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## SECTION 02100

## DIVERSION AND CONTROL OF WATER

## PART 1 GENERAL

## 1.1 DIVERSION AND CONTROL OF SURFACE WATER

All permanent construction shall be carried on in areas free from water. Water in varying quantities may be flowing in the river during the entire period of construction. Generally, little stream flow occurs within the river except during and immediately following relatively heavy precipitation. About 70 percent of the annual precipitation falls during the months of December, January, and February. The contractor will not be allowed to work within the channel from 15 November to 15 April. During this period, the Contractor shall ensure that all work in progress is completed to a level that will allow the channel to safely convey water at the maximum pre-project capacity.

## 1.2 DEWATERING AND GROUNDWATER

The groundwater will vary significantly depending on the activity of the existing groundwater recharge basins surrounding all 4 sides of the project work. These basins are typically empty from May to September. If dewatering of any basin is required, contact the Los Angeles County Flood Control District to arrange for dewatering. Groundwater is not expected during the time from May through October. However, if groundwater is encountered prior to or during construction, the construction area shall be dewatered prior to commencement or continuation of the work, and all subgrades, whether for earthfill, or concrete, shall be kept drained and free of water throughout the working period. The method of dewatering, where necessary, shall be submitted by the Contractor to the Contracting Officer for approval.

## 1.3 DRAINAGE

Surface water shall be directed away from excavation and construction sites so as to prevent erosion and undermining of foundations. Diversion ditches, dikes and grading shall be provided and maintained as necessary during construction. Excavated slopes and backfill surfaces shall be protected to prevent erosion and sloughing. Excavation shall be performed so that the site and the areas immediately surrounding the site and affecting operations at the site shall be continually and effectively drained.

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## SECTION 02150

## CLEAR SITE AND REMOVE OBSTRUCTIONS

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 881 (1999) Epoxy-Resin-Base Bonding Systems for Concrete

## 1.2 PROTECTION OF EXISTING WORK

Before beginning any cutting or demolition work for removals, the Contractor shall carefully survey the existing work and examine the drawings and specifications to determine the extent of the work. The contractor shall take all necessary precautions to insure against damage to existing work to remain in place or to be reused, and any damage to such work shall be repaired or replaced as approved by the Contracting Officer at no additional cost to the Government. The Contractor shall carefully coordinate the work of this section with all other work and construct and maintain shoring, bracing and supports, as required. The Contractor shall insure that structural elements are not overloaded and be responsible for increasing structural supports or adding new supports as may be required as a result of any cutting, removal, or demolition work performed under any part of this contract.

## 1.3 ENVIRONMENTAL PROTECTION

All work and Contractor operations shall comply with the requirements of Section 01430 ENVIRONMENTAL PROTECTION.

## 1.4 BURNING

The use of burning at the project site for the disposal of refuse and debris will not be permitted.

## 1.5 EXPLOSIVES

Use of explosives will not be permitted.

## PART 2 PRODUCTS (NOT APPLICABLE)

## PART 3 EXECUTION

### 3.1 REQUIREMENTS

Except as otherwise specified, and/or indicated, areas to be cleared shall be limited to actual excavation areas and areas on which fills and/or structures are to be placed. The removal of trees, shrubs, turf, and other vegetation outside of these areas shall be held to a minimum and care shall be exercised not to damage any trees, shrubs, turf, or vegetation which can be left in place.

### 3.2 CLEARING

Trees smaller than 1-1/2 inches in diameter, stumps, roots, brush, and other vegetation in areas to be cleared shall be cut off 6 inches below the indicated structure subgrade or at the original ground surface, whichever is lower, except as specified. Other vegetation shall be cut off flush or slightly below the original ground surface. Clearing operations shall be conducted so as to prevent damage to trees, structures, and installations under construction or to remain in place.

### 3.3 GRUBBING

Material to be grubbed, together with logs and other organic or metallic debris not suitable for foundation purposes, shall be removed to a depth of not less than 18 inches below the original surface level of the ground in areas indicated as construction areas under this contract, such as areas for structures, fills and areas to be paved.

### 3.4 EXISTING STRUCTURES AND OBSTRUCTIONS

#### 3.4.1 General

The Contractor shall clear the site, and remove and dispose of all existing structures and obstructions for project construction, except as otherwise noted on the drawings. The Contractor shall also follow the requirements in Section 02220, DEMOLITION, prior to the start of removal of all existing structures and obstructions. Obstructions which are designated or specified to be removed but which are not designated or specified to be removed by others shall be removed by the Contractor. Except as otherwise specified, obstructions designated to be removed by others will be removed in sufficient time to preclude interference with the Contractor's operations. The removal of concrete from the existing channel lining and railroad bridge shall be in accordance with the following notes and procedures:

a. Where a section of an existing structure is to be separated from a new structure, and the reinforcement is to be cut at the point of separation, the contractor shall sawcut through the concrete with an approved concrete saw. Any saw cut or irregularities in the surface of the remaining wall or joint shall be filled with an epoxy grout mixture to obtain a smooth plane surface. The reinforcing steel exposed by concrete removal shall be cut off one-inch (1") below the surface of the remaining concrete and the resulting voids shall be patched with epoxy adhesive. Epoxy resin materials shall be two component materials conforming to the requirement of ASTM C 881, Class C as specified in the Section 03307, CONCRETE FOR MINOR

STRUCTURES, specially manufactured for the intended purpose, and be applied in accordance with the manufacturer's directions.

b. Where reinforcement is required to extend through the new joint, concrete shall be removed in the following sequence.

i. A sawcut shall be made one and one-half inches (1-1/2") deep at the removal limits. Care shall be exercised in sawing at the removal limits so as not to cut the reinforcing steel in the remaining slab. The existing reinforcing steel shall be retained and extended into the new construction as indicated on the plans.

ii. Using handheld equipment, the concrete shall be carefully removed for the full depth of the wall or slab and for a minimum distance from the sawcut equal to the longest extension of the existing bars to be extended into the new construction. This extension shall be 30 bar diameters, unless otherwise shown.

iii. Existing reinforcement shall be cut to the required bar extension.

iv. The remaining concrete may be removed by any suitable method upon approval of the contracting officer, who shall be the sole judge of the use of any concrete removal equipment. Explosives, wrecking ball, or other similar devices, which are likely to damage the concrete to be left in place, shall not be used.

#### 3.4.2 Removal

The existing railroad bridge, concrete channel lining, concrete walls, asphalt concrete, guard rail, miscellaneous structures, and fencing shall be removed, where indicated. Refer to Section 02220, DEMOLITION, to determine other requirements prior to removal of the aforementioned obstructions.

#### 3.4.3 Utilities

Prior to removing an obstruction, all applicable utility relocations shall have been coordinated in accordance with Section 01200 GENERAL REQUIREMENTS, paragraph "PUBLIC UTILITIES, NOTICES, AND RESTRICTIONS." Pipes designated by owners as "abandoned" shall be removed within the limits of the project as necessary for clearing. All pipes shall be plugged at the cut ends.

#### 3.5 FILLING OF HOLES

Holes made by removal of obstructions and grubbing operations shall be refilled to subgrade with compacted fill material as specified in the Section 02250 FILLS AND SUBGRADE PREPARATION, AND DRAINAGE SYSTEMS.

#### 3.6 DISPOSAL OF MATERIAL

All material removed, except material specified and/or indicated to be salvaged, is designated as scrap and shall become the property of the Contractor and shall be removed from the site. The Contractor shall be

responsible for compliance with all Federal and State laws and regulations.  
Disposal of refuse and debris and any accidental loss or damage attendant thereto shall be the Contractor's responsibility.

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## SECTION 02200

## EXCAVATION

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 2487 (1998) Classification of Soils for Engineering Purposes (Unified Soil Classification System)

## CORPS OF ENGINEERS (COE)

COE EM 385-1-1 Safety and Health Manual

## 1.2 GENERAL

Excavation shall consist of the removal of every type of material encountered except materials covered by the provisions of the Section 02150 CLEAR SITE AND REMOVE OBSTRUCTIONS in the designated areas or from areas directed. The material to be removed may include but is not limited to earth, hardpan, silt, clay, gravel, cemented sand and gravel, cobble and boulders, adobe, detached pieces of stone and concrete, riprap rock fills, existing fills of miscellaneous debris and rubbish, and other unsuitable materials. Slope lines indicated on the drawings for temporary cuts do not necessarily represent the actual slope to which the excavation must be made to safely perform the work. Excavation for permanent cuts shall be made to the slope lines indicated. Excavation shall be performed in a manner which will not impair the subgrade. Except as otherwise specified, the finish surface of subgrades shall be smooth and shall not vary more than minus 1/2 inch to 0 inch from indicated grade.

