**



Trevor Cropp, PE

SECTION 01560 EROSION AND SEDIMENTATION CONTROL

PART 1 GENERAL

1.01 SCOPE

- A. The work specified in this Section consists of providing and maintaining temporary and permanent erosion and sedimentation controls as shown on the Drawings. This Section also specifies the subsequent removal of temporary erosion and sedimentation controls.
- B. Temporary and permanent erosion and sedimentation controls include grassing and mulching of disturbed areas and structural barriers at those locations which will ensure that erosion during construction will be maintained within acceptable limits. Acceptable limits are as established by the Tennessee Water Quality Control Act of 1977, as amended, Section 402 of the Federal Clean Water Act, and applicable codes, ordinances, rules, regulations and laws of local and municipal authorities having jurisdiction. For installation and maintenance guidance, refer to the Tennessee Erosion and Sediment Control Handbook, latest edition.
- C. Land disturbance activity shall not commence until any required local Land Disturbance Permit and all required water quality permits have been issued.
- D. Any required local Land disturbance permit shall be obtained and paid for by the Contractor.

1.02 SUBMITTALS

- A. Submit product data in accordance with the requirements of Section 01610 of these Specifications.
- B. Prior to any construction activity, the Contractor shall submit, for the Engineer's approval, a schedule for the accomplishment of temporary and permanent erosion and sedimentation control work. No work shall be started until the erosion and sedimentation control schedule and methods of operation have been approved by the Engineer.

1.03 QUALITY ASSURANCE

- A. The temporary and permanent erosion and sedimentation control measures shown on the Drawings are minimum requirements. Any additional erosion and sedimentation control measures required by the Contractor's means, methods, techniques and sequence of operation will be installed by the Contractor at no additional cost to the Owner.
- B. Perform all work under this Section in accordance with all pertinent rules and regulations including, but not necessarily limited to, those stated in these Specifications. Where provisions of pertinent rules and regulations conflict with these Specifications, the more stringent provisions shall govern.
- C. Provide all materials and promptly take all actions necessary to achieve effective erosion and sedimentation control in accordance with the Tennessee Water Quality Control Act of 1977, as amended, local ordinances, other permits, local enforcing agency guidelines and these Specifications.

- D. Basic Principles
 - 1. Coordinate the land disturbance activities to fit the topography, soil types and conditions.
 - 2. Minimize the disturbed area and the duration of exposure to erosive elements.
 - 3. Provide temporary or permanent stabilization to disturbed areas immediately after rough grading is complete.
 - 4. Safely convey run-off from the site to a stable outlet to prevent flooding and damage to downstream facilities resulting from increased runoff from the site.
 - 5. Retain sediment on-site that was generated on-site.
 - 6. Minimize encroachment upon watercourses.
- E. Implementation
 - 1. The Contractor is solely responsible for the control of erosion within the Project site and the prevention of sedimentation from leaving the Project site or entering waterways.
 - 2. The Contractor shall install temporary and permanent erosion and sedimentation controls which will ensure that runoff from the disturbed area of the Project site shall pass through a filter system before exiting the Project site.
 - 3. The Contractor shall provide temporary and permanent erosion and sedimentation control measures to prevent silt and sediment from entering the waterways. The Contractor will obtain a Land Disturbance Permit that allows encroachments on the 60-foot vegetative buffer in specific areas. The Contractor shall exercise extreme care during land disturbance operations within the 60-foot vegetative buffer to prevent degradation of the stream.
 - 4. The Contractor shall limit land disturbance activity to those areas shown on the Drawings.
 - 5. The Contractor shall maintain erosion and sedimentation control measures within disturbed areas on the entire site at no additional cost to the Owner until the acceptance of the Project. Maintenance shall include mulching, re-seeding, clean-out of sediment barriers and sediment ponds, replacement of washed-out or undermined rip rap and erosion control materials, to the satisfaction of the Engineer.
 - 6. All fines imposed for improper erosion and sedimentation control shall be paid by the Contractor.
 - 7. The Contractor shall use all means necessary to control dust on and near the work and all off-site borrow areas, in accordance to the Tennessee Erosion and Sediment Control Handbook, latest edition. The Contractor should thoroughly moisten all surfaces as required to prevent dust from being a nuisance to the public, neighbors and concurrent performance of work on the site.

PART 2 PRODUCTS

2.01 SEDIMENT BARRIERS

- A. Silt Fence
 - 1. Type C silt fence is a combination of Type A silt fence fabric with woven wire reinforcement. Type C silt fence woven wire reinforcement shall meet the requirements of Tennessee Erosion and Sediment Control Handbook, latest edition. Posts shall be 4 feet in length and shall be made of steel. Steel posts shall be 1.3lb./ft. minimum.
 - 2. Silt fence fabric shall meet the requirements of the Tennessee Erosion and Sediment Control Handbook, latest edition.

2.02 STORM DRAIN INLET PROTECTION

- A. Silt Fence Inlet Protection: Type C Silt fence supported by steel posts shall be used. See Silt Fence this Part.
- B. Sediment Tube Inlet Protection: 9.5-inch diameter tube weighing 14 lbs/foot (min.)

2.03 TEMPORARY STREAM CROSSING

A. Temporary Stream Crossing shall be constructed in accordance with the plan and details shown in the Drawings and per recommendations presented in Tennessee Erosion and Sediment Control Handbook, latest edition.

2.04 CONSTRUCTION EXIT

- A. Stone: Use sound, tough, durable stone resistant to the action of air and water. Slabby or shaley pieces will not be acceptable. Aggregate size shall be TDOT #1 or #2 stone (1.5 to 3.5-inch stone).
- B. Geotextile: The geotextile underliner must be placed the full length and width of the entrance. Geotextile selection shall be based on AASHTO M288-98 specification:
 - 1. For subgrades with a CBR greater than or equal to 3 or shear strength greater than 90 kPa, geotextile must meet requirements of section AASHTO M288 Section 7.3, Separation Requirements.
 - 2. For subgrades with a CBR between 1 and 3 or sheer strength between 30 and 90 kPa, geotextile must meet requirements of AASHTO M288 Section 7.4, Stabilization Requirements.

2.05 CLEAN WATER DIVERSION

- A. Clean Water Diversion
 - 1. Bypass pumping or temporary pipes will be required by the Aquatic Resource Alteration Permit in order to perform in-stream work separate from flowing water.
 - 2. Contractor shall submit stream bypass plan including pump sizing and location for review

and approval by the owner.

- 3. Disturbance within the confines of stream banks are required to be conducted "in the dry" or separate from flowing water. No excavation equipment should ever be operated in flowing waters.
- 4. To limit land-disturbance, overland pumping of the stream should be considered in lowflow conditions whenever possible. Temporary pipes can also convey smaller stream flows.
- 5. The duration of the instream work should be minimized to the shortest period possible. Clearing of the streambed and banks should be kept to a minimum.
- 6. The impervious dikes used to divert normal stream flow or expected flow path around a construction site must be constructed of non-erodible material. Acceptable materials for impervious dikes include, but are not limited to, sheet piles, sandbags, and/or the placement of an acceptable size stone lined with polypropylene, or other impervious fabric. Earthen material should not be used to construct an impervious dike when it is in direct contact with the stream. Dewatering devices include stilling basins and sediment filter bags.

2.06 EROSION CONTROL MATTING AND BLANKETS

- A. All blanket and matting materials shall be in accordance to the Tennessee Erosion and Sediment Control Handbook, latest edition.
- B. Temporary Erosion Control Blankets: Use in concentrated flow areas, all slopes steeper than 3:1 and with a height of ten feet or greater, and cuts and fills within stream buffers, shall be stabilized with the appropriate erosion control matting or blankets.
 - 1. Straw blankets: Shall consist of weed-free straw from agricultural crops formed into a blanket. Blankets shall have a top side of photodegradable plastic mesh with a maximum mesh size of 5/16 x 5/16 inch sewn to the straw with biodegradable thread that is appropriate for slopes. The blanket shall have a minimum thickness of 3/8 inch and minimum dry weight of 0.5 pounds per square yard.
 - 2. Excelsior blankets: Shall consist of curled wood excelsior (80% of fibers are six inches or longer) formed into a blanket. The blanket shall have clear markings indicating the top side of the blanket and be smolder resistant. Blankets shall have photodegradable plastic mesh having a maximum mesh size of 1- 1/2½ x 3 inches. The blanket shall have a minimum thickness of 1/4 of an inch and a minimum dry weight of 0.8 pounds per square yard. Slopes require excelsior matting with the top side of the blanket covered in the plastic mesh, and for waterways, both sides of the blanket require plastic mesh.
 - 3. Coconut fiber blankets: Shall consist of 100% coconut fiber formed into a blanket. The minimum thickness of the blanket shall be 1/4 of an inch with a minimum dry weight of 0.5 pounds per square yard. Blankets shall have photodegradable plastic mesh, with a maximum mesh size of 5/8 x 5/8 inch and sewn to the fiber with a breakdown resistant synthetic yarn. Plastic mesh is required on both sides of the blanket if used in waterways. A maximum of two inches is allowable for the stitch pattern and row spacing.
 - 4. Wood fiber blankets: Shall consist of reprocessed wood fibers that does not possess or contain any growth or germination inhibiting factors. The blanket shall have a

photodegradable plastic mesh, with a maximum mesh size of $5/8 \times 3/4$ inch, securely bonded to the top of the mat. The blanket shall have a minimum dry weight of 0.35 pounds per square yard. A maximum of two inches is allowable for the stitch pattern and row spacing. This practice shall be applied only to slopes.

- 5. Jute Mesh: To be applied to slopes. Jute mesh with a 48 inch width shall show between 76 and 80 warpings and a one yard length shall show between 39 to 43 weftings. The woven mesh shall be at least 45 inches wide. Yarn shall have a unit weight of at least 0.9 pounds per square yard, but not more than 1.5 pounds per square yard.
- C. Permanent Matting shall comply with Section 02371 Reinforced Turf.

2.07 GRADIENT TREATMENT

- A. Contour Furrow: Contour furrows may be used for slopes which are 3:1 (H:V) or less.
- B. Serrated Slope: A serrated slope may be used for slopes which are 2:1 (H:V) or less.
- C. Stepped Slope: Graded areas steeper than 3:1 (H:V), which will not be mowed, should preferably have a stepped slope.
- D. Terraced Slope: Should be used on most slopes which are longer than those allowed for other methods.

2.08 TEMPORARY MULCHING

- A. Dry straw or hay: Shall be applied at a depth of 2 to 4 inches providing complete soil coverage. Material shall be clean, seed-free cereal hay or straw.
- B. Wood waste (chips, sawdust or bark): Shall be applied at a depth of 2 to 3 inches. Organic material from the clearing stage of development should remain on site, be chipped, and applied as mulch.
- C. Mulch Binder: Mulch on slopes exceeding 3 (horizontal) to 1 (vertical) shall be held in place by the use of a mulch binder, as approved by the Engineer. The mulch binder shall be non toxic to plant and animal life and shall be approved by the Engineer.

2.09 TEMPORARY GRASSING

- A. Grassing materials shall meet the requirements of the Tennessee Erosion and Sediment Control Handbook, latest edition, section that includes "Disturbed Area Stabilization (With Temporary Vegetation)".
- B. Seed rate, fertilization, lime application and other requirements shall be provided as shown on the Drawings.
- C. Water: Water shall be free of excess and harmful chemicals, organisms and substances which may be harmful to plant growth or obnoxious to traffic. Salt or brackish water shall not be used. Water shall be furnished by the Contractor.

2.10 PERMANENT GRASSING AND SODDING

A. As specified in Sections 02920.

2.11 SEDIMENT FILTER BAGS

A. Filter bag shall meet the following requirements:

Properties		Test Method	
Weight	10.0 oz/yd	ASTM D3776	
Tensile Strength	250 lbs.	ASTM D4632	
Tensile Elongation at Break	x 50%	ASTM D4632	
Puncture Strength	115 lbs.	ASTM D4833	
Trapezoidal Tear	100 lbs.	ASTM D4533	
Mullen Burst	350 lbs.	ASTM D3786	
Water, Flow Rate	80 gpm/ft^2	ASTM D4491	
Permittivity	1.2 sec. ⁻¹	ASTM D4491	
UV Resistance	70% str. Ret.	ASTM D4355	

Standard Bag Minimum Dimensions	Maximum Flow Rate	
15 x 10 ft.	Up to 1500 gpm	
15 x 15 ft.	Up to 2000 gpm	

- B. Aggregate: Shall be AASHTO size 57.
- C. Geotextile: Shall be Type III and conform to the TDOT Standard Specifications for Road and Bridge Construction requirements.

PART 3 EXECUTION

3.01 GENERAL

- A. Temporary and permanent erosion and sedimentation control measures shall prevent erosion and prevent sediment from exiting the site. If, in the opinion of the Engineer, the Contractor's temporary erosion and sedimentation control measures are inadequate, the Contractor shall provide additional maintenance for existing measures or additional devices to control erosion and sedimentation on the site at no additional cost to the Owner.
- B. All erosion and sedimentation control devices and structures shall be inspected by someone possessing a TDEC Level I certification at least twice a week and within 24 hours of the end of a storm that is 0.5 inches or greater. Any device or structure found to be damaged will be repaired or replaced by the end of the day.
- C. All erosion and sedimentation control measures and devices shall be constructed and maintained as indicated on the Drawings or specified herein until adequate permanent disturbed area stabilization has been provided and accepted by the Engineer. Once adequate permanent stabilization has been provided and accepted by the Engineer, all temporary erosion and sedimentation control structures and devices shall be removed.

3.02 INSTALLATION AND MAINTENANCE OF EROSION AND SEDIMENT CONTROLS

- A. Sediment Barriers
 - 1. Sediment barriers shall include but are not necessarily limited to silt fences and any device which prevents sediment from exiting the disturbed area.

- 2. Sediment barriers shall not be used in any flowing stream, creek or river.
- 3. Sediment barriers shall be installed as shown on the Drawings and as directed by the Engineer.
- 4. Along stream buffers and other sensitive areas, two rows of Type C silt fence or one row of Type C silt fence backed by hay bales shall be used.
- 5. Sediment barriers shall be maintained to ensure the depth of impounded sediment is no more than one-half of the original height of the barrier or as directed by the Engineer. Torn, damaged, destroyed or washed-out barriers shall be repaired, reinforced or replaced with new material and installed as shown on the Drawings and as directed by the Engineer.
- 6. Sediment Barrier Removal
 - a. Sediment barrier shall be removed once the disturbed area has been stabilized with a permanent vegetative cover and the sediment barrier is no longer required as directed by the Engineer.
 - b. Accumulated sediment shall be removed from the barrier and spread over the site.
 - c. All non-biodegradable parts of the barrier shall be disposed of properly.
 - d. The disturbed area created by barrier removal shall be permanently stabilized.
- B. Storm Drain Inlet Protection
 - 1. Inlet Sediment Traps shall include, but are not necessarily limited to, Silt Fence Inlet Protection and Sediment Tube and any device which traps sediment and prevents it from exiting the disturbed area.
 - 2. Inlet Sediment Traps shall be installed as shown on the Drawings and as directed by the Engineer.
 - 3. For each Inlet Sediment Traps type the following installation guidelines shall be used:
 - a. Silt Fence Inlet Protection: Type C silt fence supported by steel posts shall be used. The stakes shall be spaced evenly around the perimeter of the inlet a maximum of 3 feet apart, and securely driven into the ground, approximately 18 inches deep. The fabric shall be entrenched 12 inches and backfilled with crushed stone or compacted soil. Fabric and wire shall be securely fastened to the posts, and fabric ends must be overlapped a minimum of 18 inches or wrapped together around a post to provide a continuous fabric barrier around the inlet.
 - b. Sediment Tub: Sediment Tube will be placed by hand or mechanically using construction equipment around existing inlets. Use stakes to secure the sediment tubes in concentrated flow locations or on slopes greater than 25%.
 - 4. The trap shall be inspected daily and after each rain and repairs made as needed. Sediment shall be removed when the sediment has accumulated to one-half the height of the trap. Sediment shall be removed from curb inlet protection immediately. For

excavated inlet sediment traps, sediment shall be removed when one-half of the sediment storage capacity has been lost to sediment accumulation. Sod inlet protection shall be maintained as specified for Permanent Sodding.

