ARPA PROJECT
WW-PDC-01
HILLSHIRE STORAGE AND CONVEYANCE
PERMIT NUMBER 0020711
CITY OF MEMPHIS

WPN24.0967

APPROVED FOR CONSTRUCTION

THE DOCUMENT BEARING THIS STAMP HAS BEEN RECEIVED AND REVIEWED BY THE

TENNESSEE DEPT. OF ENVIRONMENT & CONSERVATION
DIVISION OF WATER RESOURCES

AND IS HEREBY APPROVED FOR CONSTRUCTION BY THE COMMISSIONER

02/18/2025

THIS APPROVAL SHALL NOT BE CONSTRUED AS CREATING A PRESUMPTION OF CORRECT OPERATION OR AS WARRANTING BY THE COMMISSIONER THAT THE APPROVED FACILITIES WILL REACH THE DESIGNED GOALS.

APPROVAL EXPIRES ONE YEAR FROM ABOVE DATE

Technical Specifications for

SARP10 Hillshire Storage Basin Conveyance System - Phase 1
6800 Hillshire Drive
Memphis, TN

Owner:

City of Memphis
SARP10 Program
845 Crossover Lane,
Building D, Suite 120
Memphis, TN 38177

By: Pickering Firm, Inc. &
Cannon & Cannon, Inc.

100% Design December, 2024

HARVEY W. MATHENY
REGISTERED ENGINEER
XVI
AGRICULTURE
COMMERCE
No. 021231
STATE OF TENNESSEE

12/19/24

SECTION 000110
TABLE OF CONTENTS

The following Table of Contents outlines the list of the **SARP10 Hillshire Storage Basin, 6800 Hillshire Drive, Memphis, TN** Contract Documents. The CONTRACTOR is advised that this Project Manual, the Contract Drawings, and any and all addenda and/or change orders related thereto are hereby defined in whole as the "Contract Documents" and no separation of same will be considered.

This Project Manual follows the 2004 MASTERFORMAT Document Identifying System, with the exception of City of Memphis Standard Specifications which follows the 1995 MASTERFORMAT Section Numbers. Nonapplicable division and section references have been omitted.

Conflicts between any parts of the Contract Documents shall be brought to the OWNER's attention prior to the receiving of bids.

The CONTRACTOR is responsible for verifying that all documents have been received.

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SECTION 312500

EROSION AND SEDIMENTATION CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Implementation of temporary and permanent erosion and sedimentation controls.

1.3 REFERENCES

A. Tennessee Department of Environment and Conversation (TDEC)
   1. General NPDES Permit for Discharges of Storm Water Associated with Construction Activities, latest version.
   2. Tennessee Erosion & Sediment Control Handbook, latest edition.
   3. Stormwater Pollution Prevention Plan: when one is provided by the Owner or Engineer.

B. In the event of conflict between these requirements and pollution control laws, rules or regulations, or other federal, state, or local agencies, the more restrictive laws, rules, or regulations shall apply.

1.4 SYSTEM DESCRIPTION

A. The work specified in this Section consists of providing, maintaining, and removing temporary erosion and sedimentation control.

B. The Contractor shall follow the latest edition of the Tennessee Erosion and Sedimentation Control Handbook.

C. Temporary erosion controls include, but are not limited to, grassing, mulching, watering and reseeding on-site surfaces and spoil and borrow area surfaces, and providing interceptor ditches at ends of berms and at locations which will ensure that erosion during construction will be either eliminated or maintained in accordance with applicable regulations.

D. Temporary sedimentation controls include, but are not limited to, silt dams, traps, barriers, filter stone and appurtenances at the foot of sloped surfaces which will ensure that sedimentation pollution will be either eliminated or maintained in accordance with applicable regulations.

E. Temporary Erosion and Sedimentation Control: In general, temporary erosion and sedimentation control procedures shall be directed toward the following:
   1. Preventing soil erosion at the source.
   2. Preventing silt and sediment from leaving the site if soil erosion cannot be prevented.

3. Preventing silt and sediment from migrating downstream in the event it cannot be prevented from leaving the site.

F. Permanent Erosion Control: Permanent erosion control measure shall be implemented to prevent sedimentation of the waterways and to prevent erosion of the project site.

G. Basic Principles
1. Conduct the earthwork and excavation activities in such a manner to fit the topography, soil type, and condition.
2. Minimize the disturbed area and the duration of exposure to erosion elements.
3. Stabilize disturbed areas immediately.
4. Safely convey run-off from the site to an outlet such that erosion will not be increased off site.
5. Retain sediment on site that was generated on site.
6. Minimize encroachment upon watercourses.

PART 2 - PRODUCTS

2.1 GRASS SEED AND MULCH

A. Temporary seeding shall be in accordance with TDEC Erosion & Sediment Control Handbook.

B. Permanent seeding shall be in accordance with Section 33 11 00.01 “Surface Restoration”.

2.2 TEMPORARY SILT FENCE

A. Geotextile Fence
1. Equivalent Opening Size per US Standard Sieve: 50-100 (maximum).
2. Grab Tensile Strength per ASTM D4632: 160 lbs. (minimum).
3. UV Stability per ASTM D4355: 70% Strength Resistance (minimum).
4. With 14-gauge steel wire backing with maximum mesh size of 6 inches.

B. Support Posts:
1. Materials: Hardwoods, steel, or pressure treated softwoods.
2. Wood posts shall be 2”x2” (minimum).

C. Fasteners: Heavy-duty wire staples as least 1-inch long, tie wires, or hog rings as recommended by geotextile manufacturer.

2.3 WATTLES

A. A wattle (a.k.a. sediment logs or tubes) shall be a tubular shaped product specifically manufactured for sediment control. They may be used for slope, perimeter, channel, or inlet sediment control and capture.

B. Wattles shall be manufactured using interwoven biodegradable plant material such as straw, coir, or wood shavings (i.e. excelsior fibers) in a bio or photodegradable netting this is of sufficient strength to resist damage when handling.

C. The diameter of and spacing between wattles shall be based on the gradient and length of slope in accordance with following table:

SLOPE	WATTLE DIAMETER				
	8”	12”	18”	20”	24”
2% OR LESS	70’	100’	N/A	N/A	N/A
5%	30’	60’	100’	100’	100’
10%	20’	30’	70’	85’	100’
6:1	N/A	20’	40’	50’	55’
4:1	N/A	20’	30’	30’	30’
3:1	N/A	N/A	20’	20’	25’
2:1	N/A	N/A	20’	20’	20’

2.4 INLET PROTECTION

A. Inlet protection for area drain and curb inlets shall be via inlet filters manufactured by Flexstorm Inlet Filters, or approved equal.

2.5 STONE RIPRAP

A. Use sound, tough, durable stones resistant to the actions of air and water. Shaley pieces will not be acceptable. Specific gravity of 2.0 or greater.

B. Riprap shall have less than 66% wear when tested in accordance with AASHTO T-96.

C. Riprap sizes shall be in accordance with Tennessee Department of Transportation Standard Specifications.

PART 3 - EXECUTION

3.1 CONSTRUCTION OF STRUCTURES

A. Erosion & sediment controls shall be constructed, maintained, and removed in accordance with TDEC Erosion & Sediment Control Handbook. Different measures than those stated herein and called for on the Drawings may be required during construction, and may be found in the TDEC Handbook.

B. Temporary pollution control shall include construction activities outside the project area where such work is necessary as a result of construction. These areas include, but not limited to, borrow pits, equipment and material storage sites, and haul roads.

C. Sequence:
1. Install erosion and sediment controls prior to construction.
2. Perform and document an initial inspection of the installed measures with the Owner to review that all measures have been properly installed.
3. If at any time the Owner deems it necessary or if the Contractor observes problems during site inspections, the Contractor shall provide additional erosion prevention and sedimentation controls and mark changes on the plan or SWPPP. The site shall be provided with maximum protection from erosion and sediment loss at all times.
4. Perform regular inspection of all installed measures and document in accordance with the SWPPP or regulations.
5. Perform regular maintenance with clean any built up sediment and fix any broken or shifted control elements.

6. Install permanent controls once construction is complete in an area, and remove temporary controls once permanent controls are established. Depose of temporary measures in accordance with regulations.
7. With the Owner, complete and submit notice of completion paperwork to responsible agencies.
8. Maintain permanent controls during the warranty period in accordance with the Contract.

D. Temporary Silt Fence Installation
1. Not to be installed across areas of concentrated flow such as streams and ditches.
2. Install along the contour, never up or down a slope.
3. Maximum drainage area for silt fence with wire backing is 1 acre per 150 feet.
4. When installed at the base of a slope, install 5 to 7 feet away from the toe of slope.
5. Height of fence shall be no more than 24 to 26 inches above grade.
6. Construct from a continuous roll of fabric. When fabric joints are necessary, overlap a minimum of 4 feet.
7. Excavate a trench approximately 4 inches wide by 6 inches deep.
8. Place 10 inches of fabric in trench and backfill with compacted soil.
9. Install posts on downstream side of fabric, no more than 6 feet apart, and at least 20 inches into the ground.

E. Wattle Installation
1. Install by laying flat on the ground on contour and perpendicular to flow.
2. Excavate a small trench approximately 2-3 inches in depth, or per manufacturer's instructions.
3. Overlap ends of adjacent tubes a minimum of 6 inches, or per manufacturer's instructions.
4. Install wooden stakes at an angle, at 4 -foot intervals, and at least 12 inches deep, or per manufacturer's instructions.
5. Terminate ends of wattles with a dog leg up slope to prevent channeling of sediment.

F. Inlet protection filters shall be installed per the manufacturer's instructions.

G. Check Dams
1. Check dams are barriers composed of riprap, sandbags, wattles, or other non-corrodible material placed across or partially crossing a natural or constructed drainageway.
2. Check dams shall be constructed, maintained, and removed in accordance with TDEC Erosion & Sediment Control Handbook.
    a. If wattles are used, they may have to be stacked to meet required dimensions of check dams.

H. Temporary Berms
1. Use temporary berms at the top or base of disturbed slopes to prevent excessive erosion until permanent controls are installed or slopes stabilized.
2. Berms shall be constructed, maintained, and removed in accordance with TDEC Erosion & Sediment Control Handbook.

I. Temporary Slope Drains
1. A temporary slope drain is a facility consisting of stone, concrete, and/or asphalt gutters, fiber mats, plastic sheets, and drain pipe that may be used to carry runoff down a slope or around an area to reduce erosion on the slope or area avoided until permanent controls are installed and stabilized.
2. Slope drains shall be constructed, maintained, and removed in accordance with TDEC Erosion & Sediment Control Handbook.

J. Temporary Construction Entrance/Exit

1. Construction entrance shall be constructed wherever construction traffic leaves a site and enters a public or private roadway.
2. The entrance/exit shall be at least 50 feet long and at least 10 feet wide for one-way traffic, or at least 20 feet wide for two-way traffic. Shall have turning radii of at least 20 feet at the roadway (may be greater depending on speed of traffic). Install drain culvert as necessary for crossing ditches or streams.
3. Shall be constructed by:
   a. Undercutting at least 3 inches;
   b. Install geotextile fabric (TDOT Type III); and
   c. Install clean washed stone with a gradation of 2 to 4 inches, in a layer at least 8 inches thick.
4. Additional gravel may have to be added periodically to maintain proper function.
5. Remove gravel entrance and replace with new base course prior to construction of permanent new roadway.

K. Sediment Traps
1. Sediment basins, ponds, traps, and bags are prepared or manufactured storage areas to trap and store sediment from eroded areas in order to protect properties and drainage channels below the construction area from excessive siltation.
2. Sediment traps shall be constructed, maintained, and removed in accordance with TDEC Erosion & Sediment Control Handbook.
3. \

L. Soil Stockpiles
1. Protect from erosion with plastic sheeting and anchor from the wind with stakes or concrete blocks. If not active for more than 14 days, apply temporary seeding and mulch.
2. Surround piles with temporary silt fence or wattles within 10 feet of toe of stockpile.

M. Seeding and Mulching
1. Temporary seeding and soil stabilization shall be in accordance with TDEC Erosion & Sediment Control Handbook.
2. Permanent seeding shall be in accordance with City of Memphis Standard Construction Specifications Section 02920 – Seeding.

3.2 FIELD QUALITY CONTROL

A. Conduct regular inspections and document in accordance with the SWPPP and applicable regulations.

B. Provide inspection documentation, reports, and SWPPP updates with Owner or agency upon request.

3.3 MAINTENANCE AND CLEANING

A. Clean, repair or replace failed or overloaded silt fences, wattles, check dams, or other temporary controls within two days after inspection.

B. Install and provide maintenance for soil stabilization seeding at all times. This includes sprinkling with water to encourage and maintain growth of seedlings.

C. Temporary erosion and sediment controls once removed shall be become the property of the Contractor and disposed of properly and in accordance with applicable regulations.

D. Dress sediment deposits remaining after measure has been removed to conform to existing grade. Prepare and seed graded area.

END OF SECTION 312500

CITY OF MEMPHIS – STANDARD CONSTRUCTION SPECIFICATIONS
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 Owner 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 Owner.

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

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

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

3.02 DISPOSAL OF DEBRIS

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

PART 4 – MEASUREMENT

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

PART 5 – PAYMENT

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

5.02 Payment will be made under:

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

END OF SECTION 02230

CITY OF MEMPHIS – STANDARD CONSTRUCTION SPECIFICATIONS
SECTION 02315 EXCAVATION & FILL

PART 1 – SCOPE

1.01 This work consists of excavating; disposal of unsuitable material from roadbed excavations; construction and removal of temporary detours ordered by the Owner. Excavation shall consist of the removal of all material shown on the Plans in cut sections or necessary undercutting as ordered by the Owner.

PART 2 – EQUIPMENT

2.01 All equipment for the satisfactory performance of excavation and hauling shall be on the project and approved by the Owner before the work will be permitted to begin.

PART 3 – CONSTRUCTION REQUIREMENTS

3.01 GENERAL

A. Prior to beginning excavation all necessary Clearing and Grubbing and Removal of Structures and Obstructions shall have been completed in the area in accordance with Sections 02220 and 02230 of these Specifications. The removal of unsuitable material and/or undercutting ordered by the Owner will not be considered contract items and these two operations will be included in either excavation (unclassified) or embankment (unclassified) respectively. Unsuitable material above subgrade or from undercutting in cuts shall be disposed of as directed by the Owner at no additional cost to the Owner. Any imbalance of material quantities caused by these operations or change in actual shrinkage factor shall be the Contractor's responsibility. The Owner's decision on the suitability of material or the need for undercutting shall be final.

B. If approved by the Owner, gravel for undercut backfill or stabilization and Portland cement for stabilization will be used and paid for as separate items in the contract.

C. When ordered by the Owner, water used for dust control will be paid for as a contract item.

D. The Contractor shall provide for proper drainage of the project area to protect from ponding and erosion.

3.02 EXCAVATION

A. Excavation (unclassified) shall consist of the removal of all suitable or unsuitable material in cut sections to the lines, grades, and cross-sections shown on the Plans. All slopes, ditches and berms shall be shall be neatly trimmed to the lines given. Excavation beyond given lines or to correct slides, regardless of the location, will be at the Contractor's expense, and the suitability of the material from slides for embankment construction will be determined by the Owner.

B. Surplus excavated material, if determined to be suitable by the Owner, may be used to widen embankments or to flatten slopes or may be deposited in such other places and for such other purposes on the right-of-way as the Owner may approve. No payment to the Contractor shall be made for the placement of surplus excavated material. Materials unsuitable for construction of embankment or use as backfill shall be removed to off-site waste disposal areas. The Contractor shall secure waste disposal areas and dispose of surplus and unsuitable materials in such areas. It is the Contractor's responsibility to obtain written permission from the owners of all property(s) to be used for waste disposal areas prior to removal of material to disposal sites. The Contractor shall dispose of all materials on the sites to the satisfaction of the property owner(s).

PART 4 – MEASUREMENT

4.01 A. Excavation (Unclassified) Excavation will be computed by the cubic yard and only in cut sections of the project. No measurement will be made for material from off the project required for the satisfactory completion of the project. Measurements will be made for excavation material in its original position by cross-sections and the average-end-area method. Original cross-sections and final cross-sections will be taken from the sections shown on the Plans. Excavation volumes so measured will not include an allowance for removal of material from the Contractor's stripping operation. No measurement will be made for excavation outside the project construction limits shown on the Plans or the removal of slides.

B. Water. Water for dust control will be measured by the 1,000 gallon unit.

C. Dredging. This item will be paid for on a lump sum basis and no measurement will be made.

D. General. It is the intent of these Specifications to pay only for quantities of Excavation as shown on the Plans or Proposal. Plan changes in grade or project limits may alter payment to the limits allowed in the General Conditions of Division 0.

PART 5 – PAYMENT

5.01 Excavation (Unclassified)

A. Payment will be made at the contract unit price per cubic yard in its original position in cut sections which price will be full compensation for the excavation and hauling of acceptable materials to designated embankment areas and the disposal of excess or unacceptable materials off the project or as directed by the Owner.

5.02 Water

A. Water for dust control will be paid for at the contract unit price per 1,000 gallons (M.G.), which price will be full compensation for furnishing and distributing the water as directed by the Owner.

5.03 Dredging

A. Payment will be made for the work, completed and accepted by the Owner, at the contract ump sum price, which shall be full compensation for removal and disposal of debris.

5.04 Payment will be made under:

Item No.	Pay Item	Pay Unit
02315-01	Excavation (Unclassified)	Cubic Yard
02315-02	Water	M.G.
02315-03	Dredging	Lump Sum

END OF SECTION 02315

CITY OF MEMPHIS – STANDARD CONSTRUCTION SPECIFICATIONS
SECTION 02330 EMBANKMENT

PART 1 – SCOPE

1.01 This work consists of building controlled embankments; disposal of unsuitable material from beneath embankment areas; construction and removal of temporary detours ordered by the Owner and the sloping, shaping and dressing of all slopes.

1.02 Embankment work shall consist of constructing roadway or street embankments including preparation of the areas upon which they are to be constructed by the placing and compacting of material in holes, pits, and other depressions within the embankment area, all in conformity with the lines, grades, and typical cross-sections shown on the Plans. Only approved materials shall be used in the construction of embankments.

PART 2 – EQUIPMENT

2.01 All equipment for the satisfactory performance of embankment construction shall be on the project and approved by the Owner before the work will be permitted to begin. Compaction shall be accomplished by any type of compacting equipment that will produce the required result.

PART 3 – CONSTRUCTION REQUIREMENTS

3.01 GENERAL

A. Prior to beginning embankment operations all necessary Clearing and Grubbing and Removal of Structures and Obstructions shall have been completed in the area in accordance with Sections 02220 and 02230 of these Specifications. The removal of unsuitable material and/or undercutting ordered by the Owner will not be considered contract items and these two operations will be included in either excavation (unclassified) or embankment (unclassified) respectively. If there is insufficient suitable material from excavation on the project, it shall be the Contractor's responsibility to obtain the additional material off the project to complete embankments according to the lines, grades, and cross-sections on the Plans.

B. When ordered by the Owner, water used for dust control will be paid for as a contract item.

C. The Contractor shall provide for proper drainage of the project area to protect from ponding and erosion.

3.02 EMBANKMENTS

A. This work shall consist of constructing roadway or street embankments including the preparation of the area upon which they are to be constructed, the placing and compacting of approved materials where unsuitable material has been removed, and the placing and compaction of embankment material in holes, pits, and other depressions not filled in accordance with Sections 02220 and 02230. All work shall be in accordance with these Specifications and in conformity with the lines, grades, and cross-sections shown on the Plans. Only approved materials shall be used in the construction of embankments, which material shall come from excavation on the Project or from approved sources furnished by the Contractor.

B. Any area upon which an embankment is to be constructed shall be plowed or scarified, all cleavage planes destroyed, and the area rolled thoroughly with a sheeps-foot roller before embankment construction is begun in the area. An area upon which an embankment is to be constructed having a slope steeper than 3 to 1 shall be benched with steps of not less than eight (8) inches rise before any embankment materials are placed thereon. Benching shall be of sufficient width to permit the operation of placing and compacting equipment. Each successive benching cut shall begin at the intersection of the original ground line and the vertical side of the previous cut. Material thus cut out shall be recompacted along with new material at the Contractor's expense.

C. Embankment construction will not be permitted within fifty (50) feet of any structure or proposed structure until such structure is cured sufficiently to permit embankment formation against it. This requirement will be waived when an embankment or portion thereof is to form the foundation of a structure or part thereof. Embankment to be placed on both sides of a concrete wall, manhole, or box type structure shall be so constructed that the embankment is always approximately the same elevation on both sides of the structure. Embankments on only one side of abutments, wingwalls, or piers shall not be constructed until the superstructure is in place or final concrete design strength has been obtained.

D. Where embankment is to be constructed across ground that will not support earth moving equipment, the fill shall be started with a uniformly distributed layer of a thickness not greater than necessary to support the hauling equipment while placing subsequent layers. In the construction of such a lift the density requirement will be waived but the moisture content of the material used shall not exceed the optimum moisture content for that material. Maximum thickness and minimum density requirements will apply to all succeeding layers of embankment construction. Each succeeding layer of embankment is to be constructed with a compacted thickness not to exceed six (6) inches and shall be approved before material for the next succeeding layer is placed.

E. Embankments shall be so constructed that adequate surface drainage will be provided at all times. Roadway embankment materials shall be placed in horizontal layers not to exceed a depth which will produce a six (6) inch compacted layer. Each layer shall be compacted for the entire embankment width to a density no less than ninety-five (95) percent of maximum density as determined in accordance with the standard specification of compaction and density of soils, AASHTO T 99. The moisture content of the embankment material shall be controlled in such a way that the material will be compacted with a moisture content ranging from two (2) percent below to two (2) percent above the optimum moisture content as determined from the above mentioned test and approved by the Owner. If the moisture content of the material in the embankment prior to compaction is greater than two (2) percent above the optimum moisture content, the material shall be aerated by disking, harrowing, plowing, or other means approved by the Owner, who shall be the sole judge as to when the required density has been obtained. For each layer of embankment material, the Contractor shall disk sufficiently to break down oversize clods, thoroughly mix any different materials, secure correct moisture content, ensure uniform density, and obtain proper compaction. Rolling with compacting equipment shall start longitudinally at the sides and proceed toward the center, overlapping on successive trips by at least one-half of the width of the tamping roller. Tamping equipment shall be operated at a speed of no more than three (3) miles per hour.

F. The Contractor shall be responsible until final acceptance for the stability of all embankments and shall replace at this own expense any portion which in the opinion of the Owner has become displaced or damaged due to carelessness, negligence, or by rainfall and weathering.

G. The slopes of all embankments, ditches, channels, and such other appurtenances as may be indicated on the Plans shall be shaped and trimmed to the lines, grades, and cross-sections shown or as directed by the Owner. This work shall also include the satisfactory shaping of spoil banks, waste deposits, and any other areas deemed necessary by the Owner to prepare the project for final inspection and acceptance.

H. Water for dust control when ordered by the Owner, whether to comply with local air pollution ordinances, safety, or good construction practices, shall be readily available along with adequate distribution equipment.

PART 4 – MEASUREMENT

4.01 A. Embankment (Unclassified) Embankment construction will be computed by the cubic yard in place, compacted and ready for acceptance. Measurements for computations will be made by

cross-sections and the average-end-area method. Original cross-sections and final cross-sections will be taken from sections shown on the Plans

B. Water. Water for dust control will be measured by the 1,000 gallon unit. No payment will be made for any other water used on the project to maintain moisture control in embankment compaction or for stabilization.

C. General. It is the intent of these Specifications to pay only for quantities of Embankment as shown on the Plans or Proposal, and it shall be the Contractor's responsibility to ensure that excavation materials are suitable for embankment construction. Plan changes in grade or project limits may alter payment to the limits allowed in the General Conditions of Division 0.

PART 5 – PAYMENT

5.01 Embankment (Unclassified)

A. Payment will be made at the contract unit price per cubic yard in its final position, in place, compacted, and accepted by the Owner, which price shall be full compensation for the preparation of the area, furnishing, depositing and compacting the material, and the shaping and trimming of the embankments to the lines, grads, and cross-sections shown on the Plans.

5.02 Water

A. Water for dust control will be paid for at the contract unit price per 1,000 gallons (M.G.), which price will be full compensation for furnishing and distributing the water as directed by the Owner.

5.03 General

A. It is the Contractor's responsibility to ensure that adequate acceptable material is available to complete the project, and variations in shrinkage factors, undercut quantities, or unsuitable material quantities will not relieve him from that responsibility.

5.04 Payment will be made under:

Item No.	Pay Item	Pay Unit
02330-01	Embankment (Unclassified)	Cubic Yard
02330-02	Water	M.G.

END OF SECTION 02330

CITY OF MEMPHIS – STANDARD CONSTRUCTION SPECIFICATIONS
SECTION 02335 SUBGRADE AND ROADBED

PART 1 – SCOPE

1.01 This work consists of disposal of unsuitable material from roadbed excavations; construction and removal of temporary detours ordered by the Owner; sloping, shaping and dressing of all slopes; and the construction and preparation of the graded roadbed to receive the construction of a base or pavement.

1.02 Subgrade preparation shall consist of the final grading of the roadbed in both cuts and fills to the density specified, including gravel backfill, gravel stabilization, or cement stabilization when ordered by the Owner.

PART 2 – EQUIPMENT

2.01 All equipment for the satisfactory performance of subgrade preparation shall be on the project and approved by the Owner before the work will be permitted to begin.

2.02 Compacting equipment for final subgrade compaction shall include pneumatic tire rollers with a minimum contact pressure of eighty-five (85) pounds per square inch and a minimum single wheel load of 4,500 pounds. Each roller shall be a wobble-wheel type in which the rear set of wheels will not track the forward set and will be centered between the wheels of the forward set. The roller shall be capable of forward and backward propulsion on any grade encountered, and the Contractor shall furnish to the Owner charts or tabulations of the contact areas and pressure for the full range of tire loadings for each type of compactor tire to be used.

PART 3 – CONSTRUCTION REQUIREMENTS

3.01 GENERAL

A. Prior to beginning subgrade operations all necessary Clearing and Grubbing and Removal of Structures and Obstructions shall have been completed in the area in accordance with Sections 02220 and 02230 of these Specifications. The removal of unsuitable material and/or undercutting ordered by the Owner will not be considered contract items and these two operations will be included in either excavation (unclassified) or embankment (unclassified) respectively.

B. Unsuitable material above subgrade or from undercutting in cuts shall be disposed of as directed by the Owner at no additional cost to the City. Any imbalance of material quantities caused by these operations or change in actual shrinkage factor shall be the Contractor's responsibility. The Owner's decision on the suitability of material or the need for undercutting shall be final.

C. When ordered by the Owner, water used for dust control will be paid for as a contract item.

D. The Contractor shall provide for proper drainage of the project area to protect from ponding and erosion.

3.02 UNDERCUTTING

A. This work shall consist of the removal and disposal of unsatisfactory materials below grade in cut sections. Areas to be undercut may be designated on the Plans if sufficient information is available. However, the Owner may increase, decrease, or change such areas to be undercut if conditions dictate as construction progresses. Undercut areas shall be backfilled with suitable material from excavation quantities, gravel backfill, or material stabilized with gravel or Portland cement as ordered by the Owner..

3.03 SUBGRADE PREPARATION

A. This work shall consist of the final preparation of the roadbed to receive the immediate construction of a base or pavement, curb and gutter, driveways, or sidewalks thereon.

B. Subgrade preparation in fill sections shall consist of the compaction of the top six (6) inches below subgrade elevation in paved areas only to a density of 100 percent as determined in accordance with the standard specification of compaction and density of soils as defined in Section 02330.

C. Areas in cut sections where required density cannot be obtained may be undercut and backfilled with suitable excavation material, stabilized with gravel or portland cement, or undercut and backfilled with gravel as directed by the Owner, who shall be the sole judge as to the method to be used. Special attention shall be given to areas such as utility trenches and manhole backfill areas. Payment will be made only for the gravel or portland cement used, and no additional compensation will be paid the Contractor for the work.

D. The Contractor shall be held responsible for the proper maintenance of subgrade acceptable to the Owner, and no additional compensation shall be paid to the Contractor to restore any subgrade after preliminary acceptance. The Contractor shall also take all precautions necessary to protect the acceptable subgrade from damage, and hauling over the finished subgrade shall be limited to that which is essential for construction purposes.

PART 4 – MEASUREMENT

4.01 A. Undercut Excavation Undercut excavation will be measured by the inspector and a representative of the Contractor. They will agree on how much material, in cubic yards, was removed from the undercut area.

B. Water. Water for dust control will be measured by the 1,000 gallon unit. No payment will be made for any other water used on the project to maintain moisture control in embankment compaction or for stabilization.

PART 5 – PAYMENT

5.01 UNDERCUT EXCAVATION

A. Payment for undercut excavation will be made at the contract unit price per cubic yard of excavation unclassified (Specification Section 02315 Part 5.01A), which shall be full compensation for hauling and disposal of the unsatisfactory material.

5.02 UNDERCUT BACKFILL

A. Payment for earth material used as undercut backfill will be made at the contract unit price for Embankment (Unclassified) (Specification Section 02330 Part 5.01A), which price will be full compensation for undercutting and for furnishing, depositing, and compacting backfill material and dressing to subgrade or original ground line as directed by the Owner, complete in place.

5.03 GRAVEL FOR UNDERCUT BACKFILL OR SUBGRADE STABILIZATION

A. Gravel for undercut backfill or subgrade stabilization in cut sections will be paid for at the contract unit price per ton, which price shall be full compensation for the excavation, placing and/or mixing gravel with in-place material, compaction, and dressing to plan elevation as directed by the Owner, complete in place.

5.04 PORTLAND CEMENT FOR UNDERCUT BACKFILL OR SUBGRADE STABILIZATION

A. Portland cement for subgrade stabilization in cut sections or as backfill stabilization for undercut areas will be paid for at the contract unit price per pound in place, which price shall be full compensation for furnishing and placing cement, processing, compaction, and dressing to plan elevation as directed by the Owner, complete in place.

5.05 WATER

A. Water for dust control will be paid for at the contract unit price per 1,000 gallons (M.G.), which price will be full compensation for furnishing and distributing the water as directed by the Owner.

5.06 GENERAL

A. Subgrade preparation is not considered a pay item, and no work involved shall be paid for directly except gravel and/or portland cement as defined in Parts 5.03 and 5.04 above.

5.07 Payment will be made under:

Item No.	Pay Item	Pay Unit
02335-01	Undercut Excavation	Cubic Yard
02335-02	Undercut Backfill	Cubic Yard
02335-03	Gravel for Undercut Backfill	Ton
02335-04	Portland Cement for Undercut Backfill	Pound
02335-05	Water	M.G.

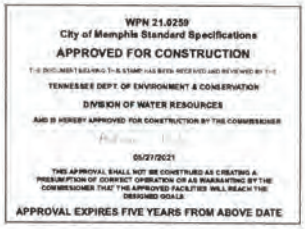
END OF SECTION 02335

CITY OF MEMPHIS

STANDARD CONSTRUCTION SPECIFICATIONS FOR SANITARY SEWERS AND APPURTENANCES

Issued for State approval

Prepared by: City of Memphis
Division of Engineering
Sewer Design Department



Faraedoon Qaladize
Sewer Design Engineer

City of Memphis Division of Engineering
125 N. Main Street., Room 644
Memphis, TN 38103

CITY OF MEMPHIS – STANDARD CONSTRUCTION SPECIFICATIONS
SECTION 02530 SEWER PIPE INSTALLATION

PART 1 - SCOPE

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

1.02 The Engineer may change the Plans, Specifications, character of work or quantity of work, provided the cost of the changes does not exceed 10% of the contract price.

PART 2 – MATERIALS AND EQUIPMENT

2.01 MATERIAL

A. Construction Material

1. All material furnished by the Contractor will 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 will be considered defective and will be removed immediately from the site.

B. Higher Strength Pipe

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

C. Qualifications of Manufacturers

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

D. Material Inspection and Testing

1. Representative samples of material intended for incorporation in the work will be submitted for examination when so specified or requested. All material to be used in the work will be sampled, inspected, and tested by current ASTM specifications, or other standard specifications. The Contractor will furnish the Engineer with three copies of certified reports from an accredited 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 will show the laboratory's stamp. The performance or cost of all testing is the responsibility of the Contractor

2. The Contractor will notify the Engineer before any deliveries of material and will make whatever provisions are necessary to aid the Engineer in the inspection and culling of the material before installation

E. Storage

1. The Contractor will 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 will be kept free from dirt and foreign matter. PVC pipe, fittings, and adapters stored outside and exposed to sunlight will be covered with an opaque material with proper ventilation.

F. Prestressed Concrete Cylinder Pipe

1. All prestressed concrete cylinder pipe shall conform to the requirements of AWWA C 301 and C 304 and will 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 AWWA C 301, whichever is greater. The interior surface of the pipe will be a smooth, cylindrical surface. Cement will meet all the requirements ASTM C 150, Type II. Steel cylinder shall be made of steel sheets not lighter than No. 16 gauge with a minimum yield strength of 33,000 psi, and conforming to the requirements of "Standard Specification for Hot-Rolled Carbon Steel Sheets and Strip Structural Quality", Grade 33, ASTM designation A 1011. Steel used for the bell rings for pipe and fittings shall have a minimum yield strength of 30,000 psi and conform to the requirements of ASTM A 1011. Steel plate and special shapes for spigot joint rings shall conform to the requirements of ASTM A 36 or the other ASTM specifications listed in AWWA C 301. High tensile prestressing wire shall be a minimum of No. 6 gauge and maximum class shall be Class III. The wire shall conform to the requirements of "Standard Specification for Steel Wire, Hard-Drawn for Prestressing Concrete Pipe", ASTM A 648. No lifting holes will be allowed. The pipe will be furnished complete with gaskets, grout bands and lubricant as required for proper installation.

2. The interior of all 36 inch and larger diameter pipe will be fully lined with a PVC liner as specified in Section 02530 Paragraph 2.01.DD. The liner will be installed by the pipe manufacturer prior to pipe delivery.

3. The liner will be welded at each joint after installation and testing of the pipe. Exceptions to the welding requirement may be granted at the direction of the Engineer.

4. Fittings shall be composed of cut and welded steel plate with all welds inspected, and the completed cylinder shall be tested for tightness by the dye penetrant method. Fittings shall have wire reinforcement applied to the interior and exterior surfaces. Concrete and mortar linings shall be at least 3/8 inch thick and exterior mortar coating shall be 1 inch thick unless otherwise indicated. All materials and workmanship shall be as specified in AWWA C 301.

a. Curves of long radius may be formed by the use of pipe on which the spigot joint rings are placed on a bevel or by the use of bevel adapters. Special pipes shall be designed to provide the same strength as the adjacent pipe. Branch connection 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 joint rings corresponding to those on adjoining straight pipes. Special ends shall be provided on concrete pipe, where required to connect to pipe of other manufacturers and special structures.

G. Reinforced Concrete Pipe

1. All reinforced concrete pipe for gravity sewer applications will conform to the requirements of ASTM C 76 for circular pipe, Wall B for the specified diameter and strength class. If no class is specified, Class III pipe will be used. The interior surface of the pipe will be a smooth, cylindrical surface. Cement will meet all the requirements ASTM C 150, Type I. No lifting holes will be allowed. The pipe will be furnished complete with gaskets, grout bands and lubricant as required.

for proper installation. Pipe will be designed for a 0.01 inch crack D-Load. The ultimate D-Load will be at least 1.5 times the 0.01 inch D-Load.

2. The interior of all 36 inch and larger diameter pipe will be fully lined with a PVC liner as specified in Section 02530 Paragraph 2.01.DD. The liner will be installed by the pipe manufacturer prior to pipe delivery.

3. The liner will be welded at each joint after installation and testing of the pipe. Exceptions to the welding requirement may be granted at the direction of the Engineer.

4. Joints in reinforced concrete pipe less than 30 inches in diameter will have compression gaskets or trapped O-ring gaskets. Pipes 30 inches in diameter or greater will have trapped O-ring gaskets meeting the requirements of ASTM C 443. When required, concrete pipe ends will be manufactured with steel bell and spigot end rings with a groove on the spigot for an O-ring rubber gasket. This joint will meet the joint requirements of ASTM C 443 and ASTM C 361. The shape, dimensions, and tolerances of the bell and spigot or tongue and groove ends of the pipe will meet the requirements of ASTM C 443. The ends of the rubber gasketed pipe will be accurately manufactured so that, when adjacent pipe sections are drawn together, the rubber gasket will be uniformly compressed around the periphery of the pipe to provide a watertight seal.

H. Ductile Iron Pipe and Fittings

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

I. Deleted.

J.

J.01 Polyvinyl Chloride (PVC) Gravity Pipe and Fittings (8-15 inch Diameter)

1. All PVC gravity pipe and fittings 8-15 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 will conform to the requirements of ASTM D 3034. The standard dimension ratio (SDR) will be SDR 26 (Type PSM). PVC resin will conform to ASTM D 1784 cell class 12454C. A different cell class will be allowed only if the material meets the requirements of a superior cell class than 12454C. Fittings for PVC gravity sewer pipe will 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 will be no less than the respective minimum thicknesses for the equivalent pipe. All fittings will be compatible with the pipe to which they are attached.

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

3. Solvent welded PVC saddle wye's may only be used on existing PVC and truss gravity sewer mains. Collar joints for fittings will be either Type SC (solvent cement) or Type OR (flexible gasketed compression joint) and will conform to the requirements of ASTM D 2680.

J.02 Polyvinyl Chloride (PVC) Gravity Pipe and Fittings (6 inch Diameter) Service Connection

6 Inches in diameter service connection may conform to either the SDR 26 Specification (ASTM D1784) or to ASTM D1785 and ASTM D 2665 (Schedule 40). All pipe and fittings to be produced by a single manufacturer and to be installed in accordance with manufacturer's recommendations and Shelby County, Tennessee code requirements. Solvent cements shall conform to ASTM D 2564. Primer shall conform to ASTM F 656.

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

1. All 18-36 inch diameter PVC gravity 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 may be conducted by the manufacturer in the presence of the Engineer. The City shall 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 will be permitted in field construction.

3. The pipe manufacturer shall furnish to the Engineer 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 plans or as approved by the Engineer.

L. Glass Fiber Reinforced Polymer Mortar Pipe and Fittings up to 72 inch Diameter

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

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

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 tested after installation in accordance with Specification Section 02530 4.02.

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.

M. High Density Polyethylene (HDPE) Pipe and Fittings

1. High Density Polyethylene Pipe (HDPE) may be used in construction of inverted siphons. No HDPE will be allowed in any other gravity sewer application. All HDPE shall be manufactured from virgin, extra high molecular weight, high density PE4710 polyethylene pipe grade resin to a minimum cell classification of PE445574C as determined by ASTM D3350. No post-consumer recycled polyethylene materials shall be allowed.

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. Polyvinyl Chloride (PVC) Pressure Pipe and Fittings

1. PVC pipe and couplings for force main applications will conform to the requirements of ASTM D 2241 and AWWA C 900 Standard for Polyvinyl Chloride (PVC) Pressure pipe 4 inches through 12 inches for Water. The minimum pressure class will be Class 100 or as specified and outside diameter base (IPS or CI) will be as specified in the Plans or Contract Documents.

2. Joints for pipe and couplings will be solid ring elastomeric gasket type. Gaskets must withstand internal pressures of not less than the minimum sustained pressure and burst pressure requirements specified for the pipe with which they are designed to be used. No solvent cement joints will be allowed. Joints will conform to the requirements of AWWA C 900 and/or ASTM D 2241.

O. High Density Polyethylene (HDPE) Pressure Pipe and Fittings

1. All HDPE shall be manufactured from virgin, extra high molecular weight, high density PE4710 polyethylene pipe grade resin to a minimum cell classification of PE445574C as determined by ASTM D3350. No post-consumer recycled polyethylene materials shall be allowed.

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.

P. Air/Vacuum Valves, Automatic Air Release Valves and Combination Valves

1. The Air/Vacuum Valves shall be single body, double orifice and shall automatically exhaust air from the force main while being initially filled with fluid. After the air has been exhausted from the line, the valve shall close tightly. The valve shall remain closed as long as the sewer line is under positive pressure. Should the force main pressure fall below atmospheric pressure, the valve shall reopen to allow air to enter the pipe thereby preventing a negative pipe pressure. The valve shall be designed to prevent clogging due to solids in the fluid. Each of these valves shall be designed to separate the liquid from the sealing mechanism. The Air/Vacuum Valves shall be as manufactured by A.R.I. or approved equal.

2. The Combination Air Valve shall consist of a combination of an air and vacuum large orifice and an automatic small orifice in a single body. The valve must be designed to operate with liquids carrying solid particles. The valve shall discharge air during the filling or charging of the system and admit air to the system while being emptied of liquid and discharge accumulated air from the system while it's under pressure and operating. Each of these valves shall be designed to separate the liquid from the sealing mechanism. The valve shall have a working pressure range up to 150 psi or as specified on the plans. Combination Valves shall be A.R.I. or approved equal.

3. The manufacturer shall certify venting capacity and provide three copies of installation and maintenance manuals for each type of Combination Air Valve and Air/Vacuum Valve supplied.

4. The Manufacturer shall guarantee all items specified to be free from defects in design, materials and workmanship for one year from the date of acceptance. During the guarantee period, the Manufacturer shall furnish and install replacement parts for any defective component at no additional cost.

Q. Check Valves, Gate Valves and Ball Valves

1. All check valves shall have external arms so that the valve may be opened and closed by hand. Check valves shall be controlled closing swing check valves and shall be Golden-Anderson Series 250, or Valve and Primer Series 6000, or as approved. Each check valve shall have a cast iron body, stainless steel plates, stainless steel springs, stainless steel hinge pins and stops, Teflon spring and hinge bearings and standard trim for IBBM construction. All wetted components shall be 316 stainless steel. Each check valve shall have Buna N seals.

2. All check valves shall be class 125 vertical or horizontal swing type with iron body and flanged ends.

3. Knife gate valves will be manufactured by Red Valve Company, Inc, Pittsburgh, PA; and shall be their Standard Flexgate, or approved equal. Knife gate valves must conform to AWWA C-504 requirements. The shaft shall be constructed of Type 304 stainless steel. The knife gate shall be Type 316 stainless steel. The valve seat shall be a resilient, mechanically retained, field replaceable, polytetraflouroethylene elastomer. The upper and lower bearings shall be self-lubricating Teflon. The valve shall be equipped with a handwheel.

4. Wedge gate valves will be resilient wedge gate valves as manufactured by Mueller Co., or approved equal. Wedge gate valves must conform to AWWA C 509 or AWWA C 515 and will be either series 2360 or series 2361.

5. All ball valves for 2 inch and 3 inch diameter fittings shall be full port, brass ball valves, shall be rated to 125 psi minimum, and shall meet the requirements of NSF/ANSI 61/8. Ball valves will have threaded connections and blowout proof stems. Ball valves will be Series FBV-3C as manufactured by Watts, or as approved.

6. Valve manufacturer shall furnish certification that each valve has been subjected to a hydrostatic water pressure twice the pressure class and that each valve is free of defects. The valve manufacturer shall guarantee all items specified to be free from defects in design, materials and workmanship for one year from the date of acceptance. The manufacturer shall, during the guarantee period, furnish and install replacement parts for any defective component at no additional cost.

R. 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.

S. Lubricants for Prefabricated Pipe Gaskets

1. The lubricant used in jointing pipes fitted with flexible, rubber gaskets will be as recommended by the pipe manufacturer. Lubricants will be suitable for use at temperatures from 5□ to 120□ F(-15 □C to 50 □C). Containers will be labeled with the intended, compatible pipe material and the manufacturer's name.

T. Primers and Adhesives

1 All primers and solvents used with ABS Composite Sewer pipe will conform to ASTM D 2235 and will be applied as recommended by the manufacturer. For bonding PVC to PVC, solvent cement will conform to ASTM D 2564. For bonding PVC to ABS, solvent cement will conform to ASTM D 3138. Adhesives used to fasten flexible rubber or rubber gaskets will conform to the requirements of the gasket manufacturer.

U. Adapters and Couplings

1. At the direction of the Engineer, a connection of sanitary sewer pipes, 6 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 will be manufactured of an approved preformed elastomeric material conforming to applicable sections of ASTM Standards C 425, C 564, C1173, D 3212, and D 5926. Mechanical couplings or adapters will 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 240. If a stainless steel shear band is not used a concrete collar is required. Each connector and adapter will bear the manufacturer's name and required markings. Installation will be by the manufacturer's recommendations.

2. At the direction of the Engineer, 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 Specification Section 02530 Paragraph 3.09.C. Mechanical connectors meeting the above requirements may be used at the direction of the Engineer.

V. Portland Cement Concrete

1. Portland Cement Concrete will be of the class and dimensions shown on the Plans, or as directed by the Engineer. The classes of concrete are called Class A and Class C. Class A concrete is intended principally for concrete structures designed for high strength. Class C concrete is low strength concrete, intended principally 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, delivery, minimum strength, sampling and testing will be as specified in Specification Section 03050.

W. Crushed Limestone

1. Crushed limestone will 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

2. Crushed limestone meeting the requirements of the Tennessee DOT Standard Specifications for Road and Bridge Construction, size No. 57 Coarse Aggregate will be used as directed by the Engineer or as shown on the plans. Size No. 57 Coarse Aggregate will meet the following gradation:

Total Percent by Dry Weight,
Passing Each Sieve (U.S. Standard)

Size No.	1-1/2"	1"	1/2"	No. 4	No. 8
57	100	95-100	25-60	0-10	0-5

X. Deleted

Y. Mortar

1. Mortar will 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 will be proportioned by measurements and not by estimating. All portland cement, sand, and water will be as specified in Specification Section 03050. All hydrated lime will be as specified by ASTM C 206.

2. The mortar will be hand mixed or machine mixed. In the preparation of hand mixed mortar, the sand, cement and hydrated lime will be thoroughly mixed in a clean, tight, mortar box until the mixture is of uniform color, after which water will be added. Machine mixed mortar will be prepared in an approved mixer and will be mixed not less than 1½ minutes. Mortar will be used within 30 minutes after mixing.

Z. Bracing Lumber

1. Lumber for tunnel bracing will be a minimum of 3 inches thick and made of bridge oak. All timbers will be of good quality, straight grained, and free from weakening knots and other defects. Bracing will be placed to form a structurally sound timber tunnel. The timber tunnel lining will remain in place after laying the pipe and backfilling.

AA. Pit Run Gravel

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

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

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

2. That portion passing the No. 40 sieve will be known as the binder. The binder aggregate will consist of hard durable particles of limestone or sound siliceous material. Shale aggregate or pipe clay binder will not be acceptable. The percent of silt will 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 Engineer, so that the resultant mixture will comply with these Specifications. The mixing will be done uniformly, and blending of material on stockpiles or in the pits by bulldozers, clamshells, draglines, or similar equipment will not be permitted.

BB. Brick

1. All brick will conform to ASTM C 55 for Grade A. Unless otherwise approved by the Engineer, bricks will conform to the following dimensions:

	Depth (in)	Width (in)	Length (in)
Standard Size	2 1/4	3 3/4	8
Allowable Variation	+ 1/4	+ 1/4	+ ½

2. All brick will be new and whole, of uniform standard size and with straight and parallel edges and square corners. Bricks will be tough and strong and free from harmful cracks and flaws. Brick will be culled after delivery if required and all culls will be removed from the work site.

3. The Contractor may be required to furnish the Engineer 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 brick will be of the same quality as the accepted samples.

CC. Non-Shrinking Grout

1. Grout will be mixed in small quantities as needed and will not be re-tempered or used after it has begun to set. Unless otherwise specified, the grout will 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 will be formulated by the incorporation of an admixture, or a premixed grout may be used.

2. The formulation, admixture or the premixed grout used will be subject to the approval of the Engineer and will be mixed and used according to the recommendations of the manufacturer. These special grouts will be classified as follows:

Type I – Non-shrinking Grout
Type II – Non-shrinking, Fast Setting Grout

Portland cement, masonry sand, and water will conform to the requirements of Specification Section 03050.

DD. Polyvinyl Chloride (PVC) Protective Lining for Concrete Pipe and Structures

1. Liner shall be Ameron T-Lock as manufactured by Ameron Protective Coatings Division, Brea, California or approved equivalent.

2. The material used in the liner and in all joint, corner, and welding strips shall be a combination of polyvinyl chloride resin, pigments, and plasticizers, specially compounded to remain flexible. Material color shall be white.

3. Polyvinyl chloride resin shall constitute not less than 99 percent, by weight, of the resin used in the formulation. Copolymer resins will not be permitted.

4. Tensile specimens shall be prepared and tested in accordance with ASTM D412 using die B. Weight change specimens shall be 1-inch by 3-inch samples of the sheet thickness. Specimens may be taken from sheet and strip at any time prior to final acceptance of the work.

5. Liner plate locking extensions embedded in concrete shall withstand a test pull of at least 100 pounds per linear inch applied perpendicularly to the concrete surface for a period of one minute, without rupture of the locking extensions or withdrawal from embedment. This test shall be made at a temperature of 70-80° F inclusive.

6. All plastic liner plate sheets, including locking extensions, all joint, corner and welding strips shall be free of cracks, cleavages or other defects adversely affecting the protective characteristics of the material. The Engineer may authorize the repair of such defects by approved methods.