## 1.3 BLASTING

Blasting will not be permitted.

## 1.4 PRESERVATION OF PROPERTY

All excavation operations shall be conducted in such a manner that street pavements, bridges, utilities, or other facilities and improvements which are to remain in place permanently will not be subjected to settlement or horizontal movement. The Contractor shall furnish and install sheet piling, cribbing, bulkheads, shores, or whatever means may be necessary to adequately support material carrying such improvements or to support the

improvements themselves and shall maintain such means in position until they are no longer needed. Temporary sheet piling, cribbing, bulkheads, shores or other protective means shall remain the property of the Contractor and when no longer needed shall be removed from the site. All shoring and bracing shall be designed so that it is effective to the bottom of the excavation, and shall be based upon calculation of pressures exerted by, and the condition and nature of the materials to be retained, including surcharge imparted to the side of the trench by equipment and stored materials. Removal of shoring shall be performed in such manner as not to disturb or damage the finished concrete or other facility.

#### 1.5 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

##### SD-04 Drawings

Bracing/Shoring; FIO

The Contractor shall submit shop drawings showing proposed method of bracing which he intends to use. A registered Civil Engineer or Geotechnical Engineer in the State of California shall design the shoring and bracing system. Calculations and design drawings shall be stamped by the registered engineer.

#### 1.6 STRIPPING

Excavation shall not be initiated until stripping has been completed by the Contractor and approved by the Contracting Officer. Stripping shall begin only after clearing and grubbing operations have been completed. Stripping shall consist of the complete removal of the top 6-inches of surface material. Disposal of stripped materials shall be in accordance with paragraph DISPOSAL OF EXCAVATED MATERIALS.

#### 1.7 EXCAVATION FOR STRUCTURES

Excavation within the vicinity of existing structures, utilities, and drainage pipes to remain in place shall be performed in a manner to prevent damage to the structure. Earth banks and facilities to remain in place shall be supported as necessary during excavation. In general, unless otherwise shown or specified, the actual side slopes shall be in accordance with COE EM 385-1-1.

#### 1.8 EXCAVATION FOR SIDE DRAINS

All side drain excavations shall be made in accordance with the Section 02630 STORM-DRAINAGE SYSTEM.

#### 1.9 EXCAVATION FOR BURIED STONE

Buried stone may be present in the excavation. The Contractor will be

required to remove all buried stones larger than 12 inches and up to a maximum size of 5 feet where they interfere with the construction. The Contractor shall notify the Contracting Officer where the buried stone is encountered for written approval of the excavation limits.

#### 1.10 REMOVAL OF UNSATISFACTORY SOILS

The removal of soils which are unsatisfactory for foundations of the levee, structures, access roads, and side drains, may be required in certain areas. Unsatisfactory materials include but are not limited to those materials containing roots and other organic matter, trash, debris and materials classified in ASTM D 2487, as Pt, MH, CH, OH, and OL. The Contractor will be required to excavate any such areas to the depth directed and backfill the areas with compacted fill conforming to the requirements of the Section 02250 FILLS AND SUBGRADE PREPARATION, AND DRAINAGE SYSTEMS.

#### 1.11 DISPOSAL OF EXCAVATED MATERIALS

Excavated materials suitable for required fills shall be placed in temporary stock piles or used directly in the work. All excess materials not utilized as part of the construction and unsatisfactory material shall become the property of the Contractor and removed from the site. The Contractor will be responsible for obtaining all permits and licenses for disposal of excavated material, off-site. No excavated material or waste of any kind shall be disposed of at any place beyond the limits of the work under this contract without express authority. Additional requirements for disposal of excess material can be found in the SPECIAL CLAUSE and Section 01200 GENERAL REQUIREMENTS, Section 01430 ENVIRONMENTAL PROTECTION, and Section 02150 CLEAR SITE AND REMOVE OBSTRUCTIONS.

#### 1.12 OVERCUT

Except as otherwise specified or as may be ordered in writing, any overcut or excavation made outside the lines indicated on the drawings or directed shall be backfilled with compacted fill conforming to the Section 02250 FILLS AND SUBGRADE PREPARATION, AND DRAINAGE SYSTEMS or concrete conforming to the Section 03307 CONCRETE FOR MINOR STRUCTURES. All excavating, backfilling, compacting of backfill, and concreting occasioned thereby shall be by the Contractor at no additional cost to the Government. Any overcut under bridge footings shall be backfilled with concrete.

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## SECTION 02220

## DEMOLITION

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## CORPS OF ENGINEERS (COE)

COE EM 385-1-1 Safety and Health Manual

## 1.2 GENERAL REQUIREMENTS

The work includes demolition of the existing bridge, abutments, part of piers, and removal of resulting demolished materials. Demolished materials shall be removed from the construction site daily, unless otherwise directed, to avoid accumulation at the demolition site. Materials that cannot be removed daily shall be stored in areas specified by the Contracting Office. All work shall be performed in accordance with COE EM 385-1-1, Section 23, Demolition, and other applicable Section.

## 1.3 SUBMITTALS

SD-09 Reports

Work Plans; GA.

The work plans shall be procedures proposed for the accomplishment of the work. The procedures shall provide for safe conduct of the work, including procedures and methods to provide necessary supports, lateral bracing and shoring when required, careful removal and disposition of materials, construction and removal of temporary access road, temporary excavation and permanent backfill, temporary bridging, protection of property which is to remain undisturbed and coordination with other work in progress. The work plans shall include a detailed description of the methods and equipment to be used for each operation, and a demolition schedule in accordance with COE EM 385-1-1. The Contractor shall develop the work plan through close coordination with the BNSF Railroad for all phases of work including the demolition phases and the construction phases prior to the start of work.

The Contractor shall coordinate with BNSF and the COE prior to the start of any demolition phase or activity. The Contractor shall notify BNSF at least 30 days in advance of performing work. The point of contact for BNSF is Mr. Roy Ketring (909) 386-4470.

## 1.4 DUST CONTROL

The amount of dust resulting from demolition shall be controlled to prevent the spread of dust to occupied portions of the construction site and to avoid creation of a nuisance in the surrounding area.

## 1.5 PROTECTION

### 1.5.1 Protection of Personnel

During the demolition work, the Contractor shall continuously evaluate the condition of the structure being demolished and take immediate action to protect all personnel working in and around the demolition site. No area, section, or component of bents, piers, abutments, superstructures, or other structural element will be allowed to be left standing without sufficient bracing, shoring, or lateral support to prevent collapse or failure while workmen remove debris or perform other work in the immediate.

### 1.5.2 Protection of Structures

Abutments, superstructures, and other structural components that are designed and constructed to stand without lateral support or shoring, and are determined to be in stable condition, shall remain standing without additional bracing, shoring, or lateral support until demolished, unless directed otherwise by the Contracting Officer. The Contractor shall ensure that no elements determined to be unstable are left unsupported and shall be responsible for placing and securing bracing, shoring, or lateral supports as may be required as a result of any cutting, removal, or demolition work performed under this contract.

### 1.5.3 Protection of Existing Property.

Before beginning any demolition work, the Contractor shall survey the site and examine the drawings and specifications to determine the extent of the work. The Contractor shall take necessary precautions to avoid damage to existing items to remain in place, to be reused, any damaged items shall be repaired or replaced as approved by the Contracting Officer. The Contractor shall coordinate the work of this section with all other work and shall construct and maintain shoring, bracing, and supports as required. The Contractor shall ensure that structural elements are not overloaded and shall be responsible for increasing structural supports or adding new supports as may be required as a result of any cutting, removal, or demolition work performed under this contract.

## 1.6 BURNING

The use of burning at the project site for the disposal of refuse and debris will not be permitted.

## 1.7 USE OF EXPLOSIVES

Use of explosives will not be permitted.