- 5. Sediment Barrier Removal
 - a. Sediment barrier shall be removed once the disturbed area has been stabilized with a permanent vegetative cover and the sediment barrier is no longer required as directed by the Engineer.
 - b. Accumulated sediment shall be removed from the barrier and removed from the site.
 - c. All non-biodegradable parts of the barrier shall be disposed of properly.
 - d. The disturbed area created by barrier removal shall be permanently stabilized.
- C. Temporary Stream Crossing
 - 1. Clearing of the stream bed and banks shall be kept to a minimum.
 - 2. All surface water from the construction site shall be diverted onto undisturbed areas adjoining the stream. Line unstable stream banks with rip rap or otherwise appropriately stabilize them.
 - 3. The invert elevation of the culvert shall be installed on the natural streambed grade.
 - 4. The culvert(s) shall extend a minimum of one foot beyond the upstream and downstream toe of the aggregate placed around the culvert. In no case shall the culvert exceed 40 feet in length.
 - 5. The culvert(s) shall be covered with a minimum of one foot of aggregate. If multiple culverts are used, they shall be separated by a minimum of 12 inches of compacted aggregate fill.
 - 6. The structure shall be inspected after every rainfall and at least twice a week, whether it has rained or not, and all damages repaired immediately. The structure shall be removed immediately after construction is finished, and the streambed and banks must be stabilized.
 - 7. Upon removal of the structure, the stream shall immediately be restored to its original cross-section and properly stabilized.
- D. Construction Exit
 - 1. Construction exit(s) shall be placed as shown on the Drawings and as directed by the Engineer. A construction exit shall be located at any point traffic will be leaving a disturbed area to a public right-of-way, street, alley, sidewalk or parking area.
 - 2. Placement of Construction Exit Material: The ground surface upon which the construction exit material is to be placed shall be prepared to a smooth condition free from obstructions, depressions or debris. The geotextile underliner shall be placed to provide a minimum number of overlaps and a minimum width of one foot of overlap at

each joint. The stone shall be placed with its top elevation conforming to the surrounding roadway elevations. The stone shall be dropped no more than three feet during construction.

- 3. Construction Exit Maintenance: The Contractor shall regularly maintain the exit with the top dressing of stone to prevent tracking or flow of soil onto public rights-of-way and paved surfaces as directed by the Engineer. This shall require periodic top dressing with 1.5-3.5 inch stone, as conditions demand.
- 4. Construction Exit Removal: Construction exit(s) shall be removed and properly disposed of when the disturbed area has been properly stabilized, the tracking or flow of soil onto public rights-of-way or paved surfaces has ceased and as directed by the Engineer.
- E. Clean Water Diversion
 - 1. A bypass pump and an impervious dike divert the flow of the watercourse from the inlet of the pipe to the outlet of the pipe. Care should be taken that the discharge is at a low flow rate to minimize turbidity and/or potential erosion of the stream channel at the outlet of the bypass pipe or hose. Do not use this practice when the discharge location cannot be adequately stabilized; when ponding of the stream to adequately submerge the pump suction line is not allowed or not practical; or when the normal flow of the stream cannot be handled by the typical bypass pump.
 - 2. Place outlet of temporary pipe to minimize erosion at discharge site or provide temporary energy dissipation measures. Firmly anchor pump and piping.
 - 3. Construct outlet protection if needed.
 - 4. Construct impervious dike upstream of work area to impound water for bypass pump intake. Use a floating intake for pumps where possible.
 - 5. Construct an impervious dike downstream, if necessary, to isolate work area.
 - 6. Check operation of pump and piping system.
 - 7. Inspect bypass pump and temporary piping daily to ensure proper operation. Inspect impervious dike for leaks and repair any damage. Inspect discharge point for potential erosion. Ensure flow is adequately diverted through pipe.
 - 8. Upon completion of construction, remove impervious dike, bypass pump, and temporary pipe and stabilize disturbed area.
- F. Gradient Treatment
 - 1. Contour Furrow: The maximum distance between furrows should be 40 feet, and the maximum slope length should be 200 feet. Refer to the Tennessee Erosion and Sediment Control Handbook, latest edition for detailed example of a contour furrow.
 - 2. Serrated Slope: Bladed equipment will be needed to make numerous passes along a slope, beginning at the top and working downward. The maximum slope length should be 100 feet. Refer to the Tennessee Erosion and Sediment Control Handbook, latest edition for detailed example of a serrated slope.

- 3. Stepped Slope: Construct stepped slope as shown in the detailed example in the Tennessee Erosion and Sediment Control Handbook, latest edition. Steps should be wide enough to work with standard earth moving equipment. Preferably the horizontal distance should be at least 1.5 times the vertical cut distance. Slightly grade the horizontal bench inwards (e.g. back towards the top of slope). Do not make individual vertical cuts more than 24 inches high in soft materials or more than 36 inches high in rocky materials.
- 4. Terraced Slope: Designed drainage channels are located in the slope at regular intervals and have a regular cross-section including slope and depth requirements. Locate intersecting channels to convey storm water to the bottom of the slope. The maximum slope height between terraces shall be 30 feet for cut slopes and 25 feet for fill slopes. Terrace widths should be at least 6 feet wide. Refer to the Tennessee Erosion and Sediment Control Handbook, latest edition for detailed example of a terraced slope.
- 5. Seeding: Roughened areas shall be seeded and mulched as soon as possible to obtain optimum seed germination and seeding growth. Refer to Specifications for temporary mulching, vegetation in this Specification and permanent vegetation in Section 02920, Permanent Seeding and the seeding table contain within the Drawings.
- G. Temporary Mulching
 - 1. When mulch is used without seeding, mulch shall be applied to provide full coverage of the exposed area. Mulch shall be applied as follows:
 - a. Dry straw or hay mulch and wood chips shall be applied uniformly by hand or by mechanical equipment.
 - b. If the area will eventually be covered with perennial vegetation, 20-30 pounds of nitrogen per acre in addition to the normal amount shall be applied to offset the uptake of nitrogen caused by the decomposition of the organic mulches.
 - c. Apply mulch binder on exposed areas, where indicated on the Drawings or as instructed by the Engineer.
 - 2. Anchoring Mulch:
 - a. Straw or hay mulch can be pressed into the soil with a disk harrow with the disk set straight or with a special "packer disk." Disks may be smooth or serrated and should be 20 inches or more in diameter and 8 to 12 inches apart. The edges of the disk should be dull enough not to cut the mulch but to press it into the soil leaving much of it in an erect position.
 - b. Straw or hay mulch shall be anchored immediately after application.
 - c. Straw or hay mulch spread with special blower-type equipment may be anchored with emulsified asphalt (Grade AE-5 or SS-1). The asphalt emulsion shall be sprayed onto the mulch as it is ejected from the machine. Use 100 gallons of emulsified asphalt and 100 gallons of water per ton of mulch.
 - d. For straw or hay mulch, plastic mesh or netting with mesh no larger than one inch by one inch shall be installed according to manufacturer's specifications.

- e. Netting of the appropriate size shall be used to anchor wood waste. Openings of the netting shall not be larger than the average size of the wood waste chips.
- H. Temporary Grassing
 - 1. Seed Bed Preparation:
 - a. When a hydraulic seeder is used, seedbed preparation is not required.
 - b. When using conventional or hand seeding, seedbed preparation is not required if the soil material is loose and not sealed by rainfall.
 - c. When soil has been sealed by rainfall or consists of smooth cut slopes, the soil shall be pitted, trenched or otherwise scarified to provide a place for seed to lodge and germinate.
 - 2. Select a grass or grass-legume mixture suitable to the area and season of the year.
 - 3. Seed shall be applied uniformly by hand, cyclone seeder, drill, culti-packer- seeder, or hydraulic seeder (slurry including seed and fertilizer). Drill or cultipacker seeders should normally place seed one-quarter to one-half inch deep. Appropriate depth of planting is ten times the seed diameter.
 - 4. Soil should be "raked" lightly to cover seed with soil if seeded by hand.
 - 5. Irrigation: During times of drought, water shall be applied at a rate not causing runoff and erosion. The soil shall be thoroughly wetted to a depth that will insure germination of the seed. Subsequent applications should be made when needed.
 - 6. Temporary Stabilization: Temporary stabilization shall be provided as shown on the Drawings and conforming to these Specifications to control erosion on the site. Temporary stabilization shall be provided to any area which will not receive permanent stabilization within the next 7 calendar days. Partial payment requests may be withheld for those portions of the Project not complying with this requirement.
- I. Permanent Grassing and Sodding
 - 1. Refer to Specifications 02920 Seeding and the seeding table contain within the Drawings for installation and maintenance.
 - 2. Permanent Stabilization:
 - a. Permanent stabilization shall be provided as shown on the Drawings and conforming to these Specifications to control erosion on the site. Permanent stabilization shall be provided to all areas of land disturbance within seven calendar days of the completion of land disturbance for any area greater than 0.25 acre.
 - b. Grass or sod removed or damaged in residential areas shall be replanted with the same variety within seven calendar days of the completion of work in any area.
 - c. Where permanent stabilization cannot be immediately established because of an inappropriate season, the Contractor shall provide temporary stabilization. The

Contractor shall return to the site at the appropriate season to provide permanent stabilization in areas that received only temporary stabilization.

- J. Sediment Filter Bags
 - 1. Installation:
 - a. Sediment filter bag to be located upstream of a vegetated buffer that is relatively flat.
 - b. Remove topsoil and install a level crushed stone pad with an area that is the size of the sediment bag.
 - c. Place bag on top of stone and encircle the stone and a 10' vegetated area with Type C silt fence.
 - d. See TDOT standard drawing EC-STR-2 for additional details.
 - 2. Removal: The structure should be removed and the area stabilized when the upslope drainage area has been stabilized.
 - 3. Maintenance:
 - a. Sediment bag should be removed and replaced when the has accumulated sediment to one half the design volume. Sediment removal should be deposited in a suitable area such as an appropriate landfill.
 - b. Maintenance needs identified in inspections or by other means should be accomplished before the next storm event if possible, but in no case more than seven days after the need is identified.

3.03 CLEAN-UP

- A. Dispose of all excess erosion and sedimentation control materials in a manner satisfactory to the Engineer.
- B. All temporary erosion control measures shall be removed after final stabilization of the site has occurred, unless otherwise noted on the Drawings or instructed by the Engineer.
- C. Final clean-up shall be performed in accordance with the requirements of Section 02630.

PART 4 PAYMENT

A. Payment will be made under:

<u>Item No.</u>	Pay Item	<u>Pay Unit</u>
01560-01	Geotextile (Typ. III)	Square yard
01560-02	Sediment Filter Bag	Each
01560-03	Temporary Silt Fence(With backing)	Linear Feet
01560-04	High Visibility Construction Fence	Linear Feet
01560-05	Construction Exit	Each
01560-06	Temporary Crossing	Each
01560-07	Clean Water Diversion	Each

01560-08

Sandbag

Each

END OF SECTION 01560

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 and 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	<u>Nearest Unit</u>
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 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.	<u>Pay Item</u>	<u>Pay Unit</u>
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 riprap 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 750 lbs. to 1,200 lbs. 400 lbs. to 749 lbs. 200 lbs. to 399 lbs. 50 lbs. to 199 lbs. 10 lbs. to 49 lbs. Less than 10 lbs.		Percent 27% 25% 25% 15% 5% 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	, c	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 75 lbs. to 125 lbs. 25 lbs. to 74 lbs. 5 lbs. to 24 lbs. Under 5 lbs. Percent 10% 40-60% 20-40% 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, rotproof 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	Constant Head	.03 (min)
Permeability, cm/scc		, , , , , , , , , , , , , , , , , , ,
Puncture Strength, Ibs.	ASTM D-751	100 (min)
Pore Size – EOS	Corps of Engineers	40 (max)
U.S. Standard Sieve	CW-02215	· · ·

- 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 ³/₄ full with a mixture of san 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 san 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 san 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 and rip-rap with grout will be measured for payment by the cubic 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 or grout.

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 without grout will be paid for at the contract unit price per ton 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. The accepted quantities of stone rip-rap with grout or sacked sand cement rip-rap will be paid for at the contract unit price per cubic 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 or sacked sand cement, compactions, applying grout to rip-rap, wetting sacked sand cement, 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:

<u>Item No.</u> 02370-01	<u>Pay Item</u> RIP-RAP (CLASS A-1) W/GROUT	<u>Pay Unit</u> Cubic Yard
02370-01.01	RIP-RAP (CLASS A-1)	Ton
02370-01.02	SACKED SAND CEMENT	Cubic Yard
02370-02	SOIL COMPACTION TEST	Each

END OF SECTION 02370

SECTION 02371 ANCHOR REINFORCED VEGETATION SYSTEM

PART 1 GENERAL

- 1.01 SECTION INCLUDES
 - A. Erosion control material to protect newly constructed or excavated stable soil slopes to be seeded and vegetated.
- 1.02 RELATED SECTIONS
 - A. Section 02631 Earthwork
 - B. Section 02920 Seeding

1.03 UNIT PRICES

- A. Method of Measurement: By the square yard including seams, overlaps, anchor trenches, and wastage.
- B. Basis of Payment: By the square yard installed.

1.04 REFERENCES

- A. American Society for Testing and Materials (ASTM):
 - 1. D 570 Standard Test Methods for Water Absorption of Plastics.
 - 2. D 6524 Standard Test Method for Stiffness of Geosynthetics Used as Turf 3.
 - 3. Reinforcement Mats.
 - 4. D 6525 Standard Test Method for Measuring Nominal Thickness of Permanent Erosion Control Products.
 - 5. D 6575 Test Method for Stiffness of Geosynthetics Used as Turf Reinforcements Mats (TRM's)
 - 6. D 4354 Practice for Sampling of Geosynthetics for Testing.
 - 7. D 4355 Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus).
 - 8. D 4439 Terminology for Geotextiles.
 - 9. D 6818 Test Method for Ultimate Tensile Properties of Turf Reinforcement Mats.
 - 10. D 4632 Test Method for Grab Breaking Load and Elongation of Geotextiles.
 - 11. D 4759 Practice for Determining the Specification Conformance of Geosynthetics.
 - 12. D 4873 Guide for Identification, Storage, and Handling of Geotextiles.
- B. Geosynthetic Accreditation Institute (GAI) Laboratory Accreditation Program (LAP).
- C. International Standards Organization (ISO) 9001:2008 Quality System Certification.

1.05 DEFINITIONS

- Certificate of Compliance (COC): An official document certified by an authorized representative within the manufacturer's company that the manufactured synthetic turf reinforcement mat product(s) meet designated property values as manufactured in a facility having achieved ISO 9001:2008 certification, and tested in accordance with GAI-LAP procedures.
- 2. High Performance Turf Reinforcement Mat (HPTRM): A long-term, non-degradable RECP composed of UV-stabilized, non-degradable, synthetic fibers, nettings and/or filaments processed into three-dimensional reinforcement matrices designed for permanent and critical hydraulic applications where design discharges exert velocities and shear stresses that exceed the limits of mature natural vegetation. HPTRMs provide sufficient thickness, strength and void space to permit soil filling and/or retention and the development of vegetation within the matrix. The HPTRM MARV tensile strength per ASTM D-6818 is 3000 lbs/ft in the weakest principle direction.
- 3. Manufacturer: Entity that produces synthetic turf reinforcement mats through a process directly utilizing obtained raw materials, in a facility owned and operated by said entity, using equipment and assemblies owned and operated by said entity, subject to a certified Manufacturing Quality Control (MQC) Program. Upon completion of production, the manufacturer may sell the turf reinforcement mat product(s) directly to the customer, or through a vendor entity.
- 4. *Manufacturing Quality Control (MQC) Program*: A certified and documented program initiated and operated by the manufacturer that outlines the operational techniques and activities which sustain a quality of the synthetic turf reinforcement mat product(s) that will satisfy given needs.
- 5. *Minimum Average Roll Value (MARV):* Property value calculated as typical minus two standard deviations. Statistically, it yields a 97.7 percent degree of confidence that any sample taken during quality assurance testing will exceed value reported.
- 6. *Rolled Erosion Control Product (RECP):* A temporary degradable or long-term non-degradable material manufactured or fabricated into rolls designed to reduce soil erosion and assist in the growth, establishment and protection of vegetation.
- 7. Securing Pin: A device designed to temporarily hold the HPTRM in place while either vegetation establishes, or the installation of the HPTRM occurs. The securing pin offers no long term value to permanent tie-down of the HPTRM in an armoring solution.
- 8. *Trilobal Monofilament Yarn:* A multi-dimensional polymer fiber consisting of a minimum of three points, providing increased surface area and grooves/channels along the fiber to capture additional moisture and sediment to enhance vegetative growth.
- 9. Typical Roll Value: Property value calculated from average or mean obtained from test data.
- 10. *Vendor:* An entity that provides synthetic turf reinforcement mat product(s) to a customer, on behalf of an independent manufacturer. A vendor does not manufacture the actual synthetic turf reinforcement mat product(s), and therefore is not subject to provisions of a certified MQC Program.