7. The lining shall have good impact resistance, shall be flexible and shall have an elongation sufficient to bridge up to 1/4-inch settling cracks, which may occur in the pipe or in the joint after installation, without damage to the lining.

8. The lining shall be repairable at any time during the life of the structure.

9. Liner shall be a minimum of 0.065 inches in thickness. Locking extensions (T-shaped) of the same material as that of the liner shall be integrally extruded with the sheet. Locking extensions shall be approximately 2.5 inches apart and shall be at least 0.375 inches high.

10. Sheets shall have transverse strap channels cut in the locking extensions so that the strap can be placed into and perpendicular to the locking extensions.

11. These channels shall be not less than 3/4 inch wide and not more than 1 1/4 inch wide and shall be cut so that a maximum 3/16 inch of the base of the locking extension remains in the base of the strap channel. Strap channels shall be provided at intervals of not less than 15 inches and no more than 20 inches center-to-center. The strap channels will not be cut through the final two locking extensions on each edge of the sheet.

12. Transverse flaps shall be provided at the ends of sheets for pipe. Locking extensions shall be removed from flaps so that a maximum of 1/64 inch of the base of the locking extension is left on the sheet.

13. Weld strips shall be approximately 1 inch wide with a minimum width of 7/8 inch. The edges of weld strips shall be beveled in the manufacturing process. Thickness of weld strip shall be a nominal 1/8 inch.

14. All sheets used shall be shop tested for pinholes using an electrical spark tester set at 20,000 volts minimum. Any holes shall be repaired and retested.

EE. Tracer Wire for Sewer Line and Force Mains

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

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

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

4. Connector shall be specifically manufactured for use in underground tracer wire and shall be dielectric silicone filled to seal out moisture and corrosion, and shall be installed in a manner to prevent any uninsulated wire exposure. Non-locking, friction fit, twist on, or taped connectors are prohibited.

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

6. All two-terminal tracer wire access points must include a manually interruptible conductive/ connective link between the terminal for the tracer wire connection and the terminal for the ground rod wire connection. All at-grade access points shall include an encapsulated magnet molded into the top portion of the tube, to allow for detection by a ferrous metal detector. On both public and private properties, tracer wire shall terminate at an approved

at-grade, two-terminal access box near the sewer clean-out. For sewer lines over 500 linear feet without service laterals, tracer wire access must be provided utilizing an approved grade level/in-ground trace wire access box, located at the edge of the road right-of-way, and out of the roadway. The grade level/in-ground tracer wire access box shall be delineated using a minimum 48" polyethylene marker post, green in color. All at-grade access points shall be supplied with anti-corrosion wax-gel to protect wires.

FF. Reserved

GG. New Material and Methods

1. The City encourages development of new products and technology and will consider the use of products or methods not previously specified. Product submittals will be reviewed by the City Engineer and a determination will be made as to the acceptability of the product. Consideration or review of a new product does not mean the City will accept its use on the Project.

2.02 EQUIPMENT

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

PART 3 - CONSTRUCTION REQUIREMENTS

3.01 SITE PREPARATION AND RESTORATION

A. Rights-of-Way and Easements

1. Rights-of-way and/or easements as shown on the Plans and/or rights-of-way/easement plats are provided by the City to the Contractor for construction of sanitary sewer facilities. The Contractor will confine his construction activities to these areas. The Contractor will 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 Contractor will immediately provide a copy of all such written agreements to the City upon obtaining the same.

B. Clearing of Rights-of-Way and Easements

1. The Contractor will confine his clearing of rights-of-way and easements to the least area necessary for construction of facilities shown on the Plans. The Contractor will protect as many trees and shrubs within the area as possible. Where necessary for construction the Contractor will clear all live and dead vegetation and growth, pole stubs, logs, and other objectionable material. Cleared material will be removed to within 3 inches of existing ground. This work will 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 Plans are approximate and are not intended as an accurate location of such obstructions. Obstructions not shown on the Plans but encountered by the Contractor will be removed and replaced in their original state or protected by the Contractor at no additional cost to the City.

D. Removal of Obstructions

1. The Contractor will 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 Contractor will 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 Plans and/or Plats due to construction operations. All damage will be repaired or restored at the Contractor's expense. Particular attention will 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 Contractor 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 will be collected and disposed of according to the City Code of Ordinances at the expense of the Contractor. There will be no separate pay item for disposal of debris. Debris will be removed from the site when practical and will not be left until the completion of the contract. If burning of debris is allowed by the Engineer all precautions will be exercised to prevent the spread of fire and such burning will be according Specification Section 01740 Paragraph 1.06. Burning will be done only at approved locations and in conformity with the laws, ordinances and requirements of agencies and officials having jurisdiction. Besides obtaining the permission of the Engineer, the Contractor will obtain and pay for any permits required. When material is to be disposed of outside the easement, the Contractor will first obtain written permission from the property owner on whose property the disposal is to be made and will file a copy with the Engineer. Unless otherwise provided in the Contract Documents, the Contractor will arrange for disposing of such material outside the right-of-way/easement. No debris will be deposited in wetlands.

2. As approved by the Engineer, wood chips, mulch, etc. placed by the Contractor to prevent soil erosion are not considered debris. All erosion prevention materials will be placed and maintained in accordance with the Memphis and Shelby County *Storm Water Management Manual* and/or the Tennessee Department of Environment and Conservation *Erosion and Sediment Control Handbook*.

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 will be replaced with new fence material similar in original quality, size, and appearance to the removed fence. Exceptions to this requirement will be allowed if written releases are obtained from the property owners by the Contractor and submitted to the Engineer. For chain link fence, new fence material and construction methods will conform to the requirements of Specification Section 02820.

I Restoration of Turfed Areas

1. All areas will be restored as nearly as practicable to their original condition. Finished lawn areas where soil has been deposited will 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 will be resodded. Areas where sod is only slightly damaged may be reseeded if so permitted by the Engineer. After final restoration of the settled trench surfaces, trench areas and areas regraded as part of the construction will be resodded, unless otherwise shown on the Plans or directed by the Engineer Seeding and sodding material and construction methods will conform to the requirements of Specification Sections 02920 and 02921

3.02 EXCAVATION

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

B. Trench Excavation

1. All trenches will be open cut unless otherwise shown on the Plans. Tunneling, boring, or jacking may be allowed by written permission of the Engineer.

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

3. No more than 300 feet of trench will be opened ahead of the completed sanitary sewer, nor will more than 100 feet be left unfilled except by written permission from the Engineer. In special cases the Engineer 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 will 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 will be 36 inches. For 18-inch diameter pipes, the width of trenches below a level 1 foot above the outside top of pipes will 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 will be at least 12 inches but no more than 15 inches on each side of the outside of the pipe. If the trench width at or below 1 foot above the top of pipe exceeds the width specified, provisions will be made at the Contractor's expense to compensate for the additional load upon the pipe.

5. The sides of the trench will be as nearly vertical as possible. The bottom of the trench will be carefully graded, formed, and aligned according to City of Memphis Standard SST-3 and to the satisfaction of the Engineer before sanitary sewers are laid.

C. Other Excavation

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

2. Undercut areas will be backfilled with No. 67 limestone or other aggregate approved by the Engineer to the grade established on the Plans. The backfill will 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. Undercut backfill will be encapsulated in geotextile fabric conforming to Specification Section 02370 2.01.C.

3. Unauthorized Excavation Below Subgrade or Outside Limits:
Any unauthorized excavation and subsequent removal and backfilling beyond the lines and grades shown on the plans will 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 will be backfilled according to Specification Section 02530 Paragraph 3.02.C.2.

D. Change in Location and Grade

1. If the Engineer orders in writing that the location or grade of a proposed sanitary sewer facility be changed from that shown on the Plans, 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 Change Order 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 will apply to payment for work along the changed location. If abandonment of an existing excavation is required due to a change by the Engineer, a Change Order will be prepared covering the backfilling and restoration of the abandoned excavation. Backfilling and restoration of the abandoned excavation will be accomplished according to the appropriate section of these Specifications.

3. Filling a portion of existing excavation to meet changed grades will be accomplished according to Specification Section 02530 Paragraph 3.11.

4. If a change in a location and/or grade is authorized in writing by the Engineer at the written request of the Contractor, the Contractor will not receive any additional compensation for the changed work. 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 as appropriate will be used to develop payment.

E. Disposition of Excavated Material

1. Excavated material suitable for backfill will be stored no closer than 2 feet from the edge of the excavation. Excavated material will not obstruct crosswalks, sidewalks, driveways, street intersections, nor interfere unreasonably with travel on streets. Gutters or other surface drainage facilities will not be obstructed. The Contractor must provide access to fire hydrants, mail boxes, sewer and conduit manholes and similar utility or municipal service facility as required. Excavated material intended for backfill will be stored in a way that minimizes loss of excavated material due to erosion. The Contractor 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 will be removed from the site and disposed of by the Contractor. If the Contractor 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 Contractor in advance. A

certified copy will be given to the Engineer. No surplus or excess material will be deposited in any stream channel nor anywhere that would change preconstruction surface drainage.

F Control of Water

1. The Contractor will keep all excavations free of water. If the trench subgrade consists of good soil in good condition at the time of excavation, it will be the Contractor'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 will be provided by the contractor. Dewatering of trenches, will be incidental to trench excavation. The Contractor will avoid producing mud in the trench bottom by his operations. If necessary or so ordered by the Engineer, the Contractor will 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 bedding, laying, jointing, and the placing of concrete or masonry will be done in a water free trench or excavation. Trenches will be kept clear of water until pipe joints, concrete and masonry have set and are resistant to water damage. The water will be disposed of in a manner acceptable to the Engineer.

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

G Excavation Around Obstructions

1. The Contractor will perform all excavation by hand where excavation by machinery would endanger trees, structures, or utilities that otherwise might be saved by hand excavation.

2. The Contractor will cautiously excavate test holes 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.

H Excavation for Manholes and Special Structures

1. The Contractor will be responsible for performing the Work according to the lines and elevations shown on the Plans or as directed by the Engineer. The Contractor will 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 will 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 will not exceed 2 feet from the outside of the masonry or concrete work. If the excavation exceeds this limit, the Contractor will be required to backfill the entire space around the structure with pit run gravel compacted as specified in Specification Section 02530 Paragraph 3.11.B.

I Special Protection

1. Treacherous Ground.
When running sand, quicksand, or other treacherous ground is encountered, the work will be

carried on with the utmost urgency and will continue day and night should the Engineer so direct

2. Sheeting and Shoring:
The Contractor will 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 Contractor will place the sheeting and shoring without the Engineer's instructions.

3. Sheeting will 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) will 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, will not exceed the maximum width of a trench per Specification Section 02530 Paragraph 3.02.B. Walers and struts will be designed and installed to present no obstructions to proper placement of the pipe, bedding, cradle or encasement, and they will not interfere with the satisfactory installation of the pipe.

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

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

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

7. Excess Width of Trench:
If the Contractor is permitted to use equipment that results in wider trenches than specified, approved methods will 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 Engineer. The contractor is 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 will be backfilled and compacted according to ASTM D 2321, and no concrete cradle will be used.

8. Blasting:
Blasting will be undertaken only after the Contractor has received written authorization from the Engineer. With respect to the use of explosives in blasting, the Contractor will obtain all necessary permits and comply with all laws, rules, and regulations of the federal, state, City, and the insurer governing the keeping, storage, use, manufacture, sale, handling, transportation, or other disposition of explosives. The Contractor will obtain additional insurance covering the use of explosives with limits and coverage as specified by the Engineer. All operations involving the handling, storage, and use of explosives will be conducted with every precaution under the supervision of a properly licensed individual. The Contractor will take special precautions for the proper use of explosives to prevent harm to human life and damage to surface structures, utilities, storm drains, sewers, or other subsurface structures. The Contractor will advise the Engineer in advance when charges are to be detonated. Blasts will not be fired until all persons in the vicinity have had ample notice and have reached positions of safety.

9. Sanitary sewer construction will be carefully protected from all blasts, and all excavations requiring blasting will be fully completed at least 30 feet ahead of the laying of the pipe. The mouth of the pipe will always be covered with a board or other plug carefully fitted to the pipe to prevent earth or other substances from entering.

10. After a blast is fired, the Contractor will thoroughly scale the excavation. All loose, shattered rock or other loose material that may be dangerous to the workers, pipe, or structure will 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 will not be entitled to extra compensation therefore.

11. Underpinning:
When excavations require underpinning of existing structures, the Contractor will submit shop drawings of underpinning details to the Engineer for review before commencement of excavation below the foundation of the structure. Review of underpinning details by the Engineer will not relieve the Contractor of his responsibilityfor protection of the structure and its contents.

d. Existing Utilities

1. Location:
The Plans show the readily available record 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 expected in built-up areas, and if relocating them is necessary, it will be the Contractor's responsibility to arrange for the relocation with the owner or owners of theutilities.

2. Protection
The Contractor will protect any storm drain, sewer, or utility within the limits of the construction. The Contractor will proceed with caution and will use every means to establish the exact location of underground structures and facilities before excavating in the vicinity. 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 broken or damaged by the Contractor's operations. All water and gas pipes and other conduits near or crossing the excavation will be properly supported and protected by the Contractor.

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

4. Service Connections:
Sewer and utility services between mains and buildings will be maintained and adjusted as necessary by the Contractor to provide as nearly a continuous operation as can be expected. This will be accomplished in any way that the Contractor chooses, provided the individual service is not interrupted for more than two consecutive hours. The occupants will be notified by the Contractor at least six hours before such service interruptions. When a break occurs, the Contractor will notify the affected occupant(s) of the probable length of time that the service will be interrupted.

5. If existing underground facilities or utilities require removal and replacement for the performance of this work, all replacements will 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 will be the

Contractor's responsibility within the limits where the new service line grade blends smoothly with the existing service line grade.

7. The removal and replacement of sewer house connections to adapt to new construction will be the Contractor's responsibility from the sewer main to a point where the new grade and existing grade can be matched.

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

3.03 SEWER PIPE INSTALLATION

A. General

1. Sewer pipe and bedding will be constructed as shown on the Plans. It will be the Contractor's responsibility to find all underground utilities before construction to insure there are no conflicts with the proposed line and grade. The Contractor's surveyor shall verify the base information on the City's plans prior to commencement of construction. Any discrepancies in the plans shall be reported to the Engineer immediately. If approved by the Engineer, 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 Contractor will arrange with the owner of said utility to have it adjusted as required to accommodate the proposed sewer at no additional expense to the City.

B. Modifications of Existing Sanitary Sewer Facilities

1. Maintenance of Flow:
Where existing sewer lines are being modified, the Contractor will arrange his work so that sewage flow will be maintained during the construction period with no discharge of sewage into the open trench, and no back up of sewage in the existing line. The contractor will 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 Plans to be abandoned will 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 will be sealed with a brick bulkhead and/or acceptable cement grout to form a solid watertight plug completely bonded to the pipe. Any sewer manholes to be abandoned will be abandoned per Specification Section 02531 Paragraph 3.03 B.

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

4. Connection to Existing Manholes:
The Contractor will core 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 Plans. Care will be used to avoid unnecessary damage to the existing manhole.

5. All loose material will be removed from the cut surfaces that will be completely coated with nonshrinking grout before setting the pipe. Before inserting the pipe, a sufficient thickness of grout will 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 will be installed on the pipe according to the manufacturer's recommendations. After setting, all spaces around the pipe will be solidly filled with nonshrinking 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 will be made to provide a smooth, plastered surface for properly channeled sewage flow from the new connection. Plaster on the exterior of brick manholes will be repaired with nonshrinking grout. Particular care will be given to ensure that the earth sub-base and bedding next to the manhole will provide firm solid support to the pipe.

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

C. Tracer Wire Installation

Tracer Wire

1. Tracer wire must be installed per manufacturer recommendations, and all service lateral tracer wires properly connected to the mainline tracer wire, to ensure full tracing/locating capabilities from a single connection point. Lay mainline tracer wire continuously, by-passing around the outside of manholes/structures. Tracer wire must be fastened on all pipe (mainline and service connections) with plastic zip ties at 5-foot intervals. Tracer wire on all sanitary service laterals must terminate at an approved at-grade, two-terminal access box color coded green and located directly above the service lateral at the road right of way.
1. Service connection tracer wire shall be a single wire, connected to the mainline tracer wire using a lug connector, installed without cutting/splicing the mainline tracer wire.
2. New tracer wire being extended or tied into an existing tracer wire shall be connected using approved splice connectors, and shall be grounded at the splice location specified.
3. Tracer wire must be properly grounded at all dead-ends/stubs. Grounding of tracer wire shall be achieved by use of a drive-in magnesium grounding anode rod with a minimum of 20 feet of HDPE copper clad wire connected to anode specifically manufactured for this purpose, and buried at the same elevation as the sewer line.
4. In case of occurring damage to the wire during installation, an immediate repair is required by removing the damaged wire and installing a new section of wire with approved connectors.

Connectors

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

3.04 PIPE BEDDING

A. Bedding will be defined as that material supporting, surrounding and extending to one foot above the top of the pipe. Bedding for sewer pipe will conform to the requirements given below for Class A, B.1, or B.2, whichever is shown on the Plans. If the class of bedding is not shown, a minimum of Class B.1 or B.2 bedding will be provided as specified below. At the direction of the engineer or as shown on the plans, sewer pipe and Class B.1 or B.2 bedding will be encapsulated in geotextile fabric as specified in Section 02370 2.01.C.

B. Class A - Concrete Cradle

1. Class A bedding for sewer pipe will consist of a continuous concrete cradle constructed in conformity with the details shown on the plans or as directed by the Engineer. Class A bedding will only be used for rigid pipe.

C. Class B.1-Crushed Limestone

1. Class B.1 bedding will be number 67 crushed limestone. Pipe 4 inches to 24 inches in diameter will be bedded on 4 inches of bedding material. Pipe 27 inches to 48 inches in diameter will be bedded on 6 inches of bedding material. Bedding for pipes larger than 48 inches in diameter will be by design based on anticipated soil conditions. After pipe installation, crushed limestone will then be tamped under the haunches continuing in layers not more than 6 inches in loose thickness around the pipe to the spring line. The remainder of the installation will be as outlined in Specification Section 02530 Paragraph 3.11. Unless otherwise instructed, concrete and ductile iron pipe will be bedded in Class B.1 bedding.

D. Class B.2-Crushed Limestone

1. Class B.2 bedding will be number 67 crushed limestone. Pipe 4 inches to 24 inches in diameter will be bedded on 4 inches of number 67 crushed limestone Pipe 27 inches to 48 inches in diameter will be bedded on 6 inches of bedding material. Bedding for pipes larger than 48 inches in diameter will be by design based on anticipated soil conditions. After pipe installation, crushed limestone will 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 will be as outlined in Specification 02530 Paragraph 3.11. Class B.2 bedding will be used for all flexible pipe including fiberglass reinforced polymer mortar pipe, PVC and HDPE.

E. Deleted

3.05 PIPE LAYING

A. Inspection Before Laying

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

B. Preparation of Pipe Ends

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

C. Care During Hoisting, Placing, And Pushing Home

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

D. Direction of Work

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

E. Uniform Pipe Bearing

1. Special care will be taken to insure that the pipe is solidly and uniformly bedded, cradled, or encased according to the Plans. For pipe with a bell that is larger than the barrel of the pipe the bedding material will be removed to a depth that will provide continuous support for the bell and barrel. No pipe will 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 will 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 will 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 will not be allowed except as directed by the Engineer.

G. Backfilling to Secure Pipe

When the joint is made, sufficient backfill material will be simultaneously placed along each side of the pipe to prevent moving the pipe off line and grade. Particular care will be used to prevent disturbance or damage to the pipe and the joints during backfilling.

H Flotation and Water in the Trench

1. The Contractor will take all necessary precautions to prevent flotation of the pipe in the trench. Water will not be allowed to rise in the trench. The Contractor will 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 Contractor will make a request to the Engineer 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 Contractor.

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 will be protected from damage and a temporary tight fitting plug or bulkhead will 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 will 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 will be in a neat workmanlike manner at right angles to the pipe axis without damage to the pipe. Observe specifications regarding joint locations. Smooth the cut end by power grinding or filing to remove burrs and sharp edges. Repair lining of the pipe asrequired.

L. Wyes and Special Fittings

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

M. Valves

1. Valves and appurtenant fittings will be installed as shown on the Plans or where directed by the Engineer.

2. Check valves and gate valves will be installed on either flanged or mechanical joint ductile iron pipe.

3. Air release, vacuum relief and combination air valves larger than 3 inches in diameter will be installed on either flanged or mechanical joint ductile iron pipe. A gate valve conforming to Specification Section 02530 2.01.Q shall be installed to isolate these air valves from the force main.

4. Air release, vacuum relief and combination air valves 3 inches in diameter and smaller will be installed on a ductile iron tap 'T' fitting. A ball valve conforming to Specification Section 02530 2.01 Q shall be installed on a 6" threaded nipple between the 'T' and the air valve

3.06 PIPE JOINTS

A. General

1. Pipe will be jointed immediately following the laying of each section. No pipe section will 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 Engineer.

B. Compression Joints

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

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

C. Mechanical Joints

1. The two ends to be joined will be thoroughly cleaned with a wire brush and the plain end, socket end, and gasket will be brushed with soapy water. The end will be centered in the socket and adequate anchorage will 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 will be made after joint assembly and before tightening bolts. Pipe deflection will 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 will be torqued to the required range recommended by the pipe manufacturer. Over stressing of bolts will be avoided. Gauge lines on the spigot end will be checked following assembly to ensure proper positioning of bell and spigot has been accomplished.

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

D. Flanged Joints

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

E. Solvent Cement Joints

1. The two ends to be joined will be thoroughly cleaned and primer liberally applied to the outside of the spigot within the joint insertion limits and inside the bell in conformance with the manufacturer's recommendations. Cement will be applied immediately to the same surfaces as the primer and the pipe joined within one minute. A sufficient quantity of cement will be applied to form a bead of excess cement around the full circumference of the joint when the spigot is fully inserted. The spigot end will be inserted to the insertion stop mark and rotated one-fourth turn. Avoid disturbing the joint until cement has had ample time to set.

F. Restrained Joints

1. Restrained push-on joints are to be used as specified on the plans or by the Engineer. These special joints will be installed as specified by the manufacturer. The length of the pipe to be restrained will be determined by the Engineer based on pipe size, internal pressure, depth of cover, and soil characteristics around the pipe.

3.07 PIPE CAPS AND PLUGS

A. Wyes, stubs, or other fittings installed in the pipe for future connections will be closed at the open end. For pipes 21 inches in diameter or smaller, an approved cap or plug will 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 Plans and Specifications to close the open end may be substituted for stoppers. Care in backfilling will be used so that such closure and its seal will not be disturbed. This stopper will 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 SERVICE CONNECTIONS

A. All service connections on new pipe up to and including 12-inch diameter will be 6-inch diameter either Schedule 40 or SDR 26 in-line wye connections unless indicated otherwise on the Plans. Service connections on pipes larger than 12 inches in diameter will not be allowed. Saddles will not be used on new construction.

B. All service connections on existing pipe up to and including 12-inch diameter will be 6 inch diameter Inserta Tee, or approved equal, or saddle wye connections.

C. Although the general location of connections may be shown on the drawings, the actual location will be determined by the Contractor, subject to approval by the Engineer. Connections for undeveloped property will generally be at the center of the lot. Connection locations for developed property will be coordinated with the property owner. The quantities shown on the proposal sheet are only approximate and are subject to change. The depth of connections at the property line will be determined by the Engineer. Service connections will be laid on no less than a 1 percent gradefor 6-inch diameter connections unless otherwise directed by the Engineer. Each building connection will be accurately recorded by station offset and depth on the as-built drawings and will be furnished to the Engineer. Unless authorized by the Engineer in writing, or shown on the drawings, building connections will not be tied into new or existing manholes. When service connections are tied into manholes at an elevation greater than 2 feet above the manhole invert, the service will be constructed as a drop construction as specified in Specification Section 02531 Paragraph 3.08.

D. Service connections will be laid in open trenches except where tunneling may be necessary under existing curbs, sidewalks, or pavements. In all such instances, a shaft must be excavated at the end of the connection for inspection purposes and measurement of length and depth. All service connections will extend to the right-of-way or easement limits. The service connection will be installed in conformance to the City of Memphis Standard No. SST-16.

3.09 PIPE ENCASEMENT, COLLARS, AND THRUST BLOCKS

A. General

1. Concrete will be Class "C" Concrete as specified in Specification Section 03050. All concrete will be placed, cured, and protected according to the applicable paragraphs of Specification Sections 03050 and 03310. Pipe alignment will be inspected immediately following concrete placement and any misalignment caused by the placement of concrete will be corrected before the initial set. Concrete will be protected against water until completely cured.

B. Pipe Encasement

1. Concrete encasement for pipes is to be used at the locations shown on the Plans or as directed by the Engineer. Concrete will be Class C and will be reinforced as required. All pipe requiring encasement will be blocked at each joint using masonry supports of a minimum size sufficient to provide the required clearance and to prevent displacement during placing of concrete. Concrete will be placed on either side of the pipe in approximately equal amounts to prevent movement of the pipe. Concrete encasement is to be rectangular in section with a thickness of ½ the pipe diameter between the outside edge of pipe and the outside of encasement at the closest point unless shown otherwise on the Plans. The absolute minimum thickness for concrete encasement shall be 6 inches regardless of pipe size.

C. Pipe Collars

1. Concrete pipe collars are to be used to join pipe ends that cannot be joined with prefabricated joints. Concrete will be Class C and will be reinforced when shown on the Plans. Concrete pipe collars will be constructed at the locations and to the dimensions shown on the Plans or as directed by the Engineer. Pipes being joined will be blocked and supported laterally to prevent movement during placing or curing of concrete. Rubber water stops will be placed on each pipe before pouring the concrete collar. Fernco or equal mechanical coupling will be used for pipe connectors 16 inches and smaller.

D. Thrust Blocks

1. Concrete thrust blocks are to be used to resist internal thrust pressures at bends and fittings in force mains at the locations shown on the Plans or as directed by the Engineer. Concrete will be Class C and will be reinforced when shown on the Plans. Thrust blocks will conform to the dimensions shown on the Plans or City of Memphis Standard SST-12. Load distribution type thrust blocks will be poured continuously from the force main to the undisturbed trench face. Backfill will not be placed as backing material for load distribution type thrust blocks.

2. All concrete will be poured in a way that leaves the pipe joint accessible for caulking or tightening of bolts. Care will be taken to permit the concrete to cure long enough to develop sufficient strength before the concrete is required to withstand the thrust. The area of the concrete bearing on the main or the restraining mass must be large enough to prevent over stressing the concrete.

3. If a concrete mass is used, a form may be necessary to contain the mass to provide access to joints or to insure the required bearing area. Generally, some form work is required for the mass of concrete necessary for blocking on mains sized 12 inches and larger. In poor soil, forming the concrete mass to construct the necessary bearing surface will be necessary. Instead of this construction, a restrained joint may be used.

4. Thrust blocks will be included in the linear foot price for the force main.

3.10 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 per Specification Section 02530 3.02 F Control of Water

C. Unless otherwise specified, inverted siphon pipe will be lined ductile iron Class 50 pipe and fittings as specified in Specification Section 02530 Paragraph 2.01.H fabricated for push-on type joints or HDPE conforming to Specification Section 02530 Paragraph 2.01.M. The siphon pipes will be encased in concrete at the locations and to the dimensions shown on the Plans or Details. 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.

3.11 BACKFILLING

A. General

1. After sanitary sewer facilities have been bedded and installed according to these Specifications and upon permission of the Engineer, the backfill may be placed. Backfilling operations will continue following as closely behind pipe installation as practical. All backfill will 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 will 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 will be responsible for the condition of the trenches and filled areas during the contract and warranty period. The Contractor will maintain frequent inspection of the same. Anytime during the 12-month warranty period the trenches or filled areas settle and sunken places appear, the Contractor will 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 will 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 and pipe trench excavations through pavements in street or highway right-of-way or where the Engineer orders, will be made with pit run gravel or other acceptable material as approved by the Engineer. The backfill will be from the top of the bedding material or 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.

b. Backfill for manhole and pipe trench excavations beyond pavements in street or highway right-of-way or outside public right-of-way will be made with select earth from the top level of the bedding 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.

c. Select material will be free from debris, organic matter, perishable compressible material and 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 will 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.

2. Placement and Compaction:

a. Sanitary Sewer Trenches:
Backfill material will 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 will

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 will be mechanically placed in 9 inch, maximum, loose layers. All backfill material will 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 Engineer 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 will 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 will be made with select material from the top level of bedding 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, 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 will come in direct contact with the pipe. Stones and lumps will be kept separated and well distributed, and all voids will be completely filled with fine material.

2. Placement of Backfill:

Backfill procedures specified in Specification Section 02530 Paragraph 3.11.B will 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. Sanitary Sewer Facilities Placed on Fill

1. All sanitary sewer pipe laid on fill will be ductile iron pipe. Fill material placed in areas over which sanitary sewer facilities will be constructed will be select, job-excavated earth from the original ground to the subgrade elevation of the facility.

2. The fill material will 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 or special structures. If compaction standards for the sanitary sewer exceed that of the adjoining fill, the width of compaction for a sanitary sewer will be not less than the outside diameter of pipe plus 10 feet. If compaction standards for the sanitary manhole or special structure exceed that of adjoining fill, the limits of compaction for the structure will be not less than 5 feet outside the structure base slab.

E. Removal of Excess Material

1. After the trench or excavation has been properly backfilled, all excess dirt will 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 Contractor will obtain written permission from the property owner for the spreading of excess soil, and a copy of the written permission will be submitted to the Engineer. Such spreading or filling will not obstruct surface drainage and be to the satisfaction of the property owner. Excess material will be disposed of by the Contractor.

3.12 TUNNELING, BORING, AND JACKING

A. General

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

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

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

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

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

B. Tunneling

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

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

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

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

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

6. Timbering will be designed and placed to allow the filling of voids. All excavated material not required for backfilling abandoned shafts 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 Part 5 and payment will be made as provided in

C. Boring

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

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

3. All carrier pipe shall be mechanical joint or restrained joint pipe. Manholes at the ends of a section of bored pipe will not be constructed until the bored section is completed.

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

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

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

D. Jacking

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

2. Heavy duty jacks suitable for forcing the pipe through the embankment will be provided by the Contractor. In operating jacks even pressure will be applied to all jacks used. A suitable jacking head and bracing between jacks and jacking head will be provided so that pressure will be applied to the pipe uniformly around the circumference of the pipe. A suitable jacking frame or backstop capable of resisting the jacking forces will be provided. The pipe to be jacked will be set on guides, properly braced together to support the section of the pipe and to direct it in the proper line and grade. The whole jacking assembly will be placed to line up with the direction and grade of the pipe. The Contractor may use a cutting edge of steel plate around the head end of the pipe extending a short distance beyond the end of the pipe with the inside angles or lugs to keep the cutting edge from slipping back onto pipe.

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

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

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

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

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

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

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

10. When unforeseen obstructions or conditions require abandonment of a partially completed pipe jack, the Contractor will grout the abandoned pipe solid. The Contractor will receive no compensation for any expenses incurred by any unsuccessful attempt.

E. Sewer Pipe in Jacked Liner

1. When required by the Plans or Contract Documents, a sewer pipe will be installed by jacking a pipe as a liner and inserting a carrier pipe of required size, type, and class. When using jacking for liners, the steel liner will be welded steel, 35,000 psi yield strength, and of the diameter and wall thickness required on the Plans and Specifications. The Contractor will provide, at his own expense, thicker walled pipe 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.

F. Reserved.

3.13 DELETED

3.14 FINAL GRADING

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

3.15 CLEANING

A. All necessary precautions will 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 will be cleaned of all dirt, jointing material and extraneous material. On small pipe where cleaning after laying may be difficult, a squeegee will be kept in the pipeline and pulled forward past each joint immediately after its completion. Before final inspection the Contractor will remove all debris and foreign material.

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. All tests will be made by the Contractor who will provide necessary equipment for testing and lamping the system in the presence of and under the supervision and instructions of the Engineer. Lamp tests will be observed first hand by the Engineer. Each section of sewer line will show a full circle of light when lamped between manholes. All defects located will be corrected before conducting leakage tests.

4.02 LEAKAGE TESTS

A. Leakage tests will be performed on the full length of all sewer lines and manholes in the presence of the Engineer before acceptance. The cost of all testing will be included in the unit price for the item being tested.

B. Exfiltration Leakage Test

1. This section will only apply to pipe larger than 24 inches and smaller than 48 inches in diameter. All pipe over 48 inches in diameter will have individual joint testing according to Specification Section 02530 Paragraph 4.02.E. The method of testing used by the Contractor will be subject to approval by the Engineer. The Contractor will provide all required testing apparatus. The method adopted must exert a minimum internal water pressure of four feet. This hydrostatic head will be measured from the inside top of the pipe at the high end of the section being tested. The height of the water level at the beginning of the test must be high enough so that the 4-foot head will be standing at the end of the test. The maximum hydrostatic head is limited to 15 feet. The exfiltration test will be maintained for at least two hours on each reach between manholes as necessary to find all leaks. The trench and backfill are intended to be free of excess water.

2. In areas where groundwater is known to exist, a one-half inch diameter capped pipe nipple approximately 10 inches long will be installed through the manhole wall on top of the lowest sewer line entering the manhole. This will be done at the time the sewer line is installed. Immediately before the performance of the leakage test, the groundwater level will be determined by removing pipe cap, blowing air through pipe nipples into the ground to clear it, and then connecting a clear plastic tube to the nipple. The tube will be held vertically and a measurement of height in feet of water will be taken after the water stops rising in this plastic tube. The height in feet will be divided by 2.3 to establish the pounds of pressure that will be added to all readings. In the event there is water present in the trench or backfill at the time of the test, the required head producing the pressure inside the pipe must be raised to offset the counteracting pressure outside of the pipe. The test will not be considered satisfactory until an acceptable method of measurement shows that the exfiltration rate does not exceed 0 gallons per inch of internal diameter per mile of pipe per day for each reach tested.

3. An initial test must be arranged by the Contractor so that the first reach of each size laid by each crew at the beginning of the work day can be tested before the backfill has been completed, but the pipe will be backfilled to a point 2 feet above the outside top of the pipe. This test reach is intended to extend only to the next proposed manhole location. However, if conditions justify, the length of the test reach may be reduced but never will this reach be less than 100 feet. No further pipe laying will be permitted by this crew until the above described test has been satisfied. All remaining pipe will be subject to the exfiltration test after manholes have been constructed and backfill placed. Manholes are to be included in this test and will be considered as sections of pipe equal to the diameter of the manhole.

4. If anytime the exfiltration observed and measured by the Engineer exceeds 0 gallons per inch of internal diameter per mile of sewer per day, the Contractor will find the point(s) of leakage and will make necessary repairs and then retest the same reach. The Contractor will submit his plans for repair to the Engineer for his review.

5. Water used for testing will be removed from the test reach following acceptance and will be disposed of properly. Water used for testing will not be discharged in such a manner to damage other construction or public or private property. The cost of providing the test water will be borne by the Contractor.

C. Air Leakage Test for 6-24 inch Diameter Pipe

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

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

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

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

4. Air leakage tests will 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 will be determined from the following table. If air tests fail to meet the following requirements, repeat tests as necessary after all leaks and defects have been repaired. Before acceptance, the same sewer reach will pass the low pressure air test.

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

Pipe Diameter (in.)	Minimum Time (min:sec)	Test Time for Length of Sewer Tested (min)
6	5:40	.854 X L(ft)/60
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	22:47	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

D 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 will be sufficient reason to require additional work by the Contractor to reduce the infiltration in such portions of the line tested. The passing of an infiltration test will in no way relieve the Contractor of any responsibility to repair visible leaks found during the visual inspection.

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

E Joint Acceptance Testing

1. Individual joints will be tested for pipe diameters of 48 inches and greater. Testing will be performed according to ASTM C 1103.

4.03 DEFLECTION TEST - SEMIRIGID AND FLEXIBLE PIPE

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

B. Tests will 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 will be repaired by re-bedding or pipe replacement and retested to the satisfaction of the Engineer.

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

4.04 SEWAGE FORCE MAINS

A. The Contractor will perform hydrostatic pressure and leakage tests concurrently conforming to AWWA C 600, AWWA C 605, ASTM D 2774 or ASTM F 2164 procedures as applicable and as modified herein. Tests will apply to all sewage force mains after backfilling.

B. Force mains will be tested separately in segments between sectionalizing valves, between a sectionalizing valve and a test plug, or between test plugs. Select test segments such that adjustable seated valves are isolated for individual checking. The Contractor will furnish and install test plugs at no additional cost, including all anchors, braces and other devices to withstand hydrostatic pressure on plugs. The Contractor will be responsible for any damage to public or private property caused by failure of plugs. Limit water fill rates of line to available venting capacity.

C. Hydrostatic Pressure Test
Conduct tests at 1.5 times maximum operating pressure determined by following

$P_{pl} = 0.650 (OP-GE)$, in which

P_{pl} = test pressure in psi at gauge elevation
OP = operating pressure in feet as indicated for highest elevation of the hydraulic gradient on each section of the line
GE = elevation in feet at center line of gauge

D. Hydrostatic Leakage Test
Conduct tests conforming to AWWA C 600, AWWA C 605, ASTM D 2774 or ASTM F 2164 procedures, as applicable, at maximum operating pressure determined by following formula:

$P_{ll} = 0.433 (OP-GE)$, in which

P_{ll} = test pressure in psi at gauge elevation
OP = operating pressure in feet as indicated for highest elevation of the hydraulic gradient on each section of the line
GE = elevation in feet at center line of gauge

E. Satisfactorily complete previously defined pressure tests before determining the amount of leakage. Maximum allowable leakage will be determined by the following formula:

$$L = ND\frac{\sqrt{p}}{7400}$$

L = Allowable leakage in gallons/hour
N = Number of joints in length of pipeline tested
D = Nominal diameter of the pipe, in inches
P = Average test pressure during leakage test, in pounds per square inch, gauge

4.05 FINAL ACCEPTANCE

A. When all work required by the Contract has been completed, the Contractor shall submit to the Engineer 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 plans. After receiving the surveyor's certification from the Contractor, the Engineer will make a final inspection of

the Work, including any tests for operation. After completion of this inspection the Engineer will, if all things are satisfactory to him, issue to the Contractor 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 Contractor or his sureties from any guarantees under the Contract or the Performance Bond. Upon receipt of the Certificate of Completion the Contractor will clean the premises and see that they are in an orderly condition.

4.06 Tracer Wire

A. All new tracer wire installations shall be located using typical low frequency (512 Hz) line tracing equipment, witnessed by the contractor, and engineer, prior to acceptance of ownership. The verification shall be performed upon completion of rough grading and again prior to final acceptance of the project. Continuity testing in lieu of actual line tracing shall not be accepted.

PART 5 - MEASUREMENT

5.01 SITE PREPARATION AND RESTORATION

A. The area to be considered for measurement will be the limit of the construction area in acres unless otherwise directed by the Engineer.

B. 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 Contractor under other contract items.

5.02 UNDERCUT BACKFILL

A. Undercut backfill will be measured by the ton of limestone in place.

5.03 SHEETING AND SHORING DIRECTED TO REMAIN IN PLACE

A. Sheeting and shoring directed to remain in place will be measured by the 1,000 board feet, in place, after being cut off below grade. Sheeting and shoring placed and removed by the Contractor or left in place at the request of the Contractor will not be measured for payment.

5.04 PAVEMENT BACKFILL

A. Pit run gravel or other acceptable material used for backfill under pavements or other areas directed by the Engineer will be measured by the ton of material in place.

5.05 SERVICE CONNECTION REMOVAL AND REPLACEMENT

A. Service connection removal and replacement for construction of sewer facilities will be measured per each, complete in place. Service connections damaged by the Contractor that do not require removal and replacement for construction of sewer facilities will not be measured for payment.

5.06 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 Contractor under other Pay Items of the Contract.

5.07 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. No measurement of pipe depth will be made unless changed field conditions result in a change in the Plans by the Engineer.

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

5.08 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.

5.09 SEWAGE FORCE MAIN

A. Sewage force main length will be measured per linear foot along the centerline of the pipe from the point of measurement at the pumping station or valve box shown on the Plans to the end of the force main at its discharge location. Shut-off and relief valves, valve boxes, and thrust blocks are incidental to the construction of the force main and/or pump station and will not be measured for payment.

5.10 DUCTILE IRON PIPE FITTINGS

A. Ductile iron pipe fittings will not be measured for payment, but are incidental to the cost of furnishing and installing ductile iron sewer pipe or inverted siphons.

5.11 SERVICE CONNECTIONS

A. Service connections between sewer main and right-of-way or easement line will be measured per linear foot to the nearest whole foot, along the centerline of the pipe from the outside face of the wye to the end of the reducer, for the various sizes and types constructed.

B. Service connections between a manhole and the right-of-way or easement line will be measured per linear foot horizontally from the inside face of the manhole to the end of the reducer. Drop service connections will be measured per vertical foot from the flow line of the service connection in the manhole wall to the end of the building connection inside the manhole to the nearest whole foot, along the centerline of the pipe for the various sizes constructed. No measurement of service connection depth will be made. Service connection length will include the length of fitting, reducers, and specials as measured along their centerline.

5.12 NON-SHRINKING GROUT

A. Non-shrinking grout for general use as indicated on the plans or as directed by the Engineer will be measured by the cubic yard, complete in place for each type used.

5.13 PLAIN CONCRETE FOR GENERAL USE

A. Concrete for general use including but not limited to pipe bedding, encasement and collars at the locations shown on the Plans or directed by the Engineer will be measured per cubic yard, complete in place for each class used.

5.14 REINFORCED CONCRETE

A. Reinforced concrete including but not limited to pipe encasement and collars at the locations shown on the Plans or directed by the Engineer will be measured per cubic yard, complete in place.

5.15 Tracer Wire

A. Tracer wire and/or appurtenances will not be measured for payment.

5.16 INVERTED SIPHON

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

5.17 SEWER IN EARTH TUNNEL

A. Sewers constructed in earth tunnels will be measured by the centerline length for tunnels with liner plate or without liner plate.

B. Measurements will be from the face of the pit to the face of the pit.

5.18 SEWER IN BORED HOLE

A. Sewers constructed in a bored hole will be measured by the centerline length for bored holes with or without liner pipe.

B. If Contractor has requested and has obtained approval to use a bored hole instead of the construction required by the Plans, no measurement of sewers in bored holes will be made.

C. Reserved.

5.19 JACKED SEWER

A. Jacked sewers will be measured by the centerline length from the face of the pit to the face of the pit. If the Contractor has requested and has obtained approval to jack a sewer instead of the construction required by the Plans, no measurement of jacked sewers will be made.

5.20 SEWER IN JACKED LINER

A. Sewers in jacked liner will be measured by the centerline length from the face of the pit to the face of the pit. If the Contractor has requested and has obtained approval to construct a sewer in a jacked liner instead of the construction required by the Plans, no measurement of sewers in jacked liner will be made.

5.21 DELETED

5.22 ABANDONMENT OF EXISTING PIPE

A. Abandonment of existing pipe will be considered as a subsidiary obligation of the Contractor under other Pay Items of the Contract.

5.23 REMOVAL OF EXISTING PIPE

A. Removal of existing pipe will be measured per linear foot, to the nearest whole foot, along the centerline of the pipe to be removed regardless of size, type, or depth. No measurement of existing pipe removal within the limits of excavation for new sewers will be made.

PART 6 - PAYMENT

6.01 SITE PREPARATION AND RESTORATION

Payment will be made for Site Preparation and Restoration at the contract lump sum price, 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 Engineer; 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 Engineer.

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 SHEETING AND SHORING DIRECTED TO REMAIN IN PLACE

A. Accepted quantities of sheeting and shoring directed by the Engineer to remain in place will be paid for at the contract unit price per 1,000 board feet in place after being cut off below grade, which will be full compensation for material only. The cost of placing sheeting and shoring to remain in place will be included in the unit cost of other items. No payment will be made for sheeting and shoring placed and removed by the Contractor or left in place upon request of the Contractor.

6.04 PAVEMENT BACKFILL

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

6.05 SERVICE CONNECTION REMOVAL AND REPLACEMENT

A. Accepted quantities of service connections removed and replaced will be paid for at the contract unit price per each for various types of service connections, which will be full compensation for excavation, removal of old service line and appurtenances, furnishing and construction of new service lines, connections to existing service line and appurtenances to remain, and backfilling, complete in place.

B. All pipeline material will be generically the same throughout the project except solid wall PVC pipe service connected to truss pipe mainlines.

6.06 OMITTED

6.07 SEWER PIPE

A. The accepted quantities of all sewer pipe will be paid for at the contract unit price per linear foot furnished and laid for the various sizes, types, classes, or wall thicknesses of pipe, which will be full compensation for material and material testing, excavation, special protection, protection of existing utilities, maintenance of sewage flow, bedding, 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. All pipeline material will be generically the same throughout the project except connecting solid wall PVC pipe service connections to truss pipe mainlines.

6.08 OMITTED

6.09 SEWAGE FORCE MAIN

A. The accepted quantities of sewage force main will be paid for at the contract unit price per linear foot furnished and laid for the various sizes, types and classes or wall thicknesses, which will be full compensation for material and material testing, excavation, special protection, protection of existing utilities, bedding, laying, jointing, fittings, shut-off valves, relief valves, valve pits, thrust blocks, cleaning and inspection, conducting acceptance tests, connection to existing sewer manholes or structures, removal and/or abandonment of existing pipe within the limits of excavation and backfilling outside pavement areas.

6.10 OMITTED

6.11 SERVICE CONNECTIONS

A. The accepted quantities of service connections will be paid for at the contract unit price per linear foot furnished and laid for the various sizes and types. The accepted quantities of drop service connection will be paid for at the contract unit price per vertical foot furnished and installed. The contract unit price will be full compensation for material and material testing, excavation, special protection, protection of existing utilities, bedding, laying, jointing, adapters and couplings, stoppers, reducers, marking reducer, removal and/or abandonment of existing pipe within the limits of excavation and backfilling outside of pavement areas.

6.12 NON-SHRINKING GROUT

A. The accepted quantities of non-shrinking grout for general use will be paid for at the contract unit price per cubic yard, complete in place for each type used, which will be full compensation for material, testing, etc. necessary for the satisfactory completion of the work.

6.13 PLAIN CONCRETE FOR GENERAL USE

A. The accepted quantities of plain concrete for general use including but not limited to pipe bedding, encasement and collars will be paid for at the contract unit price per cubic yard complete in place, which will be full compensation for material, testing, excavation, pipe support, form work, removal of forms, and curing and protection of concrete.

6.14 REINFORCED CONCRETE

A. The accepted quantities of reinforced concrete including but not limited to pipe encasement and collars will be paid for at the contract unit price per cubic yard, complete in place that will be full compensation for material, testing, excavation, pipe support, form work, reinforcing steel, removal of forms, and curing and protection of concrete.

6.15 INVERTED SIPHON

A. Payment will be made for Inverted Siphon 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 test, removal and/or abandonment of existing pipe within the limits of excavation and backfilling.

6.16 SEWER IN EARTH TUNNEL

A. The accepted quantities of sewers in earth tunnels will be paid for at the contract unit price per linear foot furnished and constructed for the various sizes, which price will be full compensation for material and material testing, pit excavation, sheeting, timber bracing, liner if required, excavation, temporary shafts, pumping, protection of existing utilities, maintenance of sewage flow, pipe, laying pipe, making pipe joints, grouting, cleaning and inspection, conducting acceptance tests and backfilling of pits and shafts.

6.17 SEWER IN BORED HOLE

A. The accepted quantities of sewers in a bored hole will be paid for at the contract unit price per linear foot furnished and constructed for the various sizes, which will be full compensation for material and material testing, pit excavation, sheeting, timber bracing, liner if required, excavation, boring temporary shafts, pumping, protection of existing utilities, maintenance of sewage flow, pipe, casing spacers, laying pipe, making pipe joints, grouting, cleaning and inspection, conducting acceptance test, and backfilling of pits and shafts.

B. Reserved

6.18 JACKED SEWER

A. The accepted quantities of jacked sewers will be paid for at the contract unit price per linear foot furnished and constructed for the various sizes; the price will be full compensation for material and material testing, pit excavation, jacking equipment and concrete slab foundation, jacking back stop, temporary shafts, pumping, protection of existing utilities, maintenance of sewage flow, pipe, jacking pipe, making pipe joint cushions, cleaning and inspection, conducting acceptance tests, and backfilling of pits and shafts.

6.19 SEWER IN JACKED LINER

A. The accepted quantities of sewers in jacked liner will be paid for at the contract unit price per linear foot furnished and constructed for the various sizes; the price will be full compensation for material and material testing, pit excavation, jacking equipment and concrete slab foundation, jacking back stop, temporary shafts, pumping, protection of existing utilities, maintenance of sewage flow, pipe liner, laying pipe, making pipe joints, grouting, cleaning and inspection, conducting acceptance tests, and backfilling of pits and shafts.