## PART 2 PRODUCTS (NOT APPLICABLE)

## PART 3 EXECUTION

## 3.1 EXISTING STRUCTURES

Existing bridge shall be demolished by mechanical means as indicated on the drawings. During demolition of the existing bridge, the other bridges shall remain operational for BNSF Railroad.

## 3.2 UTILITIES

Coordination of disconnecting utility services, with related meters and equipment, is specified in Section 01200 General Requirements. Existing utilities shall be removed as indicated. When utility lines are encountered that are not indicated on the drawings, the Contracting Officer shall be notified prior to further work in that area.

## 3.3 FILLING

Voids created by the removal shall be filled in accordance with Section 02250 Fills and Subgrade Preparation.

## 3.4 DISPOSITION OF MATERIAL

Title to materials to be demolished, is vested in the Contractor upon receipt of notice to proceed.

## 3.4.1 Items Salvaged for the Government

Salvaged items to remain the property of BNSF RR shall be removed in a manner to prevent damage, and protected from damage while in storage or during shipment. Items damaged during removal or storage shall be repaired or replaced to match existing items.

## 3.4.2 Unsalvaged Material

Steel, timber, concrete, masonry, and other noncombustible material, shall be removed from the site.

## 3.5 CLEAN UP

Rubbish shall be removed from the project site. Debris shall be removed and transported in a manner that prevents spillage on streets or adjacent areas. Local regulations regarding hauling and disposal shall apply.

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## DIVISION 02 - SITE WORK

## SECTION 02222

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## SECTION 02222

## EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 422	(1963; R 1998) Particle-Size Analysis of Soils
ASTM D 1556	(1990; R 1996) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1998) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu.m.))
ASTM D 2487	(1998) Classification of Soils for Engineering Purposes (Unified Soil Classification System)

## 1.2 DEFINITIONS

## 1.2.1 Degree of Compaction

Degree of compaction shall be expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557

## 1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-09 Reports

Field Density Tests; FIO. Testing of Backfill Materials; FIO.

Copies of all laboratory and field test reports within 24 hours of the completion of the test.

## PART 2 PRODUCTS

## 2.1 MATERIALS

### 2.1.1 Satisfactory Materials

Satisfactory materials shall consist of any material classified by ASTM D 2487 as GW, GP, GC, GM, SW, SP, SM, SC, and ML.

### 2.1.2 Unsatisfactory Materials

Unsatisfactory materials shall be materials that do not comply with the requirements for satisfactory materials. Unsatisfactory materials include but are not limited to those materials containing roots and other organic matter, trash, debris, frozen materials and stones larger than 3 inches, and materials classified in ASTM D 2487, as PT, OH, and OL. Unsatisfactory materials also include man-made refuse from previous construction.

### 2.1.3 Cohesionless and Cohesive Materials

Cohesionless materials shall include materials classified in ASTM D 2487 as GW, GP, SW, and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM will be identified as cohesionless only when the fines are nonplastic.

### 2.1.4 Rock

Rock shall consist of boulders measuring 0.1 cubic yard or more and materials that cannot be removed without systematic drilling and blasting such as rock material in ledges, bedded deposits, unstratified masses and conglomerate deposits, and below ground concrete or masonry structures, exceeding 0.1 cubic yard in volume, except that pavements will not be considered as rock.

### 2.1.5 Unyielding Material

Unyielding material shall consist of rock and gravelly soils with stones greater than 18 inches in any dimension or as defined by the pipe manufacturer, whichever is smaller.

### 2.1.6 Unstable Material

Unstable material shall consist of materials too wet to properly support the utility pipe, conduit, or appurtenant structure.

### 2.1.7 Select Granular Material

Select granular material shall consist of well-graded sand, gravel, crushed gravel, crushed stone or crushed slag composed of hard, tough and durable particles, and shall contain not more than 10 percent by weight of material passing a No. 200 mesh sieve and no less than 95 percent by weight passing the 1 inch sieve. The maximum allowable aggregate size shall be 1 inch, or the maximum size recommended by the pipe manufacturer, whichever is smaller.

### 2.1.8 Pipe Bedding Initial Backfill Material

Initial backfill shall consist of select granular material or satisfactory materials free from rocks 3 inches or larger in any dimension or free from rocks of such size as recommended by the pipe manufacturer, whichever is smaller. When the pipe is coated or wrapped for corrosion protection, the initial backfill material shall be free of stones larger than 1 inch in any dimension or as recommended by the pipe manufacturer, whichever is smaller.

#### 2.1.9 Plastic Marking Tape

Plastic marking tape shall be acid and alkali-resistant polyethylene film, 6 inches wide with minimum thickness of 0.004 inch. Tape shall have a minimum strength of 1750 psi lengthwise and 1500 psi crosswise. The tape shall be manufactured with integral wires, foil backing or other means to enable detection by a metal detector when the tape is buried up to 3 feet deep. The tape shall be of a type specifically manufactured for marking and locating underground utilities. The metallic core of the tape shall be encased in a protective jacket or provided with other means to protect it from corrosion. Tape color shall be as specified in TABLE 1 and shall bear a continuous printed inscription describing the specific utility.

TABLE 1. Tape Color

Blue:	Water Systems
Green:	Sewer Systems

### PART 3 EXECUTION

#### 3.1 EXCAVATION

Excavation shall be performed to the lines and grades indicated. Rock excavation shall include removal and disposition of material defined as rock in paragraph MATERIALS. Earth excavation shall include removal and disposal of material not classified as rock excavation. During excavation, material satisfactory for backfilling shall be stockpiled in an orderly manner at a distance from the banks of the trench equal to 2 times the depth of the excavation, but in no instance closer than 2 feet. Excavated material not required or not satisfactory for backfill shall be removed from the site. Grading shall be done as may be necessary to prevent surface water from flowing into the excavation, and any water accumulating therein shall be removed to maintain the stability of the bottom and sides of the excavation. Unauthorized overexcavation shall be backfilled in accordance with paragraph BACKFILLING AND COMPACTION at no additional cost to the Government.

##### 3.1.1 Trench Excavation

The trench shall be excavated as recommended by the manufacturer of the pipe to be installed. Trench walls below the top of the pipe shall be sloped, or made vertical, and of such width as recommended in the manufacturer's installation manual. Where no manufacturer's installation manual is available, trench walls shall be made vertical. Trench walls more than 5 feet high shall be shored, cut back to a stable slope, or

provided with equivalent means of protection for employees who may be exposed to moving ground or cave in. Vertical trench walls more than 5 feet high shall be shored. Trench walls which are cut back shall be excavated to at least the angle of repose of the soil. Special attention shall be given to slopes which may be adversely affected by weather or moisture content. The trench width below the top of pipe shall not exceed 24 inches plus pipe outside diameter (O.D.) for pipes of less than 24 inches inside diameter and shall not exceed 36 inches plus pipe outside diameter for sizes larger than 24 inches inside diameter. Where recommended trench widths are exceeded, redesign, stronger pipe, or special installation procedures shall be utilized by the Contractor. The cost of redesign, stronger pipe, or special installation procedures shall be borne by the Contractor without any additional cost to the Government.

#### 3.1.1.1 Bottom Preparation

The bottoms of trenches shall be accurately graded to provide uniform bearing and support for the bottom quadrant of each section of the pipe. Bell holes shall be excavated to the necessary size at each joint or coupling to eliminate point bearing. Stones of 3 inches or greater in any dimension, or as recommended by the pipe manufacturer, whichever is smaller, shall be removed to avoid point bearing.

#### 3.1.1.2 Removal of Unyielding Material

Where unyielding material is encountered in the bottom of the trench, such material shall be removed 6 inches below the required grade and replaced with suitable materials as provided in paragraph BACKFILLING AND COMPACTION.

#### 3.1.1.3 Removal of Unstable Material

Where unstable material is encountered in the bottom of the trench, such material shall be removed to the depth directed and replaced to the proper grade with select granular material as provided in paragraph BACKFILLING AND COMPACTION. When removal of unstable material is required due to the fault or neglect of the Contractor in his performance of the work, the resulting material shall be excavated and replaced by the Contractor without additional cost to the Government.