1.06 SUBMITTALS

- A. Submit under provisions of Section 01610:
 - 1. Certification:
 - a. The Contractor shall provide the Engineer a certificate stating the name of the HPTRM manufacturer, product name, style, chemical compositions of filaments or yarns and other pertinent information to fully describe the geotextile.

- b. The Manufacturer is responsible for establishing and maintaining a Quality Control Program to assure compliance with the requirements of the specification. Documentation describing the quality control program shall be made available prior to the approval of the HPTRM for use on the project.
- c. The manufacturer's Certificate of Compliance (COC) shall state that the furnished HPTRM meets MARV requirements of the specification as evaluated under the manufacturer's quality control program. The certificate shall be attested to by a person having legal authority to bind the Manufacturer.
- d. The Contractor shall establish and maintain a quality control procedure to assure compliance of the armoring solution with the requirements of the specification. Documentation describing the quality control procedure shall be provided to the Engineer.
- 2. Manufacturing Quality Control (MQC) test results shall be provided by the manufacturer for the HPTRM prior to installation during the duration of the project as material is delivered to the jobsite.
- 3. Independent Performance Test Results shall be provided upon request.
- 1.07 DELIVERY, STORAGE, AND HANDLING
 - A. HPTRM labeling, shipment and storage shall follow ASTM D 4873.
 - B. Product labels shall clearly show the manufacturer or supplier name, style name, and roll number.
 - C. Each shipping document shall include a notation certifying that the material is in accordance with the manufacturer's certificate.
 - D. Each HPTRM roll shall be wrapped with a material that will protect the HPTRM from damage due to shipment, water, sunlight, and contaminants. (This will be waived for HPTRMs having a 90% retention of strength after 6000 hours of exposure per ASTM D-4355.)
 - E. The protective wrapping shall be maintained during periods of shipment and storage.
 - F. During storage, HPTRM rolls shall be elevated off the ground and adequately covered to protect them from the following: Site construction damage, extended exposure to ultraviolet (UV) radiation, precipitation, chemicals that are strong acids or strong bases, flames, sparks, temperatures in excess of 71 deg C (160 deg F)m and any other environmental condition that might damage the HPTRM.

1.08 QUALITY ASSURANCE SAMPLING, TESTING, AND ACCEPTANCE

- A. HPTRM shall be subject to sampling and testing to verify conformance with this specification. Sampling for testing shall be in accordance with ASTM D 4354.
- B. Acceptance shall be in accordance with ASTM D 4759 based on testing of either conformance samples obtained using Procedure A of ASTM D 4354, or based on manufacturer's certifications and testing of quality control samples obtained using Procedure B of ASTM D 4354.
- C. Quality Assurance Sampling and Testing will be waived for ISO 9001:2008 Certified Manufacturing Facilities. Documentation of ISO 9001:2008 Certification shall be provided upon request.

PART 2 PRODUCTS

- 2.01 MANUFACTURERS
 - A. Approved Manufacturers:
 - Propex Operating Company, LLC 4019 Industry Drive Chattanooga, TN 37419 (800) 621-1273
 - B. Alternate HPTRM Manufacturers:
 - 1. For consideration, alternate systems meeting the material specification must also have a documented history of HPTRM installations totaling more than 750,000 square yards and have been in the marketplace for more than five (5) years. Past project documentation will be required for submittal for evaluation to include project name, date of installation, owner's contact information and size of the project.
 - 2. Any alternate products seeking approval must be submitted to the Engineer 10 days prior to the bid date. For acceptance on this project, any alternates seeking approval must meet the requirements outlined in this document. The alternate's product specifications and a product sample must be submitted to the Engineer for approval.
 - 3. All product manufacturers seeking approval on this project must have local representation within the state in which the project is bidding.

2.02 MATERIALS

- A. PYRAMAT[®] 75 HPTRM:
 - 1. Three-dimensional, lofty woven polypropylene RECP specially designed for erosion control applications on levees, steep slopes, and vegetated waterways.
 - 2. Matrix composed of Trilobal monofilament yarns woven into uniform configuration of resilient pyramid-like projections that minimize watering requirements while enhancing vegetation establishment.
 - 3. Must be a homogeneous matrix, and not comprised of layers, composites, or discontinuous materials, or otherwise loosely held together by stitched or glued netting.
 - 4. The woven matrix of Trilobal yarns must be heat-set to improve interlock and minimize yarn displacement around anchors and pins, which also results in greater flexibility for improved conformance to uneven surfaces.
 - 5. Material is to exhibit very high interlock and reinforcement capacity with both soil and root systems and demonstrate high tensile modulus.

6. The HPTRM should meet the following values:

Property	Test Method	Test Parameters	Units	Property Requirement
Thickness ¹	ASTM D-6525	Minimum	mm (in)	10 (0.40)
Light Penetration ¹ (% Passing)	ASTM D-6567	Maximum	percent	10
Tensile Strength ¹	ASTM D-6818	Minimum	kN/m (lb/ft)	58 x 44 (4,000 x 3,000)
Tensile Elongation ¹	ASTM D-6818	Maximum	percent	40 x 35
Resiliency ¹	ASTM D-6524	Minimum	percent	80
Flexibility ^{2, 3}	ASTM D-6575	Maximum	mg-cm (in-lb)	615,000 (0.534)
UV Resistance ²	ASTM D-4355	Minimum	percent	90 at 3,000 hrs ⁴ 90 at 6,000 hrs

Note:

- 1. Minimum Average Roll Value (MARV).
- 2. Typical Value.
- 3. A smaller value for flexibility denotes a more flexible material.
- 4. Third party / Independent Testing values must be provided showing UV resistance testing for two consecutive years including most recent year.
- 7. Performance Properties:
 - a. Flume Testing: In a vegetated state, the HPTRM must demonstrate acceptable performance (as defined by the Engineer) when subjected to at least 0.5 hrs of continuous flow producing the following conditions.
 - (1) Permissible velocity: 7.6 m/sec (25 ft/sec)
 - (2) Permissible tractive force (shear stress): 770 kPa (16 psf)
 - (3) Performance may be demonstrated by:
 - (a) Flume testing at an independent facility under conditions similar to this project provided that the manufacturer can demonstrate that the material tested is functionally equivalent to the material being supplied. This may be demonstrated by providing index property test results (listed in 2.2.A.4) from a GAI-LAP accredited laboratory for both the tested and supplied materials.
 - (b) A documented case history of successful performance (as defined by the Engineer) at an installation similar to this project where (documented) hydraulic forces met or exceeded the requirements listed above provided that the manufacturer can demonstrate that the case history material is functionally equivalent to the material being supplied. This may be demonstrated by providing index property test results (listed in 2.2.A.4) from a GAI-LAP accredited laboratory for both the case history and supplied materials.
 - b. Wave Overtopping Testing: In a vegetated state, the HPTRM must demonstrate acceptable performance (as defined by the Engineer) when subjected to wave overtopping simulations, performed by Colorado State University (CSU), and authorized and directed by the U.S. Army Corps of Engineers (USACE).

- (1) A single test shall be defined as one wave overtopping simulation down the flume on one set of trays (linear and angled sections) for 3 equivalent test hours at 4.0 cfs/ft. Passing this wave overtopping test is defined as surviving the 3 equivalent test hours without visible damage.
- (2) Failure is defined by (0.06 m) 0.2 ft. or more of soil/grass erosion over a (0.37 m²) 4 ft² area.
- (3) Each type of HPTRM armoring product shall be subject to 1 wave overtopping test on each tray set at 4.0 cfs/ft for the duration equivalent to 3 test hours (~6 elapsed hours).
- c. Functional Longevity: In addition to the UV resistance per ASTM D-4355 stated above, the HPTRM must have a documented installation showing a minimum retained tensile strength of 70% per ASTM D-6818 after a minimum of 10 years of exposure to a minimum solar radiation of 21.7 MJ/m2-day.
- Manufacturing Quality Control: Testing shall be performed at a laboratory accredited by GAI-LAP for tests required for the geosynthetic, at frequency exceeding ASTM D 4354, with following minimum acceptable testing frequency:

Property	Test Frequency m² (yd²)	
Thickness	1/10,974 (1/13,125)	
Light Penetration (% Passing)	1/10,974 (1/13,125)	
Tensile Strength	1/10,974 (1/13,125)	
Tensile Elongation	1/10,974 (1/13,125)	
Resiliency	1/43,896 (1/52,500)	
Flexibility	1/43,896 (1/52,500)	
UV Resistance	Annually	

2.03 ACCESSORIES

- A. Securing Pins:
 - 1. Securing pins should be at least 5 mm (0.2 in.) diameter steel with a 38 mm (1.5 in.) steel washer at the head of the pin. Securing pins should be driven flush to the soil surface.
 - 2. Length: 300 to 600 mm (12 to 24 inches); sufficient ground penetration to resist pullout.
 - 3. Placement: The pins provide for temporary tie-down of the HPTRM to the slope to aid with vegetation establishment. Locations of the pins along trenches are indicated in the drawings at the center of the 0.3 m x 0.3 m (1 ft x 1ft) trench spaced 0.3 m (1 ft) apart. Locations of the pins along the vertical overlaps are spaced 0.3 m (1 ft) apart. HPTRM rolls wider than 3.2 m (10.5 ft) must not have a pin spacing greater than 0.45 m (1.5 ft) in any direction to minimize wrinkling of the material common to wide roll width geosynthetics and the loss of intimate contact beneath the HPTRM.
 - 4. Heavier metal stakes may be required in rocky soils.
 - 5. Depending on soil pH and design life of the pin, galvanized or stainless-steel pins may be required.

PART 3 EXECUTION

3.01 PREPARATION

- A. Grade and compact areas to be treated with HPTRM (compacted as indicated or as directed by Engineer). Subgrade shall be uniform and smooth.
- B. Remove large rocks, soil clods, vegetation, and other sharp objects so that the installed mat will have direct contact with the soil surface.
- C. Prepare seedbed by loosening 50 to 75 mm (2 to 3 in) of soil above final grade. This may be accomplished with a rotary tiller on slopes 3H:1V or flatter.
- D. Select and apply soil amendments, fertilizer, and seed (if applicable), (in an amount equivalent to 50% of the total mixture required to be installed on the soil surface) in accordance with Section 02920 Seeding, to scarified surface prior to installation of HPTRM. Do not mulch areas where HPTRM is to be placed.
- E. Keep areas moist as necessary to establish vegetation. When watering seeded areas, use fine spray to prevent erosion of seeds or soil. If as a result of rain, prepared seedbed becomes crusted or eroded, or if eroded places, ruts, or depressions exist for any reason, rework soil until smooth and reseed such areas.
- F. Excavate a Crest of Slope (COS) trench 300 mm (12 in.) wide by 300 mm (12 in.) deep, a minimum of 900 mm (3 ft.) over the crest of the slope. Excavate a Toe of Slope (TOS) trench 300 mm (12 in.) wide by 300 mm (12 in.) deep, a minimum of 900 mm (3 ft.) past the toe of the slope.

3.02 INSTALLATION

- A. Install HPTRM at elevation and alignment indicated.
- B. Beginning at downstream end of the slope, place initial end of first roll of HPTRM into the TOS trench and secure with securing pins at 300 mm (12 in) intervals.
- C. Unroll the HPTRM down the slope and secure the HPTRM end in the TOS trench with securing pins at 300 mm (12 in) intervals.
- D. Position adjacent upstream rolls in same manner, overlapping preceding roll minimum 75 mm (3 in) until the armoring limits are completed.
- E. Backfill and compact the trenches with specified soil or as directed by Engineer.
- F. Secure HPTRM to the slope with securing pins at a frequency of 2.5 pins per square meter (2 pins per square yard). Increased anchoring frequency may be required if site conditions are such that the Engineer determines it necessary.
- G. Alternate installation methods must be approved by Engineer prior to execution.
- H. Soil fill and seed or sod the HPTRM:
 - 1. Installed HPTRM shall be seeded (or re-seeded) and soil filled OR sodded as required by the project documents.
 - 2. Do not place excessive soil above material.
 - 3. Broadcast additional seed or mulch (if applicable) above soil-filled mat and irrigate as necessary to establish/maintain vegetation.

I. Rubber-tired vehicles must be used, and sharp turns avoided. No heavy and/or tracked equipment or sharp turns are permitted on the installed HPTRM. Avoid ANY traffic over the HPTRM if loose or wet soil conditions exist.

PART 4 PAYMENT

4.01 PAYMENT WILL BE MADE UNDER:

Item No.

02371-01

Pay Item Reinforced Turf <u>Pay Unit</u>

Square yard

END OF SECTION 02371

SECTION 02382 ARTICULATING CONCRETE BLOCK (ACB) REVETMENT SYSTEM

PART 1 GENERAL

- **1.01** SCOPE
 - A. The Contractor shall furnish all labor, materials, equipment, and incidentals required and perform all operations in connection with the installation of cellular concrete erosion control mats in accordance with the lines, grades, design and dimensions shown on the Contract Drawings and as specified herein.

1.02 SUBMITTAL

- A. The Contractor shall submit to the Engineer all manufacturers' hydraulic testing and calculations in support of the proposed cellular concrete mat system and geotextile.
- B. The Contractor shall furnish the manufacturer's certificates of compliance for cellular concrete blocks/mats, revetment cable, and any revetment cable fittings and connectors. The Contractor shall also furnish the manufacturer's specifications, literature, shop drawings for the layout of the mats, and any recommendations, if applicable, that are specifically related to the project.

PART 2 PRODUCTS

- 2.01 GENERAL
 - A. All cellular concrete mats shall be prefabricated as an assembly of concrete blocks, with specific hydraulic capacities, laced with revetment cables. Cellular concrete mats may be assembled on-site by hand-placing the individual units either with or without subsequent insertion of cables.
 - B. Individual units in the system shall be staggered and interlocked for enhanced stability. The mats shall be constructed of open and/or closed cell units as shown on the contract drawings. The open cell units have two (2) vertical openings of rectangular cross section with sufficient wall thickness to resist breakage during shipping and installation. Parallel strands of cable shall extend through two (2) cable ducts in each block allowing for longitudinal binding of the units within a mat. Each row of units shall be laterally offset by one-half of a block width from the adjacent row so that any given block is cabled to four other blocks (two in the row above and two in the row below).
 - C. Each block shall incorporate interlocking surfaces that minimize lateral displacement of the blocks within the mats when they are lifted by the longitudinal revetment cables. The interlocking surfaces must not protrude beyond the perimeter of the blocks to such an extent that they reduce the flexibility or articulation capability of the cellular mats or become damaged or broken when the mats are lifted during shipment or placement. Once the mats are in place, the interlocking surfaces shall minimize the lateral displacement of the blocks even if the cables should become damaged or removed. The mats must be able to flex a minimum of 18° between any given row or column of blocks in the uplift direction and a minimum of 45° in the downward direction.
 - D. The cables inserted into the mats shall form lifting loops at one end of the mat with the corresponding cable ends spliced together to form a lifting loop at the other end of the mat. The Engineer shall approve appropriate sleeves for use in order to splice the lifting loop. The cables shall be inserted after sufficient time has been allowed for the concrete to complete the curing process.