6.20 DELETED

6.21 OMITTED

6.22 REMOVAL OF EXISTING PIPE

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

6.23 Tracer Wire

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

6.24 PAYMENT WILL BE MADE UNDER:

Item No.	Pay Item	Pay Unit
02530-6.01	SITE PREPARATION AND RESTORATION	Lump Sum
02530-6.02	UNDERCUT BACKFILL	Ton
02530-6.03	SHEETING AND SHORING DIRECTED TO REMAIN IN PLACE	1,000 Board Feet
02530-6.04	PAVEMENT BACKFILL	Ton
02530-6.04.01	DELETED	
02530-6.04.02	Pit Run Gravel Backfill	Ton
02530-6.05	SERVICE CONNECTION REMOVAL AND REPLACEMENT	EA
02530-6.05._____	Type Service Connection	EA
02530-6.07	SEWER PIPE	Linear Foot
02530-6.07.01._____"	Prestressed Concrete Cylinder Pipe	LF
02530-6.07.02._____"	Reinforced Concrete Pipe, Class II	LF
02530-6.07.03._____"	Reinforced Concrete Pipe, Class III	LF
02530-6.07.04.___ ___"	Reinforced Concrete Pipe, Class IV	LF
02530-6.07.05.___ ___"	Reinforced Concrete Pipe, Class V	LF
02530-6.07.06.___ ___"	Ductile Iron Pipe, Class 50	LF
02530-6.07.07.___ ___"	Ductile Iron Pipe, Class 51	LF
02530-6.07.08.___ ___"	Ductile Iron Pipe, Class 52	LF
02530-6.07.09.___ ___"	Ductile Iron Pipe, Class 53	LF
02530-6.07.10 ___ ___"	Ductile Iron Pipe, Class 54	LF
02530-6.07.11 ___ ___"	Ductile Iron Pipe, Class 55	LF
02530-6.07.12.___ ___"	Ductile Iron Pipe, Class 56	LF
02530-6.07.13	DELETED	
02530-6.07.14	DELETED	
02530-6.07.15.___ ___"	Polyvinyl Chloride (PVC) Pipe	LF
02530-6.07.16.___ ___"	Glass Fiber Reinforced Polymer Mortar Pipe	LF
02530-6.09	FORCE MAIN	LF
02530-6.09.01.___ ___"	Ductile Iron Force Main, Class 50	LF
02530-6.09.02.___ ___"	Ductile Iron Force Main, Class 51	LF
02530-6.09.03.___ ___"	Ductile Iron Force Main, Class 52	LF
02530-6.09.04.___ ___"	Ductile Iron Force Main, Class 53	LF
02530-6.09.05.___ ___"	Ductile Iron Force Main, Class 54	LF
02530-6.09.06.___ ___"	Ductile Iron Force Main, Class 55	LF
02530-6.09.07.___ ___"	Ductile Iron Force Main, Class 56	LF
02530-6.09.08.___ ___"	Polyvinyl Chloride (PVC) Force Main, Class 200	LF
02530-6.09.09.___ ___"	High Density Polyethylene Force Main	LF
02530-6.11	SERVICE CONNECTION	LF
02530-6.12	NON-SHRINKING GROUT	CY
02530-6.12.01	Non-shrinking grout, Type I	CY
02530-6.12.02	Non-shrinking, fast setting grout, Type II	CY
02530-6.13	PLAIN CONCRETE FOR GENERAL USE	CY
02530-6.13.01	Plain concrete for general use, Class A	CY
02530-6.13.02	Plain concrete for general use, Class C	CY
02530-6.14	REINFORCED CONCRETE FOR GENERAL USE	CY
02530-6.15	INVERTED SIPHON	Lump Sum
02530-6.16	SEWER IN EARTH TUNNEL	LF
02530-6.16.01._____	"Sewer in Earth Tunnel With Liner Plate"	LF
02530-6.16.02._____	"Sewer in Earth Tunnel Without Liner Plate"	LF
02530-6.17	SEWER IN BORED HOLE	LF
02530-6.17.01._____	"Sewer in Bored Hole With Liner Pipe"	LF
02530-6.17.02._____	"Sewer in Bored Hole Without Liner Pipe"	LF
02530-6.17.03.	Reserved	
02530-6.18	JACKED SEWER	LF
02530-6.18.01_____	"Jacked Sewer"	LF

02530-6.19 SEWER IN JACKED LINER	LF
02530-6.19.01_____"Sewer in Jacked Liner"	LF
02530-6.22 REMOVAL OF EXISTING PIPE	LF

Examples of Pay Item Numbering System for Sewer Pipes

02530-6.07.03.48	Pay Item Number
02530-6	Section of Specification
.07	Last digit(s) of applicable paragraphs for payment
.03	Type of Pipe: e.g., Reinforced Concrete, Class III
.48	Size of Pipe; e.g., 48" diameter

END OF SECTION 0253

CITY OF MEMPHIS – STANDARD CONSTRUCTION SPECIFICATIONS
SECTION 02531 MANHOLES AND SPECIAL STRUCTURES

PART 1 - SCOPE

1.01 This work consists of the construction of manholes and special structures for sanitary sewers of the type and dimensions shown on the Plans, stipulated in the Contract Documents, or as directed by the Engineer. The construction will be accomplished according to these Specifications and Plans or as established by the Engineer. The Contractor will perform all work necessary to complete the Contract with the best modern practice. Unless otherwise provided, the Contractor is required to furnish all labor, material, equipment and other items necessary to complete the manholes and structures as shown on the Plans.

PART 2 - MATERIALS AND EQUIPMENT

2.01 MATERIAL

A. Construction Material

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

B. Qualifications of Manufacturers

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

C. Material Inspection and Testing

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

2. The Contractor will notify the Engineer before any deliveries of material and will make whatever provisions are necessary to aid the Engineer in the inspection and culling of the material before installation.

D. Storage

1. The contractor will provide storage facilities and exercise measures that will maintain the specified quality and fitness of materials to be incorporated in the work.

E. Portland Cement Concrete

1. Portland cement concrete will be as designated in Specification Section 02530 Paragraph 2.01.V.

F. Steel Reinforcement

1. Deformed steel reinforcing bars and welded wire fabric will be as shown on the Plans or as directed by the Engineer. All steel reinforcement will be as specified in Specification Section 03310.

G. Mortar

1. Mortar will be as designated in Specification Section 02530 Paragraph 2.01.Y.

H. Brick

1. All brick will be as designated in Specification Section 02530 Paragraph 2.01.BB.

2. No new brick manholes are to be allowed in the City of Memphis system. This specification is included for repair of existing brick manholes and incidental use of brick for leveling courses in new construction.

I Gray Iron Castings

1. Castings will be of the standard Memphis type as detailed on the Plans and Design Standards. Castings will be made of good quality, even grained cast iron and will be smooth and free from scale, lumps, blisters, sand-holes, and defects of any nature that would render them unfit for the service for which they are intended. They will be thoroughly cleaned and subjected to a careful hammer inspection

2. Castings will meet the requirements of ASTM A 48, Class No. 35, or Grade 65-45-12 ductile iron meeting the requirements of ASTM A 536. Manhole rims and covers will be designed to withstand HS-20-44 loading defined in the AASHTO Specifications. Rims and covers will be machined or ground at touching surfaces to seat firmly and prevent rocking. Any set not matching will be removed and replaced at no additional cost.

J. Manhole Steps

1. Steps are not allowed in sewer structures.

K. Precast Concrete Manhole Sections, Bases and Other Structures

1. All precast reinforced concrete manhole risers, cones, grade rings, and flat slab tops will conform to the requirements of ASTM C 478 for the specified diameter and strength class. All cone sections and transition sections will be eccentric. Barrel sections will be custom made with openings to meet indicated pipe alignment and invert elevations. The Contractor will submit shop drawings for each typical structure shown on the Plans for approval by the Engineer. After approval by the Engineer, the Contractor can place the order for structures. The bottom manhole section and pipe(s) will be in place (supported by concrete blocks) before pouring the cast-in-place manhole base. The bottom of all precast base slabs 4 feet in diameter will extend a minimum of 6 inches beyond the outside wall of the manhole riser. The bottom of all precast base slabs 5 feet in diameter will extend a minimum of 7 inches beyond the outside wall of the manhole riser. The bottom of all precast base slabs 6 feet and larger in diameter will extend a minimum of 8 inches beyond the outside wall of the manhole riser. All poured in place bases will extend 12 inches beyond the outside wall of the manhole riser.

2. For sewer manholes four (4) to six (6) feet in diameter and less than twenty (20) feet deep, precast reinforced concrete manhole base sections shall be a minimum of 8 inches thick. For sewer manholes greater than six (6) feet in diameter or more than twenty (20) feet deep, precast reinforced concrete manhole 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 plans. Steel reinforcement shall conform to Specification Section 03310.

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

4. Gaskets between manhole sections will be a flexible material meeting the requirements of Federal Specification SS-S-00219 for Type I gaskets and AASHTO M 198 for Type B gaskets unless otherwise specified on the Plans. Joint contact surfaces will be formed with machined castings. Joints between a manhole section and precast concrete flat tops will be mortar joints conforming to the requirements of this Specification. All sewer manholes must pass the Negative Air Pressure (Vacuum) Test as required in Specification Section 02531 Paragraph 4.02.A.

5. All pump station wet wells and siphon structures shall be lined or coated with a material conforming to either Section 02530 paragraph 2.01.DD or Section 02531 paragraph 2.01.R.

6. All manholes and structures on pipe 36 inches in diameter and larger shall be lined or coated with a material conforming to either Section 02530 paragraph 2.01.DD or Section 02531 paragraph 2.01.R.

7. Manhole manufacturer shall install plastic liner as recommended by lining manufacturer.

L. Sand

1. Sand for structure abandonment will consist of sand or a natural sandy soil, all of which passes a 3/8 inch sieve and not more than 10 percent passes a No. 200 sieve.

M. Pit Run Gravel

1. Pit run gravel will be as designated in Specification Section 02530 Paragraph 2.01.AA.

N. Non-Shrinking Grout

1. Non-shrinking grout will be as designated in Specification Section 02530 Paragraph 2.01.CC.

O. Waterproofing

1. Waterproofing for manhole exteriors will consist of two coats of asphalt or coal tar pitch. Asphalt will conform to the requirements of ASTM D 449. Coal tar pitch will conform to the requirements of ASTM D 450.

P. Vent Stack

1. Vent stack pipe will be a 4-inch diameter galvanized steel pipe conforming to the requirements of ASTM A 53 with a minimum wall thickness of standard weight pipe. One end of the vent stack pipe will have a 180-degree bend fabricated by either shop welding a manufactured 180 degree elbow or fitting the pipe with a manufactured 180 degree threaded elbow and coupling. The opposite end of the pipe will be plain end. The maximum height for vent stacks for this specification shall be 20 vertical feet.

2. Vent stack supports will be fabricated from steel shapes conforming to ASTM A 36, and to the dimensions and details shown on the Plans. The vent stack supports will be welded to the vent stack pipe and to the vent stack support bottom ring around the entire contact surface.

3. The vent stack support bottom ring will be shop fabricated with bolt holes at the spacing shown on the plans for anchorage to the manhole top. All welding will be according to the American Welding Society Structural Welding Code.

4. A vent stack support ring with threaded coupling may be cast in the flat top for installation of the vent stack.

5. All surfaces of the completed vent stack and welds will be cleaned and painted. The color of the finish coat will be silver.

Q. Flexible Pipe Connectors to Manholes

1. All connections of pipe to manhole sidewalls will be made with flexible connectors. Openings in the manhole sidewall for the pipe will be precast or cored to provide required size and location. The hole will be manufactured to allow for lateral and vertical movement, and angular adjustments through 20°. A connector between manholes and pipes such as Press-Seal, Kor-N-Seal, or Z-LOK will be installed in the precast or cored opening. The connector will meet the requirements set forth in the latest revision of ASTM C 923. A corrosion resistant, stainless steel external band will be used around the flexible connector to create the external seal around the pipe.

2. Any void between the pipe and connector will be filled with an approved flexible gasket material.

3. Flexible connectors will be considered an integral part of the manhole sidewall, and no separate payment will be allowed.

R. Protective Linings and Coatings

1. All poly vinyl chloride (PVC) protective lining for concrete structures shall conform to Section 02530 Paragraph 2.01 DD.

2. Protective coating properties:

Product Type	Polymer based Polyurethane or Solid Epoxy
Color	Light
Compressive Strength	4,000 psi (minimum)
Tensile Strength	1,500 psi (minimum)
Hardness Type D	60
Bond Strength-Concrete	> than 750 psi
Dry Film Thickness	125 mils

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

4. Protective coatings for concrete structures will be SpectraShield® Liner System Products, Structure-Guard as manufactured by Quadex Rehabilitation Products, or as approved.

S. Grade Adapter Rings

1. Grade adapter rings shall be the standard Memphis type, compatible with City of Memphis standard rings and covers. Grade adapter rings shall be gray iron castings conforming to paragraph 2.01.I in these specifications.

T. Repair Materials

1. Repair materials are to be used in the rehabilitation of existing sewer manholes and structures. Repair materials shall be used to fill voids and to structurally reinforce and/or rebuild substrate surfaces as deemed necessary by the Engineer.

2. Quick blending, rapid setting, high early strength, fiber-reinforced, non-shrink repair mortar that can be trowelled or spray applied must be compatible with the specified protective coating.

3. Material properties:

Product Type	Fused Calcium Aluminate or Cementitious Fiberglass
Cure Time	<48 hours
Curing Gasses	Non-Toxic
Compressive Strength	5,000 psi (minimum)
Tensile Strength	500 psi (minimum)
Flexural Strength	600 psi (minimum)
Shrinkage	0% at 90% Relative Humidity

4. Repair materials for concrete structures will be QM-1s Restore as manufactured by Quadex Rehabilitation Products, or as approved.

2.02 EQUIPMENT

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

PART 3 - CONSTRUCTION REQUIREMENTS

3.01 SITE PREPARATION AND RESTORATION

A. Site preparation and restoration for sewer manhole and structure construction will be performed per Specification Section 02530 Paragraph 3.01.

3.02 EARTHWORK

A. Earthwork for sewer manholes and structures will be performed per Specification Section 02530 Paragraph 3.02.

3.03 REMOVAL OR ABANDONMENT OF EXISTING MANHOLES AND STRUCTURES

A. Removal

1. Existing manholes and structures to be removed will be shown on the Plans or as directed by the Engineer. 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 will be delivered by the Contractor to a City yard as directed by the Engineer. All remaining materials become the property of the Contractor who will be responsible for disposal.

2. The excavation will be backfilled per Specification Section 02530 Paragraph 3.11.

B. Abandonment

1. Existing manholes and structures to be abandoned in place will be shown on the Plans or as identified by the Engineer.

2. After removing manhole and structure rims, covers, and similar items, all pipes will be bulkheaded. The walls will be lowered to 2 feet below final grade if in earth or to 12 inches below subgrade if in a proposed pavement area. The remaining manhole or structure will be filled with sand to the limits previously mentioned.

3. The sand will be placed in approximately 12 inch layers and each layer compacted to 75 percent relative density or 95 percent of maximum density (standard proctor) as applicable. A 12 inch thick plain concrete slab will be installed over the manhole top extending 12 inches beyond the outside face of the manhole.

4. 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 disposing of same.

5. All manholes that must be removed to perform excavation for the proposed sewer pipe and/or structures will be removed as part of the sewer excavation and no additional payment will be due the Contractor.

3.04 GENERAL CONSTRUCTION REQUIREMENTS

A. New manholes and structures will be constructed of plain or reinforced concrete. Work may include the repairing of brick masonry manholes or structures. Where the top elevation is not shown on the Plans, the manhole or structure will be built to conform to the elevation ordered by the Engineer. Standard depth manholes are those having a depth of 6'-0" from rim to invert of the sewer. Manholes and special structures will be built as the pipe laying progresses. The Engineer, at his discretion may stop the laying of pipe or the building of other manholes until the manhole just passed has been completed. Completion of the manhole will include the installation of fittings, connections to pipes, placing of castings, testing, and other construction as shown on the Plans.

B. Inlet and outlet pipes will extend through the walls of manholes and special structures to allow for water tight connections with the manhole walls. The ends will be cut off flush with the inside surface of the wall as shown on the Plans, Details, or otherwise directed. The pipes will intersect at the structures so the inlet pipe will be aligned in the direction of outlet pipe such that counterflow is prevented. Water stops will be installed around pipes as they pass through the sanitary manhole wall.

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

D. All castings, rims, covers and fittings will be placed in the positions shown in the Plans or as directed by the Engineer. Rims on manhole cones will be set concentrically with the top of the cone in a full bed of mortar so that the space between the top of the manhole cone and the bottom flanges of the rim will be filled and made watertight. A ring of mortar at least 1 inch thick and pitched to shed water away from the rim will be placed around the outside of the bottom flange. Mortar will extend to the outer edge of the cone and will be finished smooth and flush with the top of the flange. If rim fittings are to be bolted or anchored in concrete or brick masonry, all anchors or bolts will be set and held in place before the concrete or mortar is placed. The unit will not be disturbed until the mortar or concrete has hardened to adequate strength. Bolt-down manhole covers will be installed at the locations shown on the Plans and all bolts securely tightened following acceptance of the manhole to provide a watertight seal.

E. Vent stacks will be installed on manholes at locations and to the elevations shown on the Plans or as directed by the Engineer. Vent stacks will be installed on flat top manholes only. The vent stack pipe will be positioned in the hole provided in the manhole top and the vent stack support bottom ring

will be attached to the concrete manhole top with anchor bolts in drilled holes with expansion sleeves. A vent stack support ring with threaded coupling may be cast in the flat top for installation of the vent stack.

F. Protective Linings and Coatings

1. The contractor shall take all necessary measures to prevent damage to installed lining from equipment and materials used in or taken through the work.

2. Wherever a pipe lateral (not of plastic lined concrete) is installed through a lined concrete manhole, the lining shall be extended over and around the end of the pipe and back into the structure for not less than 4 inches. This protecting cap may be molded or fabricated from the lining material but needs not be locked into the pipe.

3. All welding of joints is to be in strict conformance with the specifications and instructions of the lining manufacturer.

4. Welding shall fuse both sheets and weld strip together to provide a continuous joint equal in corrosion resistance and impermeability to the liner plate.

5. Hot-air welding guns shall provide effluent air to the sheets to be joined at a temperature between 500□ and 600□F. Welding guns shall be held approximately 0.5 inch from and moved back and forth over the junction of the two materials to be joined. The gun shall be moved slowly enough as the weld progresses to cause a small bead of molten material to be visible along both edges and in front of the weld strip. All welders shall be certified by the manufacturer.

6. Protective coatings shall be installed in strict conformance with the manufacturer's recommendations.

3.05 REPAIRING OF BRICK MANHOLES AND STRUCTURES

A. Where shown on the Plans or directed by the Engineer, the Contractor will repair brick manholes or structures. The work will conform to the applicable portions of Specification Section 02640 Paragraph 3.02.B.1.

3.06 PRECAST CONCRETE CONSTRUCTION

A. Precast concrete manholes will be neatly and accurately built according to the Plans or as directed by the Engineer. All precast manholes will use either a concrete slab constructed of Class A concrete on a 12 inch thick crushed stone foundation and which will be cast integrally with the base section and the inlet and outlet pipes as shown on the Plans or the precast manhole will use a precast base section conforming to Specification Section 02531 Paragraph 2.01.K.

1. Precast concrete manhole base sections shall be placed on a 12 inch minimum thickness No. 67 crushed limestone base. The stone base will be fully encapsulated in a geotextile fabric as indicated on the plans or as directed by the Engineer. Geotextile fabric shall conform to Section 02370 paragraph 2.01.C, and grade No. 67 stone shall conform to Section 02530 paragraph 2.01.W.

B. Precast concrete sections will be set so the structure will be vertical and with sections in true alignment. Joint surfaces of the base or previously installed section will have a flexible rubber gasket installed in the recess after being primed with an asphaltic cement material recommended by the manufacturer. Flexible rubber gaskets and primers will not be applied to wet or damp surfaces. Each joint will be completely filled with nonshrinking grout on the inside and outside of the manhole after sections have been placed.

C. All holes in precast sections used for their handling will be thoroughly plugged with nonshrinking grout. The grout will be finished smooth and flush with the interior and exterior manhole wall surfaces.

D. All precast concrete manhole cones will be of eccentric construction as shown on the Plans or Details.

E. If brick masonry is used to adjust manhole rims to grade, the masonry work will be performed according to Specification Section 02640 Paragraph 3.02.B.1.

F. All flat top manhole slabs will be steel reinforced with a minimum thickness of 6 inches. The manhole rim and cover will be placed eccentrically in the slab as shown on the Plans or Details. Waterproofing will be applied per Specification Section 02531 Paragraph 3.09.

3.07 CAST-IN-PLACE CONCRETE CONSTRUCTION

A. All cast-in-place manholes and structures will be built of Class A concrete as shown on the Plans. The manholes and structures will be built on an undisturbed earth foundation and conform to the dimensions, shapes and details shown on the Plans. Concrete construction will conform to the methods, forms, mixture, placement, protection, and curing for concrete per Specification Section 03310.

B. Cast-in-place manholes will be neatly and accurately built according to the Plans or as directed by the Engineer. Wall thicknesses will be as detailed on the Plans but not less than 6 inches thick.

C. All cast-in-place manholes will be of eccentric construction as shown on the Plans. Any required reinforcement will be of the kind, type, and size and will be spaced, bent, and fastened as shown on the Plans.

D. Connection of inlet and outlet pipes will conform to the sizes, alignments, and elevations shown on the Plans. Concrete reinforcement and inlet and outlet pipes will be in place and approved by the Engineer before any concrete is placed. If concrete placement is not continuous, a rubber water stop gasket will be required at each construction joint.

E. The inside and outside surfaces of the manhole or structure walls will receive a Class 1, Ordinary Surface Finish as defined by Specification Section 03310 Paragraph 3.11. Waterproofing will be applied per Specification Section 02531 Paragraph 3.09.

3.08 MANHOLE DROP CONSTRUCTION

A. Drop Construction for New Manholes

1. Drop construction will be installed for new manholes at the locations shown on the plans and/or as directed by the Engineer. Drop construction will conform to the details shown on the plans and Details SST-2 for outside drop construction. If precast manhole construction is used, the manhole sections will be custom made with openings for both the upper and lower inlet pipes. The pipe connections to the manhole sidewalls shall be made with flexible connectors conforming to Specification Section 02531 Paragraph 2.01.Q. Water stops will be installed around pipes as they pass through the sanitary manhole wall. Grout will be finished smooth and flush with the adjoining interior and exterior manhole wall surfaces. If cast-in-place manhole construction is used, the upper and lower inlet pipes will be in place and approved by the Engineer before any concrete being placed. All drop construction will be constructed of either ductile iron pipe with push-on or mechanical joints or PVC pipe conforming to the appropriate section of these Specifications. PVC pipe for drop construction at new manholes will be used only on improved property as defined in Specification Section 02530 Paragraph 3.11.A. On unimproved property the section of inlet pipe making the connection to the manhole at the higher

elevation and all fittings and drop pipe shall be ductile iron pipe. Solvent cement joints may be used on PVC for drop construction. Encasement of the outside drop pipe will be constructed of Class C concrete.

B. Drop Construction for Existing Manholes

1. Drop construction will be installed in existing manholes at the locations shown on the plans and/or as directed by the Engineer. Drop construction will conform to the details shown on the plans and Detail SST-2 for inside drop construction. The Contractor will core a hole in the manhole wall to permit installation of a flexible connector as specified in Specification Section 02531 2.01 Q Flexible Pipe Connectors to Manholes and the inlet pipe at the required flow line elevation, horizontal angle, and slope. Care will be used to avoid unnecessary damage to the existing masonry or concrete.

2. All loose material will be removed from the cut surfaces, which will be completely coated with grout before setting the pipe. Before inserting the pipe and flexible connector, a sufficient thickness of grout will be placed at the bottom and sides of the opening for proper bedding of the pipe. After setting, all spaces around the pipe will be solidly filled with grout and neatly pointed up on the inside to present a smooth joint, flush with the inner and outer wall surface. Any necessary modifications to the existing invert will be made to provide a smooth, plastered surface for properly channeled sewage flow from the new connection. All drop construction will be constructed of either ductile iron pipe with push-on or mechanical joints or PVC pipe conforming to the appropriate section of these Specifications. Solvent cement joints may be used on PVC for drop construction. The vertical drop construction will have the dead weight held by suitable means until the steel support straps are secured in place and tightened. The pipe mechanical joint bolts, if used, will not be positioned against the manhole wall. The steel support straps will be fastened to the manhole wall with two bolts per strap set in expansion sleeves in drilled holes.

3.09 WATERPROOFING

A. After the manhole masonry and concrete construction are complete, the exterior surface of each manhole wall within the limits shown on the Plans will be given two coats of approved waterproofing material. Total minimum dry film thickness will be 12 mils. Each coat will be applied at a rate not to exceed one gallon per 100 square feet. The waterproofing materials will be applied by brush or low pressure sprayer and according to the instructions of the manufacturer. Time will be allowed between coats to permit sufficient drying so that the application of the second coat does not affect the first coat.

B. Care will be exercised during backfilling to prevent damage to the waterproofing. Any waterproof coating damaged during backfill operations will be cleaned of all dirt and two coats of waterproofing reapplied as previously specified.

3.10 DEWATERING

A. Contractor shall furnish, install and operate pumps, pipes, appurtenances, and all equipment of sufficient capacity required to remove any groundwater encountered in the excavation. Contractor shall conduct said groundwater away from the construction site in an approved manner. Generally, dewatering is considered to be an incidental to the construction of sewer manholes, special structures, pipeline, etc. In some cases, at the City's discretion, dewatering may be measured and paid for as defined in Specification Section 02531 Parts 5 and 6.

3.11 BYPASS PUMPING

Contractor shall furnish, install and operate pumps, pipes, appurtenances, and all equipment of sufficient capacity required to maintain sewage flow around the work area. Contractor shall conduct

said bypass pumping in an approved manner. Generally, bypass pumping is considered to be an incidental to the construction of sewer manholes, special structures, pipeline, etc. In some cases, at the City's discretion, bypass pumping may be measured and paid for as defined in Specification Section 02531 Parts 5 and 6.

3.11. ADJUSTMENT OF RIMS AND COVERS

A. Standard adjustment method:

1. Any manhole covers not adjusted and set at final grade by others shall be adjusted by the Contractor. 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, all defective courses of brick shall be removed and the manhole rebuilt to proper grade and the rim reset as described above. The maximum finished collar height as measured from the top of the manhole rim to the beginning of the conical section shall be 18 inches. If the adjustment would require a collar of greater than 18 inches in height, then the existing collar and conical section of the manhole shall be removed, the riser section raised the required amount, the conical section and collar rebuilt and the rim reset at the proper grade.

3. Any changes in grade for manhole covers of precast or poured-in-place manholes shall be as shown on the plans or as directed by the Engineer.

B. Manhole adjustment with adapter rings:

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 Engineer. Adapter rings may be up to a maximum of 5 inches utilizing no more than one ring. Adapter rings shall be tack welded to the existing rim at a minimum of 4 locations.

C. Alternate adjustment method:

1. For manhole covers requiring adjustment where Cement Stabilized Aggregate Base (Specification Section 02710.1) or Soil Cement Base (Specification Section 02710.2) is being placed, the Contractor may, at his option, remove manhole rims and covers and adequately seal off the top of the existing manholes below the bottom of the base course prior to the aggregate or soil cementing operations. If this option is exercised, the Contractor shall reference the location of all manholes so sealed off and aggregate or soil cementing operations shall then continue over the entire street. Within 24 hours after the final compaction of a section of roadway or paved area, all manholes located within this section shall be raised to grade by removing a section of the soil or aggregate base a minimum 3 feet square directly over each manhole. The manhole rims and covers shall then be replaced with Class A concrete to the subgrade. If, in the process of adjusting the manhole rims, the Contractor removed a larger section than specified, he shall replace the entire area so removed with Class A concrete at this expense.

3.13 PUMPING STATIONS

A. Pumping stations and force mains will conform to the latest edition of the State of Tennessee Department of Environment and Conservation Division of Water Pollution Control Specification "Design Criteria for Sewage Works." The City will be responsible for providing the secondary electrical service to the top of the utility pole installed by the contractor. The City will also be responsible for any necessary extension of MLG&W water mains necessary to serve the pump stations. The Contractor will be responsible for providing the water service connection from the MLG&W main or meter box to the pump station.

PART 4 - ACCEPTANCE TEST FOR MANHOLES AND STRUCTURES

4.01 VISUAL INSPECTION

A. All work constructed will be subject to visual inspection for faults, defects, or deviations from the Plans and any such deviation or omission will be corrected at once. All tests will be made by the Contractor who will provide necessary equipment for testing and lamping the manhole or structure in the presence of and under the supervision and instructions of the Engineer. Lamp tests will be observed first hand by the Engineer. All defects found will be corrected before conducting leakage tests. Repair methods must be approved by the Engineer.

4.02 MANHOLE LEAKAGE TEST

A. All manholes and special structures will be subjected to a vacuum test as outlined in ASTM C 1244 or as specified. The manhole, including the frame, will be placed under a vacuum of 10 inches Hg (4.9 psig). The manhole will be considered acceptable if the time measured for the vacuum to drop to 9 inches Hg (4.4 psig) is greater than that shown in the table on the following page. Manholes not meeting the vacuum test requirements will be repaired and retested or replaced.

Minimum Test Times for Various Manhole Diameters

	Manhole Diameter (ft)				
	4	5	6	7	8
Depth (ft)			Test Time (sec)		
8	20	26	33	42	55
10	25	33	41	51	64
12	30	39	49	66	86
14	35	46	57	74	96
16	40	52	67	87	113
18	45	59	73	95	123
20	50	65	81	105	137
22	55	72	89	116	150
24	59	78	97	126	164
26	64	85	105	137	177
28	69	91	113	147	191
30	74	98	121	157	205

B. The Contractor will be required to furnish all equipment necessary for this test including the manhole sealing apparatus, gauges, pump, plugs and operating personnel. The cost of this work is to be included in the unit bid price for manholes.

4.03 PROTECTIVE LININGS AND COATINGS

A. After the manhole or other structure is installed, all surfaces covered with lining, including welds, shall be tested with an approved electrical hole detector (Tinker & Rasor Model No. AP-W with power pack) with the instrument set at 20,000 volts minimum. All welds shall be physically tested by a nondestructive probing method. All patches over holes, or repairs to the liner or coating wherever damage has occurred, shall be accomplished in accordance with manufacturer's recommendations.

B. Defective welds will be retested after repairs have been made. Tabs shall be trimmed away neatly by the installer of the liner after the welding strip has passed inspection. Inspection shall be made within 2 days after joint has been completed in order to prevent tearing the projecting weld strip and consequent damage to the liner from equipment and materials used in or taken through the work.

PART 5 - MEASUREMENT

5.01 STANDARD DEPTH SEWER MANHOLE

A. Standard depth manholes will be measured per each, for the various diameters and types less manhole rim and cover. Standard depth is a manhole depth less than or equal to 6 feet as measured vertically from the top of the manhole cone or slab to the invert of the manhole. No measurement shall be made for protective linings or coatings. Linings and coatings shall be considered incidental to the construction of sewer manholes. No measurement shall be made for any transition slab to switch to 4 feet diameter riser sections from larger diameter bases. No measurement shall be made for flat tops. Transition slabs and flat tops, if used, shall be incidental to the construction of the sewer manhole.

5.02 EXTRA DEPTH SEWER MANHOLE

A. Extra depth manholes will be measured per vertical foot along the vertical centerline of the manhole from a point 6.0 feet above the invert of the manhole to the top of the manhole cone or slab for the various diameters and types. Only manholes deeper than 6.0 feet will be considered for extra depth measurement. No measurement shall be made for protective linings or coatings. Linings and coatings shall be considered incidental to the construction of extra depth sewer manholes. No measurement shall be made for any transition slab to switch to 4 feet diameter riser sections from larger diameter bases. No measurement shall be made for flat tops. Transition slabs and flat tops, if used, shall be incidental to the construction of the extra depth sewer manhole.

5.03 SEWER MANHOLE DROP CONSTRUCTION

A. Drop construction in new or existing manholes will be measured per vertical foot as measured from the upper inlet pipe flowline to the flowline of drop pipe elbows at the bottom of the drop construction. Payment for drop construction for new manholes will be in addition to payment for standard depth manhole and extra depth construction (if required).

5.04 REPAIR BRICK SEWER MANHOLE AND STRUCTURE

A. Repair of brick manholes and structures will be measured per each.

5.05 SPECIAL SEWER STRUCTURE

A. Special structures will be measured per each including access shafts, but less manhole rim and cover. No measurement of depth will be made. No measurement shall be made for protective linings or coatings. Linings and coatings shall be considered incidental to the construction of the special structure.

5.06 SEWER MANHOLE RIM AND COVER

A. Manhole rims and covers will be measured per each set consisting of one rim and one cover for the various types.

5.07 VENT STACK

A. Vent stacks will be measured per each set consisting of stack pipe, 180° bend and support. No measurement of height will be made.

5.08 SEWER MANHOLE AND STRUCTURE REMOVAL

A. Removal of existing manholes and structures will be measured per each. Removal of existing manholes and structures within the limits of excavation for new sewer facilities will not be measured or paid for separately but will be included in the price of the new sewer facility.

5.09 SEWER MANHOLE AND STRUCTURE ABANDONMENT

A. Manholes and other sewer structures to be abandoned will be measured for payment per each. Material for backfilling abandoned structures will not be measured.

5.10 DEWATERING

A. Generally, dewatering is considered to be an incidental to the construction of sewer manholes, special structures, pipeline, etc. In some cases, at the City's discretion, dewatering may be measured for payment. If measured for payment, dewatering will be measured by the day, each day that the pumps are in operation and that the contractor is actively working within the excavation being dewatered. If the contractor is not actively working within the excavation, no measurement will be made for dewatering. The actual quantities used will be jointly agreed upon between the City and the Contractor.

5.11 BYPASS PUMPING

A. Generally, bypass pumping is considered to be an incidental to the construction of sewer manholes, special structures, pipeline, etc. In some cases, at the City's discretion, bypass pumping may be measured for payment. If measured for payment, bypass pumping will be measured by the day, each day that the pumps are in operation and the contractor is working on the sewer downstream of the bypass. If the contractor is not actively working on the sewer downstream of the bypass, no measurement will be made for bypass pumping. The actual quantities used will be jointly agreed upon between the City and the Contractor.

5.12 ADJUSTMENT OF RIMS AND COVERS

A. Standard adjustment method:

1. Standard manhole adjustments will be measured per each manhole rim adjusted to grade.

B. Manhole adjustment with adapter rings.

1. Manhole adjustment with adapter rings will be measured per each manhole rim adjusted to grade.

5.13 PUMPING STATION

A. Pumping station(s) constructed according to Plans and Specifications will be measured per lump sum for each pumping station, complete in place and operational. Included as a part of the pumping

station is the water service connection from the MLG&W main shown on the Plans to the pump station(s). The power pole set by the Contractor to receive MLG&W secondary service and all electrical service from the top of the pole to pumping station equipment are included in the lump sum measurement.

5.14 PROTECTIVE COATINGS

A. Generally, protective coatings are considered to be an incidental to the construction of sewer manholes and special structures. In some cases, at the City's discretion, protective coatings may be measured for payment. If measured for payment, protective coatings will be measured by square foot of surface area covered. No measurement shall be made for repair materials.

PART 6 - PAYMENT

6.01 STANDARD DEPTH SEWER MANHOLE

A. The accepted quantities of standard depth sewer manholes will be paid for at the contract unit price per each, complete in place for the various diameters and types less rim and cover, which will be full compensation for materials and materials testing, excavation, special protection, and curing of concrete, placing and jointing precast sections, transition slabs, flat tops, construction of base slabs, inverts, connection of inlet and outlet pipes, waterproofing, linings or coatings, cleaning and inspection, conducting acceptance tests, removal and/or abandonment of existing pipe, manholes, or structures within the limits of manhole excavation, and backfilling outside of pavement areas.

6.02 EXTRA DEPTH SEWER MANHOLE

A. The accepted quantities of extra depth sewer manholes will be paid for at the contract unit price per vertical foot, complete in place for the various diameters and types, which will be full compensation for materials and materials testing, excavation, special protection, placing, protection, and curing of concrete, placing and jointing precast sections, construction and installation of base slab, transition slab, flat top, invert, connection of inlet and outlet pipes, waterproofing, lining or coating, cleaning and inspection, conducting acceptance tests, removal and/or abandonment of existing pipe, manholes or structures within the limits of excavation, and backfilling outside of pavement areas.

6.03 SEWER MANHOLE DROP CONSTRUCTION

A. The accepted quantities of sewer manhole drop construction will be paid for at the contract unit price per vertical foot, complete in place for drop construction in new manholes or drop construction in existing manholes, which will be full compensation for materials and materials testing, excavation, special protection, maintenance of sewage flow during construction, construction of drop pipe, pipe fitting and connections, installation of steel support straps, placement, curing, and protection of concrete from the manhole base to the top of drop construction, cleaning and inspection, and backfilling outside of pavement areas. Payment for drop construction for new manholes will be in addition to payment for standard depth manhole and extra depth construction (if required).

6.04 REPAIR BRICK SEWER MANHOLE AND STRUCTURE

A. The accepted quantities of repair brick sewer manholes and structures will be paid for at the contract unit price per each, complete according to detail, which will be full compensation for materials and materials testing, excavation, special protection, maintenance of sewage flow during construction, masonry work, plastering, waterproofing, cleaning and inspection, conducting acceptance test, and backfilling outside of pavement areas.

6.05 SPECIAL SEWER STRUCTURE

A. The accepted quantities of special sewer structures will be paid for at the contract unit price per each, complete in place according to detail, which will be full compensation for materials and materials' testing, excavation, special protection, maintenance of sewage flow during construction, placement, curing, and protection of concrete, cleaning and inspection, waterproofing, linings or coatings, conducting acceptance test, and backfilling outside pavement areas.

6.06 SEWER MANHOLE RIM AND COVER

A. The accepted quantities of sewer manhole rim and cover set will be paid for at the contract unit price per each set complete in place for various types which price will be full compensation for materials and materials' testing, setting rim and cover, placing gaskets and bolts, protection and curing of mortar, cleaning and inspection.

6.07 VENT STACK

A. The accepted quantities of vent stacks will be paid for at the contract unit price per each, complete in place, which will be full compensation for materials and materials' testing, fabrication, painting, and installation of vent stacks.

6.08 SEWER MANHOLE AND STRUCTURE REMOVAL

A. The accepted quantities of sewer manhole and structure removal will be paid for at the contract unit price per each, which price will be full compensation for excavation, special protection, protection of existing utilities, structure removal, disposal of debris, and backfill.

6.09 SEWER MANHOLE AND STRUCTURE ABANDONMENT

A. Sewer structures to be abandoned will be paid for at the contract unit price per each, which price will be full compensation for preparing the structure for abandonment, sealing connecting pipes, furnishing and placing backfill material, compaction, handling of salvageable material, and disposal of debris.

6.10 DEWATERING

A. If measured for payment, the accepted quantities shall be paid for at the contract unit price per day, which shall be full compensation for material, installation, and operation of pumps, pipes, appurtenances, and all equipment of sufficient capacity required to conduct the groundwater away form the construction site and to satisfactorily complete the work.

6.11 BYPASS PUMPING

A. If measured for payment, the accepted quantities of bypass pumping shall be paid for at the contract unit price per day, which shall be full compensation for material, installation, and operation of pumps, pipes, appurtenances, and all equipment of sufficient capacity required to maintain sewage flow around the work area and to satisfactorily complete the work.

6.12 ADJUSTMENT OF RIMS AND COVERS

A. Standard adjustment method:

1. The accepted quantities of manholes adjusted will be paid for at the contract unit price per each for raising or lowering 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 covers to the satisfaction of the Engineer.

B Manhole adjustment with adapter rings:

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 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 Engineer.

6.13 PUMPING STATION

A. Payment will be made for pumping station at the contract lump sum price, which will be full compensation for material, structures (i.e., wet and dry wells), equipment and controls, excavation, special protection, maintenance of sewage flow, protection of existing utilities, provision of the water service connection from the MLG&W water main (valve box) to the pumping station, connection to the source of power on the site, connecting a power supply to the pumping station from top of the pole set by the Contractor at pump site, conducting acceptance tests, backfilling, and all items incidental to the construction of a complete, operational pumping station.

6.14 PROTECTIVE COATINGS

A. If measured for payment, the accepted quantities of protective coatings shall be paid for atthe contract unit price square foot, which shall be full compensation for material, surface preparation, installation, testing, and all equipment required to satisfactorily complete the work. No separate payment shall be made for repair materials.

6.15 PAYMENT WILL BE MADE UNDER:

Item No.	Pay Item	Pay Unit
02531-6.01	STANDARD DEPTH SEWER MANHOLE	EA
02531-6.01.01_____Ft.	Diameter Standard Depth Precast Concrete Manhole	EA
02531-6.01.02_____Ft	Diameter Standard Depth Poured-in-Place Concrete Manhole	EA
02531-6.02	EXTRA DEPTH SEWER MANHOLE	VF
02531-6.02.01_____Ft.	Diameter Extra Depth Precast Concrete Manhole Vertical Foot	VF
02531-6.02.02_____Ft	Diameter Extra Depth Poured-in-Place Concrete Manhole	VF
02531-6.03	SEWER MANHOLE DROP CONSTRUCTION	VF
02531-6.03.01_____In	Diameter Drop Construction in New Manhole	VF
02531-6.03.02_____In.	Diameter Drop Construction in Existing Manhole	VF
02531-6.04	REPAIR BRICK SEWER MANHOLE AND STRUCTURES	EA
02531-6.05	SPECIAL STRUCTURE	EA
02531-6.06	SEWER MANHOLE RIM AND COVER	EA
02531-6.06.01	No. 7 Manhole Rim and Cover	EA
02531-6.06.02	Bolted Down Manhole Rim and Cover	EA
02531-6.06.03	No. 6 Manhole Rim and Cover	EA
02531-6.07	VENT STACK	EA
02531-6.08	SEWER MANHOLE AND STRUCTURE REMOVAL	EA
02531-6.09	SEWER MANHOLE AND STRUCTURE ABANDONMENT	EA
02531-6.10	DEWATERING	DAY
02531-6.11	BYPASS PUMPING	DAY
02531-6.12	ADJUSTMENT OF RIMS AND COVERS	EA

02531-6.12.01	Adjustment of rim and cover by standard method	EA
02531-6.12.02	Adjustment of rim and cover with adapter rings	EA
02531-6.13	PUMPING STATION	LS
02531-6.14	PROTECTIVE COATING	SF

END OF SECTION 02531

CITY OF MEMPHIS – STANDARD CONSTRUCTION SPECIFICATIONS
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 Owner.

PART 2 – MATERIALS AND EQUIPMENT

2.01 MATERIAL

A. Lumber.
Lumber to be used for bracing trenches shall be no less than 2 inch thick rough cut oak.

B. Pit Run Gravel.
Pit run gravel shall consist of one of the three gradations shown in the table below.

1. Total Percent, by Dry Weight, Passing Each Sieve (U.S. Standard)

Size No.	2 ½ "	2"	1 ½ "	1"	3/8"	No. 40	Clay*
1	100	95-100			35-65	10-30	1-12
2		100	95-100		40-65	10-30	1-12
3			100	90-100	45-65	10-35	2-12

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

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 Owner, 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 owner 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 Owner. No undercut excavation shall be performed without prior authorization of the Owner in writing. The limits of undercut excavation will be determined by the Owner, 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 Owner. The excess space between the undisturbed bottom of the excavation and subgrade elevations shown on the Plans for box culverts and concrete channel lining shall be refilled with suitable material and compacted per Specification Section 02631, Paragraph 3.01.A.1a. The unauthorized excavation outside of side excavation limits shall be backfilled with select material unless otherwise directed by the Owner. 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 Owner 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 Owner, 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 Owner 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 Owner and permit the Owner 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 Owner 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 Owner. 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 Owner.

5. Control of Storm Water.

a. The Contractor shall keep all excavations free of water. He shall provide all dams, flumes, channels, sumps, or other works necessary to keep the excavation entirely clear of water and shall provide and operate pumps or other suitable equipment of adequate capacity for dewatering the excavations. He shall avoid producing mud in the trench or channel bottom by his operations. If necessary or so ordered by the Owner, 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 Owner.

6. Excavation Around Obstructions.

a. The Contractor shall perform all excavation by hand where excavation by machinery would endanger trees, structures, or utilities which otherwise might be saved by the use of hand excavation.

b. The Contractor shall cautiously excavate test holes to locate the limits of underground obstructions anticipated within the excavation. When a water pipe, gas pipe, sewer, or similar utility comes within the limits of the trench, such facilities shall be properly supported.

B. Trench Excavation.

1. All trenches shall be open cut unless otherwise shown on the Plans. Tunneling, boring, or jacking will be allowed only on permission of the Owner, 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 Owner. 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 Owner. In special cases the Owner 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 Owner 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 Owner. 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 Owner. 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 Owner.

3.02 SPECIAL PROTECTION

A. Treacherous Ground.

When running sand, quicksand, or other treacherous ground is encountered, the work shall be carried on with the utmost vigor and shall be prosecuted day and night should the Owner 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 Owner'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 Owner shall order that sheeting, bracing, and shoring be left in place, or where the Owner will permit the same to be left in place at the Contractor's request. The Contractor shall cut off any such sheeting at least 2 feet below the surface and shall remove the cutoff material from the excavation.

4. All sheeting, bracing, and shoring which is not left in place under the foregoing provisions shall be removed in a manner which will not endanger the completed work or other structures, utilities, sewers, or property whether public or private. The Contractor shall exercise care to prevent the opening of voids during the extraction process.

5. Steel drag shields or trench boxes may be used in lieu of sheeting, shoring, and bracing unless the Owner 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 Owner, 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 Owner. 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 Owner, 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 Owner 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 Owner 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 Owner prior to commencement of excavation below the

foundation of the structure. Review of underpinning details by the Owner shall not relieve the Contractor of his responsibility for protection of the structure and its contents.

3.03 EXISTING UTILITIES

A. Location.

The Plans indicate the available records of location of existing structures and facilities, both above and below the ground, but the City assumes no responsibility for the accuracy or completeness of this information. Utility service connections are not shown on the Plans, but can be encountered at any location on the Project. If it is necessary to adjust or relocate any utility, it shall be the Contractor's responsibility to coordinate the work with the appropriate utility. Any cost or delays incurred by the Contractor in this activity shall be incidental and no additional compensation will be made.

B. Protection.

1. If the construction of the storm drains, structures, or channel requires the removal and replacement or protection of any overhead wires or poles, the Contractor shall make satisfactory arrangements for such work with the owner or owners of such wires and poles and no additional payment will be made by the City.

2. The Contractor shall protect any sewer or utility within the limits of the construction. The Contractor shall proceed with caution in any excavation and shall use every means to determine the exact location of underground structures, pipe lines, conduits, and similar obstructions prior to excavation in the vicinity thereof. The City will not be responsible for the cost of protection or repair or replacement of any structure, pipe line, conduit, service connection, or similar facility above and below ground which may be broken or otherwise damaged by the Contractor's operations. All water and gas pipes and other conduits adjacent to or crossing the excavation shall be properly supported and protected by the Contractor.

C. Service Connections.

1. Sewer and utility services between mains and buildings shall be maintained and adjusted as necessary by the Contractor so as to provide as nearly a continuous operation as reasonably can be expected. This shall be accomplished in any way that the Contractor may desire, provided that the individual service not be inoperative more than two consecutive hours. The occupants shall be notified by the Contractor at least six hours in advance of such service interruptions. When a break occurs, the Contractor shall notify the affected occupant(s) of the probable length of time that the service will be interrupted.

2. If existing underground facilities or utilities require removal and replacement for the prosecution of this Work, all replacements of such underground construction or parts thereof shall be made with new materials conforming to the requirements of these Specifications or, if not specified, as approved by the Owner.

3. The removal and replacement of water services to accommodate new construction shall be the Contractor's responsibility within the limits where the new service line grade blends smoothly with the existing service line grade. This work will be incidental to the construction of the drainage facility and no additional compensation will be made.

4. The removal and replacement of sewer services to accommodate new construction shall be the Contractor's responsibility from the sewer main to a point where the new grade and existing grade can be matched. Payment will be made in accordance with Specification Section 02631 Paragraph 5.05.

5. The Contractor shall be responsible for any damage to the service as a result of his operations. The City does not guarantee the number, size, condition, nor length of adjustment necessary to bring a service to a new grade.

3.04 BACKFILLING

A. General.

1. Bedding for drainage facilities shall be constructed in accordance with the following specifications for the various type facilities:
   a. Storm Drain Pipe: Specification Section 02632 Paragraph 3.02.B
   b. Manholes, Inlets and Special Structures: Specification Section 02640 Paragraph 3.02
   c. Reinforced Concrete Box Culverts: Specification Section 02641 Paragraphs 3.02.B and 3.01.B

After drainage facilities have been bedded and installed in accordance with appropriate specifications and upon permission of the Owner, 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 Owner.

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 Owner orders, shall be made with pit run gravel or other acceptable material from the top of the bedding material or foundation to the subgrade elevation of the pavement. Pea gravel, sand or similar granular materials approximately uniform in size and without bonding properties shall not be used.