#### 3.1.1.4 Excavation for Appurtenances

Excavation for manholes, catch-basins, inlets, or similar structures shall be of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown. Rock shall be cleaned of loose debris and cut to a firm surface either level, stepped, or serrated, as shown or as directed. Loose disintegrated rock and thin strata shall be removed. Removal of unstable material shall be as specified above. When concrete or masonry is to be placed in an excavated area, special care shall be taken not to disturb the bottom of the excavation. Excavation to the final grade level shall not be made until just before the concrete or masonry is to be placed.

#### 3.1.1.5 Jacking, Boring, and Tunneling

Unless otherwise indicated, excavation shall be by open cut except that sections of a trench may be jacked, bored, or tunneled if, in the opinion of the Contracting Officer, the pipe, cable, or duct can be safely and properly installed and backfill can be properly compacted in such sections.

#### 3.1.1.6 Stockpiles

Stockpiles of satisfactory and wasted materials shall be placed and graded as specified. Stockpiles shall be kept in a neat and well drained condition, giving due consideration to drainage at all times. The ground surface at stockpile locations shall be cleared, grubbed, and sealed by rubber-tired equipment, excavated satisfactory and unsatisfactory materials shall be separately stockpiled. Stockpiles of satisfactory materials shall be protected from contamination which may destroy the quality and fitness of the stockpiled material. If the Contractor fails to protect the stockpiles, and any material becomes unsatisfactory, such material shall be removed and replaced with satisfactory material from approved sources at no additional cost to the Government. Locations of stockpiles of satisfactory materials shall be subject to prior approval of the Contracting Officer.

### 3.2 BACKFILLING AND COMPACTION

Backfill material shall consist of satisfactory material, select granular material, or initial backfill material as required. Backfill shall be placed in layers not exceeding 6 inches loose thickness for compaction by hand operated machine compactors, and 8 inches loose thickness for other than hand operated machines, unless otherwise specified. Each layer shall be compacted to at least 90 percent maximum density of ASTM D 1557, unless otherwise specified

#### 3.2.1 Trench Backfill

Trenches shall be backfilled to the grade shown. The joints and couplings shall be left uncovered during the pressure test. The trench shall not be backfilled until all specified tests are performed.

##### 3.2.1.1 Replacement of Unyielding Material

Unyielding material removed from the bottom of the trench shall be replaced with select granular material or initial backfill material.

##### 3.2.1.2 Replacement of Unstable Material

Unstable material removed from the bottom of the trench or excavation shall be replaced with select granular material placed in layers not exceeding 6 inches loose thickness.

##### 3.2.1.3 Bedding and Initial Backfill

Bedding shall be of the type and thickness shown. Initial backfill material shall be placed and compacted with approved tampers to a height of at least one foot above the utility pipe or conduit. The backfill shall be brought up evenly on both sides of the pipe for the full length of the pipe. Care shall be taken to ensure thorough compaction of the fill under

the haunches of the pipe.

#### 3.2.1.4 Final Backfill

The remainder of the trench, except for special materials for roadways, railroads and airfields, shall be filled with satisfactory material. Backfill material shall be placed and compacted as follows:

- a. Sidewalks, Turfed or Seeded Areas and Miscellaneous Areas:  
Backfill shall be deposited in layers of a maximum of 8 inch loose thickness, and compacted to 85 percent maximum density for cohesive soils and 90 percent maximum density for cohesionless soils. Compaction by water flooding or jetting will not be permitted. This requirement shall also apply to all other areas not specifically designated above.

#### 3.2.2 Backfill for Appurtenances

After the manhole, catchbasin, inlet, or similar structure has been constructed and the concrete has been allowed to cure for 14 days, backfill shall be placed in such a manner that the structure will not be damaged by the shock of falling earth. The backfill material shall be deposited and compacted as specified for final backfill, and shall be brought up evenly on all sides of the structure to prevent eccentric loading and excessive stress.

### 3.3 SPECIAL REQUIREMENTS

Special requirements for both excavation and backfill relating to the specific utilities are as follows:

#### 3.3.1 Water Lines

Trenches shall be of a depth to provide a minimum cover of 1 foot from the existing ground surface, or from the indicated finished grade, whichever is lower, to the top of the pipe

#### 3.3.2 Plastic Marking Tape

Warning tapes shall be installed directly above the pipe, at a depth of 8 inches below finished grade, for laterals and 12 inches for mains unless otherwise shown.

### 3.4 TESTING

Testing shall be the responsibility of the Contractor and shall be performed at no additional cost to the Government

#### 3.4.1 Testing Facilities

Tests shall be performed by an approved commercial testing laboratory or may be tested by facilities furnished by the Contractor. No work requiring testing will be permitted until the facilities have been inspected and approved by the Contracting Officer. The first inspection shall be at the

expense of the Government. Cost incurred for any subsequent inspection required because of failure of the first inspection will be charged to the Contractor.

#### 3.4.2 Testing of Backfill Materials

Characteristics of backfill materials shall be determined in accordance with particle size analysis of soils ASTM D 422 and moisture-density relations of soils ASTM D 1557. A minimum of one particle size analysis and one moisture-density relation test shall be performed on each different type of material used for bedding and backfill.

#### 3.4.3 Field Density Tests

Tests shall be performed in sufficient numbers to ensure that the specified density is being obtained. A minimum of one field density test per lift of backfill for every 100 feet of installation shall be performed. One moisture density relationship shall be determined for every 5 field density tests. Field in-place density shall be determined in accordance with ASTM D 1556. Trenches improperly compacted shall be reopened to the depth directed, then refilled and compacted to the density specified at no additional cost to the Government

#### 3.4.4 Displacement of Sewers

After other required tests have been performed and the trench backfill compacted to the finished grade surface, the pipe shall be inspected to determine whether significant displacement has occurred. This inspection shall be conducted in the presence of the Contracting Officer. Pipe sizes larger than 36 inches shall be entered and examined, while smaller diameter pipe shall be inspected by shining a light or laser between manholes or manhole locations, or by the use of television cameras passed through the pipe. If, in the judgement of the Contracting Officer, the interior of the pipe shows poor alignment or any other defects that would cause improper functioning of the system, the defects shall be remedied as directed at no additional cost to the Government.

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## SECTION 02250

## FILLS, SUBGRADE PREPARATION AND DRAINAGE SYSTEMS

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 131	(1996) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates
ASTM D 75	(1987; R 1992) Sampling Aggregates
ASTM D 422	(1963; R 1998) Particle-Size Analysis of Soils
ASTM D 1556	(1990; R 1996) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1998) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu.m.))
ASTM D 2216	(1998) Laboratory Determination of Water (Moisture) Content of Soil and Rock
ASTM D 2487	(1998) Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 4318	(1998) Liquid Limit, Plastic Limit, and Plasticity Index of Soils

## 1.2 COMPACTION EQUIPMENT

## 1.2.1 General

Compaction shall be accomplished by tamping roller, rubber tired roller, sheep's foot roller, vibratory compactor or mechanical tampers. All equipment, tools, and machines shall be maintained in satisfactory working

condition at all times. Compaction equipment shall be suitable for consistently producing uniform soil densities.

### 1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with SECTION 01330 SUBMITTAL PROCEDURES:

#### SD-09 Reports

Field Density Tests; FIO. Testing of Compacted Fill Materials; FIO.

Copies of all laboratory tests within 24 hours of the completion of the tests.

Fill Material Source Gradations; GA.

### 1.4 GENERAL REQUIREMENTS FOR COMPACTED FILLS AND COMPACTED BACKFILLS

#### 1.4.1 Control

Moisture-density relations shall be established by the Contractor. The soil used for each maximum density test shall be classified in accordance with ASTM D 2487 and shall include a particle size analysis in accordance with ASTM D 422 (analysis of particle size distribution for particles passing the No. 200 sieve shall not be required). At least one five point maximum density test shall be made for every 5 field density tests at each job site. Field density tests shall be performed by the Contractor at the frequency established in paragraph: Field Control, and in such locations to insure that the specified density is being obtained. Moisture-density relations and field densities shall be reported on approved forms. One copy of density data less dry weight determinations shall be provided on the day each test is taken. The completed test reports shall be provided with the Contractor Quality Control Report on the work day following the test.

Monthly soils reports, including maximum density test data, gradations, compaction and air void curves, and field in-place density tests with accompanying field moisture contents, supported by raw data, shall be submitted in a spreadsheet format on a computer disk to the Contracting officer.