- E. The cellular concrete mats shall be placed on a filter fabric as specified herein. Under no circumstances shall the filter fabric be affixed (i.e. chemically bonded to the blocks) to the mattress in a manner in which would jeopardize the functionality of the filter fabric. Specifically, the filter fabric shall be independent of the block system.
- F. Certification (Open-Channel Flow): Cellular concrete mats will only be accepted when accompanied by documented hydraulic performance characteristics that are derived from tests under controlled flow conditions. Testing guidelines should conform to U.S. Federal Highway Administration and U.S. Bureau of Reclamation Testing Protocol as documented in "Minimizing Embankment Damage During Overtopping Flow", Report No. FHWA-RD-88-181 and all hydraulic performance testing shall be performed in a 2H:1V flume.
- G. Performance (Open-Channel Flow): The design of the cellular concrete mats shall be in accordance with the Factor-of-Safety design methodology as described in "Erosion and Sedimentation" by Pierre Julien, Cambridge University Press, 1995. The minimum designed safety factor shall be 1.5 by utilizing the following equation.

$$SF = ((\vartheta_2 / \vartheta_1) \alpha_{\theta}) / ((1 - \alpha_{\theta}^2)^{0.5} \cos \beta + \eta (\vartheta_2 / \vartheta_1) + (\vartheta_3 F_d \cos \delta + \vartheta_4 F_l) / \vartheta_1 W_s) = 1.5$$

- H. The analysis shall be performed based upon the stability of the mat due to gravity forces alone, neglecting conservative forces added by cabling, mechanical anchorage, contact with adjacent blocks, or other restraints not attributable to gravity-based forces. The analysis must account for a 0.5-inch block projection.
- I. In order to analyze the performance of the unit, the hydraulic information listed below is required:

Parameter	Cypress Creek	Fletcher	Tenmile
	Tributary	Creek East	Creek
Block Class	50	50	50
Volumetric Flow Rate (ft ³ /sec)	646	1050	1340
Channel Friction or Bed Slope (ft/ft)	0.01	0.01	0.01
Channel Side Slope (_H:1V)	2	2	2
Channel Bottom Width (ft)	16	30	60
Allowable Unit Protrusion (in)	0.5 for	Uniform Units	S

TABLE 1. ACB HYDRAULIC INFORMATION

2.02 CELLULAR CONCRETE BLOCKS

A. Scope

1. This specification covers erosion control mats used in revetments for soil stabilization.

Note 1 - Concrete units covered by this specification are made from lightweight or normal weight aggregates, or both.

Note 2 - The values stated in U.S. customary units are to be regarded as the standard.

B. Materials

- 1. Cementitious Materials Materials shall conform to the following applicable ASTM specifications:
 - a. Portland Cements Specification C 150, for Portland Cement.
 - b. Blended Cements Specification C 595, for Blended Hydraulic Cements.

- c. Hydrated Lime Types Specification C 207, for Hydrated Lime Types.
- d. Pozzolans Specification C 618, for Fly Ash and Raw or Calcined Natural Pozzolans for use in Portland Cement Concrete.
- 2. Aggregates shall conform to the following ASTM specifications, except that grading requirements shall not necessarily apply:
 - a. Normal Weight Specification C 33, for Concrete Aggregates.
- C. Casting
 - 1. The concrete units shall be produced by a dry cast method. The dry cast units obtain strength in a shorter duration as well as an increase in the durability and overall quality of product.
- D. Physical Requirements
 - 1. At the time of delivery to the work site, the units shall conform to the physical requirements prescribed in Table 2 listed below.

-					
Compressive Strength Net Area		Water Absorption			
Min. p.s.i (mPa)		Max. lb/ft ³ (kg/m ³)			
Avg. of 3 units	Individual Unit	Avg. of 3 units	Individual Unit		
4,000 (27.6)	3,500 (24.1)	10 (160)	12 (192)		

TABLE 2. PHYSICAL REQUIREMENTS

- 2. When applicable, the manufacturer shall meet all requirements pertaining to a concrete unit's durability pertaining to a freeze-thaw environment.
- Units shall be sampled and tested in accordance with ASTM D 6684-04, Standard Specification for Materials and Manufacture of Articulating Concrete Block (ACB) Revetment Systems.
- E. Visual Inspection
 - 1. All units shall be sound and free of defects that would interfere with either the proper placement of the unit or impair the performance of the system. Surface cracks incidental to the usual methods of manufacture, or surface chipping resulting from customary methods of handling in shipment and delivery, shall not be deemed grounds for rejection.
 - 2. Cracks exceeding 0.25 inches (.635 cm) in width and/or 1.0 inch (2.54 cm) in depth shall be deemed grounds for rejection.
 - 3. Chipping resulting in a weight loss exceeding 10% of the average weight of a concrete unit shall be deemed grounds for rejection.
 - 4. Blocks rejected prior to delivery from the point of manufacture shall be replaced at the manufacturer's expense. Blocks rejected at the job site shall be repaired with structural grout or replaced at the expense of the contractor.

F. Sampling and Testing

- 1. The purchaser or their authorized representative shall be accorded proper access to facilities to inspect and sample the units at the place of manufacture from lots ready for delivery.
- 2. Field installation procedures shall comply with the procedures utilized during the hydraulic testing procedures of the recommended system. All system restraints and ancillary components (such as synthetic drainage mediums) shall be employed as they were during testing. For example, if the hydraulic testing installations utilize a drainage layer then the field installation must utilize a drainage layer; an installation without the drainage layer would not be permitted.
- 3. The theoretical force-balance equation used for performance extrapolation tends for conservative performance values of thicker concrete units based on actual hydraulic testing of thinner units. When establishing performance values of thinner units based on actual hydraulic testing of thicker units, there is a tendency to overestimate the hydraulic performance values of the thinner units. Therefore, all performance extrapolation must be based on actual hydraulic testing of a thinner unit then relating the values to the thicker units in the same "family" of blocks.
- 4. Additional testing, other than that provided by the manufacturer, shall be borne by the purchaser.
- G. Manufacturer
 - 1. Cellular concrete blocks shall be ARMORFLEX[®] (or equal). A potential manufacturer and provider:

ARMORTEC; A CONTECH COMPANY 9025 Center Point Dr. Suite 400 West Chester, OH 45069 Phone: (513) 645-7000 Fax: (513) 645-7993

2. The cellular concrete blocks shall have the following nominal characteristics:

CLASS	TYPE	BLOCK WEIGHT	BLOCK SIZE			OPEN
		Lbs (kg)	Length inches (cm)	Width inches (cm)	Height inches (cm)	%
50	Open	76.0 (34.5)	17.4 (44.2)	15.5 (39.4)	6.0 (15.2)	20

TABLE 2. STANDARD SIZE OF BLOCK

2.03 REVETMENT CABLE AND FITTINGS

- A. Galvanized Steel Revetment Cable and Fittings.
 - 1. Revetment cable shall be constructed of preformed galvanized aircraft cable. The cables shall be made from individual wires and strands that have been formed during the manufacture into the shape they have in finished cable.
2. Cable shall consist of a core construction comprised of seven (7) wires wrapped within seven (7) or nineteen (19) wire strands. The revetment cable shall have the following physical properties:

Galvanized Cable					
Nominal Cable Dia.	Туре	Approx. Stren	Ave. gth	Weight per	Length
(in.)		(Lbs)	(kN)	(Lbs)/100ft	(kg/m)
1/8	7x7	1,700	7.5	2.8	0.04
3/16	7x7	3,700	16.4	6.2	0.09
1/4	7x7	6,100	27.1	10.6	0.16
5/16	7x19	9,800	43.6	17.3	0.26
3/8	7x19	14,400	64.1	24.3	0.36

- 3. The revetment cable shall exhibit resistance to mild concentrations of acids, alkalis, and solvents. Fittings such as sleeves and stops shall be aluminum, and the washers shall be galvanized steel. Furthermore, depending on material availability, the cable type (7x7 or 7x19) can be interchanged while always ensuring the required factor of safety for the cable.
- 4. Selection of cable and fittings shall be made in a manner that insures a safe design factor for mats being lifted from both ends, thereby forming a catenary. Consideration shall be taken for the bending of the cables around hooks or pins during lifting. Revetment cable splicing fittings shall be selected so that the resultant splice shall provide a minimum of 75% of the minimum rated cable strength.

2.04 ANCHORS

A. Where permanent anchoring is required, e.g. hanging mats on steep slopes without toe construction, the cables (polyester or steel) shall be attached to the anchoring system as indicated on the Contract Drawings.

2.05 FILTER FABRIC

- A. The geotextile filter shall meet the minimum physical requirements listed in Table No. 3 of these Specifications. Consultation with the manufacturer is recommended.
- B. The geotextile must be permitted to function properly by allowing relief of hydrostatic pressure; therefore fine soil particles shall not be allowed to clog the filter fabric.
- C. The geotextile fiber shall consist of a long-chain synthetic polymer composed of at least 85 percent by weight of propylene, ethylene, ester, or amide, and shall contain stabilizers and/or inhibitors added to the base plastic, if necessary, to make the filaments resistant to deterioration due to ultraviolet and heat exposure. The edges of the geotextile shall be finished to prevent the outer fiber from pulling away from the geotextile.
- D. The Contractor shall furnish the Engineer, in duplicate, manufacturer's certified test results showing actual test values obtained when the physical properties are tested for compliance with the specifications.
- E. During all periods of shipment and storage, the filter fabric shall be protected from direct sunlight, ultraviolet rays and temperatures greater than 140 degrees Fahrenheit. To the extent possible, the fabric shall be maintained wrapped in its protective covering. The geotextile shall not be exposed to sunlight, ultraviolet rays until the installation process begins.

Physical Property	Test Procedure	Minimum Value	
Grab Tensile Strength (Unaged Geotextile)	ASTM D4632	200 Lbs. (in any principal direction)	
Breaking Elongation (Unaged Geotextile)	ASTM D4632	50% max. (in any principal direction)	
Burst Strength	ASTM D3786	400 p.s.i	
Puncture Strength	ASTM D4833	115 lbs.	
A.O.S., U.S. Std. Sieve	ASTM D4751	see Design Manual	
% Open Area	CWO-22125-86	See Design Manual	
Permittivity	ASTM D4491	See Design Manual	

TABLE 3. PHYSICAL REQUIREMENTS

- F. Final acceptance of the filtration geotextile by the Engineer shall be dependent upon the geotextile performance when tested in accordance with ASTM D5105, Standard Test Method for Measuring the Soil-Geotextile System Clogging by the Gradient Ratio test or the Hydraulic Conductivity Ratio test. Soil characteristics such as grain size distribution and plasticity shall be determined for every 200,000 square feet of geotextile installed or for each source of borrow material used during construction. Significant differences in soil characteristics shall require further performance testing by either the Gradient Ratio or the Hydraulic Conductivity Ratio tests at the discretion of the Engineer. The locations for which the material to be tested is extracted shall be approved by the Engineer. The Contractor shall provide the site-specific soil and modified proctor curves for the site-soil, at his own expense, to the manufacturer. Also, the contractor shall be responsible for the performance of the test by a certified independent laboratory experienced in performing such test. The test shall be performed under the actual field soil conditions or as otherwise required by the Engineer.
- G. At the time of installation, the filter fabric shall be rejected if it has been removed from its protective cover for over 72 hours or has defects, tears, punctures, flow deterioration, or damage incurred during manufacture, transportation or storage. With the acceptance of the Engineer, placing a filter fabric patch over the damaged area prior to placing the mats shall repair a torn or punctured section of fabric. The patch shall be large enough to overlap a minimum of three (3) feet in all directions.
- H. In the event pre-assembled panels of fabric are required, the panels of filter fabric shall be sewn together at the manufacturer or another approved location.

2.06 SIZE OF CELLULAR CONCRETE MATS

- A. General
 - 1. The cellular concrete blocks, cables and fittings shall be fabricated at the manufacturer or another approved location into mats with a width of up to eight (8) feet and a length up to forty (40) feet, which is approved by the Engineer.
- B. Mat Length
 - 1. The cellular concrete mats shall have the ability for fabrication in various lengths, widths, and combinations of length and/or widths. Special mats are a combination of two opposing dimensions either in the longitudinal or transverse direction of the mats. The special mats are available in various dimensions that allow for a custom fit to a site-specific project.

PART 3 FOUNDATION PREPARATION, GEOTEXTILE AND MAT PLACEMENT

3.01 FOUNDATION PREPARATION

- A. General
 - 1. Areas on which filter fabric and cellular concrete blocks are to be placed shall be constructed to the lines and grades shown on the Contract Drawings and to the tolerances specified in the Contract Documents and approved by the Engineer.
- B. Grading
 - 1. The slope shall be graded to a smooth plane surface to ensure that intimate contact is achieved between the slope face and the geotextile (filter fabric), and between the geotextile and the entire bottom surface of the cellular concrete blocks. All slope deformities, roots, grade stakes, and stones which project normal to the local slope face must be re-graded or removed. No holes, "pockmarks", slope board teeth marks, footprints, or other voids greater than 1.0 inch in depth normal to the local slope face shall be permitted. No grooves or depressions greater than 0.5 inches in depth normal to the local slope face shall be permitted. Where such areas are evident, they shall be brought to grade by placing compacted homogeneous material. The slope and slope face shall be uniformly compacted, and the depth of layers, homogeneity of soil, and amount of compaction shall be as required by the Engineer.
 - 2. Excavation and preparation for anchor trenches, flanking trenches, and toe trenches or aprons shall be done in accordance to the lines, grades and dimensions shown in the Contract Drawings. The anchor trench hinge-point at the top of the slope shall be uniformly graded so that no dips or bumps greater than 0.5 inches over or under the local grade occur. The width of the anchor trench hinge-point shall also be graded uniformly to assure intimate contact between all cellular concrete blocks and the underlying grade at the hinge-point.
- C. Inspection
 - 1. Immediately prior to placing the filter fabric and cellular concrete blocks, the prepared subgrade shall be inspected by the Engineer as well as the owner's representative. No fabric or blocks shall be placed thereon until that area has been approved by each of these parties.

3.02 PLACEMENT OF GEOTEXTILE FILTER FABRIC

- A. General
 - 1. Filter Fabric, or filtration geotextile, as specified elsewhere, shall be placed within the limits shown on the Contract Drawings.
- B. Placement
 - 1. The filtration geotextile shall be placed directly on the prepared area, in intimate contact with the subgrade, and free of folds or wrinkles. The geotextile shall not be walked on or disturbed when the result is a loss of intimate contact between the cellular concrete block and the geotextile or between the geotextile and the subgrade. The geotextile filter fabric shall be placed so that the upstream strip of fabric overlaps the downstream strip. The longitudinal and transverse joints shall be overlapped at least three (3) feet. The geotextile shall extend at least one foot beyond the top and bottom revetment termination points. If

cellular concrete blocks are assembled and placed as large mattresses, the top lap edge of the geotextile should not occur in the same location as a space between cellular concrete mats unless the space is concrete filled.

3.03 PLACEMENT OF CELLULAR CONCRETE BLOCKS/MATS

- A. General
 - 1. Cellular concrete block/mats, as specified in Part 2:A of these Specifications, shall be constructed within the specified lines and grades shown on the Contract Drawings.

B. Placement

- 1. The uniform cellular concrete blocks shall be placed on the filter fabric in such a manner as to produce a smooth plane surface in intimate contact with the filter fabric. No individual block within the plane of placed cellular concrete blocks shall protrude more than one-half inch or as otherwise specified by the Engineer. To ensure that the cellular concrete blocks are flush and develop intimate contact with the subgrade, the uniform blocks shall be "seated" with a roller or other means as approved by the Engineer.
- 2. If assembled and placed as large mattresses, the cellular concrete mats shall be attached to a spreader bar or other approved device to aid in the lifting and placing of the mats in their proper position by the use of a crane or other approved equipment. The equipment used should have adequate capacity to place the mats without bumping, dragging, tearing or otherwise damaging the underlying fabric. The mats shall be placed side-by-side and/or end-to-end, so that the mats abut each other. Mat seams or openings between mats greater than two (2) inches shall be filled with 4000 p.s.i. non-shrink grout. Whether placed by hand or in large mattresses, distinct changes in grade that results in a discontinuous revetment surface in the direction of flow shall require a grout seam at the grade change location so as to produce a continuous surface.
- 3. Anchor trenches and side trenches shall be backfilled and compacted flush with the top of the blocks. The integrity of the trench backfill must be maintained so as to ensure a surface that is flush with the top surface of the cellular concrete blocks for its entire service life. Toe trenches shall be backfilled as shown on the Contract Drawings. Backfilling and compaction of trenches shall be completed in a timely fashion. No more than 500 linear feet of placed cellular concrete blocks with non-completed anchor and/or toe trenches shall be permitted at any time.

C. Finishing

- 1. The cells or openings in the cellular concrete blocks shall be backfilled and compacted immediately with suitable material to assure there are no voids and so that material extends from the filter fabric to one-inch above the surface of the cellular concrete block. Backfilling and compaction shall be completed in a timely manner so that no more than 500 feet of exposed mats exist at any time.
- D. Consultation
 - 1. The manufacturer of the cellular concrete blocks/mats shall provide design and construction advice during the design and initial installation phases of the project when required.