2. Backfill Material Outside of Pavement Areas.

a. Backfill in excavations outside of pavement in street right-of-way or outside of public right-of-way shall be made with select, job-excavated earth from the top level of the bedding material or foundation to the subgrade elevation in paved area, or to within 1 inch of the surface in areas to be sodded, or to the surface in all other areas.

b. Nongranular, job-excavated material shall be free from debris, organic matter, perishable compressible materials, and shall contain no stones or lumps or rock fragments larger than 6 inches in dimension, nor be in such amount that will interfere with

the consolidating properties of the fill material. Care shall be taken that stones and lumps are kept separated and will distributed, and that all voids are completely filled with fine materials. The upper 3 feet of backfill in sodded or planted areas shall be free of such rocks or lumps larger than 1 inch in diameter.

3. Placement and Compaction.

a. Storm Drain Trenches.

As soon as the pipe has been bedded, laid, jointed, and inspected by the Owner, 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 Owner 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 Owner, select backfill material shall be placed by methods other than ramping and compacted by jetting or flooding from the foundation of the channel lining to 3 inches above the top of the wall. Backfill will be rounded slightly adjacent to the top of wall to an elevation 1 inch above the top of the wall to assure positive surface drainage over the top of the wall. Backfill operations shall be coordinated with placement of the weep hole drainage system behind the channel lining wall. Special care shall be exercised during backfilling operations to prevent settlement behind channel lining walls.

C. Backfill in Open Areas and Unimproved Property

1. Backfill Material. Backfill for storm drain pipe excavations in open areas and unimproved property shall be made with select earth material from the top level of the bedding material or foundation to the surface. Backfilling for structures, box culverts, and concrete channel lining excavations in open areas and unimproved property shall be performed in accordance with Specification Section 02631 Paragraph 3.04.B. Nongranular, job-excavated material to be used for backfill shall be free from debris, organic matter and perishable compressible materials, and shall contain no stones or lumps or rock fragments larger than 6 inches in dimension or in such amount that will interfere with the consolidating properties of the fill material. Stones and lumps shall be kept separated and well distributed, and all voids shall be completely filled with fine materials.

2. Placement of Backfill. Backfill procedures specified for improved areas shall apply from the trench bottom to a point 2 feet above the outside of the pipe. From this point to slightly above the surrounding surface elevation, suitable backfill may be placed by bulldozer or other mechanical means.

D. Drainage Facilities Placed on Fill

1. Fill material placed in areas over which drainage facilities will be constructed shall be select earth material from the elevation of suitable subgrade to the bottom elevation for bedding or foundation of the drainage facility.

2. Placement and Compaction. If drainage facilities are constructed on filled areas, the fill material shall be placed in 6 inch loose layers and compacted to 95 percent of maximum density at plus or minus 2 percent of optimum moisture content as determined by Laboratory Standard Proctor Test (ASTM D 698) up to a point at least 2 feet above the outside top of the pipe or to the foundation of manholes, inlets, special structures, box culverts, concrete channel lining and concrete ditch paving. If compaction standards for storm drain pipe exceed that of the adjoining fill, the width of compaction for the storm drain shall be not less than the outside diameter of pipe plus 10 feet. If compaction standards for the manhole, inlets, special structure, box culverts, concrete channel lining and concrete ditch paving exceed that of adjoining fill, the limits of compaction for the facility shall be not less than 5 feet outside of the facility base slab.

3.05 FINAL GRADING

A. Final grading around and above drainage facilities shall be shaped to the slope of adjacent undisturbed ground. Sufficient grading operations shall be performed to provide natural surface drainage from adjacent properties into drainage facilities.

B. Grading above the top of concrete channel lining walls shall be accomplished in accordance with proposed cross-sections supplied by the City at the preconstruction conference or as directed by the Owner. 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 Owner will be paid for by the test as performed by a testing agency which meets the approval of the Owner.

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 Owner 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 Owner will be paid for at the contract unit price per test.

5.04 UNLINED CHANNEL
Accepted quantities of unlined channel will be paid for at the contract unit price per linear foot for various channel cross-sections, which price will be full compensation for excavation, removal, and disposal of excavated material and grading, complete in place.

5.05 SEWER BUILDING (HOUSE) CONNECTION REMOVAL AND REPLACEMENT
Accepted quantities of sanitary sewer building connections removed and replaced will be paid for at the contract unit price per each connection, which price will be full compensation for excavation, removal of old connection line and appurtenances, materials and construction of new connection, joining to existing connection line, and backfilling, complete in place.

5.06 PAYMENT WILL BE MADE UNDER:

Item No.	Pay Item	Pay Unit
02631-01	Undercut Backfill	Ton
02631-02	Sheeting and Shoring Directed to Remain In Place	1,000 Board Feet
02631-03	Soil Compaction Test	Each
02631-04	Unlined Channel	Linear Foot
02631-04.____	Description	Linear Foot

Item No.	Pay Item	Pay Unit
02631-05	Sewer Building (House) Connection Removal and Replacement	Each
02631-06	Pavement Backfill	Ton

END OF SECTION 02631

02710.1 CEMENT STABILIZED AGGREGATE BASE

PART 1 – SCOPE

This work shall consist of constructing a base composed of graded aggregate base course and portland cement in accordance with these Specifications and in conformity with the lines, grades, thickness and typical cross-section shown on the Plans or as directed by the Owner.

PART 2 – MATERIALS AND EQUIPMENT

2.01 AGGREGATE

Aggregate for Cement Stabilized Aggregate Base construction shall conform to the requirements of Section 02720 Paragraph 2.01 for Graded Aggregate Base Course.

2.02 PORTLAND CEMENT

Portland Cement shall comply with the latest specifications for portland cement, AASHTO M 85 or AASHTO M 240 for the type specified.

2.03 WATER

Water shall be free of injurious quantities of oil, salt, acid, alkali, sugar, vegetable matter, or other substances detrimental to hardening of the treated base.

2.04 BITUMINOUS MATERIAL

Bituminous material for curing shall be Emulsified Asphalt Type SS-1, RS-2, or Cut-Back Asphalt, Grade RC-250.

2.05 EQUIPMENT

All equipment necessary for the satisfactory performance of this construction shall be on the Project and approved before work will be permitted to begin.

PART 3 – CONSTRUCTION REQUIREMENTS

3.01 LIMITATIONS

No cement shall be applied when the aggregate base is frozen or contains frost. Before beginning construction operations for the day, the ambient temperature shall be at least 40^{o} F in the shade and rising. Application of cement, mixing, application of water and moist mixing, compaction, and finishing shall be continuous, and surface finishing shall be completed in daylight hours. Mixing, application of water and moist mixing, and compaction inclusively shall be completed within 6 hours.

3.02 PREPARATION

Before other construction operations are begun, the area to be paved shall be graded and shaped in accordance with Section 02335 of these Specifications in order to construct the base in conformance with grades, lines, thickness, and typical cross-section shown on the Plans. Unsuitable materials shall be removed and replaced with acceptable aggregate. Soft or yielding subgrade shall be corrected and made stable before construction proceeds.

3.03 SPREADING

After subgrade preparation is complete, aggregate base material shall be spread over the moistened subgrade. The placement shall be uniform in thickness and surface contour and in such quantity that the completed base will conform to the required grade and cross-section. Aggregate shall be placed and initially compacted to specified thickness before proceeding with pulverization and application of cement.

3.04 MOISTURE CONTENT

The optimum moisture content of the graded aggregate cement mixture shall be considered to be ten (10) percent unless otherwise determined by laboratory testing by the Owner. The maximum percentage of moisture in the aggregate at the time cement is added shall not exceed the specified optimum moisture content for the aggregate cement mixture. When water application and mixing have been completed, the

percentage of moisture in the mixture based on oven dried weights shall not be more than one (1) percentage point below or more than three (3) percentage points above the specified optimum moisture content and shall be such that he mixture will not become unstable during compacting and finishing. During finishing operations, the moisture content of the surface material shall be maintained at not less than the specified optimum moisture content.

3.05 APPLICATION OF CEMENT

A. Before application of the cement, the aggregate shall be pulverized as directed by the Owner. Approved portland cement shall then be applied uniformly on the base at the rate of 6.6lbs/s.y./inch of base thickness. The Owner reserves the right to increase the rate of cement application where in his judgment additional cement is desired. When bulk cement is used, adequate equipment for handling, weighing, and spreading the cement shall be provided.

B. The percentage of moisture in the aggregate at the time of cement application shall not exceed the quantity that will permit a uniform mixture of aggregate and cement during mixing operations.

3.06 MIXING

After the cement has been applied it shall be mixed with the aggregate so that the base material shall be a homogeneous aggregate cement mixture. Water shall be added and mixing shall continue until the mixture is sufficiently blended to prevent the formation of cement balls when additional water is added. Aggregate cement mixture shall not remain undisturbed for more than thirty (30) minutes.

3.07 APPLICATION OF WATER AND MOIST MISING

Immediately after the initial mixing operation, required water shall be applied uniformly and incorporated into the mixture, and excessive concentration of water on or near the surface shall be avoided. A water supply shall be provided that will assure the application within three (3) hours of all water required. After all water has been applied, mixing shall continue until a uniform mixture of aggregate, cement, and water has been obtained.

3.08 COMPACTION

Prior to the beginning of compaction, the mixture shall be in a loose condition for sufficient depth to produce the specified finished thickness. Compaction will be obtained by use of a sheeps-foot roller which will be followed by rolling with pneumatic-tire rollers or other types of rollers as required to thoroughly compact the base for its full thickness. Shaping may be required to obtain uniform compaction. The aggregate cement mixture shall be compacted to ninety-five (95) percent of maximum density as determined by the applicable method of AASHTO T 134.

3.09 FINISHING

A. After compaction is completed, the surface of the base shall be shaped to the lines, grades, and typical cross-sections shown on the Plans. During shaping operations, the surface shall be scarified as necessary to loosen any imprints left by the compacting or shaping equipment. The resulting surface shall then be compacted to the specified density with steel wheel or pneumatic tire rollers or both. Rolling may be supplemented by broom dragging if required.

B. Surface compaction and finishing shall be done in such a manner as to produce, within two (2) hours, a smooth, dense surface free of surface compaction planes, cracks, ridges, or loose material. Any approved surface finishing method may be used provided the above final results are produced.

3.10 CURING

A. After finishing is completed, the aggregate cement shall be protected against drying for seven (7) days by the application of bituminous material as specified or allowed by the Owner. The

bituminous material shall be applied as soon as possible, but no later than two (2) hours after finishing is completed. The finished aggregate cement shall be kept moist until the bituminous material is placed. The bituminous material shall be uniformly applied at the rate of approximately 0.2 gallons per square yard with approved heating and distributing equipment. The exact rate and temperature will be specified by the Owner.

B. During application, the surface shall be dense, free of all loose and extraneous material, and shall contain sufficient moisture to prevent penetration of the bituminous material. If necessary, water shall be applied in sufficient quantity to fill any surface voids immediately before the bituminous material is applied.

C. The curing material shall be maintained by the Contractor during the seven (7) day protection period so that all of the aggregate cement will be covered effectively, and should it be necessary for construction equipment or any other traffic to use the bituminous covered surface before it has dried sufficiently to prevent pickup, sufficient granular cover shall be applied before such use as directed by the Owner. Finished portions of aggregate cement that are traveled on by equipment or other traffic for any reason shall be protected in such a manner as to prevent marring or damaging the completed work.

D. When the ambient temperature may be expected to reach the freezing point, sufficient protection from freezing shall be given the aggregate cement for seven (7) days after finishing is completed.

3.11 CONSTRUCTION JOINTS

A. At the end of each day's construction a straight transverse construction joint shall be formed by cutting back into the completed work to form a true vertical face free of loose or shattered material.

B. Aggregate cement for large, wide areas shall be built in a series of parallel lanes of convenient length and width meeting the approval of the Owner. Straight longitudinal joints shall be formed at the edge of teach day's construction by cutting back into the completed work to form a true vertical face free of loose or shattered material.

3.12 MANHOLE ADJUSTMENTS

Drainage and sanitary sewer manholes owned by the City shall be adjusted and set at final grade by the Contractor as necessary for compliance with the Plans. Adjustments of City owned manholes shall be as specified in Sections 02532 (Sanitary Sewer Manholes) and 02634 (Storm Drain Manholes) of these specifications. Manholes, valve boxes, and other utility structures not owned by the City but within the right-of-way of the Project shall be adjusted as necessary by the owner of such facilities. The Contractor shall be responsible for notifying other owners of any required adjustments and for the accomplishment of that work by the owner of such facilities according to the project schedule.

3.13 TRAFFIC AND MAINTENANCE

A. Completed portions of the base may be immediately opened to construction equipment or local traffic and to all traffic after the seven (7) day curing period, provided the base has hardened sufficiently to prevent damage and provided curing is not impaired.

B. The Contractor shall be required to maintain the base in good condition and in a manner satisfactory to the Owner from the time work first starts until all work has been completed and accepted. Maintenance shall include immediate repairs to any defects that may occur. This work shall be done by the Contractor at his own expense and repeated as often as may be necessary o keep the area continuously intact. This work shall include immediate repairs to any defects that may occur in a manner that will ensure restoration of a smooth, uniform surface and durability of

the area repaired. Any faulty work shall be replaced to the full depth of the treatment, rather than adding a thin layer of material to the completed work.

PART 4 - MEASUREMENT

4.01 AGGREGATE BASE FOR CEMENT STABILIZATION.
Measurement will be by the square yard of aggregate base in place and initially compacted to the specified thickness.

4.02 PORTLAND CEMENT FOR CEMENT STABILIZED AGGREGATE BASE.
Measurement will be made by the pounds of portland cement furnished and incorporated into the work, complete in place.

4.03 GENERAL.

A. No water used in processing the base, bituminous curing material, or processing operations will be measured for payment, as these items are considered incidental to the Work.

B. Manhole adjustments will be measured and paid for in accordance with Pay Item 02530-1 and 02630-1.

PART 5 – PAYMENT

5.01 AGGREGATE BASE FOR CEMENT STABILIZATION
The accepted quantities will be paid for at the contract unit price per square yard, which price will be full compensation for furnishing, spreading, and initially compacting the aggregate base in condition to receive portland cement.

5.02 PORTLAND CEMENT FOR CEMENT STABILIZED AGGREGATE BASE.

A. The accepted quantities of portland cement for cement stabilized aggregate base will be paid for at the contract unit price per pound, which price will be full compensation for furnishing and spreading portland cement, mixing the material, compacting, finishing, shaping, curing, and maintaining the base until final acceptance, complete in place.

5.03 PAYMENT WILL BE MADE UNDER:

Item No.	Pay Item	Pay Unit
02710.1.00	AGGREGATE BASE FOR CEMENT STABILIZATION	Square Yard
02710.1.01	Aggregate Base, 6” Thickness	Square Yard
02710.1.02	Aggregate Base, 8” Thickness	Square Yard
02710.1.03	PORTLAND CEMENT FOR CEMENT STABILIZED AGGREGATE BASE	Pound

02710.2 SOIL CEMENT BASE

PART 1 – SCOPE

This work shall consist of constructing a base composed of in-place soil material in the roadway and portland cement uniformly mixed, moistened, compacted, finished, and cured in accordance with these

Specifications and in conformity with the lines, grades, thickness and typical cross-section shown on the Plans or as directed by the Owner.

PART 2 – MATERIALS AND EQUIPMENT

2.01 SOIL.
Soil for soil-cement base shall be of such general character as to be classified as Group A-1or A-2, AASHTO M 145. The material shall be of such size that all will pass the standard two (2) inch sieve. Samples shall be tested by the Owner before work is started for determination of cement application rates and optimum moisture content.

2.02 PORTLAND CEMENT.
Portland Cement shall comply with the latest specifications for portland cement, AASHTO M 85 or AASHTO M 240 for the type specified.

2.03 WATER.
Water shall be free of injurious quantities of oil, salt, acid, alkali, sugar, vegetable matter, or other substances detrimental to hardening of the treated base.

2.04 BITUMINOUS MATERIAL.
Bituminous material for curing shall be Emulsified Asphalt Type SS-1, RS-2, or Cut-Back Asphalt, Grade RC-250.

2.05 EQUIPMENT.
All equipment necessary for the satisfactory performance of this construction shall be on the Project and approved before work will be permitted to begin.

PART 3 – CONSTRUCTION REQUIREMENTS

3.01 LIMITATIONS.
No soil-cement shall be processed that will not be covered with the succeeding stage of base or pavement during the same construction season. No cement shall be applied when the soil is frozen or contains frost. Before beginning construction operations for the day, the ambient temperature shall be at least 40^{o} F in the shade and rising. All operations shall be continuous, and all operations but final surface finish shall be completed within four (4) hours from the time cement is applied. No uncompacted soil-cement mixture shall be left undisturbed for more than thirty (30) minutes.

3.02 PREPARATION.
Before other operations are begun, the roadbed, including depth of soil for the soil-cement base, shall be graded and shaped in accordance with Section 02335 of these Specifications. After grading operations are complete and approved, any work and material required to regrade the roadbed to finished grade shall be at the Contractor's expense. The area to receive treatment shall be thoroughly scarified and pulverized for sufficient depth and width to give, after treatment and compaction, the cross-sections shown on the Plans.

3.03 MOISTURE CONTENT
The optimum moisture content should be established by soil tests or as designated by the Owner on the Plans. The maximum percentage of moisture in the soil at the time cement is added shall not exceed the specified moisture content of the soil-cement mixture by more than three (3) percentage points. When water application and mixing have been completed, the percentage of moisture in the mixture, based on oven dried weights, shall not be more than one (1) percentage point below or more than three (3) percentage points above the specified optimum moisture content and shall be such that the mixture will not become unstable during compacting and finishing. During finishing operations, the moisture content of the surface material shall be maintained at not less than the specified optimum moisture content.

3.04 APPLICATION OF CEMENT.

Approved portland cement shall be applied uniformly on the in-place soil at the rate shown on the Plans or established by the Owner, based on tests of the soil performed before work is begun. The Owner reserves the right to increase the rate of cement where in his judgment additional cement is desired. When bulk cement is used, adequate equipment for handling, weighing, and spreading the cement shall be provided.

3.05 MIXING.

After the cement has been applied it shall be mixed with the soil so that the specified thickness of base shall be a homogeneous soil-cement mixture. Water shall be added and mixing shall continue until the mixture is sufficiently blended to prevent the formation of cement balls when additional water is added.

3.06 APPLICATION OF WATER AND MOIST MISTING.

Immediately after the soil and cement have been mixed, water shall be applied uniformly and incorporated into the mixture. Excessive concentration of water on or near the surface shall be avoided. A water supply and pressure distributing equipment that will assure the application within three (3) hours of all water required. After all water has been applied, mixing shall continue until a uniform and intimate mixture of soil-cement and water has been obtained.

3.07 COMPACTION.

Prior to the beginning of compaction, the mixture shall be in a loose condition for a depth to produce the specified finished thickness. As a continuation of mixing operations, the loose mixture then shall be uniformly compacted to ninety-five (95) percent of maximum density as determined by AASHTO T 134 with two (2) hours. Initial compaction shall be obtained by use of a sheeps-foot roller of adequate weight to thoroughly compact the base for the full thickness. During compaction operations, shaping may be required to obtain uniform compaction and required grade and cross.

3.08 FINISHING.

A. After the mixture has been compacted, the surface of the soil-cement shall be shaped, if necessary, to the required lines, grades, and cross-sections shown on the Plans. During shaping operations, the surface shall be lightly scarified as necessary to loosen any imprints left by the compacting or shaping equipment. The resulting surface shall then be compacted to the specified density with steel wheel or pneumatic tire rollers or both. Rolling shall be supplemented by broom dragging if required.

B. Surface compaction and finishing shall be done in such a manner as to produce, within two (2) hours, a smooth, dense surface free of surface compaction planes, cracks, ridges, or loose material. Any approved surface finishing method may be used provided the above final results are produced.

3.09 CURING.

A. After the soil-cement has been finished as specified herein, it shall be protected against drying for seven (7) days by the application of bituminous material as specified or allowed by the Owner. The bituminous material shall be applied as soon as possible, but no later than two (2) hours after finishing is completed. The finished soil-cement shall be kept continuously moist until the bituminous material is placed.

B. The bituminous material shall be uniformly applied at the rate of approximately 0.2 gallons per square yard with approved heating and distributing equipment. The exact rate and temperature of application to give complete coverage without excessive run-off will be specified by the Owner.

C. At the time the bituminous material is applied the soil-cement shall be dense, free of all loose and extraneous material, and shall contain sufficient moisture to prevent penetration of the

bituminous material. Water shall be applied in sufficient quantity to fill any surface voids immediately before the bituminous material is applied.

D. The curing material shall be maintained by the Contractor during the seven (7) day protection period so that all of the soil-cement will be covered effectively.

E. Should it be necessary for construction equipment or any other traffic to use the bituminous covered surface before it has dried sufficiently to prevent pickup, sufficient granular cover shall be applied before such use as directed by the Owner. Finished portions of the soil-cement that are traveled on by equipment or other traffic for any reason shall be protected in such a manner as to prevent marring or damaging the completed work.

F. When the ambient temperature may be expected to reach the freezing point, sufficient protection from freezing shall be given the soil-cement for seven (7) days after finishing and until it has hardened.

3.10 CONSTRUCTION JOINTS.

A. At the end of each day's construction a straight transverse construction joint shall be formed by cutting back into the completed work to form a true vertical face free of loose or shattered material.

B. Soil-cement for large, wide areas shall be built in a series of parallel lanes of convenient lengths and width meeting the approval of the Owner. Straight longitudinal joints shall be formed at the edge of teach day's construction by cutting back into the completed work to form a true vertical face free of loose or shattered material.

3.11 MANHOLE ADJUSTMENTS.

Drainage and sanitary sewer manholes owned by the City shall be adjusted and set at final grade by the Contractor as necessary for compliance with the Plans. Adjustments of City owned manholes shall be as specified in Sections 02530 (Sanitary Sewer Manholes) and 02630 (Storm Drain Manholes) of these specifications. Manholes, valve boxes, and other utility structures not owned by the City but within the right-of-way of the Project shall be adjusted as necessary by the owner of such facilities. The Contractor shall be responsible for notifying other owners of any required adjustments and for the accomplishment of that work by the owner of such facilities according to the project schedule.

3.12 TRAFFIC AND MAINTENANCE.

A. Completed portions of the soil-cement may be opened immediately to construction equipment and local traffic, and to all traffic after the seven (7) day curing period, provided the soil-cement has hardened sufficiently to prevent marring or distorting of the surface by equipment or traffic and provided curing specified above is not impaired.

B. The Contractor shall be required to maintain the soil-cement in good condition and in a manner satisfactory to the Owner from the time work first starts until all work has been completed and accepted. Maintenance shall include immediate repairs of any defects that may occur. This work shall be done by the Contractor at his own expense and repeated as often as may be necessary to keep the area continuously intact. This work shall include immediate repairs to any defects that may occur in a manner that will ensure restoration of a smooth, uniform surface and durability of the area repaired. Any faulty work shall be replaced to the full depth of treatment, rather than adding a thin layer of material to the completed work.

PART 4 - MEASUREMENT

4.01 PORTLAND CEMENT FOR SOIL-CEMENT BASE

Portland cement will be computed by the pounds furnished and incorporated into the Work, complete in place.

4.02 GENERAL.

A. No water used in processing the base, bituminous curing material, or processing operations will be measured for payment, as these items are considered incidental to the Work.

B. Manhole adjustments will be measured and paid for in accordance with Pay Item 02530.01 and 02630.01.

PART 5 – PAYMENT

5.01 PORTLAND CEMENT FOR SOIL-CEMENT BASE.
Portland cement will be paid at the contract unit price per pound, which price will be full compensation for preparing the in-place soil, furnishing and spreading portland cement, mixing the material, compacting, finishing, shaping, curing, and maintaining the base until final acceptance, complete in place.

5.02 PAYMENT WILL BE MADE UNDER

Item No.	Pay Item	Pay Unit
02710.2.01	PORTLAND CEMENT FOR SOIL-CEMENT BASE	Pound

02710.3 PORTLAND CEMENT CONCRETE BASE (PLAIN)

PART 1 – SCOPE

1.01 This work shall consist of constructing a single course of plain portland cement concrete base, as specified, on a prepared subgrade in accordance with these Specifications and in conformity with the lines, grades, thickness and typical cross-section shown on the Plans or as directed by the Owner.

PART 2 – MATERIALS AND EQUIPMENT

2.01 CONCRETE MATERIAL
Concrete materials shall meet the requirements of Specification Section 03050, Portland Cement Concrete, for Class B concrete.

2.02 CURING MATERIALS
Curing materials shall conform to the applicable provisions of Specification Section 02750Paragraph 2.03.

2.03 CHEMICAL ADDITIVES
Chemical additives shall conform to the applicable provisions of Specification Section 02750 Paragraph 2.05.

2.04 EQUIPMENT
All equipment necessary for the satisfactory performance of this construction shall be on the Project and approved before work will be permitted to begin. The equipment shall meet the requirements of Specification Section 02750 Paragraph 2.08.

PART 3 – CONSTRUCTION REQUIREMENTS

3.01 PROPORTIONING

The proportioning of materials for portland cement concrete base shall be in accordance with the provisions of Specification Section 03050 Portland Cement Concrete, for Class B concrete.

3.02 MIXING LIMITATIONS AND PLACING CONCRETE

Limitations of mixing of concrete due to weather shall be in accordance with limitations specified in Specification Section 02750, Paragraph 3.05 A, "Mixing Limitations". Placing of concrete shall be as specified in Specification Section 02750, Paragraph 3.05 B, "Placing Concrete".

3.03 PREPARATION AND CONSTRUCTION PROCEDURES

A. The subgrade shall be prepared in accordance with the provisions of Specification Section 02335.

B. The procedures used in construction portland cement concrete base shall meet the applicable requirements of Specification Section 02750, "Portland Cement Concrete Pavement".

3.04 SURFACE FINISH AND TOLERANCES

The surface of concrete base shall meet the requirements of Specification Section 02750 Paragraph 3.10 "Surface Test". When a bituminous concrete surface is specified, the surface of the base shall be rolled prior to initial set with a roller having projections that will form grooves in the surface approximately one (1) inch wide and one-half (1/2) inch deep at intervals of approximately five (5) inches. These grooves shall form an angle of approximately 60^{o} with the pavement centerline. A tamping device may be used which will produce the same general results.

3.05 TRAFFIC AND MAINTENANCE

The Owner will determine when the concrete base has cured sufficiently for the application of bituminous concrete surface material or when local traffic or construction equipment will be allowed on the base.

3.06 TOLERANCE IN BASE THICKNESS

The owner will determine the thickness of the base by average measurements taken at the frequency he determines to be sufficient. When the finished base thickness is not deficient by more than one-quarter (1/4) inch from the Plan thickness, full payment will be made. When concrete base is determined to be deficient by more than one-quarter (1/4) inch, the Contractor shall remove and replace the deficient base at his expense.

3.07 MANHOLE ADJUSTMENTS

Drainage and sanitary sewer manholes owned by the City shall be adjusted and set at final grade by the Contractor as necessary for compliance with the Plans. Adjustments of City owned manholes shall be as specified in Specification Sections 02530 (Sanitary Sewer Manholes) and 02630 (Storm Drain Manholes) respectively. Manholes, valve boxes, and other utility structures not owned by the City but within the right-of-way of the project shall be adjusted as necessary by the owner of such facilities. The Contractor shall be responsible for notifying other owners of any required adjustments and for the accomplishment of that work by the owner of such facilities according to the project schedule.

PART 4 - MEASUREMENT

4.01 PORTLAND CEMENT CONCRETE BASE (PLAIN)

Portland cement concrete base will be measured by the square yard (yd^2) in place for the specified thicknesses.

PART 5 – PAYMENT

5.01 PORTLAND CEMENT CONCRETE BASE (PLAIN)

Portland cement concrete base will be paid for at the contract unit price per square yard (yd^2), which price will be full compensation for preparing the subgrade, furnishing, consolidating, finishing and curing the concrete, and maintaining the base until final acceptance, complete in place.

5.02 PAYEMENT WILL BE MADE UNDER:

Item No.	Pay Item	Pay Unit
02710.3.01	PORTLAND CEMENT CONCRETE BASE (PLAIN),	Square Yard
02710.3.01.__	_____ " Thickness	Square Yard

02710.4 ASHPALTIC CONCRETE (GENERAL)

PART 1 – SCOPE

These Specifications include general requirements that are applicable to all types of bituminous pavements and bases of the plant mix type. Deviations from these general requirements will be indicated in the specific requirements for each type.

PART 2 – MATERIALS AND EQUIPMENT

2.01 AGGREGATES, FILLER, AND BITUMINOUS MATERIAL

A. Aggregates, filler if required, and bituminous material for the various types of hot mix asphaltic concrete will be stipulated in the applicable Section of these Specifications.

B. Each size and type of aggregate shall be stocked in a separate bin or stall in a manner that will prevent segregation. The mineral aggregate will be accepted for quality in the stockpile and for gradation immediately preceding addition of bituminous material. This acceptance will be based on periodic samples of the various sizes of aggregate taken as they are weighed from the bins, of the combined aggregate as it is fed to the pugmill, or of batches to which the bituminous material has not been added. The bituminous material may be conditionally accepted at the source.

C. The plant mixed material will be accepted after blending and mixing at the plant.

2.02 COMPOSITION OF MIXTURES

The bituminous plant mix shall be composed of a job-mix formula of aggregate, filler if required, and bituminous material approved by the Owner. The several aggregate fractions shall be sized, uniformly graded, and combined in such proportions that the resulting mixture meets the grading requirements of the job-mix formula. The job-mix formula shall establish a single percentage of aggregate passing each required sieve size, a single percentage of bituminous material to be added to the aggregate, and a single temperature at which the mixture is to be discharged from the plant. All mixtures shall continually conform to the job-mix formula within tolerances established by Subsection 407.03 of the Tennessee Department of Transportation Standard Specifications for Road and Bridge Construction. When unsatisfactory results or other conditions make it necessary, the job-mix formula may be adjusted by the Owner.

2.03 EQUIPMENT

A. Bituminous Mixing Plants

1. Bituminous mixing plants, regardless of type, shall conform to the current requirements of the Tennessee Department of Transportation Standard Specifications for Road and Bridge Construction, Subsection 407.04.

2. At any time and without notice, the Owner shall have free access to any plant producing hot mix asphaltic concrete for the City of the purpose of checking equipment, materials, scales, or plant mixed material for compliance with these Specifications. He shall be furnished whatever assistance he requests in checking the plant, including the provision of testing equipment to check the mix and materials.

B. Trucks

1. Trucks used for hauling bituminous mixtures shall have tight, clean, smooth metal beds. The beds shall have been coated with an approved material not harmful to the mixture to prevent adherence to the beds. Each truck shall have a canvas cover to protect the mixture from the weather, and when necessary to control temperature, truck beds shall be insulated and covers securely fastened.

C. Bituminous Pavers

1. Bituminous pavers shall be self-contained units, provided with an activated screed or strike-off assembly equipped to be heated and capable of spreading and finishing courses of plant mix material in lane widths according to the typical sections and thicknesses shown on the Plans. Materials for shoulders and similar construction shall be placed by any mechanical spreading equipment approved by the Owner.

2. Bituminous pavers shall be equipped with a receiving hopper of sufficient capacity to ensure a uniform spreading operation. The hopper shall be equipped with a distribution system which prevents “cold spots” and which will place the mixture uniformly in front of the screed. The screed or strike-off assembly shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture. When laying mixtures, the paver shall be capable of forward speeds consistent with satisfactory laying of the mixtures.

3. All asphalt paving machines shall be equipped with automatic grade and slope controls which shall be in good working order at all times. In the event of mechanical failure of any of the automatic controls, the Contractor will be permitted to complete only the current day’s work using manual controls.

D. Rollers

1. Rollers shall be self-propelled and of the steel-wheel, pneumatic tire, and/or vibratory type. Rollers shall be in good condition, capable of reversing without backlash and shall be operated at speeds slow enough to avoid displacement of the bituminous mixture. All rollers shall be equipped with devices to moisten and clean the wheels as required.

2. The steel wheel roller shall weigh a minimum of eight tons and may be a three-wheel or tandem type.

3. The pneumatic tire roller shall meet the requirements of Specification Section 02335.

4. The use of vibratory rollers will be permitted only after being specifically approved by the Owner.

5. All required rollers shall be on the job, inspected, and approved before paving operations will be permitted to begin.

E. Platform Truck Scales

1. Platform truck scales shall meet the requirements of Subsection 109.01 of the Tennessee Department of Transportation Standard Specifications for Road and Bridge Construction.

F. Small Tools

1. The Contractor shall provide all necessary small tools and suitable means for keeping them clean and free from accumulations of bituminous materials.

PART 3 – CONSTRUCTION REQUIREMENTS

3.01 WEATHER LIMITATIONS

A. Bituminous plant mix may be placed on properly constructed and accepted subgrade, base, previously applied layers of asphaltic concrete, or concrete pavement provided the following conditions are met:

1. The area to be paved is not in a frozen condition and is free from snow, ice, and excessive moisture.

2. Plant production and paving operations shall be so coordinated that a uniform continuity of operation is maintained.

3. The bituminous plant mix shall be placed in accordance with the following:

a. when the compacted thickness of the mix is less than 1-1/2 inch, the minimum air or surface temperature shall be 50^{o} F.

b. when the compacted thickness of the mix is 1-1/2 inch or more, the minimum air or surface temperature shall be 40^{o} F.

3.02 CONDITIONING OF THE EXISTING SURFACE

A. When bituminous mixes are to be placed upon an existing concrete pavement, with or without a bituminous overlay, all loose or excess bituminous material shall be removed from joints and cracks. Sections of existing pavement that are broken and pumping under traffic shall be removed to subgrade as directed by the Owner. Unsatisfactory subgrade material encountered when existing pavement is removed shall also be removed as directed by the Owner. Materials removed from existing pavement, including base and subbase, and from subgrade shall be replaced with asphaltic concrete Mix No. 2, as specified in Specification Section 02740.2, Paragraph 5.03, Pay Item 02740.2.03.

B. When the bituminous mixture is to be placed upon an existing bituminous pavement, any areas having excess bitumen and any failures in the existing surface and base shall be removed to subgrade as directed by the Owner. Unsatisfactory subgrade material encountered when existing pavement is removed shall also be removed to subgrade as directed by the Owner. Materials removed from existing pavement, including base and subbase, and from subgrade shall be replaced with be replaced with asphaltic concrete Mix No. 2, as specified in Specification Section 02740.2, to the level of existing pavement surface or as directed by the Owner. Payment for removal and replacement shall be made as defined for in Specification Section 02740.2.03.

3.03 PRIME OR TACK COATS

A prime coat shall be applied to Graded Aggregate Base Course, Cement-Stabilized Aggregate Base, and Soil-Cement Base uniformly at the rage of 0.25 gallons per square yard. Prime coat shall be grade MC-30. Bituminous material for tack coat shall be applied to concrete or asphaltic concrete bases or surfaces to provide bond for superimposed courses. Tack coat shall be emulsified asphalt, grade SS-1, applied at a uniform rate not to exceed 0.05 gallons of residual bitumen per square year.

3.04 PREPARATION OF BITUMINOUS MATERIAL

The bituminous material for hot mixes shall be heated to a temperature between 275^{o} F and 325^{o} F in a manner that will avoid local overheating and provide a continuous supply to the mixer at a uniform temperature at all times.

3.05 PREPARATION OF AGGREGATES

A. The aggregates for hot mixes shall be dried and heated to a uniform temperature between 225^{o} F and 325^{o} F. Flames used for drying and heating shall be properly adjusted to avoid damage to the aggregate and to avoid soot on the aggregate.

B. On all plants requiring screens, the hot dried aggregate shall be screened into two (2) or more fractions as specified. The separated fractions shall then be conveyed into separate compartments ready for batching and mixing with bituminous material.

3.06 MIXING

A. The dried aggregates shall be combined within the mixer in the amount of each fraction of aggregates required to meet the job-mix formula. The bituminous material shall be measured or gauged and introduced into the mixer in the amount specified by the job-mix formula.

B. After the required amounts of aggregate and bituminous material have been introduced into the mixer, the materials shall be mixed until a complete and uniform coating of the particles and a thorough distribution of the bituminous material throughout the aggregate is secured. Wet-mixing time shall be determined by the Owner for each plant and for each type of aggregate used, but in no case shall the wet-mixing time be less than twenty-five (25) seconds for batch type plants and forty (40) seconds for continuous mix plants.

C. For hot-mix bituminous pavement, the temperature of the completed mixture, determined at the time it is dumped from the mixer, shall be not less than 275^{0}F, except that the temperature of mixtures made with aggregates containing absorbed moisture which causes foaming or boiling in the completed mixtures at these higher temperatures shall be not less than 225^{0}F.

D. Hot-mix bituminous mixtures may be stored in surge or storage silos provided that the mixture as used from the silos meets all the specification requirements for the particular mix involved. When the use of surge or storage silos is permitted, the following additional requirements shall apply:

1. The surge and storage systems shall be of such design that there are no appreciable differences between material being discharged from the silo and material being discharged directly from the pugmill.

2. The surge and storage silos must be equipped with low and high mix level indicators. The low level indicator shall be placed at a location on the silo that has been predetermined to prevent segregation of the mix.

3. The conveyor system used with the surge or storage silos shall be arranged in such a manner that samples of the mix or dry material may be conveniently taken from the pugmill.

4. Storage silos shall be closed, insulated, and heated in such a manner that localized heating (hot spots) does not occur. The storage system shall be capable of sealing the bin to prevent oxidation of the mixture.

5. Surge silos shall be equipped with a rain cover capable of preventing water from entering the mix in the silo.

6. Approval of a surge or storage system will be dependent upon inspection and tests which indicate that the system is capable of conveying, retaining, and delivering the bituminous mixture:

a. within the tolerance ranges as set forth on the job mix formula;
b. without segregation; and
c. without balling or hardening.

7. Approval of a surge or storage system may be withdrawn if tests and/or inspections indicate that the system is having a detrimental effect on the bituminous mixture.

8. Any bituminous mix which, in the judgment of the Owner, is damaged in any way by the use of a surge or storage system will be rejected.

9. Platform truck scales meeting the requirements of Specification Section 02710.4 Paragraph 2.03 shall be mounted under the loading hopper and shall be capable of recording tare and gross weight.

10. The storage or surge bin shall be emptied when directed by the Owner in order to check material quantities.

11. Hours of plant operation, whether for storage or direct shipment to the road, shall be limited to reasonable working hours in order that normal inspection of plant operations may be performed.

12. Bituminous material in a surge silo must be removed on the same day in which it is place.

13. Samples of the stored material may be taken following the period of storage.

14. Material stored will be subject to the temperature, segregation, and laying requirements as required for normal un-stored plant production.

15. Excessive segregation, lumpiness, or stiffness of the mix shall be sufficient cause for rejection by the Owner.

16. Surge and storage silos shall be located in a position that enables the top of the truckbed to be visible to the load operator during the loading operation.

3.07 SPREADING AND FINISHING

A. Unless otherwise specified or permitted, bituminous mixtures shall be delivered and spread on the roadway in ample time to secure thorough compaction during daylight hours. Its temperature at the time of depositing in the paver hopper shall be not more than 25^0F less than the temperature at which it is discharged from the mixer. The mixture shall be laid upon an approved surface to which the appropriate tack coat or prime coat has been applied and spread and struck off to the established line, grade, and elevation by means of approved asphalt paving machines in echelon or by one (1) paver when echelon paving is not permitted. Echelon paving will not be permitted on two (2) lane projects where traffic is being maintained. Alignment of the outside edges of the pavement shall be controlled by preset control string lines. Where multicourse pavements are placed, the longitudinal joint in one (1) layer shall offset that in the layer immediately before by approximately one (1) foot; however, the joint in the top layer shall be at the centerline of the pavement if the roadway comprises two (2) lanes of width or at lane lines if the roadway is more than two (2) lanes in width.

B. Automatic screed controls utilizing either the string line or ski type grade reference systems will be required on all work regardless of the paver width. The string line reference system may be required on new construction. In the event the base has been finished with equipment having automatic grade controls or the Contractor demonstrates that an alternate method of spreading and finishing will result in a satisfactory riding surface, the Owner may conditionally waiver the string line requirement and authorize use of the ski type reference system. In any event, the

Owner may at any time require the use of a string line reference system even though it may have previously been waived, if in his opinion the use of the string line will result in a superior riding surface. Where the ski type system is used, the ski shall have the maximum practical length and in no case shall it be less than forty (40) feet in length. Pavement lanes previously placed with automatic controls or to form grade may serve as longitudinal control reference for laying adjacent lanes by utilizing a ski or joint matching shoe.

C. The string line reference system shall consist of suitable wire or twine supported by approved devices which will be compatible with the type of automatic paver control systems used. The string line and supports shall be capable of maintaining the line and grade designated by the Plans at the point of support while withstanding the tensioning necessary to prevent sag in excess of ¼ inch between supports spaced fifty (50) feet apart. Additional supports shall then be installed to provide a minimum spacing of twenty-five (25) feet, or less, as directed by the Owner and to remove and deviation of the string line from Plan grade.

D. The Owner will furnish sufficient control reference stakes to enable the Contractor to establish the string line reference system. The Contractor shall furnish all materials, equipment, labor, and incidentals required to construct the string line reference system as described herein and shall maintain same until its use is no longer required.

E. The string line reference system shall be complete in place at least 300 feet in advance of the point where the pavement is being place.

F. Automatic screed controls will not be required on sections of projects where service connections and other conditions interfere with their efficient operation.

G. The cost of erecting and maintaining the string line reference system shall be included in the unit price bid for other items of construction.

H. On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the mixture shall be taken from the hopper of the spreading machine and shall be distributed immediately into place by means of suitable shovels and other tools and spread with rakes and lutes in a uniformly loose layer of such depth as will result in a completed course having the required thickness.

3.08 COMPACTION

A. After the bituminous mixture has been spread, struck off, and surface irregularities adjusted, it shall be thoroughly compacted. The method employed must be approved by the Owner and capable of compacting the mixture to the desired density while it is in a workable condition. When no density requirements are specified, a system of compaction for roadway pavements shall be employed which has previously produced required bituminous pavement densities. A control strip and random density samples may be employed to aid the Owner in evaluating the system.

B. In general, compaction shall be accomplished by the use of a combination of the equipment designated in Specification Section 02710.4 Paragraph 2.03D (Rollers). The following are minimum roller requirements; however, the number of rollers shall be increased if the required results are not being obtained.

1. For each paver up to sixteen (16) feet wide, two (2) rollers shall be required.

2. For each paver over sixteen (16) feet wide, three (3) rollers shall be required.

3. For each paver over twenty-six (26) feet wide, four (4) rollers shall be required.

C. The minimum number of rollers listed above may, with the approval of the Owner, be reduced to one roller of either the steel-wheel or vibratory type on the following types of construction:

1. on shoulder construction

2. on incidental construction such as bridge approaches, driveways, etc.

3. on projects containing less than 10,000 square yards of bituminous pavement

D. Unless otherwise directed, rolling shall begin at the low side and proceed longitudinally parallel to the road centerline. When paving in echelon or abutting a previously placed lane, the longitudinal joint shall be rolled first, followed by the regular rolling procedure. When paving in echelon, rollers shall not compact within six (6) inches of an edge where an adjacent lane is to be placed. Rollers shall move in a slow uniform speed with the drive wheels nearer the paver and shall be kept as nearly as possible in continuous operation. Rolling shall continue until all roller marks are eliminated.

E. To prevent adhesion of the mixture to the rollers, the wheels shall be kept properly moistened with water or water mixed with very small quantities of detergent or other approved material. An excess of liquid shall not be used.

3.09 DENSITY

A. Density Requirements

1. Asphaltic Concrete Surface Course, Mix No. 1 as specified in Specification Section 02740.2 Paragraph 2.01D, shall be compacted to 93 percent of laboratory density as determined by the Marshall Method, 75 blow.

2. Asphaltic Concrete Binder Course (Leveling or Bushing), Mix No. 2 as specified in Specification Section 02740.2 Paragraph 2.01D, shall be compacted to 90 percent of maximum theoretical density.

3. Asphaltic Concrete Base (Black Base), as specified in Specification Section 02710.5, shall be compacted to 90 percent of maximum theoretical density.

4. It is intended that acceptance density testing will be accomplished while the bituminous mixture is hot enough to permit further densification if such is shown to be necessary.

5. If the density does not conform to the requirement stated herein above, the Contractor shall continue his compactive effort until the required density is obtained.

6. Along forms, curbs, headers, walls and other places not accessible to the rollers, the mixture shall be compacted thoroughly with hot hand tampers, smoothing irons, or with mechanical tampers. On depressed areas, a trench roller of cleated compression strips may be used to compact the mix.

7. Any mixture that becomes loose or broken, mixed with dirt, or is in any way defective shall be repaired with rakes and the addition of fresh mix or shall be removed and replaced with fresh mix which shall be compacted to conform with the surrounding area. Any area showing an excess or deficiency of bituminous material shall be removed and replaced.

B. Density By Control Strips

1. When approved by the Owner, the required density may be determined by the control strip method. The target density obtained by the control strip method shall be used in lieu of theoretical or laboratory densities.

2. When this method is used, the density of all paving shall be at least 96 percent of the density obtained on the control strip. Construction of the control strip shall be as follows:

a. The base course or other pavement structure course upon which a control strip is constructed shall have been approved by the Owner prior to the construction of the control strip.

b. Equipment proposed for use in the compaction of control strips shall meet the requirements set forth in Specification Section 02710.4 Paragraph 3.08.

3. To determine the target density, a control strip shall be constructed at the beginning of work on the pavement course. New control strips shall be required when:

a. a change in the Job Mix Formula is necessary

b. a change in the source of materials occurs

c. a change in the material from the source is observed

d. a change in the paving or rolling equipment occurs

e. there is reason to believe that the control strip density is not representative of the bituminous mixture being placed

4. With the approval of the Owner, the Contractor may be permitted to construct additional control strips.

5. Each control strip shall be constructed with approved bituminous mixture and shall remain in place as a section of the completed work. Each control strip shall be one paver width wide and have an area of at least 400 square yards and shall be of the depth specified for the pavement structure course concerned.

6. Compaction of the control strip shall commence immediately after placement of the bituminous mixture and be continuous and uniform over the entire control strip.

7. The compaction of the control strip shall be continued until no appreciable increase in density (1.0 lbs/ft^3) can be obtained by additional roller coverages.

8. During the rolling process, the density of the control strip will be determined by the Owner from randomly selected tests within the control strip.

3.10 SURFACE REQUIREMENTS

A. The surface shall be tested with a twelve (12) foot steel straightedge, furnished by the Contractor, applied parallel to the centerline of the pavement. The deviation of the surface from the testing edge of the straightedge shall not exceed that specified for the respective types of bituminous construction under the applicable sections of these Specifications.

B. The transverse slopes of tilted pavements shall be tested with a string line and string level applied at right angles to the centerline of the pavement and the percent of slope, when computed for the full width of the pavement, shall not deviate more than one-half (1/2) of one percentage point from that specified on the Plans.

C. The crown in crowned pavements shall be tested with a string line applied at right angles to the centerline of the pavement, and the crown shall not deviate more than one-half (1/2) inch from that specified on the Plans.

D. Deviations greater than the specified tolerances shall be corrected by methods best suited for the purpose. Pavement that cannot be corrected to comply with the specified tolerances shall be removed and replaced at the Contractor's expense.

3.11 BLOTTING SAND

When directed by the Owner in order to control tracking of excess bituminous material from curing of base materials or from application of prime coat, a protective cover of blotting sand shall be spread over the bituminous material at a rate specified by the Owner, but not to exceed ten (10) pounds per square yard. Application of blotting sand shall be considered incidental to the work and no separate payment will be made.

PART 4 - MEASUREMENT

All asphaltic concrete will be measured for payment as stipulated under the Specification Section for each individual type.

PART 5 – PAYMENT

All asphaltic concrete will be paid for as stipulated under the Specification Section for each individual type.

02710.5 ASPHALTIC CONCRETE BASE (BLACK BASE)

PART 1 – SCOPE

This work shall consist of a foundation base composed of a hot mixture of aggregate and asphalt. It shall be constructed on a prepared subgrade in conformity with the lines, grades, thicknesses, and typical cross-sections shown on the Plans or as directed by the Owner.

PART 2 – MATERIALS AND EQUIPMENT

2.01 ASPHALT CEMENT

Asphalt cement for this construction shall be penetration grade AC-20 or AC-10, or as directed by the Owner if these grades are not available. The proportion by weight of asphalt cement to the total mixture shall be between 3.5 percent and 5.5 percent as approved by the Owner.

2.02 COURSE AGGREGATE

Course aggregate (aggregate retained on the No. 4 sieve) shall be crushed limestone conforming to the quality requirements of AASHTO M 62 or washed gravel, as approved by the Owner.

2.03 FINE AGGREGATE

Fine aggregate shall consist of natural sand consisting of hard, clean, tough grains which will have a maximum weight loss of twelve (12) percent when subjected to the sodium sulfate soundness test.

2.04 AGGREGATE GRADATION

The aggregate gradation for black base shall conform to the following master range:

Sieve Size	Total % Passing by Weight
2”	100
1-1/2”	75-100
3/4”	45-70
3/8”	30-55
No. 4	20-40
No. 8	10-30
No. 30	5-20

No. 100	0-12
No. 200	0-6

2.05 EQUIPMENT
All equipment necessary for the satisfactory performance of this construction shall be on the Project and approved before work will be permitted to begin. The equipment shall meet the requirements of Specification Section 02710.4 Paragraph 2.03.