##### 1.4.1.1 Laboratory Control

Moisture-density relations shall be established by the Contractor. One moisture-density relation shall be made for each classification, blend or change in classification of soil materials encountered. Approval of moisture-density relations shall be obtained prior to the compacting of any material in the work. The moisture-density relations shall be determined in a laboratory in accordance with ASTM D 1557.

- a. A separate batch of materials will be used for each compaction

test specimen. No materials will be re-used.

b. The desired amount of mixing water will be added for each compaction test specimen, mixed well, and the mixture will be placed in a container with an airtight cover and allowed to cure for 24 hours. A shorter curing time may be allowed where tests show that shortening the curing time will not affect the results.

#### 1.4.1.2 Field Control

Field in-place density shall be determined in accordance with ASTM D 1556, except that in each test, the weight of the disturbed sample representing the full depth of layer shall be not less than 10 pounds for fine grain material and 12 pounds for coarse grain material using a scale for weighing of sufficient capacity and sensitive to .01 pounds. Field in-place moisture content shall be in accordance with ASTM D 2216.

a. Field in-place density shall be correlated to the appropriate five point maximum density test by way of classification of material in accordance with ASTM D 2487, including a particle size analysis in accordance with ASTM D 422 (analysis of particle size distribution for particles passing the No. 200 sieve shall not be required).

b. Gradation Testing. One particle size analysis test from material obtained from field in-place density, shall be performed per 2000 cubic yards of material placed. The particle size analysis shall be in accordance with ASTM D 422. Analysis of particle size distribution for particles passing the No. 200 sieve shall not be required. Atterberg tests, in accordance with ASTM D 4318, shall accompany the particle size analysis. The materials tested shall be classified in accordance with ASTM D 2487.

#### 1.4.1.3 In-Place Densities

One test per 500 cubic yards, for the first 10,000 cubic yards of material and one test for each 2,000 yards thereafter, or fraction thereof, of each lift of fill or backfill areas compacted by other than hand-operated machines. At least one test shall be made in each 2-foot layer of compacted fill or backfill processed as a unit and not less than one test shall be made in each area.

One test per 300 cubic yards, or fraction thereof, of each lift of fill or backfill areas compacted by hand-operated machines. For walls, at least one density test shall be made for each 2-foot height of fill placement per 100 lineal feet of wall, or fraction thereof.

#### 1.4.1.4 Moisture-Density Curves for Cohesionless and Cohesive Material

Cohesionless materials include gravels, gravel-sand mixtures, sands, and gravelly sands. Cohesive materials include clayey and silty gravels, gravel-silt mixtures, clayey and silty sands, sand-clay mixtures, clays, silts, and very fine sands. When results of compaction tests for moisture-density relations are recorded on graphs, cohesionless soils will show straight lines or reverse-shaped moisture-density curves, and cohesive

soils will show normal moisture-density curves.

#### 1.4.2 Settling of Fills or Backfills with Water

Settling of fills or backfills with water will not be permitted.

#### 1.4.3 Fill and Backfill Material

Fill and backfill material shall be obtained from approved sources selected by the Contractor. The Contractor shall provide to the Contracting Officer gradation test results of representative materials obtained from the potential source(s) for authorization to use. Materials shall be free from organic matter, trash, debris, and stones larger than 3/4 of the compacted layer thickness. Compacted fill and backfill shall consist of materials classified in ASTM D 2487 as GW, GP, GM, GC, SW and SC.

#### 1.4.4 Placement

Fill and backfill material shall not be placed against concrete which has not been in place at least 14 days or until the concrete has attained a strength of 2,500 p.s.i. when tested in accordance with the SECTION 03307 CONCRETE FOR MINOR STRUCTURES. Heavy equipment shall not be operated over buried structures until at least 2 feet of fill material has been placed and compacted over them in conformance with the requirements of the subparagraphs of the paragraph 3.2 STRUCTURAL BACKFILL in this section. Compacted fill and backfill shall be placed with suitable equipment in horizontal layers which before compaction, shall not exceed 8 inches in depth for rubber-tired or vibratory rollers, 6 inches in depth for tamping rollers, and 4 inches in depth when mechanical tampers are used. The Contractor may vary the layer thickness within these limits for most efficient operations. Material containing stones shall be placed in a manner to prevent the stones from striking the concrete structures and to prevent the formation of voids. Cut slopes or existing slopes shall be benched or stepped prior to placing fill to insure proper bonding between fill and existing slope. The benching and stepping shall extend a minimum of one (1) foot horizontally into the slope and a minimum of 8 inches vertically or equal to the uncompacted layer thickness.

#### 1.4.5 Moisture Content

Material shall have a uniform moisture content while being placed and compacted. Water shall be added at the source, if required, or by sprinkling each layer of material during placement. Uniform distribution of moisture shall be obtained by disking, harrowing, or otherwise manipulating the soil during and after time water is added. Material containing an excess of moisture shall be manipulated with suitable implements to facilitate maximum aeration and shall be permitted to dry to the proper consistency before being compacted. Fill shall have a maximum moisture content of not more than 3 percent above optimum and a minimum moisture content of not less than 3 percent below optimum.

#### 1.4.6 Compaction

No layer of fill shall be compacted before the practicable uniform moisture

content has been obtained. Scarified areas shall be compacted as specified for the fill placed thereon. Rollers will not be permitted to operate within two feet of channel or structure walls or over buried structures until the compacted fill over the top of the structures has reached a depth of 2 feet. Compaction equipment shall be so operated that structures are not damaged nor overstressed during compaction operations. Mechanical tampers shall be used for compacting the fill material within two feet of structures where rolling equipment is impracticable for use in compaction.

#### 1.4.7 Use of Excavated Materials

Excavated suitable material shall be utilized to the full extent possible to meet project requirements. Suitable materials shall be free of organics, silt, clay, broken concrete, and other objectionable material. Suitable materials may consist of sand, gravelly sand, silty sand, sandy silt, clayey sand, and sandy clay. However, selective excavation, stockpiling, and moisture conditioning will be required to produce material that meets specific requirements of the specification. No excavated materials shall be used for the railroad embankment fill above elevation 150.

## PART 2 PRODUCTS

### 2.1 MATERIALS

#### 2.1.1 Sand Filter and Gravel Drain Materials

Sand filter and gravel drain materials shall be durable, hard, tough, and free from adherent coatings. The material shall not contain corrosive agents, organic matter or soft, friable, thin or elongated particles in quantities considered deleterious by the Contracting Officer.

##### 2.1.1.1 Sand Filter Material

Sand filter material shall consist of natural sand, manufactured sand, or a combination of natural and manufactured sands, and shall be reasonably well graded within the following limits:

Sieve Size	Percent by Weight Passing
1 in.	100
3/8 in.	75 - 100
No. 20	15 - 37
No. 70	0 - 5

##### 2.1.1.2 Gravel Drain Material

Gravel drain material shall consist of gravel, crushed stone, or processed crushed concrete, and shall show a loss in weight of not more than 50 percent when tested in accordance with ASTM C 131, and shall be reasonably well graded within the following limits:

Sieve Size	Percent by Weight Passing
------------	---------------------------

2 in.	100
1-1/2 in.	95 - 100
3/4 in.	35 - 70
3/8 in.	10 - 30
No. 4	0 - 5

#### 2.1.1.3 Points

Points on the individual grading curves obtained from representative samples of the sand filter or gravel drain material not only shall lie between the boundary limits as defined by smooth curves drawn through the tabulated grading limits plotted on a mechanical-analysis diagram but also shall exhibit no abrupt changes in slope denoting skip grading, scalping of certain sizes, or other irregularities which would be detrimental to the proper functioning of the filter or drain.

#### 2.1.1.4 Sampling and Testing

Sampling and testing of the sand filter and gravel drain materials shall be performed by the Contractor to determine compliance of the installed materials with specified requirements in conformance with ASTM C 131, ASTM C 136, and ASTM D 75. Sampling and testing shall be performed at regular intervals with at least one test being made for each 100 cubic yards of material.

#### 2.1.2 Sub-Ballast Material

Sub-ballast material shall be Coarse Aggregate, and shall be in accordance with SECTION 02722 AGGREGATE BASE COARSE.