CITY OF MEMPHIS – STANDARD CONSTRUCTION SPECIFICATIONS Modified by SARP10 Program

PART 4 PAYMENT

4.01 PAYMENT WILL BE MADE UNDER:

Item No.	Pay Item	<u>Pay Unit</u>
02382-01	Concrete Block Mat	Square Feet

END OF SECTION 02382

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
 - 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. <u>Material Inspection and Testing</u>

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. <u>Storage</u>

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. <u>Glass Fiber Reinforced Polymer Mortar Pipe and Fittings (up to 72 inch Diameter)</u>
 - 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. Flanged joints will conform to the requirements of ANSI A 21.11. Flanged interving 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

2. 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.	21⁄2"	2"	1½"	1"	3/8"	No.40	Clay *
1 2 3	100	95-100 100	95-100 100	90-100	35-65 40-65 45-65	10-30 10-30 10-35	1-12 1-12 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.

3. 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.

L. Non-Shrinking Grout

 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.

M. High Density Polyethylene (HDPE) Pipe and Fittings

- 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.

N. 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.

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. <u>Trench Excavation</u>

- 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 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
 - 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 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

- 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

 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 of water services to adapt to new construction shall be the Subcontractor's responsibility within the limits where the new service line grade blends smoothly with the existing service line grade.
- 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 stop 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 insure 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.

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	Constant Head	0.03 (min)
Permeability, cm/sec		
Puncture Strength, lbs.	ASTM D-751	100 (min)
Pore Size - EOS	Corps of Engineers	40 (max)
U.S. Standard Sieve	CW-02215	

B. <u>Crushed Limestone</u>

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. <u>Preparation of Pipe Ends</u>

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. <u>Uniform Pipe Bearing</u>

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.

3.05 PIPE JOINTS

A. <u>General</u>

- 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. <u>Compression Joints</u>

- 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 6inch to 4-inch concentric PVC reducer to connect the new 6-inch lateral to an existing 4inch 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
 - 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. <u>Street Right-of-Way and Improved Property</u>
 - 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. <u>Removal of Excess Material</u>

- 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. <u>General</u>
 - 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. <u>Tunneling</u>

- 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 will be removed from the site and disposed of by the Contractor at his expense.
- 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 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.
- 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 f the underside of the pipe, for at least one-third of the circumference othe 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. <u>Sewer Pipe in Jacked Liner</u>

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.

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. <u>Air Leakage Test for 8-24 inch Diameter Pipe</u>
 - 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 Leng	th 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 limestone 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.

5.11 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.

5.12 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.

5.13 NON-SHRINKING GROUT

A. Non-shrinking grout or other acceptable material used for filling abandoned pipes or structures as directed by the Purchaser will be measured by the cubic yard placed.

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

B. 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 INVERTED SIPHONS

A. Payment will be made for Inverted Siphons at the contract lump sum price, which price will be full compensation for material and material testing, excavation, special protection, cofferdams, temporary bulkheads, maintenance of sewage flow during construction,

protection of existing utilities, inlet manhole and outlet manhole with rims and covers, intermediate manholes siphon pipe and fittings, concrete encasement, conducting acceptance tests, removal and/or abandonment of existing pipe within the limits of excavation, and backfilling.

6.09 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.

6.10 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.

6.11 NON-SHRINKING GROUT

A. Accepted quantities of grout or other acceptable material used for filling abandoned pipes or structures 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.

PAYMENT WILL BE MADE UNDER:

ltem No.	Pay Item	Pay Unit
02530-6.01 02530-6.02 02530-6.03 02530-6.03.01 02530-6.06 02530-6.10 02530-6.11 02530-6.12	LOCATE AND EXPOSE MAINLINE TERMINUS UNDERCUT BACKFILL 8" POLYVINYL CHLORIDE (PVC) 0' - 6' DEEP 12" POLYVINYL CHLORIDE (PVC) 0' - 6' DEEP BYPASS PUMPING STEEL CASING CONCRETE ENCASEMENT NON-SHRINKING GROUT	Each Ton Linear Foot Linear Foot Lump Sum Linear Foot Cubic Yard Cubic Yard

END OF SECTION 02530

SECTION 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
 - 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
 - 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 6inches 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
 - 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. 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
 - 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.

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 thebase, 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	VERTICAL FOOT
02531-4.01.B	PRECAST MANHOLE INSTALLATION	VERTICAL FOOT
02531-4.01.C	PAVEMENT BACKFILL	CUBIC YARD

END OF SECTION 02531

SECTION 02532 SANITARY SEWER MANHOLE ADJUSTMENT

PART 1 GENERAL

- 1.01 SCOPE
 - A. This Work shall consist of locating and adjusting existing sanitary sewer manhole frames and covers as necessary to conform to the existing street grades or as directed by the Purchaser in accordance with these Specifications.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Mortar
 - 1. Mortar shall be composed of the following mixtures by volume: one part Portland cement, two parts sand, hydrated lime not to exceed 10 percent of the cement used, and four parts water. All ingredients shall be proportioned by measurement and not by estimation. All hydrated lime shall be as specified by ASTM C 6.
 - 2. The mortar shall be hand mixed or machine mixed. In the preparation of hand mixed mortar, the sand, cement and hydrated lime shall be thoroughly mixed together in a clean, tight mortar box until the mixture is of uniform color, after which water shall be added. Machine mixed mortar shall be prepared in an approved mixer and shall be mixed not less than 1 ½ minutes. Mortar shall be used within 30 minutes after mixing.
- B. Brick
 - 1. All brick shall conform to the Specifications for Concrete Building Brick, ASTM C55 for Grade A. Bricks shall conform to the following dimensions, unless otherwise approved by the Purchaser.

	Depth	Width	Length
	(Inches)	(Inches)	(Inches)
Standard Size	2 1/4	3 ³ ⁄4	8
Allowable Variation	+ 1/4	+ 1/4	+ 1/2

- 2. All bricks shall be new and whole, of uniform standard size and with substantially straight and parallel edges and square corners. Bricks shall be tough and strong and free from injurious cracks and flaws. Bricks shall be culled after delivery, if required, and all culls shall be removed from the work site.
- 3. The Subcontractor may be required to furnish the Purchaser with at least five bricks of the character and make he proposes to use, at least one week before any bricks are delivered for use. All bricks shall be of the same quality as the accepted samples.
- C. Portland Cement Concrete
 - 1. Portland cement concrete for adjustment of precast or poured-in-place concrete manholes shall be in accordance with Section 03050 Portland Cement Concrete.
- D. Steel Reinforcement

- 1. Deformed steel reinforcing bar and welded wire fabric shall be of the grades, sizes and dimensions and at the designated spacing's and locations as shown on the plans or as directed by the Purchaser.
- E. Grade Adapter Ring
 - 1. Grade adapter rings shall be of the standard Memphis type as supplied by Universal Scaffolding. The Subcontractor shall secure and provide the Grade Adapter Ring.
- F. Manhole Frame & Cover
 - 1. Manhole Frame & Covers shall be of the standard Memphis type as supplied by Universal Scaffolding. The Subcontractor shall secure and provide the Frame and Cover.
- G. Paving Materials
 - 1. Flexible pavement (asphaltic concrete) and rigid pavement (Portland cement) shall be restored in kind using materials in accordance with Section 02950 Removal and Replacement of Pavements and Incidentals.
- H. Precast Concrete Manhole Sections
 - Precast concrete manhole sections shall be as specified in the City of Memphis Standard Construction Specification Section 02531 – Installation and Replacement of Manholes.

2.02 EQUIPMENT

A. All equipment necessary for the satisfactory performance of this work shall be on hand and available before Work will be permitted to begin.

PART 3 EXECUTION

- A. Locate Manhole
 - 1. The Subcontractor shall be provided all available field records and plan information regarding the location of manholes that are not on grade and showing. Using field measurements, metal detectors, Sonde, or other devices, the Subcontractor shall first locate the manhole cover to be raised to grade. The surface cover (asphalt, soil) shall then be removed and the manhole frame and rim exposed prior to adjustment. The differential height between the existing manhole rim and the street or easement surface shall be measured and this differential is the basis for the selection of the adjustment method and the payment.
- B. Standard Adjustment Method (Adjustments >5" & <18")
 - 1. Any manhole covers not adjusted and set at final grade by others shall be adjusted by the Subcontractor. If the cover requires lowering, the manhole rim shall be removed, sufficient upper courses of brick removed, and the rim reset at proper grade by use of cement mortar over the top course of brick remaining.
 - 2. If the cover requires raising, and reaching the required final rim elevation at grade will exceed the allowable maximum of 5-inches using adapter rings, all existing riser rings in the frame shall be removed and defective courses of brick shall also be removed, and

the manhole shall be rebuilt to the final street or easement grade with the rim reset as described above.

- C. Manhole Adjustment with Adapter Rings (Adjustments <5")
 - 1. For manhole covers to be raised less than or equal to 5 inches and where the total collar height would not exceed 18 inches, manhole adapter rings may be used if approved by the Purchaser. Adapter rings may be added to raise the cover a maximum of 5 inches. Adapter rings shall be tack welded to the existing rim at a minimum of 4 locations.
- D. Manhole Adjustments (>18")
 - 1. For manhole covers more than 18 inches below grade, the Subcontractor shall be responsible for removing the existing cover or pavement, excavating to locate the actual depth of the existing manhole frame and cover, and raising the frame and cover in accordance with SARP10 specifications and details. If the frame and cover is between 18" and 36" below grade, the Subcontractor shall raise the frame and cover in accordance with SARP10 Detail "Adjusting Manhole Frame & Cover 5 to 18 Inches." If greater than 36", the Subcontractor shall follow the SARP10 Detail "Adjusting Manhole >18 Inches Deep." This shall include replacing existing brick corbels sections with precast manhole sections and/or corbels to attach to the existing manhole structure.
- E. Traffic Control
 - 1. 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 a 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.
- F. 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.
- G. Site Preparation and Restoration
 - 1. The Subcontractor shall prepare and restore the site in accordance with Paragraph 3.01 of Section 02530 Sewer Pipe Installation. The Subcontractor shall remove the vegetated area around a manhole as needed to adjust the manhole frame and cover. All disturbed areas shall be restored as neatly as practical to their original condition. The disturbed area shall be cleared and raked to the level of the existing turf and then watered. New sod shall be installed over the entire disturbed area. 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 10 to 12 inch squares.
- H. Removal & Replacement of Pavements Incidental

- 1. The Subcontractor shall remove and replace pavement and incidentals in accordance with requirements of Standard Construction Specifications Section 02950, Removal and Replacement of Pavement and Incidentals.
- I. Restoration of Road Surfaces
 - 1. Flexible pavement (asphaltic concrete) and rigid pavement (Portland cement) shall be restored in kind using materials in accordance with Section 02950 Removal and Replacement of Pavements and Incidentals.

PART 4 MEASUREMENT & PAYMENT

4.01 MEASUREMENT

- A. Manhole Adjustment with Adapter Rings (Adjustments <5")
 - 1. Manhole adjustment with adapter rings will be measured per each.
- B. Standard Manhole Adjustments (Adjustments >5" and < 18")
 - 1. Standard manhole adjustments will be measured per each.
- C. Manhole Adjustments (Adjustments >18" & <36")
 - 1. Manhole adjustments will be measured per each.
- D. Manhole Adjustments (Adjustments >36")
 - 1. Manhole adjustments will be measured per vertical foot.
- E. 1.5 inch Manhole Adjustment Ring
 - 1. Manhole adjustment rings will be measured per each.
- F. 2 inch Manhole Adjustment Ring
 - 1. Manhole adjustment rings will be measured per each.
- G. #7 Sewer Manhole Frame & Cover
 - 1. Manhole frames and covers will be measured per each.
- H. #7 Sewer Manhole Cover Only
 - 1. Manhole covers will be measured per each.
- I. Traffic Control
 - 1. Traffic control will be paid for per each construction area.
- J. Site Preparation and Restoration
 - 1. The area to be considered for measurement will be the limit of the construction area unless otherwise directed by the Purchaser.

- 2. When the Proposal Sheet(s) do(es) 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.
- K. Sonde Used to Locate Manhole
 - 1. Sonde use to locate manholes will be measured per each manhole employed.

4.02 PAYMENT

- A. Manhole Adjustment with Adapter Rings (Adjustments <5")
 - 1. The accepted quantities of manholes adjusted by the adapter ring method will be paid for at the contract unit price per each, for raising the manhole cover to final grade, which price will be full compensation for furnishing all labor and materials necessary for the complete adjustment of the cover to the satisfaction of the Purchaser.
- B. Standard Manhole Adjustments (Adjustments >5" and < 18")
 - 1. The accepted quantities of manholes adjusted will be paid for at the contract unit price per each, for raising or lowering the existing or new manhole frame and cover to final grade, which price will be full compensation for furnishing all labor and materials necessary for the complete adjustment of the frames and covers to the satisfaction of the Purchaser.
- C. Manholes Adjustments (Adjustments >18" & <36")
 - 1. The accepted quantities of manholes adjusted will be paid for at the contract unit price per each, for raising or lowering the existing or new manhole frame and cover to final grade, which price will be full compensation for furnishing all labor and materials necessary for the complete adjustment of the frames and covers to the satisfaction of the Purchaser.
- D. Manhole Adjustments (Adjustments >36")
 - 1. The accepted quantities of manholes adjusted will be paid for at the contract unit price per each, for raising or lowering the existing or new manhole frame and cover to final grade, which price will be full compensation for furnishing all labor and materials necessary for the complete adjustment of the frames and covers to the satisfaction of the Purchaser.
- E. 1.5 inch Manhole Adjustment Ring
 - 1. Manhole adjustment rings will be paid per each. This payment shall include procurement of the manhole adjustment ring from Universal Scaffolding and delivery to the site.
- F. 2 inch Manhole Adjustment Ring
 - 1. Manhole adjustment rings will be paid per each. This payment shall include procurement of the manhole adjustment ring from Universal Scaffolding and delivery to the site.
- G. #7 Sewer Manhole Frame & Cover

- 1. Manhole frames and covers will be paid per each. This payment shall include procurement of the manhole frame and cover from Universal Scaffolding and delivery to the site.
- H. #7 Sewer Manhole Cover Only
 - 1. Manhole covers will be paid per each. This payment shall include procurement of the manhole adjustment ring from Universal Scaffolding and delivery to the site.
- I. Traffic Control
 - 1. Traffic control will be paid for per each construction area including all appurtenances required to comply with MUTCD standards.
- J. Site Preparation & Restoration
 - 1. Payment will be made for Site Preparation and Restoration at the price, per each construction area which will be full compensation for removal of trees, shrubs, plants, brush, rubbish, fences, manmade obstructions including but not limited to structures, abandoned cars and appliances, building foundations, and all other obstructions as may be directed by the Purchaser; the disposal of debris, removing of obstructions, and the restoration of fences, turfed areas, and all other items will be as specified in the Plans and Contract Documents or as directed by the Purchaser.
- K. Sonde Used To Locate Manhole
 - 1. Payment will be made for use of a Sonde to successfully locate and raise a buried manhole that cannot be located after attempting other means. Sonde use must be approved in advance by the Purchaser.