PART 3 – CONSTRUCTION REQUIREMENTS

3.01 GENERAL
The general construction requirements for black base shall be as prescribed in the applicable portions of Specification Section 02710.4 Paragraphs 3.01 through 3.11.

3.02 PREPARATION OF SUBGRADE OR SURFACE
The surface upon which black base is to be placed shall meet the requirements of Specification Section 02335 or 02710.4 Paragraph 3.02, whichever is applicable. Black base shall be placed only upon a surface that is dry and cleaned of all loose particles.

3.03 THICKNESS AND SURFACE REQUIRMENTS
Thickness shall be controlled during the spreading operations by frequent measurements taken of the freshly spread mixture to establish a relationship between the uncompacted and compacted material. This thickness shall remain in conformity with that specified on the Plans. The surface of the base shall meet the requirements specified under Specification Section 02710.4 Section 3 and when tested in accordance with the provisions of Specification Section 02710.4 Paragraph 3.10, the deviation of the surfaces from the testing edge of the straightedge shall not exceed 3/8 inch.

3.04 MANHOLE ADJUSTMENTS
Drainage and sanitary sewer manholes owned by the City shall be adjusted and set at final grade by the Contractor as necessary for compliance with the Plans. Adjustments of City owned manholes shall be as specified in Specification Sections 02530 (drainage) and 02630 (sewer). Manholes, valve boxes, and other utility structures not owned by the City but within the right-of-way of the Project shall be adjusted as necessary by the owner of such facilities. The Contractor shall be responsible for notifying other owners of any required adjustments and for the accomplishment of that work by the owner of such facilities according to the project schedule.

3.05 TRAFFIC AND MAINTENANCE
The Owner will determine when the base has sufficient compaction and has cured sufficiently to allow construction equipment, local traffic, and/or normal traffic on the base.

PART 4 - MEASUREMENT

4.01 ASPHALTIC CONCRETE BASE (BLACK BASE)
Asphaltic concrete base will be measured for payment by the square yard in place at specified thickness.

4.02 GENERAL

A. Prime or tack coat used as specified in Specification Section 02710.4 Paragraph 3.03 will not be measured for payment, as these items are considered incidental to the work.

B. Manhole adjustments will be measured and paid for in accordance with Pay Item 02530.01 or 2630.01.

PART 5 – PAYMENT

5.01 ASPHALTIC CONCRETE BASE (BLACK BASE)

A. Asphaltic concrete base will be paid for at the contract unit price per square yard, which price will be full compensation for all materials, mixing, hauling, spreading, compaction, and maintaining the base, until final acceptance, complete in place.

B. Payment will be made under:

Item No.	Pay Item	Pay Unit
02710.5.01	ASPHALTIC CONCRETE BASE (BLACK BASE)	Square Yard
02710.5.01.___	_____ " Thickness	Square Yard

END OF SECTION 02710

CITY OF MEMPHIS – STANDARD CONSTRUCTION SPECIFICATIONS
SECTION 02720 UNBOUND BASE COURSES AND BALLASTS

PART 1 – SCOPE

This work shall consist of furnishing and placing one or more courses of graded aggregate on a prepared subgrade in accordance with these Specifications and in conformity with the lines, grades, thickness, and typical cross-sections shown on the Plans or as directed by the Owner.

PART 2 – MATERIALS AND EQUIPMENT

2.01 A. Aggregates for Graded Aggregate Base Course shall be crushed stone or crushed or uncrushed gravel together with such material as manufactured sand or other fine materials naturally contained or added thereto as needed to conform with one of the three gradations shown in the table below, as specified

Grading Table for Graded Aggregate Base Course
Total Percent, by Dry Weight, Passing Each Sieve (U.S. Standard)

Size No.	2 ½ "	2"	1 ½ "	1"	3/8"	No. 40	Clay*
1	100	95-100			35-65	10-30	1-12
2		100	95-100		40-65	10-30	1-12
3			100	90-100	45-65	10-35	2-12

* Clay content shall be determined by the Hydrometer Test – AASHTO T 88 4. Clay content may exceed 12 percent with the written permission of the Owner.

B. Mineral aggregate for graded aggregate base course shall consist of hard durable particles or fragments of stone or gravel and other finely divided mineral matter. Individual materials shall meet the requirements specified hereinafter.

1. Crushed Stone.
   Crushed stone shall be free of silt and clay. The coarse aggregate portion of the stone shall have a percentage of wear of not more than 50, and when subjected to five (5) alternations of the sodium sulfate soundness test, the weighted percentage of loss shall not exceed fifteen (15).

2. Gravel.
   Gravel shall be screened and all oversize material may be crushed and fed uniformly back over the screen. The coarse aggregate portion (retained on the No. 4 sieve) shall have a percentage of wear of not more than 50, and when subjected to five (5) alternations of the sodium sulfate soundness test, the weighted percentage of loss shall not exceed fifteen (15). The portion of the material passing the No. 40 sieve shall be nonplastic or shall have a liquid limit of not more than thirty (30) and a plasticity index of not more than eight (8).

C. If fine aggregate, coarse aggregate, or binder, in addition to that present in the base material, is needed in order to meet the gradation or density requirements or for satisfactory bonding of the material, it shall be uniformly blended with the base course material at the mixing plant by a mechanical feeder to maintain a uniform flow on the belt to the mixer. Blending of materials on the stockpiles or in the pits by bulldozer, clamshell, dragline, or similar equipment will not be permitted. The composite gradation of aggregate shall be the grading specified.

2.02 EQUIPMENT

All equipment necessary for the satisfactory performance of this construction shall be on the Project and approved before work will be permitted to begin. If mixing is required, an approved stationary twin shaft pugmill or a mechanical mixer (for road mixing) shall be included. Pneumatic-tire rollers as described in Specification Section 02335 Part 2 and motor graders shall also be included.

PART 3 – CONSTRUCTION REQUIREMENTS

3.01 GENERAL

After the subgrade has been completed as specified in Specification Section 02335, aggregate shall be spread in one or more layers for one or more lane widths as directed by the Owner. It shall not be laid on a subgrade that is frozen or contains frost. Hauling over material already placed will not be permitted until it has been spread, mixed, shaped, and compacted.

3.02 MIXING

If mixing of two or more materials is required, one of the following types of mixing operations may be used:

A. Stationary Plant Method.

The base course material shall be mixed in an approved stationary mixing plant. Water shall be added during the mixing operation in the amount necessary to provide a moisture content satisfactory for compaction.

B. Road Mix Method (Mechanical Mixer).

After the material for the base course has been placed by an aggregate spreader or windrow-sizing device, the material shall be mixed by means of an approved mechanical mixer (for road mixing). Water shall be added during mixing in the amount necessary to provide a moisture content satisfactory for compaction.

C. Road Mix Method (Motor Grader).

1. After the material has been thoroughly mixed, it shall be spread while at the required optimum moisture content by means of approved motor graders.

2. If the required compacted depth of the base course exceeds six (6) inches, the base shall be constructed in two or more layers of approximate equal thickness, unless vibrating or other approved types of special compacting equipment is used. In such cases, the compacted depth of a single layer of base course may be increased to eight (8) inches upon approval by the Owner.

3.03 MANHOLE ADJUSTMENTS

Drainage and sanitary sewer manholes owned by the City shall be adjusted and set at final grade by the contractor as necessary for compliance with the Plans. Adjustments of City owned manholes shall be as specified in Specification Sections 02532 (sewer) and 02634 (drain). Manholes, valve boxes, and other utility structures not owned by the City but within the right-of-way of the Project shall be adjusted as necessary by the owner of such facilities. The Contractor shall be responsible for notifying other owners of any required adjustments and for the accomplishment of that work by the owner of such facilities according to the project schedule.

3.04 SHAPING AND COMPACTION

A. Except where mechanical aggregate spreading equipment is used to place the base material, final shaping of each layer prior to compaction shall be accomplished by motor grader. In the event that mechanical spreading equipment fails to shape the base material properly, final shaping shall be done by motor grader or other approved means.

B. Immediately following spreading and final shaping, each successive layer shall be compacted with pneumatic-tire rollers described under Specification Section 02335 Part 2 and any other types of compacting equipment provided the required density and the required degree of uniformity and smoothness are attained. Compaction shall progress gradually from the edges of the base to the center, parallel with the centerline of the road, and shall continue until the base layer has been compacted to its full width. Where lifts of shoulder materials are placed to confine the base material, the initial pass of the compacting equipment shall overlap the shoulder to a width of not less than twelve (12) inches. In areas where rollers or other standard types of

compacting equipment cannot be used to compact the base due to surface interference of structures or other obstructions, hand operated vibratory equipment shall be used to obtain the required density.

C. Compaction of each layer shall continue until an average dry density of not less than 100 percent of theoretical density based upon 83 percent of a solid volume has been achieved. Further, no individual test shall be less than 97 percent of theoretical density. The density determination will be based on the bulk specific gravity, AASHTO T 84 and T 85 and the dry weight of the aggregate. The compaction of each layer shall be approved before material for the next successive layer is placed. Placing and compacting areas shall be kept separate.

D. Unless otherwise specified, the above described density requirements will not apply to base construction on projects that do not include the construction of a surface upon the base, nor to projects which have a specified total base thickness less than four (4) inches. When the specified density requirements do not apply, the desired degree of compaction will be considered to have been reached when the surface is tightly bound and shows no rutting or displacement under operation of the roller or other construction equipment.

E. At the direction of the Owner, the desired degree of compaction may be considered to have been reached for any graded aggregate base construction when the surface is tightly bound and does not show evidence of pumping under operation of a motor grader and/or there is no rutting or displacement under operation of a roller or other selected construction equipment. The other selected construction equipment used to check the desired degree of compaction for any graded aggregate base shall be a loaded tandem dump truck, with a minimum of ten (10) tons weight. The degree of compaction may be considered to be reached when aggregate base does not show evidence of pumping, rutting or displacement, under the weight of said truck, when driven over the base at slow speed. This is to be done in the presence of the inspector prior to the placement of finished surface.

F. The surface of each layer shall be so constructed that the aggregates become firmly keyed and a uniform texture produced and shall be maintained in that condition until covered by the following stage of construction or until final acceptance of the project. Any irregularities that develop shall be corrected by loosening the material at those places and adding or removing material as required.

G. Approved distributors shall be used to apply water uniformly over the base materials during compaction in sufficient quantity for proper compaction. Softening of the underlying subgrade resulting from use of excess water is to be avoided.

3.05 MAINTENANCE

After construction of the base has been completed satisfactorily, it shall be maintained, under traffic if required, smooth and uniform until covered by the following stage of construction or until the project has been completed and accepted.

3.06 THICKNESS REQUIREMENTS

The thickness of the completed base shall be in conformity with the thickness shown on the Plans. The thickness shall be measured at such frequency as established by the Owner by means of test holes or other approved methods.

3.07 SURFACE REQUIREMENTS

The surface of the finished base shall conform to the lines, grades and cross-sections shown on the Plans or established by the Owner and shall have a satisfactorily smooth riding quality.

PART 4 – MEASUREMENT

4.01 GRADED AGGREGATE BASE COURSE

Measurement will be by the square yard, compacted in place at specified thickness.

4.02 GENERAL

A. Subgrade preparation for the placing of base courses will be considered a part of the work for providing Graded Aggregate Base Course except where gravel for backfill or subgrade stabilization or cement for back fill or subgrade stabilization is required. In such cases, payment will be made in accordance with Specification Section 02335, Payment Items 02335-03 or 02335- 04.

B. Water used for compaction will not be measured for payment since it is considered incidental to the completion of the work.

C. Water for dust control when ordered by the Owner will be measured and paid for in accordance with Specification Section 02335, Payment Item 02335-05

D. Manhole adjustments will be measured and paid for in accordance with Specification Section 02532 (sewer), Payment Item 02532-01 or Specification Section 02634 (drain), Payment Item 02634-01.

PART 5 – PAYMENT

5.01 GRADED AGGREGATE BASE COURSE

The accepted quantities will be paid for at the contract unit price per square yard for the specified thickness, which price will be full compensation for furnishing, mixing, spreading, and compacting the aggregate, complete in place.

5.02 PAYMENT WILL BE MADE UNDER:

Item No.	Pay Item	Pay Unit
02720-01	Graded Aggregate Base Course,	Square Yard
02720-01._____	_____ " Thickness	Square Yard

END OF SECTION 02720

CITY OF MEMPHIS – STANDARD CONSTRUCTION SPECIFICATIONS
SECTION 02730 TEMPORARY SURFACING

PART 1 - SCOPE

This work shall consist of furnishing and placing of Camden gravel, limestone or pit run gravel for use in providing a temporary surface for driveways and entrances to properties where the permanent driveway or entrance surface has been removed and before such surface has been replaced, as well as providing temporary surfaces in the project area at the discretion of the Owner. The work shall be as directed by the Owner to meet conditions encountered at the site.

PART 2 - MATERIALS AND EQUIPMENT

2.01 MATERIALS.

A. Limestone.

Limestone for temporary surfacing of driveways or other areas shall consist of the gradation shown below:

	Total Percent by Dry Weight, Passing Each Sieve (U.S. Standard)				
Size No.	1 ½"	1"	½"	No.4	No. 100
CR-610	100	85 – 100	40 – 75	15 – 40	0 – 10

B. Camden Gravel.

As an alternative to limestone as specified above, gravel known locally as Camden gravel shall be used when directed by the Owner.

C. Pit Run Gravel.

As an alternative to limestone or Camden gravel as specified above, gravel known as pit run gravel shall be used when directed by the Owner. Gradation shall conform to Specification Section 02720 Paragraph 2.01.A.

2.02 EQUIPMENT.

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

PART 3 - CONSTRUCTION REQUIREMENTS

3.01 GENERAL.

A. The area upon which gravel or limestone is to be placed shall be reasonably dry and free of mud, muck, or organic material so as to form a suitable foundation for placement of temporary surfacing material, to the satisfaction of the Owner. The area shall be compacted to 90% modified proctor if it is to remain in place as a base, or 90% standard proctor if it is to remain in place as a subbase. If necessary, unsuitable material shall be removed to a depth as directed by the Owner. This excavation shall be considered incidental to other work and no separate payment will be made.

B. For the area defined to receive aggregate or gravel, the Contractor shall place the specified material in lifts not to exceed 12 inches and to a grade conforming with the adjoining driveway or surfaced area and shall properly compact each lift to provide a dense, unyielding surface suitable for temporary use of the street or driveway.

C. At such time as the project has progressed so that permanent driveway surfacing or pavement is to be placed, the material for temporary surfacing use shall remain in place to serve as base or subbase material, or shall be removed as directed by the Owner. Any removed material shall be the property of the Contractor who shall be responsible for disposing of the material. The removal of such material shall be considered incidental to other work and no separate payment will be made.

PART 4 – MEASUREMENT

4.01 LIMESTONE.
This material will be measured for payment by the ton of material furnished and placed.

4.02 CAMDEN GRAVEL.
This material will be measured for payment by the ton of material furnished and placed.

4.03 PIT RUN GRAVEL.
This material will be measured for payment by the ton of material furnished and placed.

PART 5 – PAYMENT

5.01 LIMESTONE.
The accepted quantities of limestone will be paid for at the contract unit price per ton furnished and placed, which price will be full compensation for removal of unsuitable material, preparation of subgrade, furnishing, placing, and compacting limestone to the required grade, and removal of aggregate form the site, as necessary.

5.02 CAMDEN GRAVEL.
The accepted quantities of Camden gravel will be paid for at the contract unit price per tone furnished and placed, which price will be full compensation for removal of unsuitable material, preparation of subgrade, furnishing, placing, and compacting gravel to required grade, and removal of gravel from the site, as necessary.

5.03 PIT RUN GRAVLE FOR GENERAL USE.
The accepted quantities of pit run gravel for general use will be paid for at the contract unit price per ton furnished and placed, which price will be full compensation for removal of unsuitable material, preparation for removal of subgrade, furnishing placing, and compacting to the required grade, and removal of aggregate from the site, as necessary.

5.04 PAYMENT WILL BE MADE UNDER:

Item No.	Pay Item	Pay Unit
02730-5.01	CR-610 LIMESTONE	Ton
02730-5.02	CAMDEN GRAVEL	Ton
02730-5.03	PIT RUN GRAVEL FOR GENERAL USE	Ton

END OF SECTION 02730

CITY OF MEMPHIS – STANDARD CONSTRUCTION SPECIFICATIONS
SECTION 02740 FLEXIBLE PAVEMENT-DOUBLE SURFACE TREATMENT PAVEMENT

PART 1 – SCOPE

This work shall consist of a bituminous mat composed of mineral aggregate bonded with bituminous material. It shall be constructed on a designated surface in accordance with these Specifications and in conformity with the lines, grades, and cross-sections indicated on the Plans or directed by the Owner.

PART 2 – MATERIALS AND EQUIPMENT

2.01 MATERIALS.

A. Asphalt Cement. Asphalt cement used for this construction shall be cutback asphalt grade RC-800 or as directed by the Owner if this grade is not available. RC-800 asphalt shall be applied between 175° F and 250° F.

B. Aggregate. Aggregate shall be crushed limestone meeting the following gradation requirements:

Percent Passing by Weight

Sieve Size	Mat	Seal
1”	100	-------
¾”	90 - 100	100
½”	20 - 55	90 - 100
3/8”	0 - 15	40 - 70
No. 4	0 - 5	0 - 15
No. 8	-----	0 - 5

C. Alternate Materials. The Owner will designate the alternate grade (s) of bituminous material and mineral aggregate within the limits on the Plans.

2.02 EQUIPMENT.

All equipment necessary for the satisfactory performance of this construction shall be on the Project and approved before work will be permitted to begin. The equipment shall include a power broom, a pressure distributor so designed that bituminous material at even heat may be uniformly applied at controlled widths up to 15 feet at readily controlled rates from 0.05 to 2.0 gallons per square yard with an allowable variation from any specified rate of plus or minus 0.02 gallons per square yard, self-propelled pneumatic tire and steel wheel rollers, aggregate spreading equipment that can be adjusted to spread accurately at the specified rate, and such other equipment and small tools as may be required to perform the work in a satisfactory manner.

PART 3 – CONSTRUCTION REQUIREMENTS

3.01 LIMITATIONS

Bituminous material shall be applied only when the designated surface is dry, firm, and properly cured, and only when the air temperature in the shade away from artificial heat is above 60° F.

3.02 PREPARATION OF DESIGNATED SURFACE

The designated surface upon which double surface treatment pavement is to be constructed shall meet the applicable requirements of Section 02710.4 of these Specifications. The surface shall be thoroughly cleaned of all dirt and other foreign or loose matter prior to the first application of bituminous material. All holes and surface irregularities shall be filled as directed well in advance of the construction.

3.03 MANHOLE ADJUSTMENTS

Drainage and sanitary sewer manholes owned by the City shall be adjusted and set at final grade by the Contractor as necessary for compliance with the Plans. Adjustments of City owned manholes shall be as specified in Section 02532 or 02634 (sewer or drain) of these Specifications. Manholes, valve boxes, and other utility structures not owned by the City but within the right-of-way of the project shall be adjusted as necessary by the owner of such facilities. The Contractor shall be responsible for notifying other owners

of any required adjustments and for the accomplishment of that work by the owner of such facilities according to the project schedule.

3.04 APPLICATION OF BITUMINOUS MATERIAL AND MINERAL AGGREGATE

A. The first application of bituminous material shall be applied by a pressure distributor at a uniform rate of between 0.38 and 0.42 gallons per square yard. The definite rate will be established by the Owner. Beginning and ending areas and areas which are inaccessible to the distributor shall be treated by hand as the Owner may direct.

B. Immediately after the application of bituminous material has been made, it shall be uniformly covered with mat aggregate as specified in Paragraph 2.01 B. of this Specification Section. The aggregate shall be reasonably free of surface moisture. The aggregate shall be spread from trucks equipped with mechanical spreaders at a rate of between 20 and 40 pounds per square yard, as established by the Owner.

C. The second application of bituminous material shall be applied in the same manner as for the first application at a uniform rate of between 0.30 and 0.35 gallons per square yard. The definite rate will be established by the Owner.

D. Seal aggregate as specified in Paragraph 2.01 B. of this Specification Section shall then be spread in the same manner as for the first spread at a rate of between 20 and 25 pounds per square yard, as established by the Owner.

3.05 ROLLING AND CURING

A. Immediately after spreading and brooming the first spread of aggregate, the entire area shall be rolled, beginning at the edges and progressing to the center. Rolling shall begin within 30 minutes after the aggregate has been spread. The initial rolling shall be done with steel-wheel rollers, followed by pneumatic-tire rolling. The amount and sequence of rolling shall be as directed by the Owner.

B. The first application of bituminous material and aggregate shall be allowed to cure for such length of time as deemed necessary by the Owner before the second application is begun. Immediately before the second application of bituminous material, the surface shall be rolled with a steel-wheel roller.

C. The same rolling and curing procedures required in the first application of bituminous material and aggregate shall apply for the second application.

3.06 TRAFFIC AND MAINTENANCE

The Owner will determine when the pavement has cured sufficiently to allow construction equipment, slow moving local traffic, or normal traffic to use the completed surface.

3.07 FINAL CLEANUP

Final cleanup shall include sweeping up all excessive quantities of loose cover aggregate and disposing of this material as directed.

PART 4 – MEASUREMENT

4.01 DOUBLE SURFACE TREATMENT PAVEMENT

Double surface treatment pavement will be measured for payment by the square yard, complete in place.

4.02 GENERAL

Manhole adjustments will be measured and paid for in accordance with Specification Section 02532 (sewer), Payment Item 02532-01 or Specification Section 02634 (drain), Payment Item 02634-01.

PART 5 – PAYMENT

5.01 DOUBLE SURFACE TREATMENT PAVEMENT

Double surface treatment pavement will be paid for at the contract unit price per square yard, which price will be full compensation for furnishing and placing all materials, spreading and rolling, cleaning up and maintaining surface until final acceptance, complete in place.

5.02 PAYMENT WILL BE MADE UNDER:

Item No.	Pay Item	Pay Unit
02740.1-01	Double Surface Treatment Pavement	Square Yard

END OF SECTION 02740

PART 1 – SCOPE

This work shall consist of an asphaltic concrete pavement constructed in one or more layers for surface course(s) and binder course(s). The binder course may also be used as a leveling or bushing course. Binder course shall consist of a hot mixture of aggregate and asphalt prepared in a hot bituminous mixing plant. The binder course shall be constructed on a prepared subgrade, subbase, or base conforming to the lines, grades, thicknesses, and cross-sections shown on the Plans or as directed by the Engineer. The surface course shall consist of an asphaltic concrete pavement composed of a mixture of coarse aggregate, fine aggregate, mineral filler, and asphalt cement, constructed on a prepared roadbed in conformity with the lines, grades, thicknesses, and cross-sections shown on the Plans or directed by the Owner.

PART 2 – MATERIALS AND EQUIPMENT

2.01 MATERIALS

A. Asphalt Cement. Asphalt cement shall conform to the requirements of ASSHTO M 226, Table 2, for the grade specified. Unless otherwise directed, asphalt shall be Viscosity Grade AC-20.

B. Course Aggregate. Course aggregate (aggregate retained on the No. 4 sieve) shall be crushed stone meeting the quality requirements of ASTM D 692 with the following exceptions:

1. Crushed limestone shall have a sodium sulfate soundness loss not exceeding 9 percent.

2. For Mix No. 1, material retained on the No. 4 sieve shall have a maximum of 20 percent elongated pieces (length greater than five times the average thicknesses).

3. For Mix No. 2, the aggregate shall contain no more than 5 percent soft or nondurable particles.

4. For Mix No. 3, the aggregate shall contain no more than 5 percent soft or nondurable particles.

C. Fine Aggregate. The fine aggregate shall consist of natural sand consisting of hard, clean, tough grains which will have a maximum loss of 12 percent when subjected to the sodium sulfate soundness test.

D. Composition of Mixtures.

1. Asphaltic Concrete Surface, Mix No. 1, shall be laid in one course to the thickness shown on the Plans.

2. Asphaltic Concrete Binder, Mix No. 2, shall be laid in one or more courses to the thicknesses shown on the Plans. Mix No. 2 may also be used as a leveling course or bushing course.

3. Asphaltic Concrete Binder, Mix No. 3 shall be laid in one or more courses to the thickness shown on the plans.

4. The composition of the mixes shall be as follows:

	Total Percent Passing by Weight		
Sieve Size	Mix No. 1	Mix No. 2	Mix No. 3
2”	100	100	100

1-1/2”	100	100	90 - 100
3/4”	100	100	65 - 90
3/8”	76 - 96	65 - 95	----------
No. 4	51 - 76	45 - 70	30 - 55
No. 8	36 - 60	25 - 50	20 - 45
No. 30	16 - 40	12 - 30	8 - 25
No. 100	3 - 12	2 - 12	2 - 12
No. 200	2 - 8	1 - 6	1 - 6

5. 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
Mix No. 3, Binder	93.0 – 97.5	2.5 – 7.0

6. 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.

Mix No. 1 – Section 411, Asphaltic Concrete Surface (Hot Mix), Aggregate Grading E.
Mix No. 2 – Section 307, Bituminous Plant Mix Base (Hot Mix), Aggregate Grading C.
Mix No. 3 – Section 307, Bituminous Plant Mix Base (Hot Mix), Aggregate Grading B.

7. For multiple layer construction, succeeding layers shall not be laid until the previous layer has cooled sufficiently to support the construction equipment

8. 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.

2.02 EQUIPMENT

All equipment necessary for the satisfactory performance of this construction shall be on the Project and approved before work will be permitted to begin. The equipment shall meet the requirements of Specification Section 02710.4 Paragraph 2.03.

PART 3 – CONSTRUCTION REQUIREMENTS

3.01 GENERAL

The general construction requirements for surface and binder courses shall be as prescribed in the applicable portions of Specification Section 02710.4 Paragraphs 3.01 – 3.11.

3.02 PREPARATION OF BASE OR EXISTING SURFACE

The designated surface upon which asphalt concrete courses are to be placed shall meet the applicable requirements of Specification Sections 02720, 02710.1, 02710.2, 02710.3, 02710.4 and 02710.5 and be thoroughly cleaned of all dirt and other foreign or loose matter prior to the application of the Tack Coat or Prime Coat, as specified in Specification Section 02710.4 Paragraph 3.03.

3.03 THICKNESS AND SURFACE REQUIREMENTS

Thickness shall be controlled during the spreading operations by frequent measurements taken of freshly spread mixture to establish a relationship between the uncompacted and compacted material. This thickness shall remain in conformity with that specified on the Plans. The surface of all courses shall meet the requirements specified under Specification Section 02710.4, Part 3 "Construction Requirements" and when tested in accordance with the provisions of Specification Section 02710.4 Paragraph 3.10, the deviation of the surfaces from the testing edge of the straightedge shall not exceed 1/4 inch for Mix No. 1 or 3/8 inch for Mix No. 2 and Mix No. 3.

3.04 MANHOLE ADJUSTMENTS

Drainage and sanitary sewer manholes owned by the City shall be adjusted and set at final grade by the Contractor as necessary for compliance with the Plans. Adjustments of City owned manholes shall be as specified in Section 02532 or 02634 (sewer or drain) of these Specifications. Manholes, valve boxes, and other utility structures not owned by the City but within the right-of-way of the project shall be adjusted as necessary by the owner of such facilities. The Contractor shall be responsible for notifying other owners of any required adjustments and for the accomplishment of that work by the owner of such facilities according to the project schedule.

3.05 TRAFFIC AND MAINTENANCE

The Owner will determine when the surface course has sufficient compaction and has cured sufficiently to allow construction equipment, slow moving local traffic, or normal traffic to use the completed surface.

PART 4 – MEASUREMENT

4.01 ASPHALTIC CONCRETE SURFACE AND BINDER COURSES.

The accepted quantities of asphaltic concrete surface Mixes No.1, 2, and 3 will be measured for payment by the square yard in place at specified thickness.

4.02 ASPHALTIC CONCRETE BUSHING COURSE

When Mix No. 2 is used as a "bushing" or leveling course and the thickness cannot be accurately controlled, measurement for payment will be by the ton as determined by weight tickets.

4.03 CONDITIONING OF EXISTING SURFACE, REPLACE WITH MIX NO. 2

When bituminous mixtures are to be placed upon existing concrete or bituminous pavements that require cutting out of the existing street and subgrade as specified in Specification Section 02710.4 Paragraph 3.02, the removed material shall be replaced with asphaltic Mix No. 2. Measurement for payment will be by the ton of asphaltic concrete Mix No. 2 used for replacement material with the weight determined by weight tickets.

4.04 GENERAL

Manhole adjustments will be measured and paid for in accordance with Specification Section 02532 (sewer), Payment Item 02532-01 or Specification Section 02634 (drain), Payment Item 02634-01.

PART 5 – PAYMENT

5.01 ASPHALTIC CONCRETE SURFACE AND BINDER COURSES

The accepted quantities of asphaltic concrete surface Mixes No. 1, 2 and 3 will be paid for at the contract unit price per square yard for the thickness specified which price will be full compensation for all materials, prime coat, tack coat, blotting sand, mixing, hauling, spreading, compacting, and maintaining the surface or binder course until final acceptance, complete in place.

5.02 ASPHALTIC CONCRETE BUSHING COURSE

The accepted quantities of asphaltic concrete Mix No. 2 when used as a "bushing" or leveling course will be paid for at the contract unit price per ton, which price will be full compensation for all materials, prime coat, tack coat, blotting sand, mixing, hauling, spreading, and compaction until acceptance, complete in place.

5.03 CONDITIONING OF EXISTING SURFACE, REPLACE WITH MIX NO. 2

The accepted quantities of asphaltic concrete Mix No. 2 when used to replace unsatisfactory material cut out of the existing street and subgrade as specified in Specification Section 02710.4 Paragraph 3.02 will be paid at the contract unit price per ton, which price shall be full compensation for removal of existing street surface, base, subbase, and subgrade material and for furnishing, placing, and compacting Mix No. 2 until acceptance, complete in place.

5.04 PAYMENT WILL BE MADE UNDER:

Item No.	Pay Item	Pay Unit
02741.01	Asphaltic Concrete Surface and Binder Courses	Square Yard
02741.01.01	Asphaltic Concrete Surface, Mix No. 1 ____ " Thickness	Square Yard
02741.01.02	Asphaltic Concrete Binder, Mix No. 2 ____ " Thickness	Square Yard
02741.01.03	Asphaltic Concrete Binder, Mix No. 3 ____ " Thickness	Square Yard
02741.02	Asphaltic Concrete Bushing Course, Mix No. 2	Ton
02741.03	Conditioning of Existing Surface, Replace with Mix No. 2	Ton

END OF SECTION 02741

CITY OF MEMPHIS – STANDARD CONSTRUCTION SPECIFICATIONS
SECTION 02750 RIGID PAVEMENT- PORTLAND CEMENT CONCRETE

PART 1 – SCOPE

This work shall consist of constructing a pavement of portland cement concrete as specified, on a prepared subgrade or subbase, in accordance with these Specifications and in conformity with the lines, grades and typical cross-sections shown on the Plans or as directed by the Owner.

PART 2 – MATERIALS AND EQUIPMENT

2.01 MATERIALS

A. Concrete. Materials shall meet the requirements of Specification Section 03050 for Portland Cement Concrete Class B.

B. Steel Wire Fabric, Dowel Bars, and Tie Bars

1. Fabric for reinforcement shall conform to ASTM A 185, or as indicated on the Plans.

2. Dowel bars shall be plain and shall conform to the requirements of ASTM A 306, Grade 60. Corrosion resistant coated dowels shall meet the requirements of AASHTO M 254.

3. Tie bars shall be billet steel bars conforming to the requirements of ASTM A 615. Tie bars that are to be bent in the course of construction shall be of such quality that they may be straightened after bending without breaking.

C. Curing Materials

1. Water: Water used in curing portland cement concrete shall be free from any substance which may be injurious to concrete when applied to the surface as a curing agent.

2. Burlap: 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 used.

3. Cotton Mats: Cotton mats shall conform to AASHTO M 73.

4. Waterproof Paper: Paper for curing shall conform to AASHTO M 139.

5. Liquid Membrane – Forming Compounds: These compounds shall conform to AASHTO M 148, Type 2.

6. White Polyethelene Sheeting: This material shall conform to AASHTO M 171.

7. Linseed Oil: Linseed oil emulsion curing compound shall conform to Federal Specification TC 800 A or U.S. Army Corps of Engineers Specification CRD-C-302-68.

D. Preformed Joint Fillers (Nonextruding and Resilient)

1. Preformed fillers for joints shall be of the bituminous type unless otherwise specified on the Plans and, when required, shall be punched to admit dowels. Bituminous type preformed fillers for joints shall conform to the requirements of AASHTO M 213.

2. If nonbituminous types are specified, they shall conform to the requirements of AASHTO M 153, Type 3, unless otherwise specified.

3. The filler for each joint shall be furnished in a single piece for the full depth and width required for the joint unless otherwise allowed by the Owner. When splicing is necessary and authorized, the abutting ends shall be fastened securely and held accurately in position by stapling or other positive fastening satisfactory to the Owner.

E. Chemical Additives

1. Chemical additives such as water reducing, set retarding, set accelerating, or combination admixtures shall conform to the requirements of AASHTO M 194. No chemical additive will be used unless ordered or permitted by the Owner in writing, and no reduction in the cement content of the concrete as designed without chemical additives will be made when additives are permitted.

2. Air-entraining admixtures shall be used as specified in Specification Section 03050.

F. Joint Sealants

1. Type I shall be preformed elastomeric compression joint seals with lubricant adhesives. Seals shall be of the open cell compression type. All materials shall conform to the requirements of AASHTO M 220.

2. Type II sealants shall be hot poured elastic type concrete joint sealer. This sealer shall conform to the requirements of AASHTO M 173 with the following exceptions:

a. The joint sealer shall be a mixture of virgin synthetic rubber or reclaimed rubber or a combination of the two with asphalt and plasticizers and tacifiers.

b. Ground cured rubber scrap shall not be used.

c. The sealer shall be free of foreign material and when melted shall be free of lumps.

d. The Contractor shall furnish the Owner a certified statement showing compliance with the above composition.

3. The flow at 140^{o} F shall not exceed 1.0 centimeter in 5 hours. Ductility at 77^{o} F shall be not less than 40 centimeters, when tested in accordance with AASHTO T 51.

4. The Contractor shall furnish the Owner a certified copy of the test results, showing the batch number, indicating that the material supplied conforms to the requirements of the Specifications.

G. Proportioning

1. Class B concrete for concrete pavement will be a workable, well mixed concrete proportioned in accordance with Specification Section 03050.

2.02 EQUIPMENT

Equipment and tools necessary for handling materials and performing all parts of the Work shall be approved by the Owner as to design, capacity, and mechanical condition. All equipment shall be at the job site sufficiently ahead of the start of construction operations to be examined thoroughly by the Owner and approved.

A. Forms

1. Straight side forms shall be made of metal having a thickness of not less than 7/32 inch and shall be furnished in sections not less than 10 feet in length. Forms shall have a depth at least equal to the prescribed edge thickness of the concrete, without horizontal joint, and a base width equal to not less than the depth of the forms. Flexible or curved forms of the proper radius shall be used for curves. Flexible or curved forms shall be of a design acceptable to the Owner. Forms shall be provided with adequate for secure setting so that

when in place they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Flange braces shall extend outward on the base not less than 2/3 the height of the form. The top face of the form shall not vary from a true plane more than 1/8 inch in 10 feet, and the face of the form shall not vary more than 1/4 inch. The forms shall contain provisions for locking the ends of abutting form sections together tightly and for secure setting. Metal pins shall be of proper size and length to hold the forms rigidly and securely in place.

2. Built-up forms shall not be used except when approved by the Owner and shall have a minimum base width of 8 inches.

3. Forms with battered top surfaces and bent, twisted, or broken forms shall be removed from the Work. Repaired forms shall not be used until inspected and approved by the Owner.

4. The supply of forms, provided and maintained in satisfactory condition, shall not be less than that required for a full day's run.

B. Spreading and Finishing Equipment

1. Mechanical Power-Driven Spreader: Equipment shall include a mechanical power-driven spreader capable of uniformly spreading the concrete in front of the finishing machine. The mechanical finishing machine shall be equipped with at least 2 oscillating type transverse screeds.

2. Vibrators: Vibrators for full width and full depth vibration of concrete paving slabs shall be multiple spuds or other types approved by the Owner. They may be attached to the spreader or the finishing machine or may be mounted on a separate carriage. The frequency of the vibrators shall be that recommended by the manufacturer, subject to approval of the Owner. The Contractor shall furnish the Owner the manufacturer's recommendations for installing and operating the vibrators.

3. Longitudinal Floats: The mechanical longitudinal float shall be of a design approved by the Owner, and shall be in good working condition. It shall be so constructed as to provide for accurate adjustment to the required crown.

4. Bridges: The contractor shall furnish individual bridges as required by the Owner.

5. Finishing Straightedge: Straightedges, not less than 2, with handles at least 3 feet longer than 1/2 the width of the slab, shall be constructed of light metal; shall be not less than 10 feet long; and shall be maintained clean and straight.

6. Straightedge Templates: Straightedge templates, not less than 2, shall be provided for testing the completed surface. They may be of wood or metal; shall not be less than 12 feet long; and shall be maintained clean, straight, and free from warp.

7. Water Supply Equipment: Water supply equipment shall include pumps or tanks mounted on trucks, of adequate capacity to furnish more than sufficient water to accommodate the construction and at the required and necessary pressure. A pipe line appropriate to the requirements of the construction may be used.

8. Small Tools: Small tools, such as edgers, trowels, hand floats, and brushes shall be such as will produce the results required.

9. Special Equipment and Tools: Equipment and tools necessary for the construction of special features as indicated on the Plans shall be such as will produce the results required.

10. Transverse Grooving Equipment: Mechanical transverse grooving equipment shall consist of a steel tine comb with a minimum width of 6 feet, a vibrating beam roller, or other approved devises.

11. Concrete Saw:

a. When sawed joints are elected or specified, the Contractor shall provide sawing equipment adequate in number of units and power to complete the sawing to the required dimensions and at the required rate. The saws shall be equipped with water cooled diamond edge blades or abrasive wheels. Saws used for sawing longitudinal joints shall be equipped with guides to assure proper alignment of the joints.

b. The Contractor shall provide at least one standby saw in good working order. An ample supply of saw blades shall be maintained at the site of the Work at all times during sawing operations. The Contractor shall provide adequate artificial lighting facilities for night sawing. All of this equipment shall be on the job both before and continuously during concrete placement.

C. Slip Form Paver

1. The slip form paver, if used, shall be an approved self-propelled type equipped with a crawler type track of sufficient area to prevent track slippage under load. Length of ground contact per track and arrangement of track units shall be adequate to insure the established straightedge tolerance. When this method of construction is used, all provisions and requirements of the Specifications which are not in conflict shall be applicable.

2. Pavement alignment shall be controlled by means of an electronic sensing device in continuous contact with a sensing guide. The Contractor shall furnish equipment with electronic controls for the vertical adjustment of the paver strike-off and finishing components. Electronic controls, sensing devices, and sensing guides shall be furnished, installed, and maintained at the expense of the Contractor.

3. When a slip form paver is to be used the concrete shall have sufficient cohesion to prevent appreciable slumping of the pavement edges. When the concrete will not meet these requirements, production shall be stopped or slowed, and corrections to the mix shall be immediately made.

4. The slip form paver shall be designed to spread, consolidate, screed, and float finish the concrete in one complete pass of the machine in such a manner that a minimum of hand finishing will be necessary to provide a dense and homogeneous pavement. The machine shall vibrate the concrete for the full width and depth being placed. The vibration shall be accomplished internally by vibrating tubes or arms working in the concrete or with a vibrating screed or pan operating on the surface of the concrete. The slip form paver shall be equipped with forms of sufficient length and rigidity to adequately support the edges of the slab so as to permit any necessary hand finishing and the installation of joints when joints are required.

5. The paver shall be operated with a continuous forward movement, and all operations of mixing, delivering, and spreading the concrete shall be coordinated to provide uniform progress with stopping and starting of the paver held to a minimum. If for any reason it is necessary to stop the forward movement of the paver, the vibratory and tamping elements shall also be stopped immediately.

6. Surface smoothness and texture shall meet the requirements of Specification Section 02750 Paragraphs 3.09 and 3.10 except that a longitudinal straightedge tolerance of 1/4 inch in 10 feet will apply to the area within 6 inches of the edge of the pavement.

7. An edge slump of 1/2 inch will be permitted, except that where additional concrete pavement is to be placed adjacent to the edges the edge slump shall be not more than 1/4 inch.

8. The Contractor shall have available at all times materials for the protection of the edges of the unhardened concrete. Such protective materials shall consist of either standard metal forms or wood plank having a nominal thickness of not less than 2 inches. The depth of the forms of plank shall not be less than the thickness of the pavement. When rain appears imminent, all paving operations shall stop, and all available personnel shall assist in placing forms against the sides of the pavement in addition to placing a covering over the surface of the unhardened concrete.

PART 3 – CONSTRUCTION REQUIREMENTS

3.01 SUBGRADE PREPARATION

Subgrade preparation shall be performed as provided for under Specification Section 02335 Paragraph 3.03.

3.02 CONSTRUCTION OF BASE

Base, when called for on the Plans, shall be constructed in accordance with the provisions of the applicable portions of Specification Sections under 02700, Bases, Ballasts, Pavements, and Appurtenances, and shall be completed not less than 500 linear feet in advance of paving. The Contractor shall construct or correct the base to such grade tolerances as will insure the concrete pavement thickness required. The base grading machine and slip form paver shall be equipped with automatic line (guidance) and grade controls.

3.03 SETTING FORMS

A. Base Support: The foundation under the forms shall be firm and true to grade so that each form, when set, will be firmly in contact for its whole length and at the specified grade. Any grade at the form line found below established grade shall be filled to grade with suitable material in lifts of 1/2 inc or less for a distance of 18 inches on each side of the base of the form and thoroughly compacted. Any grade at the form line found above grade shall be corrected by tamping or by cutting as necessary. Pedestals of earth or other material upon which to rest the forms to bring them to grade will not be permitted.

B. Form Setting: Forms shall be set and approved for the placing of concrete in advance of the point where concrete is being placed as approved by the Owner. After the forms have been set to correct grade, the material supporting the forms shall be thoroughly tamped, mechanically or by hand, at both the inside and outside edges of the base of the forms. Forms shall be staked into place with not less than three pins for each 10 foot section. A pin shall be placed at each side of every joint. Form sections shall be tightly locked and free from play or movement in any directions. The forms shall not deviate from true line by more than 1/4 inch at any point. Forms that settle or spring under the spreading and finishing equipment shall be reset or removed as directed. The top and face of forms shall be cleaned and oiled prior to the placing of concrete.

C. Grade and Alignment: The alignment and grade elevations of the forms shall be checked and corrections made by the Contractor immediately before placing the concrete. When any form has been disturbed or any grade has become unstable, the form shall be reset and rechecked.

3.04 CONDITIONING OF SUBGRADE OR BASE

A. After the forms have been set and approved, the subgrade or base shall be brought to proper grade and cross-section. High areas shall be trimmed. Low areas in subgrade or base may be filled with subgrade or base materials, respectively, and compacted to correspond with the

surrounding areas, except that low areas in cement treated bases shall be filled with concrete integral with the pavement.

B. Unless waterproof cover is specified, the subgrade shall have been previously wetted and shall be in a moist condition at the time of placing concrete. If it subsequently becomes dry previous to the actual placing of the concrete, it shall be sprinkled, but the formation of pools of water shall be avoided. The subgrade shall not be muddy or soft.

C. In addition to all applicable provisions mentioned previously, the slip form method of paving shall required that the subgrade or base be placed and compacted to the required density and to a width beyond the pavement limits sufficient to support all paving equipment. If any traffic is allowed to use the prepared grade, the grade shall be checked and corrected immediately prior to the placing of the concrete.

3.05 MIXING LIMITATIONS AND PLACING CONCRETE

A. Mixing Limitations: Limitations of mixing of concrete due to weather shall be in accordance with the limitations specified in Specification Section 03050 Paragraph 5.02, “Limitations on Concrete Operations”.

B. Placing Concrete

1. The concrete shall be unloaded into an approved spreading device, or deposited on the subgrade or subbase, and spread in such manner as to prevent segregation of the materials. As deposited, the mixture shall be placed where it will require as little re-handling as possible.

2. Placing shall be continuous between transverse joints without the use of intermediate bulkheads. Necessary hand spreading shall be done with shovels or other approved tools. Workmen shall not be allowed to walk in the freshly mixed concrete with boots or shoes coated with earth or other foreign substances.

3. Where concrete is to be placed adjoining a previously constructed lane of pavement and mechanical equipment will be operated upon the existing lane of pavement, that lane shall meet the requirements for opening to traffic stipulated in Specification Section 02750 Paragraph 3.15. If only finishing equipment is carried on the existing lane, paving in adjoining lanes may be permitted after 7 days.

4. Concrete shall be thoroughly consolidated against and along the faces of all forms and along the full length and on both sides of all joint assemblies, by means of vibrators inserted in the concrete. Vibrators shall not be permitted to come in contact with a joint assembly, the grade, or a side form. In no case shall the vibrator be operated longer than 5 seconds in any one location.

5. The use of hand operated vibrators will be permitted. Vibrators mounted on a machine shall be operated only while the machine is in motion.

6. Concrete shall be deposited as near to expansion and contraction joints as possible without disturbing them but shall not be dumped from the discharge bucket or hopper onto a joint assembly unless the hopper is well centered on the joint assembly.

7. Should any concrete materials fall on or be worked into the surface of a completed slab, they shall be removed immediately.

3.06 TEST SPECIMENS

The Contractor shall furnish the concrete necessary for casting test specimens in the field. The Owner will supply all molds and labor necessary to cast and test the specimens. The Owner will designate the

frequency of sampling the fresh concrete. The method of making and curing test specimens will be in accordance with AASHTO T 23. Test cores shall be drilled by the Contractor at his expense if required by the Owner at locations selected by the Owner. When so directed, test cores shall be taken at a rate of one core per unit, with one unit defined as a poured lane or lanes 1,000 feet in length, a street intersection, an interchange ramp, or small areas such as crossovers and entrances of 1,000 square yards or less.

3.07 STRIKE-OFF OF CONCRETE AND STEEL FABRIC PLACEMENT

A. Following the placing of the concrete, it shall be struck off to conform to the cross-section shown on the Plans and to an elevation such that when the concrete is properly consolidated and finished, the surface of the pavement will be in conformity with the elevation shown on the Plans or established by the Owner. When steel fabric reinforced concrete pavement is placed in 2 layers, the entire width of the bottom layer shall be struck off to such length and depth that the sheet of fabric may be laid full length on the concrete in its final position without further manipulation. The steel fabric shall be placed in strips transversely with the roadway at the depth and with the lap shown on the Plans. The fabric shall extend to within 2 inches of the ends and sides of the slab. The reinforcement shall be placed directly upon the concrete, after which the top layer of the concrete shall be placed, struck off, and screeded. Any portion of the bottom layer of concrete which has been placed more than 30 minutes without being covered with the top layer shall be removed and replaced with freshly mixed concrete at the Contractor's expense.

B. Reinforcing steel fabric shall be free from dirt, oil, paint, grease, mill scale, and loose or thick rust which could impair bond of the steel with the concrete.

3.08 JOINTS

A. Joints shall be constructed of the type and dimensions and at the locations required by the Plans and in accordance with the provisions of these Specifications.

B. Longitudinal joints shall be perpendicular to the pavement surface and shall be along or parallel to the centerline of the pavement, unless otherwise specified. Transverse joints shall be straight, perpendicular to the pavement surface and, unless otherwise specified, shall be at right angles to the centerline of the pavement.

C. Longitudinal Joints

1. Deformed steel tie bars of specified length, size, spacing, and materials shall be placed across and perpendicular to the longitudinal joints. They shall be placed by approved mechanical equipment or rigidly secured by chars or other approved supports to prevent displacement.

2. When adjacent lanes of pavement are constructed separately, a keyway shall be formed along the construction joint of the first lane constructed by the use of one of the alternate metal center strip types as detailed on the Plans, or as directed by the Owner. Tie bars may be bent at right angles against the form and straightened into final position before the concrete of the adjacent lane is placed, or they may be placed in holes drilled through the forms. Construction joints shall be tooled to a 1/4 inch radius during finishing operations and later sawed as detailed on the Plans or as directed by the Owner.

3. Longitudinal sawed joints shall be cut by means of approved concrete saws to the depth, width, and line shown on the Plans, or as directed by the Owner, not later than 10 days after placing concrete and before any equipment or vehicles are allowed on the pavement.

4. Inserts that are to be sawed shall be an approved rigid material of the thickness and width shown on the Plans or as directed by the Owner, with a length equal to one-half the

pavement width for transverse joints and not less than 10 feet for longitudinal joints. Insert material that cracks, shatters, warps during installation, or that leaves a residue from sawing that will prevent seal material from adhering to the concrete will not be acceptable.

5. After the concrete has sufficiently set, the insert shall be sawed to the width and depth shown on the Plans or as directed by the Owner, leaving the remainder of the insert in place.