### PART 3 EXECUTION

#### 3.1 COMPACTED FILL

##### 3.1.1 Preparation for Placing

Before placing material for compacted fill, the surface shall be cleared of all existing obstructions and debris. Unsuitable material not meeting the requirements for fill material shall be removed where directed.

##### 3.1.1.1 Compaction

Each layer of the materials shall be compacted to not less than 95 percent of maximum density, per ASTM D 1557.

##### 3.1.2 Limitations on Equipment Behind Concrete Walls and Bridge Abutments

The gross weight of any piece of equipment, or the combined weight of any combinations of equipment coupled together, used to place, moisten and/or compact fill behind and within 4 feet of concrete walls and bridge abutments shall not exceed 35,000 pounds, including dynamic forces produced by vibratory equipment. Equipment used to compact the fill behind the concrete walls shall be of such size as to be capable of operating in the area between the cut slope and the concrete wall.

### 3.2 STRUCTURAL BACKFILL

#### 3.2.1 Backfill About Structures

##### 3.2.1.1 Location

Backfill shall consist of all fill against and/or around structures.

##### 3.2.1.2 Material

Backfill material shall be obtained from the required excavation as approved by the Contracting Officer. In general, the best material available will be designated as backfill and fill about structures. Backfill may consist of sand, gravelly sand, silty sands, sandy silts, clayey sands, and sandy clays. Organic material, silt, clay, broken concrete and other objectionable material shall not be used.

##### 3.2.1.3 Placing

Backfill material shall not be placed against concrete which has not been in place at least 14 days or until the concrete has attained a strength of 2,500 p.s.i when tested in accordance with SECTION 03307 CONCRETE FOR MINOR STRUCTURES. Backfill shall be placed in 4-inch layers. Hand-operated equipment shall be used within 2 feet of the structure.

##### 3.2.1.4 Compaction

Except as specified hereinbefore, compaction shall not be less than 95 percent, per ASTM D 1557.

### 3.3 SUB-BALLAST SECTION

#### 3.3.1 Placement

Sub-ballast material shall be placed with suitable equipment in horizontal layers which before compaction, shall not exceed 6 inches. Tolerance for finished grade shall be 0 to plus 1/2-inch.

#### 3.3.2 Compaction

Each layer of the sub-ballast materials shall be compacted to not less than 95 percent of ASTM D 1557.

#### 3.3.3 Vehicular Traffic

Vehicular traffic on the sub-ballast surface shall be kept to a minimum. The Contractor shall be responsible for maintaining a firm, true, and smooth surface compacted to the required density.

### 3.4 DRAINAGE SYSTEMS

#### 3.4.1 Location

Drainage systems consist of the weephole drainage system behind retaining walls and the subdrainage system beneath the channel invert.

#### 3.4.2 Protection of Existing Subdrainage System

Following excavation below the channel invert, all filter and drain material to remain in place shall be protected by plastic sheeting to insure that contamination to, or loss of, these materials does not occur. Contamination by clogging of the voids in the materials includes infiltration by muddy water, dust, etc. The perforated pipe shall be protected in place.

#### 3.4.3 Installation

##### 3.4.3.1 Behind Retaining Walls

a. Gravel Drain and Sand Filter Materials shall be moistened and evenly spread until a uniform density is achieved. Limitations on equipment as specified in Paragraph 3.1.2 shall be followed.

##### 3.4.3.2 Beneath Channel Invert

a. Sand Filter Material shall be placed, moistened, and spread in a uniform layer to the lines and grades indicated. Placing and spreading equipment shall be operated in such manner as to not disturb the underlying material. Water shall be added and the material manipulated with spreading equipment until a uniform density is achieved. After installation of the filter material, equipment shall not be operated over the blanket except for placement of gravel drain material. Any filter material contaminated with muddy water or dust or rutted by equipment shall be removed and replaced with fresh filter material.

b. Gravel Drain Material shall be placed over the sand filter material, moistened and spread to a uniform grade to the elevations indicated. Following spreading, the surface of the gravel drain material shall be compacted with one pass of a vibratory roller or tamper. Gravel drain material contaminated with muddy water or dust or rutted by equipment shall be removed and replaced with fresh gravel drain material.

c. Just prior to placing steel reinforcement for the invert, the gravel drain material shall be moistened and shall be kept in a moist state during the entire period steel is being placed. Prior to placing concrete, the material shall be moistened again in conformance with the requirements of the SECTION 03307 CONCRETE FOR MINOR STRUCTURES. The required amounts of water to be applied during moistening operations shall be as directed and shall be applied with approved equipment.

#### 3.5 SUBGRADE PREPARATION

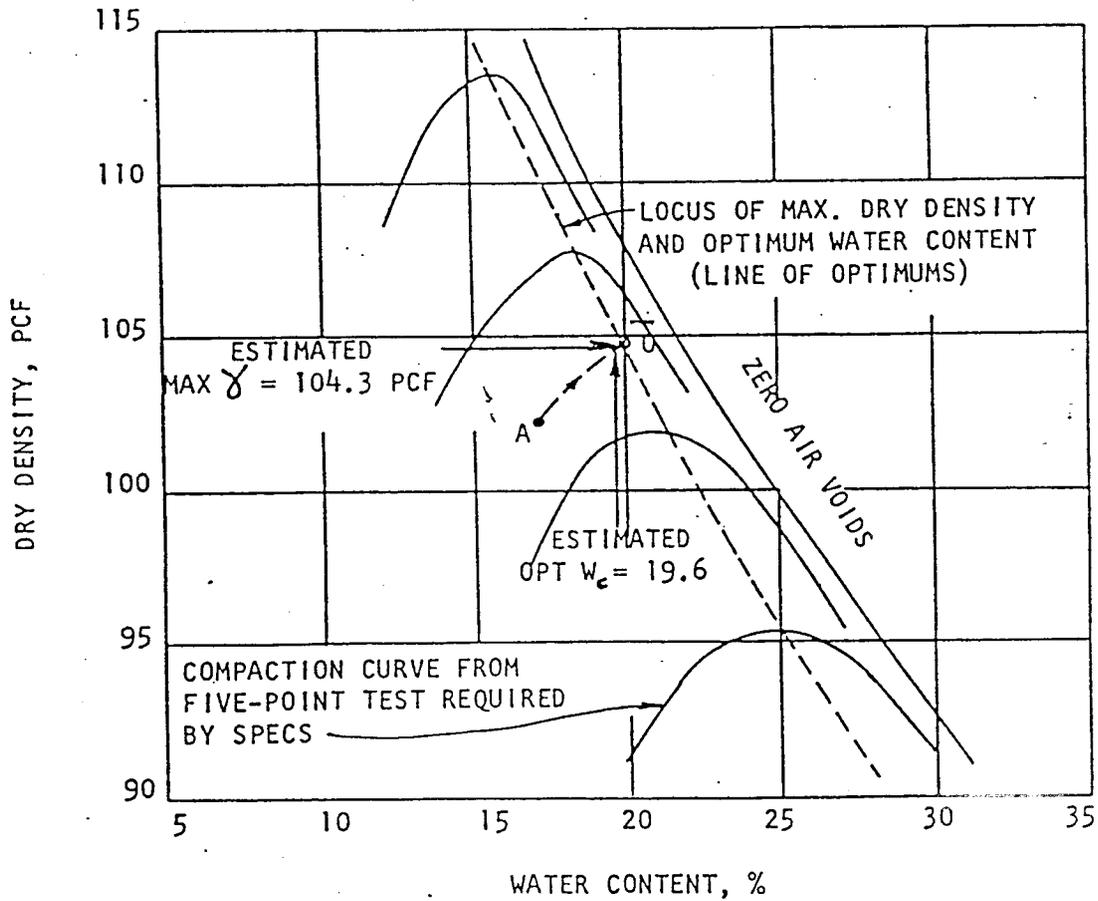
##### 3.5.1 Subgrade for the Modifications of Abutment and Pier-footings

After excavation to rough grade, the entire subgrade for the modification areas of abutments and pier-footings shall be proofrolled by 4 passes of the compaction equipment and trimmed to a uniform grade and smoothed with a steel-wheeled roller to make the subgrade ready to receive concrete. Subgrade excavation must be free of standing water before concrete is placed. If the subgrade is disturbed by the Contractor's operations or is overexcavated, or is soft or yielding, the subgrade shall be restored to grade and compacted to a density of 95 percent of maximum density, per ASTM D 1557. The finished surface of the subgrade shall not be more than 1/2 inch from the indicated grade at any point when tested with a 10-foot straightedge. Dry subgrade will be required for placement of footing concrete and the existing improvements to remain in place. Compaction under pier footings and abutments may require hand machine or other compaction method to attain 95 percent of maximum density.