4.03 PAYMENT WILL BE MADE UNDER:

Item No.	Pay Item	Pay Unit
02532-4.01.A	MANHOLE ADJUSTMENTS WITH ADAPTER RINGS (ADJUSTMENTS <5")	EACH
02532-4.01.B	STANDARD MANHOLE ADJUSTMENT (ADJUSTMENT >5" AND <18")	EACH
02532-4.01.C	STANDARD MANHOLE ADJÚSTMENT (ADJUSTMENT >18" AND <36")	EACH
02532-4.01.D	STANDARD MANHOLE ADJUSTMENT (ADJUSTMENT >36")	EACH
02532-4.01.E	1.5 – INCH MANHÓLE ADJUSTMENT RING	EACH
02532-4.01.F	2 – INCH MANHOLE ADJUSTMENT RING	EACH
02532-4.01.G	#7 SEWER MANHOLE FRAME AND COVER	EACH
02532-4.01.H	#7 SEWER MANHOLE COVER ONLY	EACH
02532-4.01.1	TRAFFIC CONTROL PER CONSTRUCTION AREA	EACH
02532-4.01.J	SITE PREPARATION AND RESTORATION	EACH
02532-4.01.K	SONDE TO LOCATE MANHOLE END OF SECTION 02532	EACH

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, "blinkouts," 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. or is a P.E. in another state and has a Tennessee P.E. or is a P.E. in another state and has a tennessee P.E. or is a P.E. in another state and has a Tennessee P.E. or is a P.E. in another state and has a Tennessee P.E. or is a P.E. in another state and has a Tennessee P.E. or is a P.E. in another state and has a Tennessee P.E. or is a P.E. in another state and has a Tennessee P.E. or is a P.E. in another state and has 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:

(1) **100%** - (error count/total header fields)*100% = Header Accuracy

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:

(1) **100% - (error count/total entries) * 100% = Detail Accuracy**

- 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 EACH DIAMETER	LF
02541-4.01.B 02541-4.01.C	HEAVY CLEANING FOR EACH DIAMETER REMOTE TRIMMING OF PROTRUDING LATERAL	LF EACH

END OF SECTION 02541

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
 - 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 36inches 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. GPS Coordinates of 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 lamphole 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. MACP Level 1 for Lamphole Inspections
 - 1. The inspection and recording of all lamphole observations in a MACP format shall be paid for at the unit price bid per each MACP Level 1 inspection performed in accordance with the specification, provided that QA/QC standards are met.
 - The unit price for each MACP lamphole 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, power supply for equipment, interim and final reports and all other appurtenant work.
- C. 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	GPS COORDINATES OF MANHOLE COVER	EACH
02544-4.01.B 02544-4.01.C-1	MACP LEVEL 1 LAMPHOLE INSPECTIONS MACP LEVEL 2 MANHOLE INSPECTIONS-	EACH

CITY OF MEMPHIS – STANDARD CONSTRUCTION SPECIFICATIONS Modified by SARP10 Program

	NO 3D SCAN	EACH
02544-4.01.C-2	MACP LEVEL 2 MANHOLE INSPECTIONS	
	WITH 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

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)

<u>Size No.</u>	<u>2 ¼ "</u>	<u>2"</u>	<u>1 ½ "</u>	<u>1"</u>	<u>3/8"</u>	<u>No. 40</u>	<u>Clay*</u>
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 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. <u>Control of Storm Water.</u>

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. <u>Trench Excavation.</u>

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. <u>Treacherous Ground.</u>

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.

Modified by SARP10 Program

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. <u>Service Connections.</u>

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. <u>General.</u>

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. <u>Placement and Compaction.</u>

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. <u>Backfill Material.</u> 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. <u>Placement of Backfill.</u> 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. <u>Placement and Compaction</u>. 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:

<u>Item No.</u>	<u>Pay Item</u>	<u>Pay Unit</u>
02631-01	Mineral Aggregate, Ty A Base Grading D (2.03 Tons/CY)	Ton
02631-04	Unlined Channel	Linear Foot

END OF SECTION 02631

PART 1 - SCOPE

This work shall consist of the construction of storm drain pipe of the kinds and dimensions shown on the Plans, stipulated in the Contract Documents, or as directed by the Owner. The construction shall be accomplished in accordance with these Specifications and in conformity with the lines, grades, and details shown on the Plans or established by the Owner. The work shall include such labor, material, equipment, bedding, laying pipe, making joints, tunneling or jacking, encasement, foundation concrete, connection to other drainage structures, abandonment or removal of pipe, and all other items as may be necessary to complete the storm drains as shown on the Plans.

PART 2 – MATERIALS AND EQUIPMENT

2.01 MATERIAL

A. New Material.

All materials shall be subject to sampling, testing, and approval or rejection by the Owner. Unless otherwise specified all materials incorporated into the work shall be new and unused in previous construction. Used materials in acceptable condition may be used for trench bracing, forms, falsework, and similar uses.

B. <u>Manufacturer's Qualifications.</u>

The source of supply for each material to be supplied by the Contractor shall be subject to approval by the Owner before orders are placed. Storm drainage pipe shall be the standard product of a manufacturer of established good reputation in the industry and manufactured in a permanent plant adapted to meet the specified design requirements of the pipe.

C. Inspection and Testing.

1. Representative samples of materials intended for incorporation in the work shall be submitted for examination when so specified or requested. All materials to be used in the work shall be sampled, inspected, and tested in accordance with current ASTM specifications, or other specified standard specifications. The Contractor shall furnish the Owner with three copies of certified reports from a reputable testing laboratory showing the results of the tests carried out on representative samples of materials delivered and to be used in the project. The performance of all testing shall be done at no cost to the City.

2. The Contractor shall notify the Owner in advance of any deliveries of the materials and shall make whatever provisions are necessary, including the furnishing of such labor as may be required to aid the Owner in the examination, and culling of the materials on the site prior to installation in the work.

3. All materials not conforming to the requirements of these Specifications shall be considered as defective and rejected for use and shall be removed from the site of the work.

D. Storage.

The Contractor shall provide such storage facilities and exercise such measures as will insure the preservation of the specified quality and fitness of materials to be incorporated in the work.

E. <u>Reinforced concrete Pipe.</u>

1. All reinforced concrete pipe shall conform to the requirements of ASTM Standards for the specified diameter and strength class as follows:

- a. Circular Pipe ASTM C 76 Wall B
- b. Horizontal and Vertical Elliptical Pipe ASTM C 507
- c. Arch Pipe ASTM C 506

2. Strength class or classes shall be as required by the Plans or Contract Documents but in no case shall pipe of less than strength Class III be used. The interior surfaces of the pipe shall be a smooth, true cylindrical surface free from undulations or corrugations. Bungholes for lifting drain pipe shall be eliminated with the exception of radius pipe, manhole sections and elliptical pipe. Lift holes are to be provided for radius and elliptical pipe and manhole sections only. Lifting holes when provided shall be cast in the wall of the pipe to receive a precast truncated conical concrete plug of such size as will allow 1/8 inch cementing material on the sides of the joining surfaces of the plug and will fill at least 50 percent of the lifting hole depth. Cement shall meet all the requirements of the Specifications for Portland Cement, ASTM C 150, Type II. Curved alignments shall be constructed with precast, beveled end concrete radius pipe which meet the same requirements as for straight pipe. Concrete radius pipe less than or equal to 36 inch diameter shall have a minimum centerline radius of 20 feet and all radius pipe greater than 36 inch diameter and less than 72 inch diameter shall have a minimum centerline radius of 30 feet.

- 3. Joints in reinforced concrete pipe shall conform to one of the following types:
 - (A) Rubber Trapped "O" Ring Gasket type ASTM C 443
 - (B) Flexible Plastic Rope Gasket type AASHTO M 198 Type B
 - (C) Flexible Butyl Rope Gasket type AASHTO M 198 Type A
 - (D) Portland Cement Mortar Joint type

4. Type D, Portland Cement Mortar Joint, may only be used on radial, elliptical, and arch pipe. The shape, dimensions and tolerance of the bell and spigot or tongue and groove ends of the pipe shall be compatible with the type joint used and shall conform to the above referenced specifications.

F. <u>Nonreinforced Concrete Pipe.</u>

1. All nonreinforced concrete pipe shall conform to ASTM C 14 for the specified diameters and strength classes. Cut pipe for curved alignments shall be of uniform length along the same curve, and otherwise meet the requirements for straight pipe.

2. Joints in nonreinforced concrete pipe shall be the same as specified for reinforced concrete pipe.

G. Corrugated Steel Pipe

1. All corrugated steel pipe shall be zinc coated (galvanized) corrugated steel pipe conforming to AASHTO M 36 for Type I and Type II pipe. All special sections such as radii and flared end sections shall be the same sheet thickness and corrugation dimensions as ajoining pipe and shall conform to AASHTO M 36 unless specified otherwise on the Plans or Contract Documents. Type IA Pipe will not be permitted. When elongated pipe is called for by the contract, the pipe shall be shop formed to provide for a 5 percent vertical elongation. The zinc coated sheets used to manufacture the pipe and specials shall conform to AASHTO M 218. Corrugated steel pipe shall have one of the following protective coating systems:

a. Pipe and specials described above when specified by the Owner, additional protective coating shall be provided conforming on the requirements of AASTO M-190 or M-245 as indicated on plans and specifications.

The pipe shall be furnished with lifting straps for handling. The lifting straps may be attached by welding. No burning of holes will be permitted.

2. <u>Connections</u>.

All connections shall conform to AASHTO M 36 with the following exceptions:

a. Coupling bands shall have the same material and corrosion protection bondings and coatings as the pipe and specials which they connect.

b. Connections shall be made by recorrugating the end of pipe, a full 12 inches and using an annular band and a 12 inch flat gasket.

3. Field Applied Coating.

Field applied bituminous coatings for filling joints between adjacent paved inverts and coating coupling bands and all touch-up work shall conform to AASHTO M 243.

4. Radius Pipe.

All corrugated steel pipe radii shall be shop fabricated to provide a smooth internal radius of not less than the following for various size pipes:

a. Less than or equal to 36 inch diameter - 20 foot radii

b. Greater than 36 inch diameter and less than or equal to 72 inch diameter – 30 foot radius

No elbows, tees, wyes, and similar specials shall be permitted, except where specified by Plans and Design Standards.

- 5. Corrugated metal pipe will not be used unless specified by the Owner on the plans.
- H. Ductile Iron Culvert Pipe.

All ductile iron culvert pipe shall conform to the requirements of ASTM A 716 for the specified diameters and strength classes. All pipe shall be smooth and circular in cross section. All gray and ductile iron fittings shall conform to the requirements of ANSI A21.10 for the specified diameters. All joints shall be push-on type conforming to the requirements of ANSI A21.11 for the specified diameters.

I. <u>Vitrified Clay Culvert Pipe.</u>

All vitrified clay culvert pipe shall meet the requirements of ASTM C 700 for Extra Strength Clay Pipe. All joints shall be compression type meeting the requirements of ASTM C 425.

J. Portland Cement Concrete.

Portland Cement Concrete shall be of the class and dimensions as shown on the Plans, or as directed by the Owner. The classes of concrete for drainage facility construction are referred to as Class A and Class C. Class A concrete is intended principally for concrete structures designed for high strength. Class C concrete is intended principally for low strength concrete, used for foundation stabilization, pipe cradles and encasement and other general purpose uses. All portland cement, coarse aggregate, fine aggregate, water, air entraining agents and chemical admixtures; their proportioning, mixing, and delivery, shall be as specified in Division 3 of these specifications.

K. Crushed Limestone.

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)

<u>Size No.</u>	<u>1"</u>	<u>3/4"</u>	<u>3/8"</u>	<u>No. 4</u>	<u>No. 8</u>
67	100	90-100	20-55	0-10	0-5

L. Mortar.

1. Mortar shall be composed of one part portland cement, two parts masonry sand, hydrated lime not to exceed 10 percent of the cement used, and 4 parts water. All ingredients shall be proportioned by measurement and not by estimation. All portland cement, sand, and water shall be as specified in Division 3 of this Specification. All hydrated lime shall be as specified by ASTM C 6.

2. The mortar shall be hand mixed or machine mixed. In the preparation of hand mixed mortar, the sand, cement and hydrated lime shall be thoroughly mixed together in a clean, tight, mortar box until the mixture is of uniform color, after which water shall be added. Machine mixed mortar shall be prepared in an approved mixer and shall be mixed not less than $1\frac{1}{2}$ minutes. Mortar shall be used within 30 minutes after mixing.

3. Precast manhole sections, radius pipe and elliptical pipe lifting holes shall be filled with a non-shrinking grout from the outside and inside. Grout shall be set firmly before backfilling around structures.

M. Bracing Lumber.

Lumber for tunnel bracing shall be sound bridge oak placed to form a structurally sound timber tunnel lining properly braced. The timber tunnel lining shall remain in place after laying the pipe and backfilling. All timbers used in tunnels shall be of good quality reasonably straight grained and free from weakening knots and other defects.

2.02 EQUIPMENT.

A. The equipment provided by the Contractor shall include hoisting equipment capable of handling and placing the pipe in final position without damage to the pipe. Mechanical tamps shall also be provided.

B. All of the above equipment, as well as any additional equipment necessary for the satisfactory performance of this construction, shall be on the project and inspected by the Owner before work will be permitted to begin.

PART 3 – CONSTRUCTION REQUIREMENTS

- 3.01 MODIFICATION OF EXISTING STORM DRAIN.
 - A. Abandonment of Drainage Pipe.

1. Drainage pipe to be abandoned shall be sealed by mortaring (bricking) the end of the pipe for a distance of 18 inches minimum, or one-half the diameter of the pipe, whichever is larger. The pipe shall be sealed with solid concrete block or brick and acceptable cement grout to form a solid waterproof plug completely bonded to the pipe, unless otherwise specified.

2. The Contractor will be allowed to remove that portion of the pipe to be abandoned in lieu of filling and blocking. If the Contractor elects the removal method, all cost for backfilling the excavation and all costs for surface restoration, in addition to removing and properly disposing of the pipe, shall be included in the unit bid price for Abandonment.

B. <u>Connection to Existing Structures.</u>

1. The Contractor shall cut suitable openings as approved by the Owner into existing structures or remove existing pipe to accommodate the drain pipe if at the proper elevation,

location, and direction, as indicated on the Plans. The existing pipe shall be removed or a hole cut in the structure wall to permit inserting the drain pipe at the required flow line elevation, horizontal angle, and slope, and to allow 2 inches space around the pipe for bedding and filling solidly with mortar. Care shall be used to avoid unnecessary damage to the existing masonry.

2. All loose material shall be removed from the cut surfaces, which shall be completely coated with mortar before setting the pipe. If the structure wall is reinforced concrete, a cage of steel reinforcement shall be installed and the existing bars reshaped and tied to the cage around the entire pipe before mortar is placed in accordance with the Design Standard. Before inserting the pipe, a sufficient thickness of mortar shall be placed at the bottom and sides of the opening for proper bedding of the pipe. After setting, all spaces around the pipe shall be solidly filled with mortar and neatly pointed up on the inside to present a smooth joint, flush with the inner wall surface. Any necessary revisions in the existing invert shall be mad to provide a smooth plastered surface for properly channeled drainage from the new connection. Particular care shall be given to insure that the earth subbase and bedding adjacent to the manhole will provide firm solid support to the pipe.

C. <u>Removal of Drainage Pipe.</u>

Existing pipes to be removed and their locations are shown on the Plans. The City reserves the right to retain or reject salvage of any materials encountered. All remaining materials become the property of the Contractor who will be responsible for properly disposing of same off-site. All pipe whose removal is required to facilitate the installation of the proposed drainage facilities shall be removed without separate measurement or payment. This work shall be included in the price of the new drainage facility.

3.02 STORM DRAIN PIPE INSTALLATION

A. General.

Drain pipe and bedding shall be constructed of the sizes, classes, dimensions, and materials and to the alignments and grades shown on the Plans.

B. <u>Pipe Bedding.</u>

Bedding for drainage pipe shall conform to the requirements given below for Class A, B, or C bedding, whichever is shown on the Plans. If the class of bedding is not shown, a minimum of Class C bedding shall be provided.

1. <u>Class A – Concrete Cradle.</u>

Class A bedding for drainage pipe shall consist of a continuous concrete cradle up to springline constructed in conformity with the details shown on the Plans or as directed by the Engineer.

2. <u>Class B – Crushed Limestone.</u>

Class B bedding shall be constructed by bedding the drainage pipe on a six inch thickness of crushed limestone and sufficient additional crushed limestone which is accurately shaped by a template to fit the lower part of the pipe exterior for at least 10 percent of its overall height. After pipe installation crushed limestone shall then be rammed under the haunches and tamped in layers not over 6 inches in loose thickness around the pipe to the springline. The remaining depth of trench shall then be backfilled and compacted as specified in Specification Section 02631. When bell and spigot pipe is to be placed, recesses shall be dug in the bedding material of sufficient width and depth to accommodate the bell without its resting on the bottom of the recess. The width of the recess shall not exceed the width of the bell by more than 2 inches

3. <u>Class C – Natural Subgrade.</u>

Class C bedding shall be constructed by bedding the drainage pipe on a natural earth subgrade shaped by a template to fit the lower part of the pipe exterior for at least 10 percent of its overall height. After pipe installation select earth material shall then be rammed and tamped in layers not over 6 inches in loose thickness around the pipe to the springline. The remaining depth of trench shall then be backfilled and compacted as specified in Specification Section 02631. When bell and spigot pipe is to be placed, recesses shall be dug in the subgrade of sufficient width and depth to accommodate the bell without its resting on the bottom of the recess. The width of the recess shall not exceed the width of the bell by more than 2 inches.

C. <u>Pipe Laying.</u>

1. Inspection Before Laying.

The Contractor shall inspect all pipe upon delivery and such pipe as does not conform to the requirements of these Specifications and which are not suitable for use shall be rejected and immediately removed from the work site.