6. Immediately after sawing, all longitudinal contraction and construction joints shall be thoroughly cleaned of all residue by flushing with water under pressure.

7. As an alternate to sawing, the longitudinal contraction joints may consist of forming the joints by placing a permanently installed continuous strip of polyethylene sheeting having a minimum thickness of 10 mils (0.010 inches) and a width equal to 1/3 of the total thickness of portland cement concrete being placed. The joint material shall be such that it will not react adversely with the chemical constituents of the concrete.

8. The joint insert material shall be such that when placed perpendicular to the pavement surface, it will not bond with the concrete and will form an effective weakened plane joint of the specified depth. The joint material shall be inserted with an approved mechanical device that places the material in a continuous strip, except where intervening structures break the continuity of paving. Splices in the joint material will be permitted provided they are effective in maintaining the continuity of the joint material as placed. The joint material shall be placed in such manner that the top of the strip is not more than 1/4 inch below the finished surface of the concrete. The joint material shall not be deformed from a position perpendicular to the surface, either in the installation or in subsequent finishing operations performed on the concrete. The mechanical installation device shall vibrate the concrete during placing the strip sufficiently to cause the concrete to flow evenly about the joint material producing homogeneous concrete free of segregation and rock pockets or voids. The alignment of the finished joint shall meet the approval of the Owner.

D. Transverse Expansion Joints

1. Dowels shall be prepared and placed across transverse expansion joints as indicated on the Plans or as directed by the Owner.

2. Dowels shall be held in position, parallel to the surface and centerline of the slab, by an approved metal device that is left in the slab. Dowels that are not corrosion resistant shall be painted with on coat of approved primer. When the paint has dried and immediately before placing the dowel in position, the dowel shall be thoroughly coated with a thick film of heavy grease. Bond breaker for corrosion resistant dowels shall be a s recommended by the coating manufacturer. One end of each dowel shall be covered with a close fitting, closed end metal sleeve, no less than 4 inches long, with a flange or other approved device to separate the end of the sleeve and the end of the dowel during the placing of the concrete so that a space of not less than the proposed thickness of the joint plus 1/4 inch will be provided for subsequent movement of the dowel in the sleeve. The type of metal sleeve to be used on the dowel bars shall meet the approval of the Owner. Dowels shall have ends free from burrs and distortions.

3. Transverse expansion joints shall be of the kind and type shown on the Plans or as directed by the Owner. When pre-molded joint filler is used, it shall be installed by the use of one of the alternate expansion joint and dowel assembly devices shown on the Plans, or other approved expansion joint assemblies may be used. The installing device shall have a length 1/2 inch less than the width of the slab. Assemblies shall be a rigid metal device capable of holding dowels and filler firmly in position during the entire construction operation and shall remain in place. The top of the filler shall be set below the surface of the proposed slab to accommodate the type sealant specified, as detailed on the Plans or directed by the

Owner. When in position, the filler shall be perpendicular to the surface of the slab. The top edge of the filler shall be protected, while the concrete is being placed, by an approved metal channel cap. The assembly device may be designed with this cap self-contained.

E. Transverse Contraction Joints

1. Transverse contraction joints shall be placed at the intervals specified and shall be of the plain sawed groove or insert and sawed groove type, as detailed on the Plans or as directed by the Owner and in accordance with these Specifications.

2. Formed contraction joints shall not be used unless specified or required by the Owner to control random cracking. Unless otherwise directed or shown on the Plans, all joints shall be at right angles to the centerline of the pavement and perpendicular to the surface. When called for on the Plans or directed by the Owner, contraction joints shall include load transfer assemblies.

3. In lieu of using dowel assemblies at contraction joints, dowel bars may be placed in the full thickness of pavement by a mechanical device approved by the Owner.

4. Sawed Contraction Joints

a. Sawed contraction joints shall be made by sawing grooves in the surface of the pavement of the dimensions shown on the Plans.

b. Sawing of the joints shall commence as soon as the concrete has hardened sufficiently to permit sawing without excessive raveling – usually 6 to 12 hours. All joints shall be sawed before uncontrolled shrinkage cracking takes place. If necessary, the sawing operations shall be carried on both day and night, regardless of weather conditions. The sawing of any joint shall be omitted if a crack occurs at or near the joint location prior to the time of sawing. The sawing of a joint shall be discontinued when a crack develops ahead of the saw. In general, all joints shall be sawed in sequence.

c. All contraction joints in lanes adjacent to previously constructed lanes shall be sawed before uncontrolled cracking occurs. If extreme conditions exist which make it impractical to prevent erratic cracking by early sawing, a contraction joint groove shall be formed at intervals of every third or fourth joint or as often as required prior to initial set of concrete as provided for under paragraph 4.d below. Immediately after sawing, the joints shall be thoroughly cleaned of all residue by flushing with water under pressure.

5. Transverse Contraction Joints: Transverse contraction joints made by the insert and sawed groove method shall comply with the applicable requirements of Specification Section 02750 Paragraph 3.08 C for the longitudinal contraction joint.

6. Formed Contraction Joints: Formed contraction joints shall be formed during the placing of the concrete. These joints shall be formed by placing inserts in the plastic concrete, at right angles to the centerline of the pavement and perpendicular to the surface. When the concrete has attained its initial set and after the joint has been carefully finished, the insert shall be removed. The groove so formed shall maintain its full width and depth as shown on the Plans, and the pavement at the joint shall meet surface requirements.

F. Transverse Construction Joints

1. Transverse construction joints shall be constructed as detailed on the Plans. Grooves shall be formed by one of the methods specified under Paragraph 3.08 E.4 or E.5 of this Specification Section. The joints shall be constructed when there is an interruption of more than 30 minutes in the concreting operations. No transverse joint shall be constructed within

10 feet of an expansion joint, contraction joint, or plane of weakness. If sufficient concrete has not been mixed at the time of interruption to form a slab at least 10 feet long, the excess concrete back to the last preceding joint shall be removed and disposed of as directed.

G. Expansion Joints at Structures

1. Expansion joints shall be formed about all structures and features projecting through, into, or against the slab by the use of pre-molded joint filler. Unless otherwise indicated such joints shall be 1/2 inch in width.

3.09 FINAL STRIKE-OFF, CONSOLIDATION AND FINISHING

A. Sequence

1. The sequence of operations shall be the strike-off and consolidation, floating and removal of laitance, straightedging, and final surface finish.

B. Finishing at Joints

1. The concrete adjacent to joints shall be compacted or firmly placed without voids or segregation against the joint material and under and around all load transfer devices, joint assembly units, and other features designed to extend into the pavement.

2. After the concrete has been placed and vibrated adjacent to the joints as required in Specification Section 02750 Paragraph 3.05, the finishing machine shall be brought forward, operating in a manner to avoid damage or misalignment of joints. If uninterrupted operation of the finishing machine, to, over, and beyond the joints causes segregation of concrete, damage to, or misalignment of the joints, the finishing machine shall be stopped when the front screed is approximately 8 inches from the joint. Segregated concrete shall be removed from in front of and off the joint; the front screed shall be lifted and set directly on top of the joint, and the forward motion of the finishing machine resumed. When the second screed is close enough to permit the excess mortar in front of it to flow over the joint, it shall be lifted and carried over the joint. Thereafter, the finishing machine may be run over the joint without lifting the screeds, provided there is no segregation in the concrete immediately between the joint and the screed or on top of the joint.

C. Machine Finishing.

1. The concrete shall be distributed or spread as soon as placed. As soon as the concrete has been spread, it shall be struck off and screeded by an approved finishing machine meeting the requirements specified under Specification Section 02750 Paragraph 2.02 B. When the pan-float finisher combination machine is used for finishing the pavement, longitudinal floats will not be required. The machine shall go over each area of pavement as many times and at such intervals as necessary to give the proper compaction and to leave a surface of uniform texture. Excessive operation over a given area shall be avoided. The tops of the forms shall be kept clean by an effective device attached to the machine, and the travel of the machine on the forms shall be maintained true without lift, wobbling, or other variation tending to affect the precision finish.

2. During the first pass of the finishing machine, a uniform roll of concrete shall be maintained ahead of the front screed for its entire length. The moving of rolls of concrete in excess of 6 inches with the finishing machine will not be permitted.

3. Vibrators, for full width and depth vibration of concrete paving slabs, shall meet the requirements specified in Specification Section 02750 Paragraph 2.02 B. If uniform and satisfactory density of the concrete is not obtained by the vibratory method at joints, along

forms, at structures, and throughout the pavement, the Contractor will be required to furnish equipment and methods which will produce satisfactory work.

D. Hand Finishing

1. Unless otherwise specified, hand finishing methods will not be permitted except under the following conditions:

a. In the event of breakdown of the mechanical equipment, hand methods may be used to finish the concrete already deposited on the grade when the breakdown occurs.

b. Ramps and variable width sections, where the use of finishing machines is impractical, may be finished by hand methods.

2. When hand finishing is permitted, the concrete as soon as placed shall be struck off and screeded. The screed shall be at least 2 feet longer than the maximum width of the slab to be struck off. It shall be of approved design and sufficiently rigid to retain its shape.

3. Consolidation shall be attained by the use of a suitable vibrator and other approved equipment.

4. Screeding shall be repeated until the surface is of uniform texture, true to grade and cross-section, and free from porous areas.

E. Floating

1. After the concrete has been struck off and consolidated, it shall be further smoothed, trued, and consolidated, using one of the following methods as specified or permitted:

a. Hand Method: When hand finishing is permitted as provided for under Specification Section 02750 Paragraph 3.09 D, the Contractor shall use equipment and methods approved by the Owner.

b. Mechanical Method: The mechanical float described under Specification Section 02750 Paragraph 2.02 B.3 shall be used unless otherwise specified. The tracks from which the float operates shall be accurately adjusted to the required cross-section. The float shall be accurately adjusted and coordinated with the adjustments of the transverse finishing machine so that a small amount of mortar is carried ahead of the float at all times. The forward speed shall be adjusted so that the float will lap the distance specified by the Owner on each transverse trip. The float shall pass over each area of pavement at least two times, but excessive operation over a given area will not be permitted. Any excess water or soupy material shall be wasted over the side forms on each pass. After floating, any excess water and laitance shall be removed from the surface of the pavement by a straightedge 10 feet or more in length. Successive drags shall be lapped one-half the length of the blade.

F. Straightedge Testing and Surface Correction

1. After the floating has been completed and the excess water removed, but while the concrete is still plastic, the surface of the concrete shall be tested for trueness. For this purpose the Contractor shall furnish and use and accurate metal straightedge, not less than 10 feet in length, swung from handles at least 3 feet longer than one-half the width of the slab. The straightedge shall be held in contact with the surface in successive positions parallel to the road centerline, and the whole area gone over from one side of the slab to the other as necessary. Advance along the road shall be in successive stages of not more than one-half the length of the straightedge. Any depressions found shall be immediately filled

with freshly mixed concrete, struck off, consolidated, and refinished. High areas shall be cut down and refinished. Special attention shall be given to assure that the surface across joints meets the requirements for smoothness. Straightedge testing and surface corrections shall continue until the entire surface is found to be free from observable departures from the straightedge and the slab conforms to the required grade and cross-section.

2. When in the opinion of the Owner, superficial water is required to assist in finishing, it shall be applied by lightly fogging.

3. Straightedging shall be followed by belting with an approved belt or hose. Belts shall not be permitted to rest on the pavement.

G. Final Finish

1. The surface texture shall be a burlap drag finish. The drag shall consist of a seamless strip of damp burlap which, when dragged longitudinally along the full width of pavement, will produce a uniform surface of gritty texture. For pavement 24 feet or more in width, the drag shall be mounted on a bridge. The dimensions of the drag shall be such that a strip of burlap at least 3 feet wide is in contact with the full width of pavement surface while the drag is used. The drag shall consist of not less than 2 layers of burlap with the bottom layer approximately 6 inches wider than the upper layer. The drag shall be maintained in such condition that the resultant surface is of uniform appearance and reasonably free from grooves over 1/16 inch in depth. Drags shall be maintained clean and free from encrusted mortar. Drags that cannot be cleaned shall be discarded and new drags substituted.

2. After the pavement has been finished by the burlap drag, the surface shall be textured by the formation of transverse grooves. The transverse grooves shall be formed by mechanical equipment using a comb made of steel tines, vibrating beam roller, or other approved device. Manual tools such as rakes with spring steel tines may be used on areas inaccessible to mechanical equipment.

3. The grooves shall be formed in the concrete at an appropriate time during the setting of the concrete mixture, so that in the hardened concrete, the grooves will be between 0.09 inch and 0.13 inch in width, between 0.12 inch and 0.19 inch in depth, and will be spaced at random intervals between 0.3 inch and 1.0 inch.

4. Regardless of the method used to form the grooves, the grooves shall be relatively smooth and uniform and shall be formed without excessive tearing of the surface or without bringing pieces of the coarse aggregate to the top of the surface.

5. In the event of mechanical failure or equipment breakdown, manual tools may be used for grooving, provided all placing operations cease until proper repairs are made.

6. Any individual areas of 50 square yards or larger of the hardened grooved concrete which do not conform to these requirements shall be corrected at the Contractor's expense, by the cutting of acceptable grooves in the hardened surface with an approved cutting machine, or by other approved methods.

H. Edging at Forms and Joints

1. After the final finish, but before the concrete has taken its initial set, the outside edges of the pavement shall be rounded to a 3/4 inch radius. When pavement is formed along a lane line, the edges shall be rounded to a 1/4 inch radius. The edges of the pavement on each side of transverse expansion joints, formed joints, and transverse construction joints shall be rounded to a 1/4 inch radius. Edging shall be performed with an approved edging tool which

will produce a well defined and continuous radius. All tool marks formed by the edging tool shall be eliminated by brushing to form a texture similar to the burlap drag finish.

3.10 SURFACE TEST

A. As soon as the concrete has hardened sufficiently, the pavement surface shall be tested with a 12 foot steel straightedge provided by the Contractor or other specified device. When the straightedge is placed parallel to the centerline of the pavement, the surface shall not vary more than 1/8 inch from the lower edge of the straightedge. Areas showing high spots of more than 1/8 inch, but not exceeding 1/2 inch in 12 feet, shall be marked and immediately ground down with an approved grinding tool to an elevation where the area will not show surface deviations in excess of 1/8 inch when tested with a 12 foot straightedge. The ground area shall then be sealed with an epoxy resin system meeting the requirements of AASHTO M 200, Class I, as approved by the Owner. Grinding and sealing shall be at the Contractor's expense. Where surface deviation exceeds 1/2 inch, the pavement shall be removed and replaced by and at the expense of the Contractor.

B. Any area or section removed shall be not less that 10 feet in length nor less than the full width of the lane involved. When it is necessary to remove and replace a section of pavement, any remaining portion of the slab adjacent to the joints that is less than 10 feet in length shall also be removed and replaced.

3.11 CURING

A. In all cases in which curing requires the use of water, the curing shall have prior right to all water supply or supplies. Failure to provide a sufficient quantity of one of the curing materials described under Specification Section 02750 Paragraph 2.01 C or lack of water to adequately take care of both curing and other requirements shall be cause for immediate suspension of concreting operations. The concrete shall not be left exposed for more than one-half hour between stages of curing or during the curing period. Immediately after the finishing operations have been completed and as soon as marring of the concrete will not occur, the entire surface of the newly placed concrete shall be covered and cured in accordance with one of the following methods.

1. Cotton or Burlap Mats: The surface of the pavement shall be entirely covered with mats. The mats used shall be of such length (or width) that, as laid, they will extend at least twice the thickness of the pavement beyond the edges of the slab. The mats shall be placed so that the entire surface and both edges of the slab are completely covered. Prior to being placed, the mats shall be saturated thoroughly with water. The mats shall be so placed and weighted down as to cause them to remain in intimate contact with the surface covered, and the covering shall be maintained fully wetted and in position for 72 hours after the concrete has been placed unless otherwise specified.

2. Waterproof Paper: The top surface and sides of the pavement shall be entirely covered with waterproofed paper. The units shall be lapped at leas 18 inches. The paper shall be so placed and weighted down as to cause it to remain in intimate contact with the surface covered. The paper shall have such dimensions that each unit as laid will extend beyond the edges of the slab at least twice the thickness of the pavement, or it shall be of pavement width with 3 foot strips of paper for the edges. If laid longitudinally, paper not manufactured in sizes which will provide this width shall be cemented together in such a manner that the joints do not open up or separate during the curing period. Unless otherwise specified, the covering shall be maintained in place for 72 hours after the concrete has been placed. The surface of the pavement shall be thoroughly wetted prior to the placing of the paper.

3. Impervious Membrane Method

a. The entire surface of the pavement shall be sprayed uniformly with white pigmented curing compound immediately after the finishing of the surface and before the set of the concrete has taken place, or if the pavement is cured initially with jute or cotton mats, it may be applied upon removal of the mats. The curing compound shall not be applied during rainfall.

b. Curing compound shall be applied under pressure by mechanical sprayers at the rate recommended by the manufacturer but in no case at a rate less than one gallon to each 150 square feet. The spraying equipment shall be of the fully atomizing type equipped with a tank agitator. At the time of use, the compound shall be in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle. During application, the compound shall be stirred continuously by effective mechanical means. Hand spraying of odd widths or shapes and concrete surfaces exposed by the removal of forms will be permitted. Curing compound shall not be applied to the inside faces of joints to be sealed. Should the film become damaged from any cause within a 72 hour curing period, the damaged portions shall be repaired immediately with additional compound.

c. Upon removal of side forms, the sides of the slabs exposed shall be protected immediately by applying curing treatment equal to that provided for the surface.

4. White Polyethylene Sheeting: The top surface and sides of the pavement shall be entirely covered with polyethylene sheeting. The units used shall be lapped at least 18 inches. The sheeting shall be so placed and weighted down as to cause it to remain in intimate contact with the surface covered. The sheeting as prepared for use shall have such dimension that each unit as laid will extend beyond the edges of the slab at least twice the thickness of the pavement. The surface of the pavement shall be thoroughly wetted prior to placing the sheeting. Unless otherwise specified, the covering shall be maintained in place for 72 hours after the concrete has been placed.

5. Curing in Cold Weather

a. Concrete pavement that is placed during cold weather, when the air temperature in the shade, away from artificial heat, is or may be expected to drop below 35^{o} F, shall be protected by suitable blanket material placed over the surface and sides of the slab to sufficient depth to prevent freezing of the concrete. Care shall be taken during application of the blanket material not to mar the surface of the concrete. The period of time such protection shall be maintained shall be not less than 5 days.

b. The Contractor shall be responsible for the quality and strength of concrete laid during cold weather, and any concrete injured by freezing action shall be removed and replaced at this expense.

3.12 REMOVING FORMS

A. Forms may be removed at any time that removal does not cause damage to the slab edges. The forms shall be removed carefully so as to avoid damage to the pavement. After the forms have been removed, the sides of the slab shall be cured as outlined in one of the methods indicated above. Major honeycombed areas will be considered as defective work, and all unsound material shall be removed and replaced with satisfactory material at the Contractor's expense.

3.13 SEALING JOINTS

A. Joints shall be sealed with one of the joint sealing materials specified in Specification Section 02750 Paragraph 2.01 F before the pavement is opened to traffic and as soon after completion of

the curing period as is feasible. The pavement temperature shall be that recommended by the manufacturer of the sealant. Just prior to sealing, each join shall be thoroughly cleaned of all foreign material, including membrane curing compound, by sandblasting. The joint faces shall be clean and dry when the seal is applied. The sealant shall be applied to the joint immediately after cleaning.

B. The sealing material shall be applied to each joint opening to conform to the details shown on the Plans or as directed by the Owner. The sealing shall be done in such manner that material will not be spilled on the exposed surface of the concrete. Any excess material on the surface of the concrete pavement shall be removed immediately and the pavement surface cleaned.

C. Sealing material that does not bond to the concrete shall be removed, and the joint recleaned and resealed to the Contractor's expense.

D. All random cracks shall be reamed with a suitable tool and filled with an approved liquid joint sealant.

3.14 PROTECTION OF PAVEMENT

A. The Contractor shall protect the pavement and its appurtenances against both public traffic and traffic caused by his own employees and agents. This shall include watchmen to direct traffic and the erection and maintenance of warning signs, barricades, lights, pavement bridges or crossovers.

B. Any damage to the pavement occurring prior to final acceptance shall be repaired or the pavement replaced at the Contractor's expense.

3.15 OPENING TO TRAFFIC

The Owner will determine when the pavement will be opened to traffic. The pavement will not be opened to traffic until test specimens have attained the strength specified in Specification Section 03050. If such tests are not conducted, the pavement shall not be opened to traffic until 14 days after the concrete is placed. Prior to opening to traffic, the pavement shall be cleaned and all joints shall be sealed.

3.16 MANHOLE ADJUSTMENTS

Drainage and sanitary sewer manholes owned by the City shall be adjusted and set at final grade by the Contractor as necessary for compliance with the Plans. Adjustments of City owned manholes shall be a specified in Specification Section 02530 or 02630 as appropriate. Manholes, valve boxes, and other utility structures not owned by the City but within the right-of–way of the project shall be adjusted as necessary by the owner of such facilities. The Contractor shall be responsible for notifying other owners of any required adjustments and for the accomplishment of that work by the owner of such facilities according to the project schedule.

3.17 TOLERANCE IN PAVEMENT THICKNESS

Deficiencies in pavement thickness will be determined and payment made in accordance with the provisions of Specification Section 02710.3 Paragraph 3.06, "Tolerance in Base Thickness".

PART 4 – MEASUREMENT

4.01 PORTLAND CEMENT CONCRETE PAVEMENT

Concrete pavement will be measured by the square yard, in place at specified thickness.

4.02 GENERAL

A. Dowel bars and assembly devices, reinforcing fabric, tie bars, curing materials, joint fillers, preparing and sealing joints, and any chemical additives used will not be measured for payment, as these items are considered incidental to the work.

B. Manhole adjustments will be measured and paid for in accordance with Pay Item 02530-01 or 02630-01.

PART 5 – PAYMENT

5.01 PORTLAND CEMENT CONCRETE PAVEMENT

Cement concrete pavement will be paid for at the contract unit price per square yard, which price will be full compensation for preparing the subgrade, forming, furnishing, consolidating, curing the concrete, provision of all items identified in Specification Section 02750 Paragraph 4.02, and maintaining the pavement until final acceptance, complete in place.

5.02 PAYMENT WILL BE MADE UNDER:

Item No.	Pay Item	Pay Unit
02750-01	Portland Cement Concrete Pavement	Square Yard
02750-01.____	_____ " Thickness	Square Yard

END OF SECTION 02750

CITY OF MEMPHIS – STANDARD CONSTRUCTION SPECIFICATIONS
SECTION 02770 CURB, CURB AND GUTTER, AND WATER TABLE

PART 1 – SCOPE

1.01 This work shall consist of constructing concrete curb, concrete curb and gutter, asphalt curb, and concrete water table in conformity with the lines, grades, and dimensions shown on the Plans or directed by the Owner

PART 2 – MATERIALS AND EQUIPMENT

2.01 MATERIALS

A. Concrete Materials: Concrete materials shall meet the requirements of Specification Section 03050, Portland Cement Concrete for Class A concrete, except for special mix for use with approved curb machines as approved by the Owner.

B. Curb Dowel Bars: If specified, curb dowel bars shall be deformed billet steel bars conforming to the requirements of ASTM A 615.

C. Asphaltic Concrete For Curbs: Asphaltic concrete for curbs shall be Mix No. 1 as specified in Specification Section 02741 Paragraph 2.01 D. Other gradations which have a history of satisfactory performance may be used when approved by the Owner.

D. Curing Materials: Curing materials shall conform to the applicable provisions of Specification Section 02750 Paragraph 2.01C.

E. Preformed Joint Fillers: Preformed joint fillers shall be of the bituminous type and shall conform to the requirements of AASHTO M 213 and shall not be less than 1/2 inch or more than 1 inch in thickness. For water table slab, their width shall be at least equal to the full thickness of the water table slab and their length shall be sufficient to eliminate any splicing. For curbs and curb and gutter, they shall be precut to the full cross-section of the concrete.

2.02 EQUIPMENT

Equipment for this work shall conform to the requirements of Specification Section 02775 Paragraph 2.02. When concrete or asphalt curb machines are used, the necessary special tools required for satisfactory curb machine work shall also be included. All equipment necessary for the satisfactory performance of this construction shall be on the Project and approved before work will be permitted begin.

PART 3 – CONSTRUCTION REQUIREMENTS

3.01 EXCAVATION AND SUBGRADE PREPARATION

All major excavation for curb and gutter or water table construction shall be performed under other Sections of these Specifications. Only the final grade preparation for this Work shall be included in this Section, will be considered incidental to the work, and shall be performed in accordance with the applicable provisions of Specification Section 02775 Paragraph 3.01 or to the satisfaction of the Owner.

3.02 CURBS

Portland cement concrete curbs shall be constructed to the dimensions shown on the Plans and Design Standards. Dowels, if specified, shall be 1/2 inch deformed steel bars conforming to the length and spacing shown on the Plans and will be considered incidental to the Work. Asphaltic Concrete Curbs, when specified, shall conform to the lines, grades, and typical cross-section shown on the Plans and the Work shall be in accordance with Section 715 of the Tennessee Department of Transportation's Standard Specifications for Roads and Bridges.

3.03 FORMS

A. Forms for Portland cement concrete curbs shall conform to the requirements of Specification Section 02775 Paragraph 2.02. Bracing and staking of forms shall be such that the forms remain in both horizontal and vertical alignment until their removal.

B. Forms for curb and gutter and water table shall conform to the applicable provisions of Specification Section 02775 Paragraphs 2.02 and 3.02. The forms for combination curb and gutter and back forms for water table shall have readily detachable face forms held in place by 1/8 inch thick templates. The templates shall have lugs or other devises to hold them in position during placing of concrete and be of such design to permit removal without causing damage to the concrete. The templates, unless otherwise specified on the Plans, shall be spaced so as to form sections having uniform lengths of 10 feet except where reduced to a minimum of 6 feet when necessary for closures.

3.04 JOINTS

Three-fourths inch thick expansion joints in curb and curb and gutter shall be placed at intervals shown on the Plans but shall not exceed 40 foot maximum spacing . Dummy joints shall be installed at 10 feet on center.

3.05 PLACING AND FINISHING CONCRETE

The work shall be performed in accordance with the applicable provisions of Specification Section 02775 Paragraph 3.04, or as directed by the Owner.

3.06 TESTING CONCRETE

Concrete for curbs, curb and gutter, and water table shall be tested in accordance with the provisions of Specification Section 02775 Paragraph 3.05.

3.07 CURING AND PROTECTION

Curing and protection shall be performed in accordance with the applicable provisions of Specification Section 02775 Paragraph 3.06.

3.08 USE OF CURB MACHINES

A. Extruding type curb machines for Asphaltic concrete curbs or portland cement concrete curbs or curbs and gutters may be used if approved by the Owner. The molds shall be so constructed as to produce the desired cross-section and so that the thrust against the extruded material will eliminate objectionable surface voids as the material passes through the mold.

B. When portland cement concrete curb or curb and gutter is placed by curb machines, finishing shall be performed as specified above except that dummy or construction joints may be sawed at specified intervals in lieu of constructing the curb or curb and gutter in sections as stipulated in Specification Section 02770 Paragraph 3.04.

3.09 WATER TABLE

A. Water tables, unless otherwise shown on the Plans, shall be constructed in accordance with the Plans and Design Standards for concrete water table.

B. The concrete curb, gutter, and 8” concrete slab shall be monolithic for each unit. A unit consists of the construction at the turning radius at any one corner of two intersecting streets and within the limits as shown on the Plans. The 8 foot wide x 8 inch deep invert between the radius slabs shall be a monolithic pour. Measurement for payment of the water table will begin outside of the front edge of the gutter on the approaches to the intersection. For example, the curb and 2 feet of standard 6-30 curb and gutter will be paid for as Curb and Gutter for the distance around the turning radius with the balance of the concrete slab being measured and paid for as concrete water table. One inch expansion joints shall be placed between the invert section and the radii unit. The flow lines of the gutters shall be maintained across the intersection.

C. No formed or sawed dummy or contraction joints shall be placed in the radius curb.

D. The portland cement concrete inverts across the traveled portion of approaching streets shall be constructed to the grade and invert depth shown on the Plans or as directed by the Owner. Portland cement concrete inverts shall have a 1 inch expansion joint at each end where they abut the monolithic radius slab.

3.10 MISCELLANEOUS
The location of all driveways, curb inlets, or other openings to be left in curb and gutter will be staked by the Owner, and no additional compensation will be allowed other than for actual quantities of curb and gutter constructed.

PART 4 – MEASUREMENT

4.01 CONCRETE CURB
Concrete curb of the dimensions specified will be measured for payment by the linear foot along the face of the curb, complete in place.

4.02 6-30 CONCRETE CURB AND GUTTER
6-30 Concrete Curb and Gutter will be measured for payment by the linear foot along the face of the curb, complete in place.

4.03 6-18 MEDIAN CONCRETE CURB AND GUTTER
6-18 Median Concrete Curb and Gutter will be measured for payment by the linear foot along the face of the curb, complete in place.

4.04 VALLEY GUTTER
Valley gutter will be measured for payment by the linear foot along the gutter line, complete in place.

4.05 CONCRETE WATER TABLE
Eight inch (8”) thickness Concrete Water Table will be measured for payment by the square foot, complete in place within the limits described in Specification Section 02770 Paragraph 3.09.

4.06 ASPHALTIC CONCRETE CURB
Asphaltic Concrete Curb will be measured for payment by the linear foot along the face of the curb, complete in place.

4.07 GENERAL
No payment will be made for preformed joint filler material or curb dowel bars as they are considered incidental to the Work.

PART 5 – PAYMENT

5.01 CONCRETE CURB
The accepted quantities of Concrete Curb will be paid for at the contract unit price per linear foot for the size specified, which price will be full compensation for preparing the base; forming; furnishing, placing, finishing and curing the concrete; furnishing and setting all dowels; backfilling; and protection until final acceptance, complete in place.

5.02 6-30 CONCRETE CURB AND GUTTER
6-30 Concrete Curb and Gutter will be paid for at the contract unit price per linear foot, which price will be full compensation for preparing the subgrade; forming; furnishing, placing, finishing, and curing the concrete; and protection until final acceptance, complete in place.

5.03 6-18 MEDIAN CONCRETE CURB AND GUTTER

6-18 Median Concrete Curb and Gutter will be paid for at he contract unit price per linear foot, which price will be full compensation for preparing the subgrade; forming; furnishing, placing, finishing, and curing the concrete; and protection until final acceptance, complete in place.

5.04 VALLEY GUTTER

Valley gutter will be paid for at the contract unit price per linear foot, which price will be full compensation for preparing the subgrade; forming; furnishing, placing, finishing, and curing the concrete; and protection until final acceptance, complete in place.

5.05 CONCRETE WATER TABLE

Eight inch (8") thickness Concrete Water Table will be paid for at the contract unit price per square foot, which price will be full compensation for preparing the subgrade; forming; furnishing, placing, finishing, and curing the concrete; and protections until final acceptance, complete in place.

5.06 ASPHALTIC CONCRETE CURB

Asphalt Concrete Curb will be paid for at the contract unit price per linear foot for the size specified, which price will be full compensation for preparing the base, tack coat, furnishing and placing the curb, and protection until final acceptance, complete in place.

5.07 PAYMENT WILL BE MADE UNDER:

Item No.	Pay Item	Pay Unit
02770-01	Concrete Curb	Linear Foot
02770-01.____	____" x ____"	Linear Foot
02770-02	6-30 Concrete Curb and Gutter	Linear Foot
02770-03	6-18 Median Concrete Curb and Gutter	Linear Foot
02770-04	Valley Gutter	Linear Foot
02770-05	Concrete Water Table	Square Foot
02770-06	Asphaltic Concrete Curb	Linear Foot
02770-06.____	_____"	Linear Foot

END OF SECTION 02770

CITY OF MEMPHIS – STANDARD CONSTRUCTION SPECIFICATIONS
SECTION 02775 PORTLAND CEMENT CONCRETE SIDEWALKS AND DRIVEWAYS

PART 1 – SCOPE

1.01 This work shall consist of constructing sidewalks, wheelchair ramps, and driveways of portland cement concrete on a prepared subgrade, in accordance with these Specifications and in conformity with the lines, grades, and typical cross-sections shown on the Plans or directed by the Owner. Wheelchair ramps and commercial and residential driveways shall be constructed in accordance with the Design Standards.

PART 2 – MATERIALS AND EQUIPMENT

2.01 MATERIALS

A. Concrete Materials: Concrete materials shall meet the requirements of Specification Section 03050, Portland Cement Concrete for Class A concrete.

B. Curing Materials: Curing materials shall conform to the applicable provisions of Specification Section 02750 Paragraph 2.01 C.

C. Preformed Joint Fillers: Preformed joint fillers shall be of the bituminous type and 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. Their width shall be at least equal to the full thickness of the slab, and their length shall be sufficient to eliminate any splicing.

2.02 EQUIPMENT

A. Forms shall be of wood, metal, or other suitable material and shall be true to line, free from warp, and of sufficient strength to resist springing out of shape during placing, consolidating, and finishing the concrete. Curved forms of proper radius or flexible forms acceptable to the Owner shall be used on all radial sections.

B. Satisfactory floats, templates, straightedges, edgers, spades, tamps, and all other equipment necessary for the satisfactory performance of this construction shall be on the Project and approved before work will be permitted to begin.

PART 3 – CONSTRUCTION REQUIREMENTS

3.01 SUBGRADE PREPARATION

Subgrade preparation for sidewalks and driveways shall be made to the required configuration to conform to the slab thicknesses shown on the Plans. The subgrade shall be shaped and compacted in conformance with Specification Section 02335 Paragraph 3.03 and to a width that will permit satisfactory installation and bracing of forms. Density requirements may be waived if approved by the Owner.

3.02 FORMS

Forms shall be well staked or otherwise held to the established lines and grades, and their grade shall be such that finished sidewalks shall have one-quarter of tan inch per foot fall toward the curb for drainage unless shown otherwise on the Plans or directed by the Owner. Driveway forms shall be of such width and slope that the finished driveway will conform to the slope of the adjacent sidewalk, grass plot, parking lot, or drive.

3.03 JOINTS

A. Unless otherwise indicated on the Plans or directed by the Owner, preformed expansion joint filler, 1/2 inch in thickness, shall be placed in sidewalks at the locations of and in line with expansion joints in the adjoining pavement, curb, or curb and gutter, but at spacings not to exceed 25 feet. When expansion joints have not been installed in the adjoining pavement or

gutter, a 1/2 inch preformed expansion joint filler shall be placed transversely at intervals of not over 25 feet. Preformed expansion joint filler shall be placed at all abutting concrete such as driveways, buildings, or walls. Transverse expansion joints with 1/2 inch preformed expansion joint filler shall be placed to match existing joints in abutting facilities but not to exceed 25 feet between joints. Preformed expansion joint filler shall be placed at each intersection of sidewalk and street curb, longitudinally between sidewalks and street curb, and at such other points as may be shown on the Plans or directed by the Owner. Preformed expansion joint filler, 1 inch in thickness, shall be placed around all appurtenances such as manholes, valve, utility poles, fire hydrants, and signs extending into or through the sidewalk or driveway area, forming an isolated square or rectangular slab around the appurtenance with a minimum of 4 inches clearance of the appurtenance.

B. The surface of sidewalks shall be divided into blocks by use of a grooving tool. The grooves shall be spaced approximately 5 feet apart and the blocks shall be rectangular unless otherwise ordered by the Owner. The grooves shall be cut to a depth of 1/2 inch. The edges of the grooves shall be edged with an edging tool having a radius of 1/4 inch.

C. Expansion joint filler material shall not be placed at sidewalk drains. Driveway joints shall be placed as shown on the Design Standards.

3.04 PLACING AND FINISHING CONCRETE

A. Concrete shall be placed only on a moist subgrade and shall not be placed unless the ambient temperature is 35^{o} F and rising. In no case shall concrete be placed on a frozen or frosty subgrade. After the concrete is placed in the forms, it shall be spaded along the forms (including cross forms for joints), tamped, and struck off in an approved manner to required section and grade and shall be finished with floats and straightedges until the surface requirements have been obtained. When the surface of the concrete is free from water and just before the concrete obtains its initial set, it shall be finished with a wooden float and swept lightly at right angles to the street centerline to produce a sandy texture. The longitudinal surface variations shall not be more than 1/4 inch under a 12 foot straightedge nor more than 1/8 inch on a 5 foot transverse section, or as approved by the Owner.

B. The edges of sidewalks and driveways shall be carefully finished and rounded with an eging tool have a 1/2 inch radius. An edge having a 1/4 inch radius shall be placed adjacent to and on both sides of all intermediate transverse expansion joints in sidewalks, and all marks caused by the edging tool shall be removed with a wetted brush or wooden float. The top of all expansion joint material shall be cleaned of all concrete, and the expansion joint material shall be trimmed if necessary as to be left slightly below the surface of the concrete.

3.05 TESTING CONCRETE

Concrete for sidewalks and driveways shall be tested by test specimens made and cured in accordance with AASHTO Designation T 23. The frequency and specific test method will be determined by the Owner. The Contractor shall furnish the concrete necessary for casting test specimens in the field. The City will supply all molds and labor necessary to cast and test the specimens.

3.06 CURING AND PROTECTION

A. Curing and cold weather protection shall be performed as provided for under Specification Section 02750 Paragraph 3.11 “Curing”.

B. Forms may be removed and the slab backfilled at any time that removal will not damage the concrete. Pedestrians will not be allowed upon sidewalks or driveways until 72 hours after finishing the concrete, and no vehicles or loads shall be permitted on any sidewalk or driveway until the Owner has determined that the concrete has attained sufficient strength for such loads. The Contractor shall construct and place such barricades and protection devices as are

necessary to protect the concrete. Any sidewalk or driveway damaged prior to final acceptance of the work shall be removed within joint or groove limits and replaced with concrete of the type and finish of the original construction.

3.07 WHEELCHAIR RAMPS

Wheelchair ramps shall be installed at each intersection at locations as reflected in the Design Standards or as directed by the Owner. For purposes of payment, wheelchair ramps shall be considered as sidewalk area in new construction areas. Where wheelchair ramps are to be installed at locations where curb and gutter is in place, wheelchair ramps will be paid as a unit in place, including removal of curb.

3.08 THICKNESS

Thickness of sidewalks and driveways shall be as shown on the Plans and Design Standards. Where a washed surface is specified for the concrete surface, and additional 1/2 inch thickness is required over that for the above specified finish.

PART 4 – MEASUREMENT

4.01 CONCRETE SIDEWALK

Concrete sidewalks will be measured for payment by the square foot at specified thickness, complete in place.

4.02 CONCRETE DRIVEWAY

Concrete driveways will be measured for payment by the square foot at specified thickness, complete in place.

4.03 WHEELCHAIR RAMP, EXISTING CONDITIONS

Wheel ramps placed in areas where curb and gutters exist will be measured by the unit, per each, complete in place.

PART 5 – PAYMENT

5.01 CONCRETE SIDEWALK

The accepted quantities of concrete sidewalk, including area of wheelchair ramps in new construction areas, will be paid for at the contract unit price per square foot of each specified thickness, which price will be full compensation for excavating and preparing the subgrade; forming; furnishing, placing, finishing, and curing the concrete; providing all joints; and protecting the concrete until final acceptance, complete in place.

5.02 CONCRETE DRIVEWAY

The accepted quantities of concrete driveway will be paid for at the contract unit price per square foot of each specified thickness, which price will be full compensation for excavating and preparing the subgrade; forming; furnishing, placing, finishing, and curing the concrete; providing all joints; and protection of concrete until final acceptance, complete in place.

5.03 WHEELCHAIR RAMP, EXISTING CONDITIONS

The accepted quantities of wheelchair ramps placed in areas where curb and gutter exist will be paid for at the contract unit price per each, which price will be full compensation for removing existing curb and, if required, gutter and sidewalk; excavating and preparing the subgrade; furnishing, placing, and finishing the concrete; and protecting the concrete until final acceptance, complete in place.

5.04 PAYMENT WILL BE MADE UNDER:

Item No.	Pay Item	Pay Unit
02775-01	Concrete Sidewalk	Square Foot
02775-01.____	_____ " Thickness	Square Foot

02775-02	Concrete Driveway	Square Foot
02775-02.____	_____ " Thickness	Square Foot
02775-03	Wheelchair Ramp (Existing Conditions)	Each

END OF SECTION 02775

CITY OF MEMPHIS – STANDARD CONSTRUCTION SPECIFICATIONS
SECTION 02820 CHAIN LINK FENCE

PART 1 - SCOPE

This work shall consist of the construction of chain link fences and gates in accordance with these Specifications and at the locations and in conformity with the lines, grades, and dimensions shown on the Plans or as directed by the Owner. Chain link fence may be located atop concrete channel lining walls, retaining wall or similar structure, or may be located independently of structures.

PART 2 - MATERIALS AND EQUIPMENT

2.01 MATERIALS.

Materials used throughout the project shall be of constant design and manufacture in respect to individual items or parts, excepting where the proposed fence will be an extension of an existing fence, in which case the new fence shall be constructed of materials similar in appearance to those in the existing fence and continued until broken by cross street, railroad, fence ditch, or other physical feature. Unless otherwise directed, new materials shall be as described hereinafter.

A. Fabric.

The fabric shall be zinc coated steel chain link type meeting the requirements of AASHTO M 181 for Type I, Class B fabric (zinc coating = 2 oz/ft^2). All chain link fabric shall be manufactured of No. 9 gauge wire pickets, forming a uniform 2 inch mesh, and shall be of the height shown on the Plans or specified in the Contract Documents. Fabric up to and including 60 inches high shall be knuckled at the top and bottom selvage and fabric over 60 inches high shall be twisted on the top selvage and knuckled on the bottom selvage.

B. Line Posts.

1. Line posts shall be zinc coated steel pipe or H-sections of the following dimensions and of the lengths shown on the Plans or specified herein:

				H - Section	
Fence Height	Nominal Size (inch)	Outside Diameter (inch)	Weight Per Foot (Pounds)	Dimension (inches)	Weight Per Foot (pounds)
6 feet or less	1 ½	1.9	2.72	1.875 x 1.625	2.70
6 feet to 8 feet	2	2.375	3.65	2.25 x 1.95	4.10

2. Steel pipe shall conform to ASTM A 120 or AASHTO M181-85I Grade 2 and H-Sections shall be produced from ASTM A 570 and ASTM A 572, Grade 45. The weight of zinc coating shall be a minimum of 1.8 oz/square foot. The weight of zinc coating and weight per foot for steel post meeting the requirements of AASHTO M181-85I grade 2 may vary from the above noted valves.

C. End Posts, Corner And Pull Posts, And Braces.

1. End posts, corner posts, and pull posts shall be zinc coated steel pipe or square sections of the following dimensions and of the lengths shown on the Plans or specified herein:

	Steel Pipe			Square Section	
Fence Height	Nominal Size (inch)	Outside Diameter (inch)	Weight Per Foot (Pounds)	Outside Dimension (inches)	Weight Per Foot (pounds)
6 feet or less	2	2.375	3.65	2.0	3.60
6 feet to 8 feet	2 ½	2.875	5.79	2.5	5.70

2. Diagonal braces shall be 1 ¼ inch (1.660 inch O.D.) galvanized steel pipe, weighing 2.27 pounds per foot. Steel pipe and square sections shall conform to ASTM A 120 or AASHTO M181-85I Grade 2. The weight of zinc coating and weight of pipe per foot for steel post meeting the requirements of the AASHTO M181-85I grade 2 may vary from the above noted valves.

D. Top Rail.

Top rail shall be used when specified on the Plans in lieu of top tension wire. The top rail shall be 1 ¼ inch (1.660 inch O.D.) galvanized steel pipe, weighing 2.27 pounds per foot, meeting the requirements of ASTM A 120 or AASHTO M181-85I Grade 2. Top rails in random lengths shall be fitted with expansion sleeves for connecting lengths into a continuous run or shall have a 3 inch swagged end. Suitable fittings shall be provided for securing top rail to each gate, corner, and end post.

E. Barbed Wire.

Barbed wire shall consist of two No. 12 ½ gauge, twisted steel strands with No. 14 gauge four-point barbs spaced not more than 5 inches apart. The galvanized strands shall meet the requirements of ASTM A 121, Class II coating.

F. Miscellaneous Fittings And Hardware.

Zinc coated miscellaneous fittings and hardware shall be commercial grade steel or better quality, pressed, wrought, or cast as appropriate to the article, and sufficient in strength to provide a balanced design when used in conjunction with fabric, posts, and wires of the quality specified herein. All steel fittings and hardware shall be galvanized in accordance with AASHTO M 111.

G. Barbed Wire Support Arms.

Barbed wire support arms shall be single arms for carrying 3 barbed wire strands. Barbed wire support arms for line posts shall be at an angle of 45 degrees (plus or minus 5 degrees) and shall be fitted with clips or other suitable means for attaching three lines of barbed wire, with the top strand of barbed wire 12 inches (plus or minus 1 inch) above and horizontally from the fence line, and the remaining two strands of barbed wire spaced uniformly between the top of the fence fabric and top strand of barbed wire. Support arms shall be capable of withstanding a load of 250 pounds when the base is clamped securely and the vertical load applied from where the outer strand of barbed wire passes over the arm.

H. Wire Ties.

Wire ties shall be No. 9 gauge and shall be either zinc coated steel, aluminum coated steel or aluminum alloy and sufficient in strength and other properties to provide a balanced design when used in conjunction with fabric, posts, and wire of the qualities specified herein. When tension wire is used, wire ties and clips for fastening fabric to tension wire shall be No. 11 gauge.

I. Tension Wire.

Tension wire shall be used at the bottom of fencing fabric when not otherwise secured and used at the top unless a top rail is specified. Tension wire shall be No. 6 gauge, spring rolled, aluminized steel wire.

J. Truss Rods and Turnbuckle.

Truss rods shall be 3/8 inch diameter steel rods and shall be equipped with a turnbuckle having a take-up of not less than four inches and shall be galvanized in accordance with AASHTO M 111.

K. Fence Gates.

Fence gates shall be of the kinds and sizes shown on the Plans or specified in the Contract Documents. They shall be of the swing type, complete with latches, stops, keepers, hinges, and fabric. The latch shall have provision for fastening with a padlock. The gates shall be covered with fabric matching the fence. The hinges shall be of adequate strength to support the gate and shall not twist or turn under action of the gate. The gates, gate posts, and braces shall be of the same material

and finish as the adjoining fence. All gate posts and rails shall be furnished complete with ball caps and rail ends.

1. Posts, braces, and framing members for chain link fence gates shall be zinc coated steel pipe meeting the requirements of Specification Section 02820 Paragraph 2.01.C. Gate post shall be 2 ½ inch (2.875 inch O.D.) pipe weighing 5.79 pounds per foot for gate widths of 5 feet or less; and 3 ½ inch (4.0 inch O.D.) pipe weighing 9.10 pounds per foot for gate widths between 5 feet and 13 feet.

2. Framing members and interior bracing shall be of the following minimum dimensions:

		Framing and Bracing	
Fence Height	Nominal Size	Outside Diameter	Weight Per Foot
6 feet or less	1 ¼	1.66	2.27
6 feet to 8 feet	1 ½	1.90	2.72

Gate frames shall be welded at all corners or assembled with corner fittings. When corner fittings are used, gates shall have truss rods as specified in Specification Section 02820 Paragraph 2.01.J to prevent sag or twist. All welded joints shall receive a shop applied zinc coating equivalent in thickness to that of the members being joined.

3. Fabric shall meet the requirements of Specification Section 02820 Paragraph 2.01.A.

4. Barbed wire shall meet the requirements of Specification Section 02820 Paragraph 2.01.E.

5. Miscellaneous fittings and accessories shall meet the applicable requirements of Specification Section 02820 Paragraphs 2.01 F, G, H, and J. The hinges shall be of such design to allow the gate to swing back 180 degrees, parallel with the fence line.

L. Concrete.

Concrete for post footings shall be Class A as specified in Specification Section 03050.

M. General.

1. Posts shall be fitted with ornamental tops or extension arms as stipulated in the Plans or in the Contract Documents. Caps or ornamental tops for tubular posts shall have a base fitting into the post with a flange extending over the top of the posts to protect against moisture. When a top rail is provided, all posts shall be provided with caps having a ring or hole suitable for the through passage of the top rail. Rail and brace ends, or other suitable means of connection, shall be provided when top rail or braces are required.

2. Fabrication of all materials shall be in conformity to the sizes, shapes, and other factors set out in these Specifications or shown on the Plans, and shall show careful, finished craftsmanship in all respects.

3. The weights specified for steel posts, braces, and rails are nominal weights, and a plus or minus tolerance of 5 percent will be permitted. All posts located on the top of concrete channel lining walls or similar structure shall be of sufficient length to be set fully 12 inches into the wall or structure.

4. All line posts located on the ground shall be of sufficient length to be set fully 24 inches deep

into concrete footings, and all end, corner, and pull posts shall be of sufficient length to be set 30 inches deep into concrete footings.