### 3.5.2 Sub-ballast Subgrade

The sub-ballast subgrade shall be trimmed to the lines and grades shown on the drawings. The surface shall be smooth and uniformly compacted, containing no ruts, potholes, loose soil, or any imperfection which may retain surface water. No sub-ballast material shall be placed on any part of the sub-ballast subgrade until such areas have been inspected and approved by the Contracting Officer.

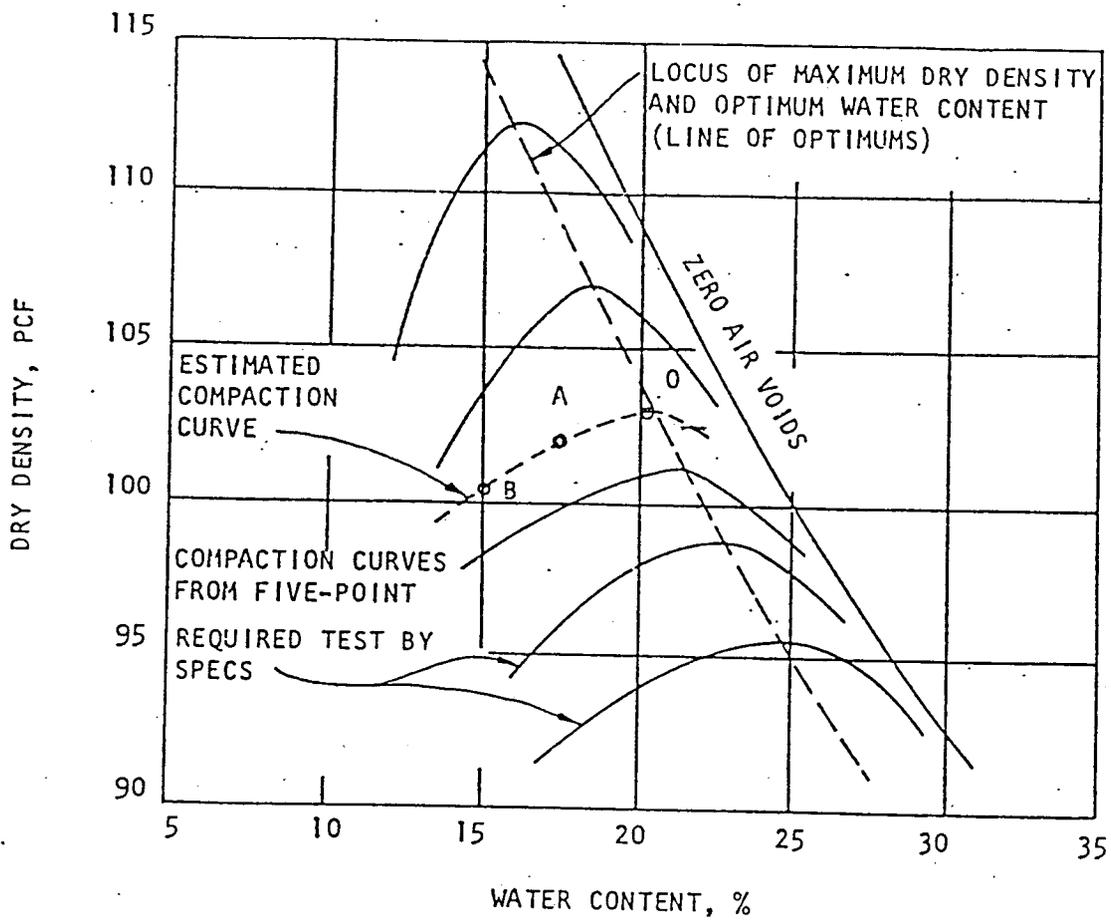
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**PROCEDURE:**

1. Point A is the result of a one-point test on material from field density test. This point must be on the dry side of optimum water content.
2. Point O gives the estimated OPT  $w_c$  and Max  $\gamma$  of the fill material based on a projection of point A approximately parallel to the adjacent compaction curves.
3. Point A must plot within 3 percent of the line of optimums.

**FIGURE 1.** Illustration of one-point compaction method.



PROCEDURE:

1. Points A and B are results of a two-point compaction test on material from field density test. Points A and B must be on the dry side of optimum water content.
2. The estimated compaction curve based on Points A and B establishes Point O on the locus, which is the estimated maximum dry density and optimum water content of the fill material.
3. One point must plot within 3 percent of the line of optimums.

FIGURE 2. Illustration of two-point compaction method.

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## SECTION 02458

## PRESTRESSED CONCRETE PILING FOR CIVIL WORKS

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## ACI INTERNATIONAL (ACI)

ACI SP-66 (1994) ACI Detailing Manual

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36/A 36M (1996) Carbon Structural Steel

ASTM A 82 (1995a) Steel Wire, Plain, for Concrete Reinforcement

ASTM A 416/A 416M (1996) Steel Strand, Uncoated Seven-Wire for Prestressed Concrete

ASTM A 615/A 615M (1996a) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

ASTM C 31/C 31M (1998) Making and Curing Concrete Test Specimens in the Field

ASTM C 33 (1999a) Concrete Aggregates

ASTM C 39 (1996) Compressive Strength of Cylindrical Concrete Specimens

ASTM C 88 (1999a) Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate

ASTM C 150 (1998a) Portland Cement

ASTM C 494 (1999) Chemical Admixtures for Concrete

ASTM C 618 (1999) Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete

ASTM C 666 (1992) Resistance of Concrete to Rapid Freezing and Thawing

ASTM D 4945 (1989) Method for High-Strain Dynamic

## Testing of Piles

## AMERICAN WELDING SOCIETY (AWS)

AWS D1.4 (1992) Structural Welding Code -  
Reinforcing Steel

## CORPS OF ENGINEERS (COE)

COE CRD-C 400 (1963) Requirements for Water for Use in  
Mixing or Curing Concrete

## PRECAST/PRESTRESSED CONCRETE INSTITUTE (PCI)

PCI Mnl-116S (1985) Manual for Quality Control for  
Plants and Production of Precast and  
Prestressed Concrete Products

## 1.2 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-01 Data

Pile Driving Equipment; GA.

Descriptions of all pile driving equipment to be employed in the work, at least 30 days prior to commencement of pile installations, including details of the pile hammer, power plant, lead, cushion material, cap block, driving helmet, extractors, and preboring equipment.

Cutting of Piles; GA.

Submit the proposed method for cutting piles for desired length and for removal of driving heads 30 days prior to the start of pile driving.

Delivery, Storage, and Handling; GA.

Submit delivery, storage, and handling plans for piles at least 30 days prior to delivery of piles to the jobsite.

Concrete Mix; FIO.

Submit concrete mixture proportions prior to casting piles.

Curing of Piles; GA.

Submit methods and details for curing piles prior to casting piles.

## SD-04 Drawings

Prestressed Concrete Piles; GA.

Submit detail drawings of piles at least 30 days prior to commencement of work.

Pile Placement Plan and Tolerances; GA.

Submit pile placement plan and tolerances at least 30 days prior to delivery of piles to the jobsite.

#### SD-08 Statements

Cap Block; GA.

Submit the make-up of the proposed cap block, including material type, dimensions, modulus of elasticity, and coefficient of restitution. This information shall be included with the Pile Driving Equipment submittal.

Driving Records Form; GA.

Submit the proposed form for recording pile driving records 30 days prior to commencement of work.

Pile Driving Tests; FIO.

Submit pile driving test results for test piles within one (1) day of completing field work.

#### SD-09 Reports

Dynamic Testing; GA.

Submit a summary report of dynamic test results for test piles within three (3) days of completing field work.