2. Pipe Ends Cleaned and Lubricated Before Laying.

Preparatory to making pipe joints, all surfaces of the portions of the pipe to be jointed or of the factory made jointing materials shall be clean and dry. All necessary lubricants, primer, adhesives, etc., shall be used as recommended by the pipe or joint manufacturers specifications.

3. Care During Hoisting, Placing, and Shoving Home.

Equipment used to handle, lay and joint pipe shall be so equipped and used as to prevent damage to the pipe and its jointing materials. All pipe and fittings shall be carefully handled and lowered into the trench. Damaged pipe or jointing material will not be accepted and shall not be installed. All rejected material shall be removed from the job site.

4. <u>Uniform Pipe Bearing.</u>

a. Special care shall be taken to insure that the pipe is solidly and uniformly bedded, cradled, or encased in accordance with the type of bedding, cradle, or encasement required by the Plans. No pipe shall be brought into position for joining until the preceding length has been bedded, joined and secured in place.

b. Where a concrete cradle is required, the pipe shall be supported at not more than two places with masonry supports of minimum size sufficient to provide the required clearance and to prevent displacement during placing of concrete.

5. Direction of Work.

The laying of pipe in finished trenches shall be commenced at the lowest point. When installed the bell or grooved end shall be forward or upgrade. All pipe shall be laid with ends abutting and true to line and grade. They shall be carefully centered so that when laid they will form a drain with a uniform invert.

6. <u>Alignment and Grade.</u>

Each piece of pipe shall be checked for vertical and horizontal alignment immediately after being laid.

7. <u>Bedding to Secure Pipe.</u>

As soon as possible after the joint is made, sufficient material shall be placed alongside each side of the pipe to offset conditions that might tend to move the pipe off line and grade. Particular care shall be used to prevent disturbance or damage to the pipe and the joints during backfilling.

8. Flotation and Water in the Trench.

a. The Contractor shall take all necessary precautions to prevent flotation of the pipe in the trench.

b. Water shall not be allowed to rise in the trench until the joint materials and any concrete cradle or encasement is hardened and cannot be damaged by the water.

9. Open Ends.

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 displacement, flotation, cave-in, in-wash of soil or debris, or other injuries. A suitable temporary tight fitting plug, stopper, or bulkhead shall be placed in the exposed ends of the pipe.

10. Curved Alignment.

Curved storm drain alignments shall be constructed with manufactured, beveled end radius pipe for circular pipe sizes of 21 inch diameter and larger. Curved storm drain alignments for noncircular pipe and circular pipe smaller than 21 inch diameter shall be constructed with a brick radius. Brick radius shall be constructed to the radius and dimensions shown on the Plans, but not less than 20 foot radius, and in accordance with Specification Section 02640 Paragraph 3.02.B. Curved storm drain alignments shall not be constructed by breaking joints of straight pipe sections. Curved alignments of corrugated metal storm drain shall be constructed to the radius specified.

- D. Pipe Joint.
 - 1. <u>General.</u>

a. Jointing operations shall continue immediately following the laying of such pipe section. In no case shall any pipe section be left overnight which has not been completely jointed to the preceding pipe section in conformance with these Specifications.

b. No composition or asphalt base joint material shall be used to seal pipe joints.

c. The rubber trapped "O" ring gasket and flat rubber gasket shall be used on all drain pipe on City C.I.P. Projects. In sub-divisions the flexible butyl gasket joint may be used outside of the street right-of-way; the rubber gasket shall be used in the street right-of-way. The butyl gasket material may be placed on the end of the spigot only (not in the bell). See Specification Section 02632 Paragraph 3.04.

2. Concrete Pipe.

a. <u>Rubber Trapped "O" Ring Gasket Joints:</u>

(1) The two ends to be joined shall be thoroughly cleaned and a rubber gasket compatible with the type of pipe ends to be and a rubber gasket compatible with the type of pipe ends to be joined shall be placed on the tongue or spigot end of the pipe. Care shall be taken to assure even tensioning and uniform cross-section of the gasket around the full circumference of the pipe. When required, lubricant recommended by the joint material manufacturer shall be liberally applied to the gasket and both ends of the pipe immediately before pipe ends are joined. The upstream pipe shall be positioned such that the tongue or spigot may enter the groove or bell squarely.

(2) Suitable means shall be used to force the tongue or spigot end of the pipe into the groove or bell end without damage to the pipe and its jointing materials, and without disturbing the previously laid pipes and joints. Any pipe or gasket damaged during jointing operations shall be removed and pipe rejointed at the Contractor's expense.

b. Flexible Plastic or Butyl Gasket Joints.

(1) The two ends to be joined shall be thoroughly cleaned. If primers are recommended by the gasket material manufacturer, they shall be applied sufficiently in advance to allow primer to dry prior to placement of gasket material. Protective paper shall be removed from one side of gasket and gasket laid around joint surfaces near center of final gasket position desired. Gasket material may be placed on either the bell or spigot ends of the pipe as well as the tongue or groove ends of pipe. Gasket shall be placed and pressed firmly around the entire circumference of the joint and butted end to end forming a continuous gasket without stretching the gasket material. Care shall be exercised to ensure that the proper gasket size for the associated pipe joint is used.

(2) The upstream pipe shall be positioned and remaining protective paper removed. Suitable means shall be used to force the tongue or spigot end of the pipe into the groove or bell end without damage to the pipe and its jointing materials, and without disturbing the previously laid pipes and joints. Pipe shall be shoved home until gasket material is squeezed out of the joint. Squeeze out will be external if gasket material is placed on the tongue or spigot and internal if on the groove or bell ends of the pipe. All joints not fully filled with gasket material until "squeeze-out" occurs shall be rejoined with new gasket material at the Contractor's expense.

- c. Portland Cement Mortar Joints for Radius, Elliptical and Arch Pipe.
 - (1) Bell and Spigot Pipe.

(a) When the bell and spigot type of joint is used, a closely twisted hemp or oakum gasket, of such diameter as required to support the spigot of the pipe at the proper grade and make truly concentric joints and in one piece of sufficient length to pass around the pipe and meet at the top, shall be thoroughly saturated in portland cement mortar. This gasket shall be laid in the bell for the lower third of the circumference of the joint and covered with mortar specified for pipe joining. The spigot of the pipe shall be thoroughly cleaned with a wet brush, inserted, and carefully driven home, after which a small amount of mortar shall be inserted in the annular space around the entire circumference of the pipe.

(b) The ends of the gasket shall then be wrapped around the pipe and solidly rammed into the joint with a caulking tool, the mortar previously placed being driven ahead of the gasket. The remainder of the joint shall then be completely filled with mortar and beveled off to an angle of 45 degrees with the outside of the pipe. The fresh mortar joint shall then be protected by wrapping with a strip of suitable tight woven cloth passed under the pipe, drawn up tight around the joint and tied at the top with a knot behind the bell. The bell hole under the pipe shall then be fully packed with cement mortar.

(c) On pipes of 24 inches or larger in diameter, the joints shall be pointed and smoothed from the inside and excess or wasted mortar removed from the inside of the pipe. On smaller pipes, the inside of the pipe shall be smoothed and wasted mortar removed.

(2) Tongue and Groove Pipe.

(a) When the tongue and groove type of joint is used, the groove end of the first pipe must be thoroughly cleaned with a wet brush and a layer of soft mortar applied to the lower half of the groove. The tongue end of the second pipe must be thoroughly cleaned with a wet brush and, while in a horizontal position, a layer of soft mortar applied to the upper half of the tongue. The tongue end of the second pipe is then inserted into the groove end of the first pipe until the mortar is squeezed out on the interior and exterior surface.

(b) The pipe is then to be partially bedded in place in the trench by tamping dirt on both sides leaving a gap or open space at the joints, special care being exercised so that no dirt gets into the joint. The annular space is then to be completely filled by calking mortar into the joint from the outside and on the inside around the entire perimeter of the pipe.

(c) A strip or band of cement mortar 1 inch thick and 3 inches wide shall then be built up around the entire outside perimeter of the pipe. The joint shall then be protected by wrapping with a strip of burlap, cotton cloth, or strong waterproof paper of suitable width. This strip of protective covering shall pass underneath the pipe, be drawn uptight around the joint and securely fastened at the top. The space under the pipe at the joint shall then be packed with mortar.

(d) In addition to the above outlined method of sealing pipe joints, the Contractor will be required to caulk the joints with mortar around the entire perimeter of the pipe on the inside, finally pointing up and brushing the joint to a smooth finish.

(3) Poured Mortar Joint.

(a) A continuous diaper shall be placed around the outside of each joint with a 12 inch gap at the top for pouring. Diapers shall consist of heavy cotton, burlap or approved synthetic fiber of such strength and texture that leakage and sagging under the weight of the grout will be prevented. Diapers shall be attached to the pipe with steel wires or bands of adequate strength to hold the loaded diaper without stretching or slipping. Diapers shall be filled with mortar. Consistency of the mortar shall be such that the diaper will be completely filled in one continuous pouring operation. The pouring space at the top of the joint shall be plastered with mortar. Diapers shall be left in place.

(b) Provision shall be made on the inside of the pipe to prevent loss of mortar through the joint. The Contractor shall then grout the joint around the entire perimeter of the pipe on the inside with stiff mortar, point and brush the joint to a smooth finish.

d. Jointing Tolerances.

(1) The maximum allowable joint width measured on the inside surface of concrete pipe shall not be more the $\frac{3}{4}$ inch for pipe sizes 15 inches through 21 inches in inside diameter; 1 inch for pipe sizes 24 inches through 45 inches in inside diameter; and $\frac{1}{4}$ inch for pipe sizes 48 inches and larger in inside diameter.

(2) When the width of any joint exceeds the foregoing limits, the Owner will determine the acceptability of the joint, the requirements for acceptable repair, or will reject the joint to require relaying and rejointing.

3. <u>Corrugated Steel Pipe.</u>

a. Coupling Band.

(1) The two ends to be joined and the coupling band shall be thoroughly cleaned within the area to be covered by the coupling band and the inside of the coupling band. The coupling band and O-ring gasket shall be placed on the end of the pipe section to be lowered into the trench such that one-half the band width is exposed. Care shall be taken during the pipe positioning operations to prevent dirt or foreign matter from becoming lodged between the pipe ends and the coupling band. The upstream pipe shall be positioned such that the two pipe ends butt together squarely. Coupling bands shall be positioned such that the band corrugations and O-ring gaskets are aligned with the pipe corrugations and the coupling band laps on an equal portion of each pipe section. Fastening devices shall be located to facilitate ease of tightening. Fastening bolts shall be tightened uniformly to the required torque recommended by the pipe manufacturer but shall not be over tightened creating excessive stresses in the pipe.

(2) After coupling band installation the interior joint between asphalt pavements shall be completely filled with trowel grade mastic material as outlined in this Specification. The mastic shall be brought up flush with the asphalt pavement surfaces being joined. The entire exterior of each joint assembly, including bands, rods, lugs, bolts, and nuts shall be given one coat of mastic material of spraying or brushing consistency

b. Jointing Tolerances.

(1) The maximum allowable separation between adjoining sections of pipe when measured on the inside surface of corrugated steel pipe shall not be more than 1 inch. When the width of any joint exceeds the foregoing limits, the Owner will reject the joint and require relaying rejointing.

4. Ductile Iron Pipe.

a. The two ends to be joined shall be thoroughly cleaned and a rubber gasket compatible with the type of pipe ends to be joined shall be placed on the spigot end of the pipe. Lubricant recommended by the joint material manufacturer shall be liberally applied to the gasket and both ends of the pipe immediately before pipe ends are joined. The upstream pipe shall be positioned such that the spigot may enter the bell squarely.

b. Suitable means shall be used to force the spigot end of the pipe into the bell end without damage to the pipe and its jointing materials and without disturbing the previously laid pipes and joints.

5. <u>Vitrified Clay Culvert Pipe.</u>

a. The two ends to be joined shall be thoroughly cleaned and a compression gasket compatible with the type of pipe ends to be joined shall be placed on the spigot end of the pipe. Lubricant recommended by the joint material manufacturer shall be liberally applied to the gasket and both ends of the pipe immediately before pipe ends are joined. The upstream pipe shall be positioned such that the spigot may enter the bell squarely.

b. Suitable means shall be used to force the spigot end of the pipe into the bell end without damage to the pipe and its jointing materials and without disturbing the previously laid pipes and joints.

E. <u>Cleaning and Inspection.</u>

1. The interior of the pipe shall, as the work progresses, be cleared of all dirt, cement extruded joint materials, debris, and extraneous materials of every description. On small pipe where cleaning after laying may be difficult, a squeegee shall be kept in the pipe line and pulled forward past each joint immediately after its completion.

2. All work shall be in undamaged condition and constructed properly in accordance with the Plans and Contract Documents. All defects and leaks disclosed by tests shall be remedied. No piping shall be buried, covered, or concealed until it has been inspected, tested, and approved. To do otherwise will be grounds for rejection of the pipe by the Owner. All tests shall be performed by the Contractor under supervision of the Owner.

3. While the pipe is being laid between adjoining structures in each straight or working section of the drain, light from the finished or other end of the section shall remain constantly in plain view throughout the entire length of such section and shall show the true character and shape of the interior surface of the drain. The test shall be applied for each working section after the drain is complete in all respects before it is accepted

4. Pipe sizes greater than 36 inch diameter or equivalent diameter shall be entered and examined while smaller diameter or equivalent diameter pipe shall be visually inspected from each end of the pipe section. Pipe sections shall be visually inspected for debris and obstructions, structural cracks and defects, joint tolerances, joint workmanship, and satisfactory connection to drainage structures.

3.03 CONCRETE ENCASEMENT

A. Concrete encasement for pipes is to be used at the locations shown on the Plans or as directed by the Owner. Concrete used for encasement shall be Class "C" Concrete.

B. All pipe requiring encasement shall be blocked at each joint using masonry supports of a minimum size sufficient to provide the required clearance and to prevent displacement during placing concrete.

C. All concrete shall be placed, cured and protected in accordance with Specification Section 03310, "Concrete Structures". Concrete shall be placed on either side of the pipe in approximately equal amounts to prevent movement of the pipe. Pipe alignment shall be inspected immediately following concrete placement, and any misalignment caused by the placement of concrete shall be corrected prior to the concrete's initial set. Concrete shall be protected against water flowing over the concrete until completely cured.

D. Concrete encasement is to be rectangular in section with a minimum concrete thickness of 6 inches between the outside edge of pipe and the outside of encasement at the closest point unless shown otherwise on the Plans. Encasement around pipe joints shall extend a minimum of 2 feet either side of the joint as measured along the centerline of the pipe. Encasement shall be reinforced if specified on the Plans or in the Special Instructions.

3.04 TUNNELING AND JACKING

A. <u>General</u>

1. Storm drain shall be constructed by tunneling or jacking only at those locations and within limits shown on the Plans or directed by the Owner.

2. Where pipe is required to be installed under railroads, highways, streets, or other facilities by tunneling or jacking, construction shall be made in such a manner that will not interfere with the operation of the railroad, street, highway, or other facility, and shall not weaken or damage any embankment or structure.

3. If any storm drain, sewer, or utility above or adjacent to the tunnel is endangered or has been damaged because of the tunneling or jacking operations or movements of earth, the owner of same shall be notified immediately and shall be given access to the work for repair. The Contractor shall repair, at his expense, any storm drain or sewer damaged during the tunneling or jacking operation. If any public or private property is endangered, or has been damaged, it shall be repaired at the Contractor's expense. All cost and expense to the Contractor of carrying out the above requirements shall be incidental to the work.

4. The jacking pit shall be of sufficient size to provide ample working space for the jacking equipment, reaction blocks, bracing, liner plates, spoil removal and 1 or 2 sections of pipe. Provisions shall 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 shall be provided. Wherever end trenches are cut in the sides of the embankment or beyond it, such work shall be sheeted securely and braced in a manner satisfactory to prevent earth caving.

5. The Contractor shall furnish and operate all necessary pumping equipment of ample capacity and make all necessary provisions to keep tunnels and shafts free of water during construction and to satisfactorily dispose of such water. During placing of concrete, drainage and pumping shall be so arranged that concrete is placed in the dry and that no water will flow over the concrete until it has set and will not be damaged and not sooner than two hours after initial set. The Contractor shall have on hand at all times sufficient equipment in good working order for all ordinary emergencies that are likely to arise.