2.02 EQUIPMENT

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

PART 3 - CONSTRUCTION REQUIREMENTS

3.01 GENERAL REQUIREMENTS.

A. Fencing shall be placed atop concrete structures, such as concrete channel linings, in accordance with Plans and Design Standards. Fence post inserts will normally have been set into the concrete walls prior to fence construction activities. Inserts shall be 12 inch ling solid wall PVC pipe conforming to ASTM D2241, thin wall metal conduit conforming to ANSI C 80.3 and sealed at one end or other material approved by the Owner. Cans, bottles and the like shall not be used as inserts. Alternatively, posts may be sect directly into the structure concrete as the concrete is poured, making sure that all posts are plumbed and held securely in the proper position until the concrete has set.

B. The inside diameter of the inserts shall be sufficient to provide a minimum of ¼ inch clear space between the outside surface of the post and the inside surface of the insert. Inside of inserts shall be cleaned of debris and other foreign matter, insert space filled full of nonshrinking grout, the posts set into place in the insert and plumbed, and the post held plumb until the grout has set. All excess grout shall be removed before it sets. Where inserts have not been provided in the concrete structure, post holes of the same diameter and depth as required for inserts shall be cored in the concrete. Posts shall be set in cored holes in the same manner as posts set in inserts.

3.02 FENCING SET INDEPENDENTLY OF STRUCTURES.

A. Before beginning construction or placing of fences, all necessary work for clearing and grubbing, removal of structures and obstructions, and site preparation shall be performed in accordance with the applicable Sections of these Specifications. Clearing for fence construction shall not extend beyond the construction easements without written approval of the property owner. Living trees and shrubs one foot or more each side of the fence line shall remain undisturbed unless otherwise directed by the Owner. Any rock protruding above the ground surface and in the line of the fence shall be removed to ground surface.

B. Posts for chain link fence shall be set at intervals not to exceed 10 feet. The interval between posts shall be measured parallel to the bottom of the fabric of the proposed fence and in line of fence from center to center of post.

C. All line posts located on the ground shall be set fully 24 inches deep in concrete footings; end, corner and pull post shall be set 30 inches deep in concrete footings. Diameters of footing shall be : for line post not less than 8 inches; for end, corner or pull post not less than 10 inches. Footings for gate post shall be designed to support the cantilever load of the gate. Concrete for embedment of posts and for anchors shall be Class A and shall be crowned to shed water. Concrete shall be cured a minimum of 3 days prior to installation of fabric.

3.03 ERECTING FENCE.

A. For fence heights less than 6 feet a top and bottom tension wire shall be installed, unless specified otherwise. For fence heights 6 feet or greater a top rail and bottom tension wire shall be installed. When a top rail is specified, the top rail shall be connected with expansion sleeves to form a continuous rail.

B. Bracing assemblies consisting of the specified bracing pipe as the compression member and

specified truss rod as the tension member shall be installed and securely tightened prior to installation of fabric. One brace assembly shall be provided for end post and two brace assemblies for corner and pull posts. When fence alignment changes abruptly by more than 30^0 a corner brace assembly shall be installed. When the internal angle of a curved fence alignment exceeds 30^0 one brace assembly shall be installed at each point of curvature. Pull post shall be installed at abrupt changes in grade or at the midpoint of a straight fence alignment exceeding 500 feet in length.

C. The fabric shall be placed on the side of the post as directed by the Owner and 2" above ground or concrete structure. Fabric shall be secured at one end and sufficient tension applied to remove all slack before making attachment elsewhere. The fabric shall be fastened to the posts with wire ties at intervals not exceeding 14 inches. Fabric shall be fastened to the tension sire or rail with wire ties at intervals not exceeding 24 inches. When specified, barbed wire shall be installed and pulled taut before being permanently attached to a post or arm. Fence gates shall be constructed in accordance with the Plans, Specifications and manufacturer's standards and instructions, or as directed by the Owner.

3.04 TEST

Before any fencing is installed, manufacturer's certificates stating that the fabric, post, rails, braces, barbed wire, tension wire, ties and hardware are made in accordance with applicable standards as specified herein shall be filed with the Owner. At the option of the Owner, test samples of any materials to be furnished shall be furnished at the job site before work commences.

PART 4 – MEASUREMENT

4.01 CHAIN LINK FENCE.

Fences will be measured for payment by the linear foot along the bottom of the fabric and from end to end of fence, complete and in place, deducting the width of gates and openings, for each type and height of fence provided.

4.02 CHAIN LINK FENCE.

Gates will be measured for payment by the unit, per each, complete and in place, for the kinds and dimensions as shown on the Plans.

PART 5 – PAYMENT

5.01 CHAIN LINK FENCE.

The accepted quantities of chain link fence will be paid for at the contract unit price per linear foot, complete and in place, for each type and height of fence, which price will be full compensation for fabric, posts, rails, tension wire, miscellaneous hardware, post hole excavation, concrete footings, concrete coring and grouting.

5.02 FENCE GATES.

The accepted quantities of gates will be paid for at the contract unit price per each, complete and in place, for the kinds and dimensions of gates stipulated or shown on the Plans.

5.03 Payment will be made under:

Item No.	Pay Item	Pay Unit
02820-5.01	CHAIN LINK FENCE	Linear Foot
02820-5.01.__.__	___' Height x Description	Linear Foot
02820-5.02	FENCE GATES	Each
02820-5.02.__.__	___' Height x ___' Width of Opening	Each

END OF SECTION 02820

SECTION 02920 SEEDING

PART 1 - SCOPE

This work shall consist of furnishing and placing seed, commercial fertilizer, agricultural limestone, erosion control fabric, and mulch material when specified, and of caring for such areas until acceptance, all in accordance with these Specifications, on all newly graded earthen areas that are not to be paved, stabilized, or sodded, unless otherwise indicated on the plans or directed by the Owner.

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 Owner 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 Owner, samples of the seed may be taken for a check against the certified laboratory report. Sampling and testing will be in accordance with the requirements of the Tennessee Department of Agriculture.

3. When a seed group is used, the percentages forming the group shall be as set out below, unless otherwise specified.

Name	Quantity, Percent by Weight
Group A	
Lespedeza (Common or Korean)	20
Sericea Lespedeza	15
Ky. 31 Fescue	40
English Rye	15
White Dutch Clover	5
Weeping Love Grass	5
Group B	
Ky. 31 Fescue	55
Redtop	15
English Rye	20
White Dutch Clover	5
Weeping Love Grass	5
Group C	
Sericea Lespedeza	50
Ky. 31 Fescue	30
English Rye	15
White Dutch Clover	5

4. In mixing or forming "Groups" of seed, they shall be uniformly mixed. "Group" seed shall not be mixed until after each type seed that is used to form the "Group" has been tested and inspected separately and approved for purity and germination. Seed mixed before tests and inspection are made will not be accepted.

B. Fertilizer.
Manufactured fertilizer shall be a standard commercial fertilizer containing the specified percentages by weight of nitrogen (N), phosphoric acid (P_2O_5) and potash (K_2O). The fertilizer shall be furnished in standard containers with the name, weight, and guaranteed analysis of the contents clearly marked. The containers shall insure proper protection in handling and transporting the fertilizer. All commercial fertilizer shall comply with local, state, and federal fertilizer laws.

C. Agricultural Limestone.
Agricultural limestone shall contain not less than eighty-five (85%) of calcium carbonate and magnesium carbonate combined and shall be crushed so that at least 85 percent will pass the No. 10 mesh sieve and 100 percent will pass the 3/8 inch sieve.

D. Mulch Material.
All mulch material shall be air dried and virtually free of noxious weeds and weed seeds or other materials detrimental to plant growth on the work site or on adjacent agricultural lands. Hay shall be stalks of approved grasses, sedges, or legumes seasoned before baling or loading. Straw shall be stalks of rye, oats, wheat, or other approved grain crops. Both hay and straw shall be suitable for spreading with standard mulch blower equipment. Biodegradable fabric as specified in this section may be used as an alternate to mulch material at the Contractor's option.

E. Inoculants for Legumes.
Inoculants for treating legume seed shall be standard cultures of nitrogen fixing bacteria that are adapted to the particular kind of seed to be treated. The inoculant shall be supplied in convenient containers of a size sufficient to treat the amount of seed to be planted. The label on the container shall indicate the specified legume seed to be inoculated and the date period to be used.

F. Mulch Binder.
Cut back asphalt, Grade RC-70 or RC-250 conforming to AASHTO Specifications shall be used.

G. Water.
Water shall be free from any harmful or objectionable qualities or organisms.

H. Biodegradable Fabric.

1. Biodegradable fabric shall consist of a knitted or bonded construction of yarn with uniform openings interwoven with strips of biodegradable paper. The fabric shall be degradable by exposure to ultraviolet light. The fabric shall be "Hold/Gro" as manufactured by Gulf States Paper Corporation of Tuscaloosa, Alabama, or equal. The fabric shall be furnished in rolls and shall conform to the following requirements:

   a. Roll Widths: 5 feet minimum and 10 feet maximum.

   b. Roll Length: Approximately 360 feet.

   c. Weight: Approximately 0.2 pounds per square yard of fabric.

2. Fabric shall be secured in a place with wood pegs or other biodegradable materials.

3. The manufacturer shall provide moisture proof bags comparable to 4 to 6 mil opaque polyethylene bags for protection of the fabric prior to installation.

2.02 EQUIPMENT.
All equipment necessary for the satisfactory performance of this construction shall be on the project and inspected before work will be permitted to begin.

PART 3 - CONSTRUCTION REQUIREMENTS

3.01 GENERAL

The Contractor shall notify the Owner 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 Owner. Before starting seeding operations on any area, final dressing and the placing of topsoil shall have been completed in accordance with the project requirements. All seeding and related operations shall be continuous operations.

3.02 PREPARING THE SEEDBED.

Each area to be seeded shall be scarified, disked, harrowed, raked, or otherwise worked until it has been loosened and pulverized to a depth of not less than one inch. This operation shall be performed only when the soil is in a tillable and workable condition. Fertilizer, at the rate of not less than 23 pounds of Grade 6-12-12 or equivalent, per 1,000 square feet, and agricultural limestone, at the rate of not less than 100 pounds per 1,000 square feet, shall be distributed evenly over the seedbed, unless other are specified on the plans or in the Contract Documents. The limestone and fertilizer shall be lightly harrowed, raked, or otherwise incorporated into the soil as specified above when mixed with seed in water and applied with power sprayer equipment.

3.03 TIME OF SEEDING.

Group "A" seed shall be used for seeding from February 1 to August 1, and Group "B" seed shall be used from August 1 to December 1, except that either Group "A" or "B" may be used during the month of August. Group "C" seed shall be used from February 1 to December 1 and only when specified on the Plans or in the Contract Documents. Seeding shall be performed only when the soil is in a tillable and workable condition, and no seeding shall be performed between December 1 and February 1, unless otherwise permitted.

3.04 SEEDING.

Seed of the specified group shall be sown as soon as preparation of the seedbed has been completed and thoroughly watered after seeding. Care shall be exercised to not wash seeding by over watering. Seed shall be sown uniformly by means of a rotary seeder, wheelbarrow seeders, hydraulic equipment, or other satisfactory means, and unless otherwise specified on the Plans or in the Contract Documents, at the rate of 1 ½ pounds per 1,000 square feet. Group "C" seed and seeds of legumes when sown alone shall be inoculated before sowing in accordance with the recommendations of the manufacturer of the inoculant and as directed by the Owner. 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 Owner 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 Owner, 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 Owner'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 Owner. 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 Owner. 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 Owner directs the Contractor to place additional fertilizer on the area to be reseeded, and additional 4 pounds of agricultural limestone will be required for each additional pound of fertilizer.

PART 4 – MEASUREMENT
The furnishing of seeding as specified herein may be incidental to the work of the Contract, or may be measured and payment made under the Pay Items described herein, as defined by the Pay Items in the Proposal Sheet(s) and/or as included in the Plans and Contract Documents. If payment is made separately, measurement for the work of this Specification will be as described below.

4.01 SEEDING (WITH MULCH).
The area of seeding (with mulch) to measured for payment will be the number of seeding units, with mulch, in accordance with these Specifications. Each unit will consist of 1,000 square feet measured along the surface.

4.02 SEEDING (WITHOUT MULCH).
The area of seeding (without mulch) to be measured for payment will be the number of seeding units in accordance with these Specifications. Each unit will consist of 1,000 square feet measured along the surface.

4.03 BIODEGRADABLE FABRIC.
Biodegradable fabric to be measured for payment will be the number of 1,000 square foot units for which biodegradable fabric has been applied over seeded areas. Measurement will be along the surface.

4.04 GENERAL.
All work and materials for seed bed preparation, application of fertilizer and limestone, application of mulch binder, watering and maintenance and repair of work, and all other similar items included in this section of the Specifications but not covered by a Pay Item herein will be considered as a subsidiary obligation of the Contractor under other items of the Contract.

PART 5 – PAYMENT

5.01 SEEDING (WITH MULCH).
Seeding (with mulch) will be paid for at the contract unit price per unit (1,000 square feet), for the accepted quantities, which price will be full payment for preparing the seedbed, and for furnishing and placing all materials including fertilizer, water, agricultural limestone, seed, mulch materials, mulch binder and inoculant,

complete in place; and for maintenance and repair of the seeded and grassed area.

5.02 SEEDING (WITHOUT MULCH).
Seeding (without mulch) will be paid for at the contract unit price per unit (1,000 square feet) for the accepted quantities, which price will be full payment for preparing the seedbed, and for furnishing and placing all materials including fertilizer, water, agricultural limestone, seed, and inoculant, complete in place; and for maintenance and repair of the seeded and grassed areas.

5.03 BIODEGRADABLE FABRIC.
Biodegradable fabric will be paid for at the contract unit price per unit (1,000 square feet) for furnishing, installing, maintaining, and protecting the fabric, which price will be full payment for accomplishing the above.

5.04 PAYMENT WILL BE MADE UNDER:

Item No.	Pay Item	Pay Unit
02920-5.01	SEEDING (WITH MULCH)	Unit of 1,000 SF
02920-5.02	SEEDING (WITHOUT MULCH)	Unit of 1,000 SF
02920-5.03	BIODEGRADABLE FABRIC	Unit of 1,000 SF

END OF SECTION 02920

SECTION 02921 SODDING

PART 1 - SCOPE

This work shall consist of furnishing and placing sod at all locations shown on the Plans or where directed by the Owner, and in conformity with these Specifications. Ordinarily, the work will consist of the furnishing and placing of new sod originating from sources outside the rights-of-way and easement limits. In some cases, however, the work will include removing sod from areas where the requirements of the project would destroy existing sod, storing the sod so removed, and resetting it in areas shown on the Plans or designated by the Owner.

PART 2 - MATERIALS AND EQUIPMENT

2.01 MATERIALS.

A. Sod.

1. New sod shall consist of live, dense, well rooted growth of Bermuda grass, free from Johnson grass, nutgrass, and other obnoxious grasses or weeds, well suited for the intended purpose and for the soil in which it is to be planted. All sod shall be cleanly cut in strips having a reasonably uniform thickness of not less than 2 inches and cut in 10 to 12 inch squares.

2. The sale or movement of sod for propagation is controlled by Tennessee Plant Pest Act of 1955, TCA 43-55 et. Seq., and the Contractor shall be responsible for obtaining all inspections, authorizations, and permits which may be required by such law and the Tennessee Department of Agriculture.

B. Fertilizer.
Manufactured fertilizer shall meet the requirements of Specification Section 02920 Paragraph 2.01.B and shall be Grade 15-15-15 unless otherwise specified on the Plans or in the Contract Documents.

C. Ammonium Nitrate.
Ammonium nitrate shall be a standard commercial product, shall conform to the requirements for other commercial fertilizers as specified in Specification Section 02920 Paragraph 2.01.B, and shall have a minimum of 33 ½ percent nitrogen.

D. Agricultural Limestone.
Agricultural limestone shall meet the requirements of Specification Section 02920 Paragraph 2.01.C.

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 WEATHER LIMITATIONS.
Sod shall be set or reset only when the soil if most and favorable to growth. No setting or resetting shall be done between December 1 and February 1, unless weather and soil conditions are considered favorable and permission is granted by the Owner.

3.02 REMOVING AND STORING SOD FOR RESETTING.
If specified, sod removed from such areas as lawns, yards, and lots shall be so cut, handled, and stored that the sod can be reset in the same locations from which it was removed. No exchange of sod will be permitted unless approved by the Owner. Unless reset immediately after cutting, sod shall be stacked in piles and kept moist until reset. Sod shall be reset within 7 days after removal, unless otherwise specifically permitted by the Owner. Reset sod shall show vitality and growth at the time of acceptance by the City and for duration of the warranty period.

3.03 SODDING.

A. The area to be sodded shall be brought to the lines and grades shown on the Plans or as directed by the Owner. The surface of the ground to be sodded shall be loosened to a depth of not less than one inch with a rake or other device. If necessary, it shall be sprinkled until saturated for a minimum depth of one inch and kept moist until the sod is placed. Immediately before placing the sod, fertilizer and lime shall be applied uniformly to the prepared surface of the ground. Fertilizer shall be applied at the rate of 8 pounds of Grade 15-15-15, or equivalent per 1,000 square feet. Agricultural limestone shall be applied at the rate of 100 pounds per 1,000 square feet.

B. Sod shall be placed as soon as practical after removal from the point of origin and shall be kept in a moist condition during the interim. The sod shall be carefully placed by hand on the prepared ground surface with the edges in close contact and, as far as possible, in a position to break joints. Each strip of sod laid shall be fitted and rolled using a roller of sufficient size and weight to fix the sod into place. Immediately after placing, the sod shall be thoroughly wetted and rolled with an approved roller or hand tamped, as approved by the Owner. Pinning or pegging shall be required on slopes greater than 2 to 1 to hold the sod in place or in other instances at the direction of the Owner.

3.04 MAINTENANCE AND REPAIR.
The sod shall be watered as frequently as necessary for a period of two weeks, after which, ammonium nitrate shall be applied at the rate of 3.5 pounds per 1,000 square feet, and the sod given an additional watering. The Contractor shall not allow any equipment or material placed on any planted area and shall erect suitable barricades and guards to prevent his equipment, labor, or the public from traveling on or over any area planted with sod. Care shall include periodic watering, fertilizing and mowing necessary to maintain the vitality and appearance of the sod. When mowing is required, mower blades shall be set at sufficient height to protect the vitality of the growth. Sodded areas that become eroded, damaged or fail to successfully establish a stand of grass shall be repaired and/or replaced as directed by the Owner. All material and labor required to maintain and repair seeded areas shall be furnished by the Contractor at no cost to the City. Sod must be living at the time of final acceptance of the project and through the duration of the warranty period.

3.05 DISPOSAL OF SURPLUS MATERIAL.
All surplus material shall be disposed of off-site.

PART 4 – MEASUREMENT
The furnishing and setting of sodding as specified herein may be incidental to the work of the Contract, or may be measured and payment made under the Pay Items described herein, as defined by the Pay Items in the Proposal Sheet(s), and/or as included in the Plans and Contract Documents. If payment is made separately, measurement for the work of this Specification shall be as described below.

4.01 SODDING.
Sod will be measured for payment by the square yard of surface upon which the sod has been set.

4.02 REMOVING, STORING, AND RESETTING SOD.
Sod to be removed, stored, and reset will be measured for payment by the square yard of surface upon which the removed sod has been reset.

PART 5 – PAYMENT

5.01 SODDING.
Sodding will be paid for at the contract unit price per square yard for the accepted quantities, which price will be full payment for furnishing, setting, pinning and pegging if required, fertilizing, watering, mowing, providing and placing agricultural limestone, and for the maintenance and repair of the sodded area.

5.02 REMOVING, STORING, AND RESETTING SOD.
This work will be paid for at the contract unit price per square yard for the accepted quantities, which price will be full payment for removing and storing the sod or turf, setting, pinning and pegging if required, fertilizing,

watering, mowing, providing and placing agricultural limestone, and for the maintenance and repair of the sodded area.

5.03 PAYMENT WILL BE MADE UNDER:

Item No.	Pay Item	Pay Unit
02921-5.01	SODDING (NEW SOD)	Square Yard
02921-5.02	REMOVING, STORING, AND RESETTING SOD	Square Yard

END OF SECTION 02921

SECTION 02950 REMOVAL AND REPLACEMENT OF PAVEMENTS AND INCIDENTALS

PART 1 – SCOPE

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 construction of drainage facilities, sanitary sewers, traffic control conduit, 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 Plans, these Specifications, or as directed by the Owner. The Work which will be included in the Contract and for which the Contractor shall be compensated therefore is limited to that area within the rights-of-way and construction easements for the Project. The Contractor 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 – MATERIALS AND EQUIPMENT

2.01 MATERIALS

A. Concrete: Concrete materials shall meet the requirements of Specification Section 03050, Portland Cement Concrete for Class A concrete.

B. Curing Material: Curing materials shall conform to the applicable provisions of Specification Section 02750 Paragraph 2.01 C.

C. Asphaltic Concrete Wearing Surface and Asphalt Curb: Asphaltic concrete wearing surfaces and asphalt curb shall meet the requirements of Specification Section 02741 Paragraph 2.01 D., “Composition of Mixtures”, for Mix No. 1.

D. Asphalt Driveway Pavement: Asphalt driveway pavement shall meet the requirements of Specification Section 02741 Paragraph 2.01 D., “Composition of Mixtures”, for Mix No. 2.

E. Expansion Joint Filler: Preformed expansion joint filler shall be of the bituminous type, shall conform to eh 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.

F. Gravel Pavement or Base: Camden gravel or crushed limestone meeting the requirements of Specification Section 02720 Paragraph 2.01, Aggregates for Gradation No. 1, 2 or 3 shall be used to replace graveled areas disturbed by construction.

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 Owner.

B. When saws are used to cut pavement, the Contractor 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 Contractor 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.

E. Equipment necessary for the handling, placement, and finishing of concrete shall meet the applicable requirements of Specification Section 02750 Paragraph 2.02, "Portland Cement Concrete Pavement"; Specification Section 02775 Paragraph 2.02, "Portland Cement Concrete Sidewalks and Driveways"; and Specification Section 02770 Paragraph 2.02, "Curb, Curb and Gutter, and Water Table" .

F. Equipment necessary for the handling, placement, and compaction of asphalt shall meet the requirements of Specification Section 02741 Paragraph 2.02.

PART 3 – CONSTRUCTION REQUIREMENTS

3.01 REMOVAL OF ASPHALT PAVEMENT

Asphalt pavement shall be removed to a clean straight line as detailed on the Plans. Pavement shall be cut by saw or other equipment approved by the Owner 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 detailed on the Plans. Care shall be used to avoid damage to pavements and to the pavement base remaining in place.

B. Concrete pavement may, at the Contractor's option, be removed by saw cutting to a neat straight line. Saw cuts shall be made to a minimum depth of 1-1/2 inches and at a location to provide a cutback edge in accordance with the Design Standards. The edges of the existing concrete pavement adjacent to trenches where damaged subsequent to saw cutting of pavement shall again be saw cut in a neat straight line to remove the damaged pavement areas. Such saw cuts shall be parallel to the original saw cuts and perpendicular to the pavement surface.

3.03 REMOVAL OF CONCRETE SIDEWALK, CURB AND GUTTER, AND DRIVEWAY

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

Gravel surfaces encountered in construction shall be removed to the limits shown on the Plans.

3.05 REPLACEMENT OF PAVEMENT

A. Asphalt or Surface Treated Pavements: Replacement of asphalt or surface treated pavement and base shall consist of 8 inches of Class A concrete base and 1 inch of asphaltic concrete surface course Mix No. 1 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 8 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 Owner, 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^{o} 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. Curing and cold weather protection shall be performed as provided for under Specification Section 02750 Paragraph 3.11. No vehicles or loads shall be permitted on any concrete until the Owner has determined that the concrete has obtained sufficient strength for such loads. The contractor shall construct and place such barricades and protection devices as are necessary to protect the concrete.

D. Placing Asphaltic Concrete Wearing Surface: After the concrete base has been placed and adequately cured, an asphaltic concrete wearing surface of the minimum specified thickness shall be placed and compacted as specified in Specification Section 02710.4 Paragraphs 3.01 – 3.11, Asphaltic Concrete, Construction Requirements.

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 requirements of Specification Section 02775 Paragraphs 3.01 – 3.08, “Portland Cement Concrete Sidewalks and Driveways, Construction Requirements”. 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 concrete elevation, texture, and color shall conform to the adjacent concrete surfaces.

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 trate of 1 inch in 5 feet. Granite curb shall be replaced with new concrete curb whose height matches existing adjacent curb top elevations. New concrete curb and gutter construction shall conform to the requirements of Specification Section 02770 Paragraphs 3.01 – 3.10, “Curb, Curb and Gutter, and Water Table, Construction Requirements”. 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 Owner.

3.07 DAMAGE DUE TO SETTLEMENT

A. The Contractor 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 and after the date of Final Acceptance of the Work covered by the Contract.

B. During such period, the Contractor 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 City. Should the Contractor fail to repair settlement damage which may occur as described above within 30 days after being given notice thereof, the City shall have the right to repair such settlement and charge the cost of such repairs to the Contractor.

3.08 DAMAGE OUTSIDE CONSTRUCTION EASEMENT LIMITS

A. The Contractor 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 Subcontractors in hauling or otherwise transporting materials to and from the several sites of Work, regardless of the location of such damage. The Contractor 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 owner or owners of such damaged surfaces or structures, or to their legally responsible officers, agents, or other representatives, at the Contractor's cost and expense.

PART 4 – MEASUREMENT

4.01 PAVEMENT REMOVAL AND REPLACEMENT
Pavement removal and replacement shall be measured for payment by the square yard, complete in place.

4.02 CONCRETE SIDEWALK REMOVAL AND REPLACEMENT
Sidewalk removal and replacement shall be measured for payment by the square foot, complete in place.

4.03 CONCRETE DRIVEWAY APRON REMOVAL AND REPLACEMENT
Driveway apron removal and replacement shall be measured for payment by the square foot, complete in place.

4.04 CONCRETE CURB AND GUTTER REMOVAL AND REPLACEMENT
Curb and gutter removal and replacement shall be measured for payment by the linear foot, complete in place.

4.05 ASPHALT OR CONCRETE DRIVEWAY AND PAVED AREA REMOVAL AND REPLACEMENT
Asphalt or concrete driveway and paved area removal and replacement shall be measured for payment by the square foot, complete in place.

4.06 GRAVEL DRIVEWAY AND GRAVEL AREA REMOVAL AND REPLACEMENT
Gravel driveways and gravel area removal and replacement shall be measured for payment by the ton of Camden gravel or crushed limestone, complete in place.

4.07 ASPHALT AND CONCRETE CURB REMOVAL AND REPLACMENT
Asphalt and concrete curb removal and replacement shall be measured for payment by the linear foot along the face of curb, complete in place.

PART 5 – PAYMENT

5.01 PAVEMENT REMOVAL AND REPLACEMENT
The accepted quantities of pavement removal and replacement shall be paid for at the contract 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.

5.02 CONCRETE SIDEWALK REMOVAL AND REPLACEMENT
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.

5.03 CONCRETE DRIVEWAY APRON REMOVAL AND REPLACEMENT
The accepted quantities of driveway apron removal and replacement shall be paid for at the contract unit price per square foot for the type specified, which price will be full compensation for removal and disposal of driveway apron; preparing the subgrade; and placing, finishing, curing, and protection of concrete, complete in place.

5.04 CONCRETE CURB AND GUTTER REMOVAL AND REPLACEMENT.
The accepted quantities of curb and gutter removal and replacement shall be paid for at the contract 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.

5.05 ASPHALT OR CONCRETE DRIVEWAY AND PAVED AREA REMOVAL AND REPLACMENT
The accepted quantities of asphalt or concrete driveway and paved area removal and replacement shall be paid for at the contract unit price per square foot 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 asphalt, complete in place.

5.06 GRAVEL DRIVEWAY AND GRAVEL AREA REMOVAL AND REPLACEMENT
The accepted quantities of gravel driveway and gravel area removal and replacement shall be paid for at the contract unit price per ton of Camden gravel or crushed limestone, which price will be full compensation for preparing the subgrade and replacing the gravel, complete in place.

5.07 ASPHALT AND CONCRETE CURB REMOVAL AND REPLACEMENT
The accepted quantities of asphalt and concrete curb removal and replacement shall be paid for at the contract unit price per linear foot, which price will be full compensation for removal and disposal of curb and placing new curb, complete in place.

5.08 PAYMENT WILL BE MADE UNDER:

Item No.	Pay Item	Pay Unit
02950-01	PAVEMENT REMOVAL AND REPLACEMENT	Square Yard
02950-01.01	Asphaltic Concrete Pavement	Square Yard
02950-01-02	Concrete Pavement	Square Yard
02950-02	CONCRETE SIDEWALK REMOVAL AND REPLACEMENT	Square Foot
02950-03	CONCRETE DRIVEWAY APRON REMOVAL AND REPLACEMENT	Square Foot
02950-03.___	(Description)	Square Foot
02950-04	CONCRETE CURB AND GUTTER REMOVAL AND REPLACEMENT	Linear Foot
02950-04.___	(Description)	Linear Foot

02950-05	ASPHALT OR CONCRETE DRIVEWAY AND PAVED AREA REMOVAL AND REPLACEMENT	Square Foot
02950-05.01	Asphalt Driveway and Paved Area	Square Foot
02950-05.02	Concrete Driveway and Paved Area	Square Foot
02950-06	GRAVEL DRIVEWAY AND GRAVEL AREA REMOVAL AND REPLACEMENT	Ton
02950-06.01	Replacement with Camden Gravel	Ton
02950-06.02	Replacement with Crushed Stone	Ton
02950-07	ASPHALT AND CONCRETE CURB REMOVAL AND REPLACEMENT	Linear Foot
02950-07.01	Concrete Curb	Linear Foot
02950-07.02	Asphalt Curb	Linear Foot

END OF SECTION 02950

SECTION 03050
PORTLAND CEMENT CONCRETE

PART 1 GENERAL

1.01 SCOPE

A. This specification covers the classification, materials, proportioning of materials, equipment, mixing requirements, and testing for Portland cement concrete to be used for construction of streets, bridges, and miscellaneous structures and facilities as defined in Division 2 – Site Construction of these Specifications. The classification requirements, forming, curing, measurement, and payment for specific uses of concrete are specified and defined in the appropriate sections of Division 2.

PART 2 PRODUCTS

2.01 CONCRETE CLASSIFICATION

A. Portland cement concrete used for construction of the various items covered in Division 2 of these Specifications shall be classified by usage as follows

1. Class A

    a. Class A concrete shall be used as specified for such items as concrete curb, curb and gutter, sidewalks, drainage and sewer structures other than box culverts, ditch paving, bridges (other than superstructure) and similar uses.

2. Class A S

    a. Class A S concrete shall be used for bridge superstructures and channel lining of ditches.

3. Class B

    a. Class B concrete shall be used for roadway base and pavement.

4. Class C

    a. Class C concrete shall be used as specified for such items as concrete cradles, encasements, embankment slope paving at bridge abutments, and other low strength applications.

5. Class P

    a. Class P concrete shall be used for cast-in-place box culverts and precast and precast-prestressed concrete structures or structural members. High-early-strength concrete shall be as specified in Specification Section 03050 Paragraph 6.05.

2.02 HIGH-EARLY-STRENGTH CONCRETE

A. High-early-strength concrete may be required in the Plans and Specifications or substituted at the request of the Subcontractor, subject to the approval of the Purchaser. When high-early-strength cement concrete is authorized, it shall conform to the requirements of Table 03050.2 except that the 28 day strength (or 14 day strength for Class B concrete) shall be obtained in 7 days. The use of Type I or Type III cement for high-early-strength concrete in lieu of using Type III cement. When type I cement is used, the concrete shall have a

minimum of 7.6 sacks (714 pounds) of cement per cubic yard of concrete. If admixtures are used to obtain high-early-strength concrete, such admixtures may only be used if previously approved by the Tennessee Department of Transportation for similar uses of the concrete and if specifically approved for the project by the Purchaser.

B. The gradation of fine and coarse aggregates shall be the same as that approved for the concrete for which the high-early-strength concrete is substituted. All materials entering into the high-early-strength concrete shall be of the same kind and class as the materials entering into the other part or parts of the facility constructed of the class of concrete for which high-early-strength is being substituted.

C. No additional compensation will be made if the Subcontractor elects to substitute high-early-strength concrete for any class of concrete. The unit price for the class for which the substitution is made shall be full compensation for the concrete.

2.03 MATERIALS

A. Materials used in the production of Portland cement concrete of the various classifications specified herein shall meet the following requirements.

2.04 PORTLAND CEMENT

1. Portland cement shall be Type I cement conforming to the requirements of AASHTO M 85, except that for high-early-strength concrete, Type III cement may be used.

2.05 FINE AGGREGATE.

A. Fine aggregate shall consist of natural sand, clean and free from any surface film or coating and graded from fine to coarse. Fine aggregate shall conform to the requirements of ASTM C 33 and the specifications included herein. The amount of deleterious substance shall not exceed the following percentage by weight:

1.	Removed by decantation……	3 percent
2.	Coal or lignite……	1 percent
3.	Clay lumps……	1 percent
4.	Other local deleterious substances (such as shale, alkali, Mica, coated grains, soft and flaky particles)……	1 percent
5.	Total coal, clay lumps, shale, soft fragments and other local deleterious substances ……..	5 percent

B. All fine aggregate shall be free from amounts of organic impurities that would be detrimental to concrete strength and durability. Aggregate shall be subjected to the colorimetric test made in the field as follows:

1. Fill a 12 oz. graduated bottle to the 4 ½ oz. mark with the sand to be tested. Add a 3% solution of sodium hydroxide until the volume, after shaking, amounts to 7 ounces. Shake thoroughly and let stand for 24 hours. The sample shall then show a practically colorless solution, or at least, a solution not darker than straw color.

C. Fine aggregate shall be well graded from coarse to fine and, when tested by means of laboratory sieves, shall conform to the following requirements:

Passing	Percent
3/8 in. Sieve……	100
No. 4 Sieve……	95 to 100
No. 16 Sieve……..	50 to 90
No. 50 Sieve……..	10 to 30
No. 100 Sieve……..	0 to 10
No. 200 Sieve……..	0 to 3

a. Note: Not more than 45% should be retained between any two consecutive sieves.

D. Fine aggregate shall be of such quality that mortar composed one (1) part Portland cement and three (3) parts fine aggregate, by weight when made into briquets or cylinders, shall show a tensile or compressive strength at seven (7) and twenty-eight (28) days at least equal to the strength of briquets or cylinders composed of one (1) part of the same cement and three (3) parts standard Ottawa sand by weight. The percentage of water used in making the test specimens of cement and fine aggregate shall be such as to produce a mortar of the same consistency as that of the Ottawa sand test specimens of standard consistency.

2.06 COARSE AGGREGATE

A. Coarse aggregate for any class of Portland cement concrete shall consist of crushed stone or crushed or uncrushed gravel unless otherwise specified.

B. Coarse aggregate for Class A, Class B, or Class C concrete shall be furnished in two sizes: Size No. 4 and Size No. 67 as shown hereinafter in Table 03050.1, Coarse Aggregate Gradation Table. The two sizes shall be manufactured, within the specified limits, to produce Size No. 467 when combined in the proper proportions at the batching plant. If the supplier provides a proper stockpile to prevent segregation, then a combined Size No. 467 can be used in lieu of blending Size No. 4 and Size No. 67.

C. Coarse aggregate for Class AS concrete shall be Size No. 57. Only limestone coarse aggregate will be used for Class AS concrete; gravel coarse aggregate will not be permitted.

D. Coarse aggregate for Class P concrete shall be size No. 57 or Size No. 67 as may be specified or directed. Only limestone coarse aggregate shall be used for Class P concrete; gravel coarse aggregate will not be permitted.

E. Coarse aggregate for concrete curbing placed by machine extrusion methods shall be Size No. 57 or Size No. 67.

F. The coarse aggregates shall otherwise conform to the requirements of AASHTO M 80 and ASTM C 33 with the following exceptions and stipulations:

1. Deleterious Substances: The amount of deleterious substances shall not exceed the following limits:

		Maximum Percent by Weight
a.	Soft or nondurable fragments (fragments which are structurally weak such as shale, soft sandstone, limonite concretions, gypsum, weathered schist or cemented gravel) ……..	3.0
b.	Coal and lignite ……	1.0
c.	Clay lumps ……	0.25
d.	Material passing the No. 200 sieve ……..	1.00
e.	Thin or elongated pieces (length greater than 5 times average thickness)	10.00
f.	Other local deleterious substances	1.00

i. Notes:

(1) In the case of crushed aggregate, if all the material finer than the 200 mesh sieve consists of the dust of fracture essentially free of clay or shale, Item 4, Maximum Per Cent by Weight, may be increased to 1.5.

(2) The sum of the percentages of Items No. a, b, c, d, and f shall not exceed 5.0.

(3) When the coarse aggregate is subjected to five alternations of the sodium sulfate soundness test, the weighted percentage of loss shall be not more than nine.

(4) Alternate freeze/thaw tests for soundness will not be performed.

(5) The percentage of wear as determined by AASHTO T 96 shall not exceed 40.

COARSE AGGREGATE GRADATION TABLE
Table 03 05 00.1

Size Number	Amounts Finer Than Each Lab. Sieve (Sq. Openings), % By Weight							
	2”	1-1/2”	1”	¾”	½”	3/8”	No. 4	No.8
4	100	90-100	20-55	0-15	----	0-5	----	----
467	100	95-100	----	35-70	----	10-30	0-5	----
57	----	100	95-100	----	25-60	----	0-10	0-5
67	----	----	100	90-100	----	20-55	0-10	0-5

2.07 WATER

A. The water used in mixing concrete shall be clean, free from oil, acid, strong alkalis, organic or vegetable matter.

2.08 AIR-ENTRAINING ADMIXTURES

A. Air-Entraining Admixtures shall conform to the requirements of AASHTO M 154, except that the tests for bleeding, bond strength and volume change will not be required.

B. The Purchaser will maintain a list of qualified products. The Subcontractor shall be required to furnish a material that appears on this list.

C. A product may become approved by furnishing test data from a recognized laboratory showing that the air-entraining admixture proposed for use conforms to the requirements of these Specifications. A recognized laboratory is defined as one of the following: A State Transportation Department Laboratory; a Federal Highway Administration Laboratory; or other laboratories which are approved by the Purchaser.

2.09 CHEMICAL ADDITIVES

A. For Portland cement concrete mixtures, these additives shall conform to the requirements of AASHTO M 194 covering the following five types:

1. Type A – Water reducing admixtures

2. Type B – Retarding admixtures

3. Type C – Accelerating admixtures

4. Type D – Water reducing and retarding admixtures

5. Type E – Water reducing and accelerating admixtures

B. Additionally, admixtures for increasing the flowable characteristics of concrete (super plasticizers) may be used, subject to the approval of the Purchaser for each class and intended use of the concrete. Such admixtures shall meet the applicable requirements of ASTM C 494. The use of a plasticizer shall not change the maximum water requirements for the approved design mix. When approved for use, the admixture shall be introduced into the mix in the manner and quantities recommended by the manufacturer.

C. Additives listed in items A through E above and super plasticizers may only be used with the written approval of the Purchaser. Before any admixture is approved, the manufacturer of the admixture or the Subcontractor shall furnish the Purchaser documentary evidence that the material proposed for use has been tested in accordance with the methods of test specified in AASHTO M 194 (or ASTM C 494 for super plasticizers) and meets the requirements of the Specification. Documentary evidence for all additives shall be the results of tests conducted by a testing laboratory inspected at regular intervals by the National Bureau of Standards. The Purchaser may require a notarized certification from the manufacturer of any additives used stating that the material is identical with that originally approved and has in no way been changed or altered. Even through additives have been approved by the Purchaser, the Subcontractor shall be responsible for the successful use of the additives. No reduction in the cement content of the concrete as designed without chemical additives will be made when additives are permitted.

D. Calcium chloride additives will not be permitted.

2.10 CURING MATERIALS

A. Curing materials shall be as specified in the various Specification Sections of Division 2 and as specified below:

B. Water

1. Water used in curing Portland cement concrete shall be free from any substance which may be injurious to concrete when applied on the surface as a curing agent.

C. Burlap

1. Burlap shall conform to AASHTO M 182, Class 3 or Class 4. If Class 1 or Class 2 burlap is permitted, at least two layers shall be use.

D. Liquid Membrane-Forming Compounds

1. These compounds shall conform to AASHTO M 148. Where applied texture finish is specified, a Type 1-D, Class B, membrane which is compatible with the texture finish shall be used. Type 2 (white pigmented) membrane shall be used in all other applications, unless otherwise specified.

E. White Polyethylene Sheeting

1. This material shall conform to AASHTO M 171.

2.11 FLY ASH

A. Class C fly ash conforming to the requirements of ASTM C 618-84 may be used as a replacement for Portland cement if approved in writing by the Purchaser. The maximum amount of cement being replaced by fly ash shall not exceed 15 percent. Before any fly ash will be approved for use, the Subcontractor shall furnish the Purchaser documentary evidence that the fly ash proposed for use has been tested in accordance with ASTM C 311-7 and meets the requirements of that specification. Documentary evidence shall be the results of tests conducted by a testing laboratory inspected at regular intervals by the National Bureau of Standards. Even though the fly ash has been approved by the Purchaser, the Subcontractor shall be responsible for its successful use. When a specific air content has been required and fly ash is being used, the air content shall be tested on each truck load of concrete at the batch plant and the tested value shall be indicated on the ticket.

2.12 EQUIPMENT

A. General

1. Equipment and tools necessary for handling materials and performing all parts of the Work shall be subject to the approval of the Purchaser. The equipment shall be at the job site sufficiently ahead of the start of construction operations to be examined thoroughly and approved. The equipment and organization shall be of sufficient capacity to accomplish the maximum continuous concrete placement, as governed by the construction joints shown on the Plans and Design Standards or as directed by the Purchaser.

2.13 BATCHING PLANT AND EQUIPMENT

A. General

1. The batching plant shall include bins, weighing hoppers, and scales. If cement is used in bulk, a bin, hopper, and separate scale for cement shall be included. The Subcontractor shall provide adequate means for cement cut off checks. The weighing hoppers shall be properly sealed and vented to preclude dusting during operation. The bulk cement storage bin or hopper shall be provided with adequate means for sampling the cement in

storage.

B. Bins and Hoppers

1. Bins with adequate separate compartments for fine aggregates, each size of coarse aggregate, and cement shall be provided in the batching plant. Each compartment shall discharge efficiently and freely into the weighing hopper. Means of control shall be provided so that as the quantity desired in the weighing hopper is being approached, the material may be added slowly and shut off with precision. A port or other opening shall be provided for removing an overload of any one of the several materials from the hopper. Weighing hoppers shall be constructed so as to eliminate accumulations of tare materials and to discharge fully without jarring the scales. Partitions between compartments, both in bins and in hoppers, shall be ample to prevent spilling under any working conditions.

C. Scales

1. The scales for weighing aggregates and cement shall be of either the beam type or the springless-dial type. They shall be accurate within 0.5 percent throughout the range of use. The value of the minimum graduation on the scale for weighing cement shall not be greater than 5 pounds. The value of the minimum graduation on the scale for weighing amounts of aggregates up to 10,000 pounds or more shall be not greater than 10 pounds. The value of the minimum graduation of scales used in weighing amounts of aggregate 10,000 pounds or more shall be not greater than 0.1 per cent of the nominal capacity of the scales but shall not exceed 50 pounds. When beam type scales are used, provision, such as a “tell-tale” dial, shall be made for indicating to the operator that the required load in the weighing hopper is being approached. The “tell-tale” device on weighing beams shall indicate critical position clearly. Poises shall be designed so that they cannot be easily removed from the beam and can be held firmly in place. The weigh beams and “tell-tale” device shall be in full view of the operator while charging the hopper, and he shall have convenient access to all controls.

2. Scales shall be tested no less than once monthly by a certified scale testing company. Testing shall meet the requirements of applicable City ordinances and State law. The Subcontractor shall have available not less than 10 standard 50 pound weights meeting the requirements of the U.S. Bureau of Standards for calibrating and testing weighing equipment. The person dispensing weighed material shall certify that the amounts of materials used is in accordance with quantities shown on the delivery ticket.

D. Equipment for Structural Concrete

1. The requirements for batching plants shall be as prescribed above, except that when approved by the Purchaser, the requirement for storage compartments in addition to weigh bins, for fine and coarse aggregates may be waived, provided the batching tolerances specified in Specification Section 03050 Paragraph 5.02.A are maintained.

2. Ample and satisfactory equipment for conveying concrete from the mixer to final position in the forms shall be provided. Closed chutes or pipes shall be used when concrete is to be dumped or dropped for a distance greater than 5 feet. Where steep slopes are required, the chutes shall be equipped with baffle boards or shall be in short lengths that will enable the direction of movement to be reversed. Tremies for placing seal concrete under water shall consist of a water tight tube 10 inches to 14 inches in diameter. It shall be constructed so that the bottom can be sealed and opened after it is in place and fully charged with concrete. It shall be supported so that it can be easily moved horizontally to cover all the work area and vertically to control the concrete flow.

2.14 MIXERS

A. General

1. Concrete may be mixed at a central point or wholly or in part in truck mixers. Each mixer shall have attached in a prominent place a manufacturer's plate showing the capacity of the drum, in terms of mixing and agitating capacity, and the speed of rotation of the mixing drum or blades for both mixing and agitation.

2. Mixers shall be capable of combining the aggregates, cement, additives when specified, and water into a thoroughly mixed and uniform mass within the specified mixing period. They shall have a minimum capacity sufficient to comply with minimum production requirements.

3. Mixers shall be equipped with an approved device for accurately measuring water within a range of error of not more than one percent. The amount of water used in each batch shall be shown by an indicator which is accurately calibrated and easily read.

4. Central plant mixers shall be equipped with an approved batch meter and timing device which will automatically lock the discharge lever during the full time of mixing and release it at the end of the mixing period. This device shall be equipped with a bell or other suitable warning device that will give a clearly audible signal each time the lock is released. In case of failure of the timing device, the mixer may be used for the balance of the day while it is being repaired, providing the Subcontractor furnishes a satisfactory means of determining the mixing time.

B. Mixers at Site of Construction

1. Mixers at the site of construction will not be permitted, unless permitted by the Purchaser.

C. Truck Mixers and Truck Agitators

1. Truck mixers used for mixing and hauling concrete and truck agitators used for hauling central-mixed concrete shall meet all the applicable requirements under Paragraph A above, and in addition, the manufacturer's plate shall indicate the various uses for which the equipment is designed, the gross volume of the drum, and the minimum and maximum speed of rotation of the drum or blades for charging, mixing and agitating. Trucks equipped for mixing shall be equipped with an approved device for recording the number of revolutions of the drum or blades. Mixers or agitators used to mix and transport paving concrete shall be of the hydraulic drum lift type or other especially designed types which will discharge low slump concrete (1 – 2 ½ inch) at a satisfactory rate without segregation.

D. Non-agitator Trucks

1. Bodies of nonagitator hauling equipment for concrete shall be smooth, mortar tight, metal containers, and shall be capable of discharging the concrete at a satisfactorily controlled rate without segregation. Covers shall be provided when needed for protection of the concrete. Nonagitator trucks may be used only with approval of the Purchaser.

E. Admixture Induction

1. A satisfactory method and equipment for setting the dosage for admixtures must be furnished and if admixtures other than air entraining agents are used, they shall be added in the manner and in the dosage recommended by the manufacturer.

F. Vibrators

1. Vibrators shall be of an approved type and design, and shall operate under load at the rate as recommended by the manufacturer and approved by the Purchaser. For concrete structures, all concrete to be vibrated shall be compacted by means of approved high frequency internal vibrators or other approved types of vibrators immediately after being deposited in the forms. At least two vibrators in good operating condition and tow sources of power shall be available at the site where more than 25 cubic yards of concrete are to be poured. The use of external vibrators for compacting concrete will be permitted where the concrete is inaccessible for adequate compaction, provided the forms are sufficiently rigid to prevent displacement or damage from external vibration and approved by the Purchaser. For concrete pavement, the frequency of surface vibrators shall not be less than 3,500 impulses per minute and the frequency of the internal type shall not be less than 5,000 impulses per minute for tube vibrators and not less than 7,000 impulses per minute for spud vibrators. When spud type internal vibrators, either hand operated or attached to spreader or finishing machines, are used adjacent to forms, they shall have a frequency not less than 7,000 impulses per minute. For prestressed concrete, all concrete shall be thoroughly compacted with approved high frequency vibrators operating at a minimum of 7,000 vibrations per minute.

PART 3 EXECUTION

3.01 HANDLING BATCHING AND MIXING

A. Stockpiling Aggregates

1. Sites for aggregate stockpiles shall be grubbed and cleaned prior to storing aggregates, and the ground shall be firm and smooth and well drained. A cover of at least three inches of aggregate shall be maintained in order to avoid the inclusion of soil or foreign material. The stockpiles shall be built in layers not exceeding four feet in height, and each layer shall be completely in place before the next layer is started so as to prevent segregation. The material shall be deposited in such manner as to prevent coning, except in the case of aggregate composed essentially of material finer than the No. 4 sieve and base material.

2. Dumping, casting or pushing over sides of stockpiles will be prohibited, except in the case of aggregate for base material and fine aggregate materials.

3. Unless otherwise authorized, aggregates from different sources, different gradings or differing in specific gravity by more than 0.03 shall not be stockpiled together. Stockpiles of different types or sizes of aggregates shall be spaced far enough apart, or separated by suitable walls or partitions, to prevent the mixing of the aggregates.

4. When it is necessary to operate trucks or other equipment on a stockpile in the process of building the stockpiles, it shall be done in a manner approved by the Purchaser. Any method of stockpiling aggregate which allows the stockpile to become contaminated with foreign matter or causes excessive degradation of the aggregate will not be permitted. Excessive degradation will be determined by sieve tests of samples taken from any portion of the stockpile over which equipment has operated, and failure of such samples to meet all grading requirements for the aggregate shall be considered cause for discontinuance of such stockpiling procedure.

5. Stockpiles shall be maintained in a saturated surface dry condition to the extent possible.

3.02 HANDLING, MEASURING AND BATCHING MATERIAL

A. General

1. The batch plant site, layout, equipment and provisions for transporting material shall be such as to assure a continuous supply of material to the Work.

2. Aggregates shall be handled from stockpiles or other sources to the batching plant in such manner as to maintain a uniform grading of the material. Aggregates that have become segregated, or mixed with earth or foreign material, shall not be used. All aggregates produced or handled by hydraulic methods, and washed aggregates, shall be stockpiled or binned for draining at least 12 hours before being batched. Rail shipment requiring more than 12 hours will be accepted as adequate binning only if the car bodies permit free drainage. In case the aggregates contain high or non-uniform moisture content, storage or stockpile periods in excess of 12 hours may be required by the Purchaser. The Purchaser may require sprinkling of aggregate that has dried to the extent that it absorbs mixing water.

3. The fine aggregate and each size of coarse aggregate shall be separately weighed into the hopper or hoppers in the respective amounts set by the Subcontractor and approved by the Purchaser. Cement shall be measured by the sack or weight. Separate scales and hoppers shall be used for weighing the cement. The scales shall be equipped with a device to indicate positively the complete discharge of the batch of cement into the batch box or container. Ninety-four pounds of bulk cement shall be considered one sack. Batches involving fractional sacks will not be allowed except when bulk cement is used.

4. Batching plants equipped to proportion aggregates and bulk cement by weight by means of automatic and interlocked proportioning devices of approved type may be used.

5. Batching shall be so conducted as to result in the required weights of each material being within a tolerance of 1.0 percent for cement and 1.5 percent for aggregates.

6. Water may be measured either by volume or by weight. The accuracy of measuring the water shall be within a range of error of not over 1.0 percent. Unless otherwise permitted, calibrated tanks for measuring water shall include an auxiliary tank from which the measuring tank shall be filled. The measuring tank shall be equipped with an outside tap and valve to provide for checking the setting unless other means are provided for readily and accurately determining the amount of water in the tank. The volume of the auxiliary tank shall be at least equal to that of the measuring tank.

7. The use of chemical additives shall be as prescribed under Paragraph 3.06 of this Specification and they shall be added to the mix using the methods and at the time and in the manner recommended by the manufacturer of the additive, subject to approval by the Purchaser.

8. Unless specifically provided in the contract, the furnishing and use of approved additives or admixtures and the other precautions necessary to provide satisfactory concrete and concrete products shall be considered subsidiary to the furnishing and placement of the concrete and any and all additional costs related thereto and risks resulting there from shall be borne by the Subcontractor.

9. Different types of cement shall not be mixed, nor shall they be used alternately. Where it is necessary for the color of the concrete to be uniform, only those cements which will produce similar color in concrete may be used alternately. The Purchaser shall designate which cements may be used alternately.

10. Air entraining agents shall be added to the mix by an approved procedure and by the use of an approved dispenser to assure an accurate proportioning of the agent.

11. All admixtures shall be measured with an accuracy of plus or minus 3.0 percent.

B. Limitations on Concrete Operations

1. Mixing of concrete shall be discontinued in time to allow finishing to be completed in daylight hours, unless an adequate and approved artificial lighting system is provided and operated.

2. When concrete is being placed during hot weather, appropriate measures shall be taken to reduce the hazards of increased rate of cement hydration and high concrete temperatures. The temperature of the concrete at point of discharge shall not exceed 90^0 F. The Purchaser may require any or all, but not limited to, the following precautions to reduce the temperature of the concrete:

   a. Sprinkle coarse aggregate stockpiles in a manner so as to distribute the water evenly and to prevent a variation of moisture within the stockpile.

   b. Use crushed or chipped ice as a portion of the mixing water, or use water cooled by refrigeration or other means. If ice is used, it shall be substituted on a pound for pound basis for water and completely melted before the concrete is discharged from the mixer.

   c. The Subcontractor may employ other means which he may have at his disposal if approved by the Purchaser. In order to minimize the number and extent of precautions as indicated during the production and use of concrete during hot weather, the Subcontractor may use approved chemical admixtures for set-retarding purposes, with the Purchaser's approval. However, the use of such approved set-retarding admixtures shall not relieve the Subcontractor of the necessity for other precautions deemed necessary to minimize variability of the physical characteristics, strength, and other requirements of the green concrete.

   d. Unless authorized in writing by the Purchaser, mixing and concreting operations shall be discontinued when a descending air temperature in the shade and away from artificial heat reaches 40^0F (if the temperature is expected to reach 35^0F or below), and not resumed until an ascending air temperature in the shade and away from artificial heat reaches 35^0F.

   e. When concreting at temperatures above 35^0F, the aggregates or water shall be heated or cooled if necessary prior to being placed in the mixer so that the temperature of the resultant mixture will be not less than 50^0F nor more than 90^0F at the time of placement. If heating is required, the apparatus used shall heat the mass uniformly and shall be so arranged as to preclude the possible occurrence of overheated areas which might injure the concrete.

   f. When concreting is authorized at temperatures 35^0F or less, the Purchaser will require the water or the aggregates or both to be heated to not less than 70^0F nor more than 150^0F. The temperature of the mixed, heated concrete shall be not less than 50^0F nor more than 100^0F at the time of placement. No concrete shall be placed on frozen grade nor shall frozen aggregates be used in the concrete.

   g. When it is expected that the ambient temperature will drop below 35^0F, the Subcontractor shall provide sufficient canvas and framework, other types of housing, or to enclose and protect the concrete in such a way that the air surrounding the fresh concrete can be maintained at a temperature of not less than 45^0F and the temperature of the concrete shall not exceed 80^0F. The above conditions shall be

maintained for a period of 120 hours after the concrete is placed. The Subcontractor shall be responsible for the quality of concrete placed during cold weather, and any concrete injured by frost action or freezing shall be removed and replaced at the Subcontractor's expense. When impending weather conditions indicate the possibility of the need for such temperature protection, all necessary heating and covering material shall be on hand ready for use before the Purchaser's permission is granted to begin placement.

3.03 MIXING CONCRETE

A. General

1. The concrete may be mixed in a central mix plant or in truck mixers. The mixer shall be of an approved type and capacity, and shall comply with the applicable requirements of Paragraph 4.03 of this Specification Section. Mixers shall be cleaned at suitable intervals. Equipment having components made of aluminum or magnesium alloys which would have contact with plastic concrete during mixing, transporting or pumping of Portland cement concrete, shall not be used.

2. The batch shall be so charged into the drum that a portion of the mixing water shall enter in advance of the cement and aggregates. Mixing time shall be measured from the time all materials except water are in the drum. The flow of water shall be uniform, and all water shall be in the drum buy the end of the first 15 seconds of the mixing period. The throat of the drum shall be kept free of such accumulations as may restrict the flow of materials into the drum.

3. When mixed in a central mixing plant, the mixing time shall not be less than 60 seconds nor more than 90 seconds. Mixing time ends when the discharge chute opens. Transfer time in multiple drum mixers shall be included in the mixing time. The contents of an individual mixer drum shall be removed before a succeeding batch is emptied therein.

4. The mixer shall be operated at the drum speed recommended by the manufacturer. Any concrete mixed less than the specified time shall be discarded and disposed of by the Subcontractor at his expense. Mixers for central mix plants shall not be operated at a capacity greater than the manufacturer's guaranteed mixing capacity.

5. Mixed concrete from the central mixing plant shall be transported in truck mixers, truck agitators or nonagitating trucks having special bodies. The time elapsing from the time water is added to the mix until the concrete is deposited in place at the site of the Work shall not exceed 30 minutes when the concrete is hauled in nonagitating trucks, nor 60 minutes when hauled in truck mixers or truck agitators. When high early strength concrete is used, agitator trucks only shall be used and the concrete shall be deposited in place at the site of the Work within 30 minutes from the time water is added to the mix, regardless of the method of transportation, unless otherwise approved by the Purchaser.

6. Truck mixers and truck agitators used to transport concrete from a central mixing plant and truck mixers used to mix concrete in transit from a central batching plant shall meet all applicable requirements of Paragraph 4.03 of the Specification Section, and in addition, the mixing speed and agitating speed shall be those recommended by the manufacturer of the mixer and the total revolutions at mixing speed shall not be less than 70 nor more than 100. Truck mixers and truck agitators shall be operated within the capacity recommended by the manufacturer.

7. Retempering concrete by adding water or by other means will not be permitted. Concrete that is not within the specified slump limits at time of placement shall not be used. Admixtures for increasing the workability or for accelerating the set will be used only

when provided for in the Contract, or permitted by the Purchaser. The addition of admixtures to the mix shall be in accordance with the provisions of Paragraph 5.02.A of this Specification Section.

8. Tests for air content shall be made on samples of fresh concrete when and as directed. The air content shall be that specified under Part 6 of this Specification Section and shall be determined in accordance with AASHTO T 152, T 196 or T 199.

B. Ready Mixed Concrete

1. Ready mixed concrete shall fully comply with ASTM C 94 for Ready Mixed Concrete and to the requirements of these Specifications. Ready mixed concrete shall be discharged from the mixer within 1 hour after the introduction of water, provided the air temperature or the concrete temperature does not exceed 70^0F. When the air temperature or concrete temperature exceeds 70^0F, the elapsed time between the addition of water to the mix and discharge shall not exceed 30 minutes. The 30 minute time limit for temperatures exceeding 70^0F may be extended to 1 hour, provided an approved admixture is used. The admixture shall be a water reducing and retarding agent meeting the requirements of Paragraph 3.06, Type D of this Specification Section and shall be used in accordance with the provisions of Paragraph 5.02.A of this Specification Section. The ready-mix plant furnishing the concrete shall have been inspected and approved for use as provided for in Part 4 of this Specification Section.

2. The delivery ticket accompanying each load of concrete shall show the class and quantity of concrete, the quantity of cement, aggregates, water, and additive used in the batch, and the time of batching. Materials used in the concrete shall be tested and approved.

3.04 MIX DESIGN AND PROPORTIONING

A. GENERAL

1. A Concrete Classification Table, Table 03050.2 is provided hereinafter to indicate to the Subcontractor the five classes of concrete to be use. The table contains certain criteria to be met in the design of job mixes for the different classifications of concrete. Data included are the minimum 28 day compressive strength of the concrete (14 day strength for Class B concrete), the range of 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.

CONCRETE CLASSIFICATION TABLE

Table 03 05 00.2

Minimum #/CY Class Of Concrete	28-Day Limestone Compressive Strength (psi)	Slump In Inches	(i) (3) Min. Cement Factor-Sacks/CY Gravel Course Aggregate	Limestone Course Aggregate	(3) Min. Cement Factor-#/CY Gravel Course Aggregate	Limestone Course Aggregate	(3) Net Water Max. Gals./CY Gravel Course Aggregate	Limestone Course Aggregate	(3) Net Water Max- Gravel Course Aggregate	
A 3,000	3-5	6.0	5.5	564	517	36	33	300	275	
AS	4,000	3-5	**(2)**	6.2	**(2)**	583	**(2)**	37.2	**(2)**	310
B 3,500 **(1)**	1-2 ½	6.2	5.8	583	545	34.1	31.9	284	266	
C 2,500	2-4	5.0	4.5	470	423	34	30.6	283	255	
P 5,000	1-3	**(2)**	7.0	**(2)**	658	**(2)**	35.0	**(2)**	292	

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

3.05 MIX DESIGN

A. Prior to mixing any concrete for the project, the Subcontractor shall submit his proposed design mix and reports of tests for each classification of concrete to the Purchaser for approval. The design mix shall be submitted on a form that indicates the supplier and type of the concrete and materials to be used as well as the amounts of materials per cubic yard for at least the following items and units (based upon saturated surface dry aggregate):

1. Cement-Pounds
2. Coarse Aggregate-Pounds
3. Fine Aggregate-Pounds
4. Air Entraining Admixture – Ounces
5. Other Admixtures (if allowed) – Ounces
6. Water – Pounds
7. Fly Ash (if allowed) – Pounds

3.06 PROPORTIONING

A. Each class of concrete shall be manufactured by combining the several materials prescribed in the design mix in the proportions necessary to obtain the specified compressive strength for each class. Proportioning shall be based upon the specified cement content, and the amount of water for each class of concrete shall not exceed the quantity shown in Table 03050.2. Below this limit, the quantity of water shall be adjusted to meet the slump requirements. Aggregate weights shown in the Subcontractor's mix design(s) shall be based on saturated surface dry aggregate; batch weights shall be corrected to compensate for surface moisture on the aggregate in order to determine the amount of water to be added at the mixer.

B. In addition to the requirements specified herein and on Table 03050.2, Portland cement concrete for pavement, Class B, (Specification Section 02750) shall have a flexural strength at 14 days of not less than 550 pounds per square inch when tested in accordance with AASHTO T 22.

3.07 CHANGES IN MIX

A. When approved by the Purchaser, the ration of coarse and fine aggregate may be adjusted in order to assure better workability or to accommodate placement by pumping. However, in no case shall the fine aggregate exceed 44 percent of the total aggregate.

B. If during the progress of the Work, the specific gravity of one or both of the aggregates change more than plus or minus 0.03 from those shown on the concrete design, the design weights shall be adjusted by a design change to conform to the new specific gravity.

3.08 TESTING

A. Test Samples

1. The Purchaser shall provide for all test cylinders. All samples shall be cast, cured and tested by the Purchaser at its expense. The Subcontractor will be required to assist the Purchaser in securing necessary materials for casting the required number of cylinders.

Testing ages will be 7 days and 28 days unless otherwise determined by the Purchaser. Laboratory cylinders shall be used to determine the quality of concrete produced. The number of cylinders to be cast daily for any quantity of concrete and laboratory tested, shall be specified by the Purchaser. With prior consent of the Purchaser, the Subcontractor may prepare field cylinders. These cylinders may be used as a gauge for early safe removal of forms where the Subcontractor requests earlier removal than set out in the Specifications.

B. Cement Testing

1. All cement used in the Work shall be pre-tested before use. Cement may be used upon completion of a satisfactory 3 day physical test made in accordance with current ASTM Specifications. Cement shall be tested by an approved commercial testing laboratory at the Subcontractor's expense.

C. Core Samples

1. If the Purchaser's testing of cylinders indicates compressive strength less than required in Table 03050.2 for the class of concrete specified, the Subcontractor may, at his option, elect to drill core samples from the actual concrete placed. If the Subcontractor elects to drill (or is instructed by the Purchaser to drill) core samples from the hardened concrete, the costs of obtaining the cores and of repairing the core holes with non-shrinking grout shall be borne by the Subcontractor.

2. The cores shall be drilled as directed by the Purchaser, at the same approximate locations from which the test cylinder concrete was obtained. The locations of the drilled cores shall be selected so that the remaining structure will not be impaired or sustain permanent damage after the holes are repaired by the Subcontractor. The drilled samples shall be tested for compressive strength by the Purchaser, and the equivalent 28 day strength of the concrete placed and represented by the drilled core samples shall be determined. The Purchaser shall use the test results of the drilled cores to determine the acceptability of the concrete.

3.09 METHODS OF SAMPLING AND TESTING

A. Test cylinders cast to determine acceptability for minimum AASHTO strength requirements shall be made and cured in accordance with AASHTO T 23 and tested in accordance with AASHTO T 22. Test cylinders cast to determine when a precast unit or a structure may be put into service or to determine when a tensioning load may be transferred shall be cured by methods identical to those used in curing the concrete member, and tested in accordance with AASHTO T 22.

B. Drilled core samples shall be taken and tested in accordance with AASHTO T 24. Due to possible fracturing effect of the coring operation, drilled core samples having a compressive strength of 85 per cent or more of specified strength will be considered acceptable.

C. Slump shall be determined in accordance with AASHTO T 119 on the job site during each placement.

D. The amount of air entrained shall be determined by pressure or volumetric meters of approved design and in accordance with AASHTO Method T 152 or AASHTO Method T 196, except that AASHTO Method T 199 may be used after the accuracy of the Chace Air Indicator has been determined by comparison tests.

3.10 CONCRETE FAILING TO MEET STRENGTH REQUIREMENTS

A. Concrete which has been mixed and placed in accordance with these Specifications, and which fails to meet the minimum 28 day strength requirements shall be removed and disposed of by the Subcontractor, at his expense, unless specifically authorized by the Purchaser, in writing, to remain in place. The removal shall be in such manner as will not cause damage to the remaining concrete or to other structural units or other facilities and property.

B. The Purchaser may, at his discretion, allow concrete which fails to meet the minimum strength requirement to remain in place. Payment for this concrete will be at a reduced price, to compensate the Purchaser for loss of durability. The amount of the reduction shall be determined by the Purchaser and shall be based on the particular circumstances.

3.11 MISCELLANEOUS

A. Concrete Mixed and/or Batched Off Project Site

1. Concrete may be mixed and/or batched off the immediate project site, subject to specific approval of the Purchaser and under the direct supervision of the Subcontractor. A delivery ticket (certified by the batch plant) showing mix, quantity of cement, quantity of fine and coarse aggregate, moisture content, total water and gallons per cubic yard of concrete shall be furnished to the Purchaser with each delivery of concrete and the Subcontractor shall show to the satisfaction of the Purchaser that the plant is so located and equipped as to produce and deliver concrete fully meeting the specification requirements.

PART 4 MEASUREMENT AND PAYMENT

The methods of measurement and payment for concrete shall be as specified in Divisions 2 and 3 of these Specifications for each particular item constructed by the Subcontractor.

END OF SECTION 03050

SECTION 03051
CONCRETE FOR GENERAL USE

PART 1 - SCOPE

1.01 This work shall consist of the furnishing and placing of portland cement concrete for general purposes not defined on the Plans, but as directed at the site by the Purchaser. Uses might include but not be limited to subgrade patching and use in patching pavement for utility cuts, bulkheads, pipe collars, underpinning, spillways, or such other uses as might be required by conditions encountered at the site.

PART 2 - MATERIALS AND EQUIPMENT

2.01 MATERIALS.

A. Concrete.
Concrete shall meet the requirements of Specification Section 03050, Portland Cement Concrete, for Class A Concrete.

2.02 EQUIPMENT.
All equipment necessary for the satisfactory performance of this work shall be on hand and inspected before work will be permitted to begin.

PART 3 - CONSTRUCTION REQUIREMENTS

3.01 GENERAL.

A. Concrete for general use shall be provided as directed by the Purchaser for such purposes as may occur during the construction of a project that are not defined on the Plans but result from field conditions encountered. Concrete shall be nonreinforced. Concrete shall be placed at the locations and in the amounts directed by the Purchaser.

B. Concrete shall be placed only on a moist subgrade or other surface material and shall not be placed unless the temperature is 35^0F and rising. In no case shall concrete be placed on a frozen or frosty surface. After the concrete has been placed, it shall be struck off to an appropriate grade or shape and finished as directed by the Purchaser.

PART 4 – MEASUREMENT

4.01 CONCRETE FOR GENERAL USE.
Concrete for general use shall be measured for payment by the cubic yard, to the nearest one-half cubic yard, complete in place.

PART 5 – PAYMENT

5.01 CONCRETE FOR GENERAL USE.
The accepted quantities of concrete for general use will be paid for at the contract unit price per cubic yard, which price will be full payment for preparing the area to receive the concrete, including excavation and form work and for furnishing, placing, finishing, and protecting the concrete, compete in place, to the satisfaction of the Purchaser.

5.02 PAYMENT WILL BE MADE UNDER:

Item No.	Pay Item	Pay Unit

03051-5.01	CONCRETE FOR GENERAL USE (CLASS A)	Cubic Yard

END OF SECTION 03051

SECTION 03310
CONCRETE STRUCTURES

PART 1 GENERAL

1.01 SCOPE

A. This work shall consist of the construction of all structures, or parts of structures, composed of Portland cement concrete whether plain, reinforced, or a combination of both. Concrete structures shall be constructed of Class A Concrete, unless otherwise specified. They shall be constructed on prepared foundations, at the locations indicated or directed in conformity with the dimensions, lines and grades shown on the Plans or as directed by the Purchaser and in accordance with these Specifications.

B. The concrete used in this construction shall be composed of a mixture or mixtures of Portland cement, aggregates, air-entraining agents, water, and chemical additives when approved, combined by the methods an in the proportions defined for the particular class of concrete designated as shown in Specification Section 03050.

C. Parts of a structure, or structures, indicated to be constructed with materials other than Portland cement concrete and concrete reinforcement steel shall be constructed in accordance with the provisions set out in the Specification Section covering the particular type of construction.

PART 2 PRODUCTS

2.01 MATERIALS

Materials used in this construction shall meet the requirements of the applicable Sections or Paragraphs of Specification Section 03 05 00, “Portland Cement Concrete” and the following:

A. Waterstops

1. Waterstops shall be of the type, shape, and dimension shown on the Plans.

2. Metallic: Metallic waterstops shall be sheet copper conforming to the requirements as specified in the current Specifications for Copper Sheet, Strip, Plate, and Rolled Bar, Type ETP, ASTM Designation B 152. The weight per square foot shall be as specified on the Plans.

3. Nonmetallic:

a. Nonmetallic waterstops shall be manufactured from either natural rubber, synthetic rubber, or polyvinylchloride (PVC) at the option of the Subcontractor. Waterstops shall be produced by such a process that, as supplied for use, they will be dense, homogeneous, and free from holes and other imperfections. The cross-section of the waterstop shall be uniform along its length and transversely symmetrical so that the thickness at any given distance from either edge of the waterstop will be uniform.

b. Rubber Waterstop:

i. The waterstop shall be fabricated from a high grade thread-type compound. The basic polymer shall be natural rubber or a copolymer of butadiene and styrene, or a blend of both. The compound shall contain no less than 70 percent by volume of the basic polymer, and remainder shall consist of reinforcing carbon black, zinc oxide, accelerators, antioxidants, vulcanizing agents and plasticizers, but shall contain no factice.

ii. Samples taken from the finished waterstop shall meet the following requirements when tested in accordance with the current specified ASTM method of test.

Title	ASTM Requirement	Method of Test
Tensile Strength (Die “C”)	2500 psi. min.	D 412
Ultimate Elongation (Die “C”)	450 percent, min.	D 412
Shore Durometer Hardness	60-70	D 2240
Specific Gravity (Sec. 17)	1.15 + 0.03	D 297
Water Absorption (% by Wt.)	5 percent, max.	D 570
Tensile Strength after accelerated Aging, oxygen-pressure method	80 percent, min.	D 572

c. Polyvinylchloride Waterstop

i. This waterstop shall be extruded from an elastomeric plastic material. The material shall be a plastic compound, the basic resin of which shall be polyvinylchloride. The compound shall contain any additional resins, plasticizers, stabilizers, or other materials needed to insure that when the material is compounded it will meet the performance requirements of this Specification. No reclaimed polyvinylchloride shall be used.

Title	ASTM Requirement	Method of Test
Tensile Strength (Die “C”)		
Sheet Material	2,000 psi	D 412
Finished Waterstop	1,700 psi	D 412
Ultimate Elongation (Die “C”)		
Sheet Material	350% Min.	D 412
Finished Waterstop	300% Min.	D 412
Stiffness in Flexure	750 psi Min.	D 747
Accelerated Extraction		CRD C 572
Tensile Strength (Die “C”)	1,750 psi	D 412
Elongation (Die “C”)	300%	D 412
Effect of Alkali (After 7 Days)		
Change in Weight	-0.1 to +0.25%	
Change in Hardness, Shore Durometer	+ or – 5%	
Low Temperature Brittleness	-35^{o}	D 746
Specific Gravity	1.3	D 792

ii. For polyvinylchloride waterstops, the supplier shall submit a certificate stating that all of the performance requirements specified for the sheet material under Polyvinylchloride Waterstops have been complied with. Field splices for Polyvinylchloride waterstops shall be performed by heat sealing the adjacent surfaces in accordance with the manufacturer’s recommendations. Waterstops shall be manufactured with an integral cross-section which shall be uniform within plus or minus 1/8 inch in width, and the web thickness or bulb diameter within plus 1/16 inch and minus 1/32 inch.

iii. The Subcontractor shall furnish the Purchaser at this request and at no cost to the Purchaser a certified test report from an approved laboratory covering each lot or

unit of finished waterstops. These test reports shall contain the numerical laboratory test data of the required test.

d. Bentonite and Butyl Rubber Waterstop
   i. Configuration: As indicated on drawings
   ii. Size: 3/4" wide x 3/8" high

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:

c. 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.

d. 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.

e. Binder in epoxy resin concrete and mortar for repairing spalls and other defects in concrete.
Requirements: The material shall meet the compositional specification of AASHTO M 235, Class II and the applicable requirements of the Class III performance specification.

C. Bar Reinforcement

1. Unless otherwise specified, all steel reinforcement for concrete shall be billet steel bars conforming to the requirements of ASTM A 615, Grade 60.

D. Dowel Bars

1. Dowel bars shall be plain and shall conform to the requirements of ASTM A 306, Grade 55, 60, 65, or 70.

E. Welded Wire Fabric

1. Fabric for reinforcement shall conform to ASTM A 185, or as indicated on the Plans, and shall be supplied in mats of the size, design and weight shown on the Plans.

1.02 EQUIPMENT

A. Equipment and tools necessary for handling materials and performing all parts of the Work shall be subject to approval by the Purchaser as to design, capacity, and mechanical condition. Equipment shall be on hand sufficiently ahead of the start of construction operations to be examined and approved. The equipment and organization shall be of sufficient capacity to accomplish the maximum continuous concrete placement, as governed by the construction joints shown on the Plans or as directed by the Purchaser.

B. The requirements for batching plant and mixers shall be as prescribed in Specification Section 03 05 00.

C. Ample and satisfactory equipment for conveying concrete from the mixer to final position in the forms shall be provided. Closed chutes or pipes shall be used when concrete is to be dumped or dropped for a distance greater than 5 feet. Where steep slopes are required, the chutes shall be equipped with baffle boards or shall be in short lengths that will enable the direction of movement to be reversed.

D. Vibrators shall be of an approved type and design and shall operate under load at a rate as recommended by the manufacturer and approved by the Purchaser.

PART 3 EXECUTION

3.01 FORMS

A. Construction

1. Forms shall be mortar-tight and sufficiently rigid to prevent distortion due to the pressure of the concrete and other stresses incidental to the construction operations, including vibration. Forms shall be so constructed and maintained as to prevent the opening of joints due to shrinkage of the lumber.

2. The forms shall be built true to line and grade and shall be held in place by means of studs or uprights, and waling, which shall be sufficiently and substantially braced and tied.

3. All forms and studding shall be cut off and capped with not less than a 2 inch by 4 inch piece so that the top of the cap will be at the elevation of the finished exposed surface of the concrete.

4. All edges shall be chamfered with ¾ inch material, unless otherwise specified. All chamfer strips shall be straight, of uniform width, and dressed.

5. Wood devices of any kind used to separate forms shall be removed before placing concrete within 4 inches of such devices.

B. Form Lumber

1. Form lumber for all exposed concrete surfaces shall be dressed at least on one side and two edges and shall be so constructed as to produce mortar-tight joints and smooth, even concrete surfaces.

2. Plywood forms, or forms face-lined with plywood, masonite, or other approved similar material may be used, provided the plywood forms and form linings are substantial, of uniform thickness, and are mortar-tight when in position.

C. Metal Ties

1. Metal ties or anchorages within the forms shall be so constructed as to permit their removal to a depth of at least one inch from the face without injury to the concrete. In case wire ties are permitted, the wires shall be cut back at leas ¼ inch from the surface of the concrete, and the surface left sound, smooth, even, and uniform in color.

D. Walls

1. Sufficient openings shall be provided at intervals along the bottom of wall forms to permit thorough cleaning prior to concrete placement. Such openings shall be closed before placing concrete in the forms.

E. Surface Treatment

1. Prior to placing reinforcement, all forms shall be treated to prevent the adherence of concrete. Forms not provided with a special treatment shall be treated with an approved oil. Any material that will adhere to or discolor the concrete shall not be used.

F. Metal Forms

1. The specifications for forms, as regards design, mortar tightness, filleted corner, beveled projections, bracing, alignment, removal, and reuse and oiling apply to metal forms. The metal used for forms shall be of such thickness that the forms will remain true to shape. All bolt and revet heads shall be countersunk on the face forming the concrete surface. Clamps, pins, or other connecting devices shall be designed to hold the forms rigidly together and to allow removal without injury to the concrete. Metal forms which do not present a smooth surface or do not line up properly shall not be used. Care shall be exercised to keep metal forms free from rust, grease, or other foreign matter.

2. When the Subcontractor wishes to utilize a special forming system not specifically authorized in this Specification, he shall submit his design and calculation to the Purchaser for review and approval.

3.02 FALSEWORK

A. The falsework used to support the forms and concrete for concrete structures shall be supported on sills resting on rigid foundations composed of piles driven until the bearing capacity of each pile is sufficient to support the load to which it will be subjected, or earth-borne footings as hereinafter provided.

B. Earth-borne footings will be permitted only when, in the opinion of the Purchaser, the soil can adequately support the superimposed loads and the following conditions are met:

1. Spread footings will only be permitted on stable ground, capable of supporting the superimposed load.

2. The site is graded and so maintained to prohibit ponding of water or erosion of soil in the proximity of the spread footings.

3. The falsework system shall be designed and constructed to preclude exceeding the bearing capacity of the soil but in no case shall exceed 3,000 pounds per square foot.

4. The footings shall be designed and constructed to carry the superimposed loads.

5. All footings shall be constructed on a level plane.

C. The falsework shall be designed and constructed to support the required loading without distortion or settlement of the forms.

D. The Subcontractor shall place “tell-tales” for observation of the amount of falsework settlement at locations designated by the Purchaser.

E. The Purchaser may require the Subcontractor to submit detailed falsework plans, together with a soils report, design calculations or any other information necessary for a thorough review.

The Subcontractor is totally responsible for the design and construction of the falsework system and shall repair, or remove and replace, as directed and at his expense, any concrete, other material or portions of the structure which are damaged or destroyed due to failure of the falsework.

3.03 REINFORCEMENT

A. All reinforcement shall consist of deformed steel bars, unless otherwise indicated or directed. Deformed steel bars shall have a net area at all sections equivalent to that of plain round or square bars of the corresponding nominal size.

B. Structural steel shapes shall conform strictly to the shapes indicated or required.

C. Steel wire fabric may be furnished in rolls or sheets.

D. Reinforcing steel shall be stored above the ground surface upon platforms, skids or other supports located without the scope of the active construction operations and shall be protected at all times from injury and damage. All brush and weeds shall be removed from the area immediately prior to storing reinforcing steel thereon.

E. Reinforcing steel, where indicated, shall be accurately bent, without heating, to the forms and dimensions indicated on the Plans. Minimum bend diameters shall be in accordance with the requirements of the American Concrete Institute. Unless otherwise indicated, all bends shall be in one plane. Bars of ¾ inch or less which have only hooks or a single bend may be bent in the field, provided satisfactory equipment for proper and accurate work is used and provided the bending is accomplished true to form and dimensions without damage to the bars. All other bending shall be done in the shop before shipment.

F. Substitution of bars of different sizes from those indicated on the Plans may only be made with the written permission of the Purchaser. If substitution is permitted, the following shall apply:

1. The total area of steel in any one linear foot in each direction shall not be reduced.

2. For cast-in-place concrete the clear distance between parallel bars in a layer shall not be less than 1.5 bar diameters, 1.5 times the maximum size of the coarse aggregate, nor 1-1/2 inches.

3. Where positive or negative reinforcement is placed in two or more layers, bars in the upper layers shall be placed directly above those in the bottom layer with the clear distance between layers not less than 1 inch.

4. Clear distance limitation between bars shall also apply to the clear distance between a contact lap splice and adjacent splices or bars.

5. Groups of parallel reinforcing bars bundled in contact to act as a unit shall be limited to 4 in any one bundle. Bars larger than #11 shall be limited to two in any one bundle in beams. Bundled bars shall be located within stirrups or ties. Individual bars in a bundle cut off within the span of a member shall terminate at different points with at least 40 bar diameters stagger. Where spacing limitations are based on bar diameter, a unit of bundled bars shall be treated as a single bar of a diameter derived from the equivalent total area.

6. In walls and slabs, the primary flexural reinforcement shall be spaced not farther apart than 1.5 times the wall or slab thickness, nor 18 inches.

G. All reinforcement shall be furnished in the full lengths shown on the Plans, unless otherwise approved in writing by the Purchaser. No splices shall be made unless indicated on the Plans

or authorized by the Purchaser. Splices shall be so arranged and manipulated as to provide a minimum of 2 inches net clearance between the splices and the surface of the complete concrete work, unless otherwise indicated or directed. Splices of tension reinforcement at points of maximum stress shall be avoided. The members at all splices shall be rigidly clamped by means of at least two approved metal clips located approximately 3 inches from the ends of the bars and bolted around them or securely wired in a manner satisfactory to the Purchaser.

H. Steel shapes shall be spliced only as indicated on the Plans.

I. Steel fabric shall be spliced by overlapping of the sheets by not less than 12 inches; by matching at least three transverse member; and by securely wiring the overlapped sections in a manner satisfactory to the Purchaser.

J. All reinforcing steel before being placed shall be thoroughly cleaned of mill scale, rust, dirt, paint, oil, or other foreign substances or coating of any character that will reduce the bond. If reinforcement which has been placed becomes dirty, rusty, or spattered with mortar which dries before concrete is placed around it, such reinforcement, or part affected, shall be thoroughly cleaned before being covered with concrete.

K. Reinforcement shall be accurately placed and firmly held in position as indicated on the Plans. Steel bars shall be securely fastened together with metal clips or wire at each intersection, except where spacing is less than on 1 foot in each direction then alternate intersections shall be fastened. All reinforcing steel shall be securely spaced from the forms and between adjacent reinforcement by means of precast mortar blocks, metal spacers or other approved devices or methods, and where possible, all spacer devices shall be so arranged that their use cannot be detected in the completed structure. Spacer blocks shall be cast of mortar mixed in the same proportions as that in the concrete mixture and shall not have a length or width greater than the depth required for proper spacing from the forms or between adjacent reinforcement. The use of gravel, concrete, brick, or wooden blocks is prohibited.

L. All the reinforcing steel necessary for a section of a concrete structure shall be accurately and securely placed and the placement approved by the Purchaser before any concrete is deposited in the section, and care shall be observed not to disturb it during the placing of the concrete.

M. All dimensions relating to reinforcing bars are to the centers of the bars, unless otherwise indicated.

N. Tolerances for bending and cutting during fabrication shall be in accordance with the “Manual of Standard Practice” published by the Concrete Reinforcing Steel Institute.

3.04 DRAINAGE AND WEEP HOLES

A. Drainage openings and weep holes shall be constructed using materials in the manner and at the locations shown on the Plans or established by the Purchaser. Ports or vents for equalizing hydrostatic pressure, when required, shall be placed as directed.

3.05 PLACING PIPES, CONDUITS, ANCHORS, CASTING, AND OTHER APPURTENANCES

A. Pipes, conduits, anchors, castings, bolts, plates, grillage, and other appurtenances which are necessary or desirable to be placed in the concrete of a structure, whether indicated on the Plans or not, shall be placed by the Subcontractor during construction, as directed.

B. No compensation will be allowed for placing such pipes, conduits, and other appurtenances, except that no deductions will be made for the volume of concrete displaced by those items.

3.06 EXPANSION JOINTS

A. Expansion devices shall be as indicated on the Plans. The devices shall be securely anchored in correct position. All sliding surfaces shall be true and smooth and shall form complete contact throughout. Movement shall not be impeded by the concrete in which they are embedded.

B. Unless otherwise provided, where portions of concrete bridge superstructure rest on the substructure, the contact area shall be separated by at least two layers of three-ply bituminous-saturated paper.

C. Open joints shall be constructed using forms which will permit removal without injury to the concrete. After removal of the forms, the joints shall be cleaned thoroughly. Filled joints shall be constructed with premolded filler, unless otherwise indicated. Joints requiring a sealant shall be thoroughly cleaned and sealed with one of the specified joint sealing materials before the structure is opened to traffic. Edges of open and filled joints shall be chamfered or edged, as directed. Mortised joints shall be constructed as shown on the Plans or as directed.

3.07 PLACING CONCRETE

A. General

1. Concrete shall not be placed until forms and reinforcing steel have been checked and approved. The forms shall be clean of all debris and kept wet immediately before concrete is placed. The method and sequence of placing concrete shall be approved by the Purchaser. Unless otherwise permitted, all concrete shall be placed in daylight, and the placing of concrete in any portion of the structure shall not be started unless it can be entirely completed in daylight. When the placing of concrete is permitted during other than daylight hours, an adequate and approved artificial lighting system shall be provided and operated.

2. All concrete shall be thoroughly worked during the placing by means of tools of approved type. The working shall be such as to force all coarse aggregate from the surface and to bring mortar against the forms to produce a smooth finish, substantially free from water and air pockets or honeycomb.

3. If the forms show bulging or settlement while concrete is being placed, the placing shall be stopped until correction has been made.

4. T-beam girders, slabs, arch rings, and all horizontal sections of bridges except curbs and sidewalks shall be constructed monolithically and continuously, unless otherwise permitted. Curbs and sidewalks shall be constructed after the bridge deck is completed, unless otherwise indicated on the Plans.

5. After initial set and prior to final set of the concrete, the forms shall not be jarred, and no strain shall be placed on the ends of the projecting reinforcement. Piles shall not be driven closer than 20 feet to footings less than 7 days old nor to foundations supporting concrete less than 7 days old.

B. Railings and Curbing

1. When constructing curb, careful attention shall be given to the installation of railing steel or anchoring devices.

2. Concrete railings shall not be constructed on any structure until the falsework has been struck.

C. Chutes and Troughs

1. Concrete shall be placed so as to avoid segregation of the materials and the displacement of the reinforcement.

2. All chutes, troughs, and pipes shall be kept clean and free from coatings of hardened concrete by thoroughly flushing with water after each run. The water used for flushing shall be discharged clear of the concrete already in place.

3. Care shall be taken to fill each part of the form by depositing the concrete as near final position as possible. The coarse aggregate shall be worked back from the forms and around the reinforcement without displacing the bars. After initial set of the concrete, the forms shall not be jarred and no strain shall be placed on the ends of projecting reinforcement.

D. Vibrating

1. Unless otherwise directed, the concrete shall be compacted with suitable mechanical vibrators operating within the concrete. When required, vibrating shall be supplemented by hand spading with suitable tools to assure proper and adequate compaction.

2. Vibrators shall be so manipulated as to work the concrete thoroughly around the reinforcement and embedded fixtures and into corners and angles of the forms. Vibrators shall not be used as a means to cause concrete to flow or run into position in lieu of placing. The vibration at any point shall be of sufficient duration to accomplish compaction but shall not be prolonged to the point where segregation occurs.

3. At least 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^{o} F., or 21 calendar days, whichever occurs first.

D. For continuous concrete girder or slab units, any length, the falsework and supports shall not be released or removed from any span in the continuous unit until the concrete in all spans in the unit has been placed a sufficient length of time to meet all requirements for the removal of falsework and supports as set forth above.

E. Forms supporting bridge decks between girders and outside curb overhangs may be removed after seven days.

3.10 DEFECTIVE CONCRETE

A. Any defective concrete discovered after the forms have been removed shall be removed immediately and replaced. If the surface of the concrete is bulged, uneven, or shows honeycombing which cannot be repaired satisfactorily, the entire section shall be removed and replaced.

B. Concrete having a 28 day strength of less than the minimum specified shall be removed and disposed of by the Subcontractor, at his expense, unless specifically authorized by the Purchaser, in writing, to remain in place. The removal shall be in such a manner as will not cause damage to the remaining concrete or to other structural units or other facilities and property.

3.11 FINISHING CONCRETE SURFACES

A. Unless otherwise authorized, the surface of the concrete shall be finished immediately after form removal.

B. All concrete surfaces shall be given a Class 1 finish. The following surfaces of all structures shall be given a Class 2 Finish: roadway face and top of curb, vertical outside face of curb overhang or sidewalk slab, bottom surface of slab overhang, bridge railings, barrier railings, all vertical surfaces of the superstructure of dual bridges exposed to view from either structure, and all surfaces of retaining walls, wingwalls, and end walls which are visible from passing vehicles.

1. Class 1, Ordinary Surface Finish

a. Immediately following the removal of the forms, all fins and irregular projections shall be removed from all surfaces which are to be exposed or waterproofed. On all surfaces, the cavities produced by form ties and all other holes, honeycomb spots, broken corners or edges, and other defects, shall be thoroughly cleaned, saturated with water, and carefully pointed and trued with a mortar of cement and fine aggregate mixed in the proportions used in the Class of the concrete being finished. Mortar used in pointing shall not be more than 30 minutes old. All construction and expansion joints in the completed work shall be left carefully tooled and free of all mortar and concrete. The joint filler shall be left exposed for its full length with clean and true edges.

b. All surfaces which cannot be repaired to the satisfaction of the Purchaser shall be "rubbed" as specified for a Class 2 finish.

2. Class 2, Rubbed Finish.

a. After removal of forms, the rubbing of concrete shall be started as soon as its condition will permit. Immediately before starting this work, the concrete shall be kept thoroughly saturated with water. Sufficient time shall have elapsed before the wetting down to allow the mortar used in the pointing to thoroughly set. Surfaces to be finished shall be rubbed with a wetted wooden block or a medium coarse carborundum stone. The carborundum stone shall not be used until the concrete has hardened to the state where the sand will grind, rather than ravel or roll. Rubbing shall be continued until all form marks, projections, and irregularities have been removed; all voids filled; and a uniform surface has been obtained. The paste produced by this rubbing shall be left in place. A brush finish or painting with grout will not be permitted.

b. After all concrete above the surface being finished has been cast, the final finish shall be obtained by rubbing with a fine carborundum stone and water. This rubbing shall be continued until the entire surface is of a smooth texture and uniform color.

c. After the final rubbing is completed and the surface has dried, it shall be rubbed with burlap to remove loose powder and shall be left free from all unsound patches, paste, powder, and objectionable marks.

3. Class 3, Float Finish

a. This finish, for unformed surfaces, except slab surfaces for pavements or bases, shall be achieved by placing an excess of material in the form and removing or striking off the excess with a template, forcing the coarse aggregate below the mortar surface. Creation of concave surfaces shall be avoided after the concrete has been struck off, the surface shall be thoroughly worked and floated with a suitable floating tool of wood, canvas, or cork. Before the finish has set, the surface cement film shall be removed with a fine brush in order to have a fine-grained, smooth but sanded texture.

3.12 FINISHING SLAB SURFACES FOR PAVEMENTS OR BASES.

A. Bridge floors or top slabs of structures serving as finished pavements or bases shall be finished either by hand methods or approved mechanical finishing machines.

B. When the hand method is used, the bridge floors or slabs shall be struck off with a screed which is parallel to the centerline of the roadway, resting on bulkheads or screed strips cut or set to the required cross-section of the roadway. This screed shall be so constructed as to have sufficient strength to retain its shape and that the cutting edge may be adjusted to conform to the profile of the roadway. Screeds shall be of sufficient length to finish the full length of spans 40 feet or less in length. Spans over 40 feet in length shall be finished in two or more

sections, but no section shall be less than 20 feet in length. Screed strips or headers shall be accurately set to 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^{o} with the centerline. All strokes shall begin at the center and end at the edge. After the slab has been finished by the burlap drag, surfaces which will become traffic lanes shall be textured by the formation of transverse grooves. The grooves shall be formed in the surface at an appropriate time during the stiffening of the concrete, so that in the hardened concrete the grooves will be between 0.09 inch and 0.13 inch in width; between 0.12 inch to 0.19 inch in depth; and spaced at random intervals between 0.3 inch and 1.0 inch. The grooves shall terminate approximately 18 inches from curbs, parapets, barrier walls, and other vertical walls. The grooves shall be relatively smooth and uniform; shall be formed without tearing the surface and without bringing pieces of coarse aggregate to the top of the surface; and shall be formed to drain transversely. All areas which do not conform to these requirements shall be corrected at the Subcontractor’s expense by approved methods.

G. As soon as the surface has set sufficiently to withstand damage when walking on it and not later than the morning following the placing of the concrete, it shall be straightedged with the 12 foot straightedge and all variations exceeding 1/8 inch shall be plainly marked. The Subcontractor shall correct a seal such variations in the same manner as specified for Portland Cement Concrete Pavement.

3.13 CURING CONCRETE

A. All concrete surfaces, except those surfaces protected by forms that remain in place seven days or longer as required under the provisions of Specification Section 03310 Paragraph 3.09, “Removal of Forms and Falsework”, shall be cured as specified below. Curing shall begin as soon as the concrete has hardened sufficiently to withstand surface damage to unformed surfaces and immediately after the forms have been removed from formed surfaces.

B. When the temperature is expected to fall below 35^{O} F., the concrete shall be protected in accordance with the provisions of Specification Section 03310 Paragraph 3.14.

C. The initial curing period for concrete surfaces shall be by the “Water Method” for a period of not less than 24 hours, or until the concrete surfaces have been prepared for the application of curing compound, in accordance with the provisions under B below. During the initial curing period, the concrete shall be protected from the sun by burlap mats or other approved materials and kept completely and continuously moist.

D. The “Water Method” and membrane-forming compound method of curing will be required for all bridge decks, and on all concrete slabs when the temperature exceeds 90^{O} F during placement.

1. Water Method

a. All concrete slabs shall be covered immediately with material suitable for use with the water cure and kept thoroughly wet for at least 120 hours from the beginning of the initial curing period. All surfaces other than slabs shall be protected from the sun and shall be kept wet for a period of at least 72 hours from the beginning of the initial curing period. Curbs, walls, handrails, and other surfaces requiring a Class 2 finish may have the covering temporarily removed for finishing, but the covering shall be restored as soon as possible.

2. Membrane-Forming Compound Method

a. All surfaces shall be given the required surface finish prior to application of the curing compound. Prior to the application of curing compound, the surface shall be kept moist.

b. The rate of application of curing compound shall be as recommended by the manufacturer but shall not be less than one gallon for 150 square feet of concrete surface. The curing compound shall be applied, under pressure, immediately after completion of the initial curing period or acceptance of the concrete finish. If the surface is dry, the concrete shall be thoroughly wet with water and the curing compound applied just as the surface film of water disappears. At the time of use, the compound shall be in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle. If the application of the compound results in a streaked or blotchy appearance, the method shall be stopped and water curing, as set out above, applied until the cause of the defective appearance is corrected. The coating shall be protected against marring for a period of seven days from date of application. Any coating marred or otherwise disturbed within the seven day period shall be replaced at once.

3.14 PROTECTION OF CONCRETE IN COLD WEATHER

A. Concrete shall be protected in cold weather a specified in Specification Section 03050.

3.15 WATERPROOFING AND WATERSTOPS

A. Waterproofing shall be applied as indicated in the Division 2 Specifications.

B. Metallic or nonmetallic waterstops, as specified, shall be installed in accordance with the details shown on the Plans and in conformity with the requirements of these Specifications.

C. Metallic waterstops shall be spliced, welded or soldered, as necessary, to form continuous, watertight joints.

D. Nonmetallic waterstops shall be installed in continuous strips without splices, except that splices will be permitted at changes in direction when necessary to avoid buckling or distortion

of the web or flange. All splices of nonmetallic waterstops shall be performed in accordance with the manufacturer's recommendations and in the case of polyvinylchloride waterstops, the heat used shall be sufficient to melt but not char the plastic.

E. Adequate provisions shall be made to support the waterstops during the progress of work and to insure their proper embedment in the concrete. The concrete shall be thoroughly worked in the vicinity of the joints to insure maximum density and imperviousness. Forms shall be so designed that they can be removed without damaging the waterstops. Suitable guards shall be provided to protect exposed projecting edges and ends of partially embedded waterstops from mechanical damage.

PART 4 MEASUREMENT & PAYMENT

4.01 MEASUREMENT

A. All concrete will be measured for payment as stipulated under the Specification Section specifying each individual type of construction.

B. No allowance will be made for furnishing the material and the construction of drainage openings and weep holes as indicated or as directed, provided such openings are 6 inches in diameter or less, except that no deduction will be made for such openings in the computation of concrete quantities. Allowance will be made for other openings as indicated.

C. No allowance will be made for additional cement used in depositing concrete underwater; for use of calcium chloride or chemical additives; for fillers, sealer, and tar paper used in expansion joints; for dowels or other materials used in bonding construction joints; for waterstops; and for painting metals.

D. No allowance will be made for concrete placed below the foundation elevation shown on the Plans or as directed by the Purchaser.

E. No additional compensation will be made for high-early-strength concrete substituted by the Subcontractor.

4.02 PAYMENT

A. All concrete will be paid for as stipulated under the Specification Section specifying each individual type of construction.

END OF SECTION 03310