B. Tunneling.

1. The Contractor shall carry out the work of tunneling and supporting the tunnel face, roof, walls, and floor so that there will be no fall or flow or caving or heaving of earth or other materials into the tunnel excavation. If there should be any fall or movement of earth into the tunnel at any time, the Contractor shall proceed with the work with all necessary precautions and in such a manner as will insure the safety of life and of all sewers, utilities and public and private property above and adjacent to the tunnel. The Contractor shall comply with all applicable OSHA regulations as stipulated in Part 11 – General Conditions during tunnel construction work.

2. The Contractor shall furnish, place, and maintain all sheeting, bracing, lining or casing required to support the tunnel floor, roof, sides, and face until the pipe and its bedding, jointing, encasement, and backfilling have been completed. All liners shall remain in place. Care shall 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 drain alignment. Sheeting or lining must be placed and held tightly against the trimmed earth surface of the excavated section so that will be no voids between the earth and the lining or sheeting placed against it. No part of the lining, bracing, or flanges of steel liner plates shall 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. If timber is used for lining and bracing instead of steel liner plates, invert struts shall 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, shall be properly fitted and wedged in place. Timber sets in tunnels shall be abutting. All void spaces in back of timbers shall be filled with blocking or other suitable material.

3. Timbering shall be so designed and placed that there will be no space or pockets that cannot be packed and filled. All excavated material not required for backfilling abandoned shafts shall be removed from the site and disposed of by the Contractor at his expense.

4. Shafts shall be constructed at the location shown on the Plans. Temporary construction shafts shall be of adequate size and properly constructed and equipped to meet all requirements of safety to personnel and to the work. All shafts shall be barricaded and properly guarded from the beginning of the excavation until the shaft is completely backfilled.

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

6. A substantially constructed ladder shall be provided in each shaft and shall be kept in safe good repair, clean, and clear of debris.

7. Cavities or spaces between the actual surfaces of excavation and the tunnel liner plates or sheeting, whether from avoidable or unavoidable causes, shall be completely filled with a uniform sand cement grout, consisting of 1 part portland cement and maximum 5 parts sand and the minimum amount of water necessary for proper placing, placed under pressure through grout-hold nipples in the steel liner plates or grout holes in sheeting. The grout holes shall be so located and the grout be placed in such sequence as to insure the complete filling of all cavities and spaces and of carrying loads uniformly from the undisturbed material to the tunnel lining or sheeting.

8. All pipe used in tunnels shall be reinforced concrete pipe with rubber O-ring gasket joints and shall be the strength class or classes required by the Plans.

9. After the tunnel section is excavated, lined, and braced, the pipe shall be placed on and supported by steel rails or other approved supports. The supporting system shall assure line and grade and shall allow space below the pipe for concrete grout. Care shall be used to avoid damage to the pipe or to the liner plates. Any such damage shall be replaced when so directed by the Owner.

10. The space between the pipe and the sides and roof of the tunnel shall be backfilled 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 placing whether placed under pressure or by hand. The cement grout shall be uniformly placed and compacted to fill all spaces between the outside of the pipe and inside surface of the sheeting or lining.

11. Temporary shafts shall be completely abandoned. Unless otherwise specified in the Plans or Contract Documents, all sheeting, bracing, and similar items may be removed or left in place at the Contractor's option. No payment will be made for such items left in place at the Contractor's option. If the Plans required leaving the sheeting, bracing, and similar materials, in place, payment will be made as provided in Specification Section 02631 Paragraph 5.02.

C. Jacking

1. Heavy duty jacks suitable for forcing the pipe through the embankment shall be provided by the Contractor. In operating jacks, even pressure shall be applied to all jacks used. A suitable jacking head, usually of timber, and suitable bracing between jacks and jacking head shall be provided so that pressure will be applied to the pipe uniformly around the ring of the pipe. A suitable jacking frame or back stop capable of resisting the jacking forces shall be provided. The pipe to be jacked shall be set on guides, properly braced together to support the section of the pipe and to direct it in the proper line and grade. For pipes greater than 54 inch diameter or equivalent diameter the rails shall be set in a concrete slab. The whole jacking assembly shall be placed so as to line up with the direction and grade of the pipe. If the Contractor desires, he 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 inside angles or lugs to keep the cutting edge from slipping back onto pipe.

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

3. Preferably, the pipe shall be jacked from the low or downstream end. Lateral or vertical variation in the final position of the pipe from the line and grade established by the Owner will be permitted only to the extent of 1 inch in 10 feet, provided that such variation shall be regular and only in one direction and that the final grade of flow line shall be in the direction indicated on the Plans. Manholes at the ends of a section of jacked pipe shall not be constructed until the jacked section is completed, in order to allow corrections for deviations in the line or grade of the jacked section.

4. All pipe used in jacking shall be tongue and groove type reinforced concrete pipe with rubber O-ring gasket joints and shall be the strength class or classes required by the Plans or Contract Documents. Any pipe damaged in jacking operations shall be removed and replaced by the Contractor at his own expense. A cushion material shall be placed between the butt ends of each pipe section adequate to uniformly distribute the jacking forces around the entire periphery of the pipe. Cushion material shall allow proper positioning of the O-ring gasket upon completion of the jacking operation.

5. Embankment material shall 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. The excavation for the underside of the pipe, for at least one-third of the circumference of the pipe, shall 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. The distance that the excavation shall extend beyond the end of the pipe depends on the character of the material, but it shall not exceed 2 feet in any case. This distance shall be decreased on instructions from the Owner if the character of the material being excavated makes it desirable to keep the advance excavation closer to the end of the pipe.

6. When jacking of pipe is begun, the operation shall be carried on without interruption, until completion, to prevent the pipe from becoming firmly set in the embankment.

7. The pits or trenches excavated to facilitate jacking operations shall be backfilled immediately after the jacking of the pipe has been completed in accordance with Specification Section 02631 Paragraph 3.04.

D. <u>Pipe Drains In Jacked Liner.</u>

1. When permitted as an alternate method of construction by the Plans or Contract Documents, or when permitted by the owner upon written request of the Contractor as an alternate to jacking without a liner or tunneling, a storm drain may be installed by jacking a pipe as a liner and inserting a carrier pipe of required size, type and class. When planning to use jacking for liners, the Contractor shall state in writing the kind, type and strength of liner, the type of joint proposed and the method of operation. Approval in writing by the Owner shall be obtained in advance of starting the work. In any case, the Contractor shall retain full responsibility for the adequacy of his jacking operation, equipment, and complete work.

PART 4 – MEASUREMENT

4.01 STORM DRAIN PIPE.

Storm drain pipe length will be measured per linear foot along the centerline of the pipe from inside face to inside face of drainage structures or to plain ends of pipe for the various sizes, types, classes, wall thicknesses, coatings or linings. Beveled end (radial) pipe length will be measured per linear foot along a centerline of the required radius and deflection angle. Storm drain pipe depth will be measured as the vertical depth between pipe flowline and natural ground surface along the pipe centerline for the various depth classifications specified in the Proposal. For depth measurement and classification purposes, the natural ground surface is defined as the subgrade template elevation for streets or other graded areas under which drains are placed or the actual natural ground surface, whichever is at the lower elevation.

4.02 PLAIN CONCRETE FOR PIPE BEDDING AND ENCASEMENT.

Plain concrete for pipe bedding and encasement at the locations shown on the Plans or directed by the Owner will be measured per cubic yard, complete in place.

4.03 REINFORCED CONCRETE FOR PIPE BEDDING AND ENCASEMENT.

Reinforced concrete for pipe bedding and encasement at the locations shown on the Plans or directed by the Owner will be measured per cubic yard, complete in place.

4.04 STORM DRAIN IN TUNNEL OR JACKED LINER.

Storm drain in tunnel or jacked liner will be measured per linear foot along the centerline length unless directed otherwise by the Owner in writing.

4.05 JACKED STORM DRAIN.

Jacked storm drain will be measured per linear foot along the centerline length unless directed otherwise by the Owner in writing.

4.06 REMOVAL OF EXISTING PIPE.

Removal of existing pipe will be measured per linear foot along the centerline of the pipe to be removed for various sizes or types. No measurement of existing pipe removal within the limits of excavation for new storm drain will be made.

PART 5 – PAYMENT

5.01 STORM DRAIN PIPE.

The accepted quantities of storm drain pipe will be paid for at the contract unit price per linear foot furnished and laid for the various sizes, types, classes, wall thicknesses, coatings, linings, and depths which price will be full compensation for materials and materials' testing, excavation, special protection, protection of existing utilities, specified bedding, laying, jointing, cleaning and inspection, fittings, connection to existing structures, removal and/or plugging of abandoned pipe within the limits of excavation and backfilling.

5.02 PLAIN CONCRETE FOR PIPE BEDDING AND ENCASEMENT.

The accepted quantities of plain concrete for pipe bedding and encasement will be paid for at the contract unit price per cubic yard, complete in place which price will be full compensation for materials and materials' testing, pipe support, formwork, removal of forms, and placement, curing and protection of concrete.

5.03 REINFORCED CONCRETE FOR PIPE BEDDING AND ENCASEMENT.

The accepted quantities of reinforced concrete for pipe bedding and encasement will be paid for at the contract unit price per cubic yard, complete in place which price will be full compensation for materials and materials' testing, pipe support, formwork, reinforcement, removal of forms, and placement, curing and protection of concrete.

5.04 STORM DRAIN IN TUNNEL OR JACKED LINER.

The accepted quantities of storm drain in tunnel or jacked liner will be paid for at the contract unit price per linear foot furnished and laid for the various sizes, which price will be full compensation for materials and materials' testing, pit excavation, sheathing, timber bracing, liner, excavation, temporary shafts, pumping, grouting, pipe, laying pipe, making pipe joints, cleaning and inspection, and backfilling of pits and shafts.

5.05 JACKED STORM DRAIN.

The accepted quantities of jacked storm drain will be paid for at the contract unit price per linear foot furnished and laid for the various sizes; which price will be full compensation for materials and materials' testing, pit excavation, jacking equipment, and concrete slab foundation, jacking back stop excavation, temporary shafts, pumping, pipe, laying pipe, making pipe joint cushions, cleaning and inspection, and backfilling of pits and shafts.

5.06 REMOVAL OF EXISTING PIPE.

The accepted quantities of existing pipe removal shall be paid for at the contract unit price per linear foot for various pipe sizes and types which price will be full compensation for excavation, special protection, protection of existing utilities, pipe removal, salvage or disposal, backfilling and site restoration.

5.07.1 PAYMENT WILL BE MADE UNDER:

Item No.	Pay Item	<u>Pay Unit</u>
02632-01.03.60.04	60" Reinforced Concrete Pipe, Class IV, 15-20' Depth	Linear Foot
02632-06.03.60.04	Removal Of Existing 60" Pipe	Linear Foot
02632-07	Removal Of Existing Structures	Each
02632-08	Concrete Endwall	Each
02632-09	Catch Basin	Each

Examples of Pay Item Numbering System for Storm Drain Pipes

02632-01.02.12.01	Pay Item Number
02632	Section of Specification
-01	last digit(s) of applicable paragraphs for measurement and payment
.02	Type of Pipe; e.g., reinforced concrete pipe, Class II
.12	Size of Pipe; e.g., 12" diameter
.01	Depth of Pipe; e.g., 0' – 6' depth

END OF SECTION 02632

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.

_ <u>Nam</u> e	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. <u>Fertilizer.</u>

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. <u>Biodegradable Fabric.</u>

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 $\frac{1}{2}$ 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	<u>Pay Unit</u>
02920-4.01	STRIPPING AND REPLACING TOPSOIL	Cubic Yards
02920-5.01	SEEDING (WITH MULCH)	Unit of 1,000 SF
02920-5.02	SEEDING (WITHOUT MULCH)	Unit of 1,000 SF

END OF SECTION 02920

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 1⁄2 "	2"	1 1⁄2"	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.B 02950-4.01.C	CONCRETE SIDEWALK REPAIR CONCRETE CURB AND GUTTER REMOVAL AND REPLACEMENT	SQUARE YARD SQUARE YARD

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 precastprestressed 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-earlystrength 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 highearly-strength is being substituted.
- C. No additional compensation will be made if the Subcontractor elects to substitute high-earlystrength 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.

PORTLAND CEMENT 2.04

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 $\frac{1}{2}$ 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 ı such as schist o	nondura shale, s r cemer	ble fragmo soft sands ited grave	ents (fragmen tone, limonite l)	ts which a concretio	re structurally ns, gypsum, v	v weak veathered	3.0
	b.	Coal an	d lignite						1.0
	C.	Clay lur	nps						0.25
	d.	Materia	l passin	g the No. 2	200 sieve				1.00
	e.	Thin or	elongate	ed pieces	(length greate	er than 5 ti	mes average	thickness) 1	0.00
	f.	Other lo	ocal dele	terious su	bstances				1.00
		i. Not	es:						
		(1)	aggreg dust of Weight	ate, if all fracture e , may be ii	the material ssentially free	finer than of clay or .5.	In the the 200 mes shale, Item 4	case o sh sieve con I, Maximum I	f crushed sists of the Per Cent by
		(2)	Items N	lo. a, b, c,	d, and f shall	not excee	The sun ed 5.0.	n of the perc	centages of
		(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.						the sodium e not more	
		(4)	Alterna	te freeze/t	haw tests for	soundnes	s will not be p	erformed.	
		(5)	The pe	rcentage o	of wear as det	ermined b	y AASHTO T	96 shall not	exceed 40.
			COAR	SE AGGE T	REGATE GRA able 03 05 00	ADATION).1	TABLE		
Size Number	Am 2"	ounts Fi 1-	iner Tha 1/2"	n Each La 1"	ab. Sieve (Sq. ¾"	Openings 1/2"	e), % By Weig 3/8"	ht 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		1(00	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 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 $(1 2\frac{1}{2} \operatorname{inch})$ 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.

CITY OF MEMPHIS – STANDARD CONSTRUCTION SPECIFICATIONS Modified by SARP10 Program

- F. Vibrators
 - Vibrators shall be of an approved type and design, and shall operate under load at the 1. 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° 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°F (if the temperature is expected to reach 35°F or below), and not resumed until an ascending air temperature in the shade and away from artificial heat reaches 35°F.
 - e. When concreting at temperatures above 35°F, 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°F nor more than 90°F 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°F or less, the Purchaser will require the water or the aggregates or both to be heated to not less than 70°F nor more than 150°F. The temperature of the mixed, heated concrete shall be not less than 50°F nor more than 100°F 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°F, 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°F and the temperature of the concrete shall not exceed 80°F. 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°F. When the air temperature or concrete temperature exceeds 70°F, 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°F 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.
 - 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 slum 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.

P 5,000	C 2,500	B 3,500 (1	AS	A 3,000	Course Concrete) Ō	#/CY Class	Minimum	
1-3	2-4) 1-2 ½	4,000	ა -5	Strength (ps Aggregate	Limestone Compressiv	28-Day		
(2)	5.0	6.2	ა 5	6.0	i) Inches	e In	Slump	(i) Min. Cerr	
7.0	4.5	5.8	(2)	5.5	Aggregate	Course	Gravel	(3) nent Factor-Sack	
(2)	470	583	6.2	564	Aggregate	Course	Limestone	s/CY (3	Tat
658	423	545	(2)	517	Aggregate	Course	Gravel) Min. Cement	ole 03 05 00.2
(2)	34	34.1	583	36	Aggregate	Course	Limestone	(Factor-#/CY	
35.0	30.6	31.9	(2)	33	Aggregate	Course	Gravel	3) Net Water N	
(2)	283	284	37.2	300	Aggregate	Course	Limestone	(3) ⁄lax. Gals./CY	
292	255	266	(2)	275	Aggregate	Course	Gravel	Net Water I	
			310					Max-	

CITY OF MEMPHIS – STANDARD CONSTRUCTION SPECIFICATIONS Modified by SARP10 Program

CONCRETE CLASSIFICATION TABLE

Minimum compressive strength @ 14 days. Minimum flexural strength @ 14 days of 550 psi per AASHTO T 22. Gravel Coarse Aggregate no permitted. Tabulated valves are for Type I cement conforming to the requirements of AASHTO M 85 only.

(4)

03050-14

5/30/2025

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
 - 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.

ASTM						
Title	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.

	ASTM	
Title	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°	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:
 - 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.
 - 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.
 - 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
- C. Bar Reinforcement

specification.

- 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 ³/₄ 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 1/4 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 on 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° 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 the4 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° 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° 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