#### SD-13 Certificates

Admixtures; FIO. Aggregates; FIO. Cement; FIO. Pozzolan; FIO.  
Prestressing Steel; FIO. Reinforcing Steel; FIO.

Submit certificates of compliance for admixtures, aggregates, cement, pozzolan, reinforcement steel, and prestressing steel prior to commencing fabrication of piles. Submit certificates for admixtures, aggregates, cement, and pozzolan along with concrete mix proportions. Submit aggregate source and gradation information for aggregates.

#### SD-18 Records

Driving Records; FIO.

Submit original pile driving records daily.

### 1.3 QUALIFICATIONS

The precast concrete manufacturing plant shall be certified by the Precast/Prestressed Concrete Institute (PCI), Plant Certification Program, or the manufacturer shall establish a quality control program based on PCI Mnl-116S prior to the start of production.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

Piles shall be stored, handled, and transported in accordance with PCI Mnl-116S except as follows. Methods used for handling and storage of piles shall be such that the piles are not subjected to excessive bending stress, cracking, spalling, or other damage. Piles which are damaged during delivery, storage, or handling to the extent they are rendered unsuitable for the work, in the opinion of the Contracting Officer, will be rejected and shall be removed from the work site at no cost to the Government.

##### 1.4.1 Delivery and Storage

Piles shall be held at the plant until the specified ultimate compressive strength is obtained or 14 days, whichever is greater. Storage areas for piles shall be stabilized and suitable foundations provided so differential settlement or twisting of the pile does not occur. Stacked piles shall be separated and supported by dunnage placed across the full width of each bearing point and in vertical planes between the piles. The stacks shall be limited to 5 feet in height unless otherwise approved. Each pile shall be stacked in a straight position and supported every 10 feet or less along its length (ends inclusive) to prevent excessive sweep in the pile.

##### 1.4.2 Handling

Piles shall be lifted by means of a suitable bridle or slings attached to the pile at the embedded lifting points. Alternate pickup methods or locations shall be subject to approval. Dragging of piles across the ground will not be permitted. The Contractor shall inspect each pile for sweep and structural damage such as cracking and spalling before transporting them from the storage site to the driving area. Sweep shall be checked by placing the pile on a firm level surface and rotating the pile. Sweep shall be limited to 2 inches over the length of the pile. The Contractor shall again check the pile for excessive sweep and damage immediately prior to placement in the driving leads. Piles having excessive sweep shall be rejected.

## PART 2 PRODUCTS

### 2.1 MATERIALS

#### 2.1.1 Admixtures

Chemical admixtures shall conform to ASTM C 494. Calcium chloride or admixtures containing chlorides or nitrates shall not be used.

#### 2.1.2 Aggregates

Aggregates shall conform to ASTM C 33, Class 3M, except as specified otherwise herein. Fine aggregates from different sources of supply shall

not be mixed or stored in the same stockpile, or used alternately in the same concrete mix or the same structure without approval. The fineness modulus of fine aggregate shall not be less than 2.40 or greater than 3.00.

For piles that will be exposed to freezing and thawing, fine and coarse aggregate subjected to five cycles of the sodium sulfate soundness test in accordance with ASTM C 88 shall show a loss not greater than 10 percent. If the selected aggregates fail the soundness test, the aggregate source may be used if the concrete specimens made with the aggregates have a durability factor of not less than 80, based on 300 cycles of freezing and thawing, when tested in accordance with ASTM C 666.

#### 2.1.3 Cement

Portland cement shall conform to ASTM C 150, Type II, low alkali.

#### 2.1.4 Pozzolan

Pozzolan shall conform to ASTM C 618, Class F, with the loss on ignition limited to 6 percent.

#### 2.1.5 Prestressing Steel

Prestressing steel shall be seven-wire, 1/2-inch diameter, Grade 270, low relaxation steel strand conforming to the requirements of ASTM A 416/A 416M, and supplement I. Steel shall be free from grease, oil, wax, paint, soil, dirt, loose rust, kinks, bends, and other defects.

#### 2.1.6 Reinforcing Steel

Non-prestressing reinforcing steel shall conform to ASTM A 615/A 615M, Grade 60, deformed, or ASTM A 36, as indicated on the drawings.

#### 2.1.7 Incidental Steel

Incidental steel for use in manufacture of the piles shall conform to ASTM A 36/A 36M.

#### 2.1.8 Ties and Spirals

Steel for ties and spirals shall conform to ASTM A 82.

#### 2.1.9 Water

Water for mixing concrete shall be fresh, clean, drinkable, and free from injurious amounts of oils, acids, alkalies, salts, organic materials, or other substances that may be deleterious to concrete or steel. Undrinkable water may be used if it meets the requirements of COE CRD-C 400. Time of set for concrete made with undrinkable water may vary from one hour earlier to one and one-half hours later than a control sample made with distilled water.

### 2.2 FABRICATION

#### 2.2.1 Prestressed Concrete Piles

Prestressed concrete piles shall be solid concrete piles of the type indicated. Piles shall be cast as monolithic units of homogeneous concrete and pretensioned with prestressing steel. Manufacturing requirements for piles shall conform to PCI Mnl-116S except as modified. Embedded lifting devices for pick-up shall be as shown. Detail drawings of piles, showing dimensions and fabrication details including forms, reinforcement, collars, shoes, and embedded lifting devices shall be submitted for approval. The Contractor shall notify the Contracting Officer one (1) week prior to the date casting of piles is to begin.

#### 2.2.2 Forms

Forms shall be of steel, braced and stiffened against deformation, accurately constructed, watertight, and supported on unyielding concrete casting beds. Form surfaces shall be within 1/4 inch of a true plane in a length of 50 feet. Forms shall permit movement of the pile without damage during release of the prestressing force.

#### 2.2.3 Reinforcement and Embedments

Reinforcing steel, prestressing steel, and embedded items shall be accurately positioned in the forms and secured to prevent movement during concrete placement. Steel shall have a minimum concrete cover of 2-inches. Reinforcing steel details shall conform to ACI SP-66. Welding of reinforcing steel shall be in accordance with AWS D1.4.

#### 2.2.4 Concrete Mix

The concrete mix shall be selected by the Contractor to have an ultimate compressive strength of 8000 psi at 28 days and a slump of 2 to 4 inches. The water-cement ratio (by weight) shall be held to the minimum consistent with workability required for placement but in no case shall it exceed 0.45. Nominal maximum size coarse aggregate shall be 1-inch. Once production begins, changes to the mix will not be permitted without written submittal and approval of the proposed changes.

#### 2.2.5 Concrete Work

Concrete shall not be deposited in the forms until the placement of the reinforcement and anchorages has been inspected and approved by the Contracting Officer. Conveying equipment shall be cleaned thoroughly before each run and the concrete conveyed from the mixer to the forms as rapidly as practicable using methods that will not cause segregation or loss of ingredients. Concrete shall be deposited as nearly as practicable in its final position in the forms. At any point in conveying, the free vertical drop of the concrete shall not exceed 3 feet. Chuting will be permitted if the concrete is deposited into a hopper before being placed in the forms. Concrete that has segregated in conveying shall be removed. Each pile shall be produced of dense concrete with smooth surfaces. Vibrator heads shall be smaller than the minimum distance between steel pretensioning. Side forms shall not be removed until concrete has attained 3500 psi compressive strength. Dimensional tolerances shall conform to PCI Mnl-116S. The ends of all piles shall be chamfered 3/4 inch or, in lieu of

chamfering, may be rounded to a 1 inch radius.

#### 2.2.6 Pretensioning

Anchorage for tensioning the prestressing steel shall be an approved type.

The tension to which the steel is to be pretensioned shall be measured by the elongation of the steel and also by the jack pressure reading on a gauge or by the use of an accurately calibrated dynamometer. The gauge or dynamometer shall have been calibrated by a calibration laboratory approved by the Contracting Officer within 12 months of commencing work and every 6 months thereafter during the term of the contract. Means shall be provided for measuring the elongation of the steel to the nearest 1/4 inch. The applied load determined from elongation measurements shall be computed using load-elongation curves for the steel used. When the difference between the results of measurement and gauge reading is more than 5 percent, the cause of the discrepancy shall be corrected. The tensioning steel shall be given a uniform prestress prior to being brought to design prestress. The same initial prestress shall be induced in each unit when several units of prestressing steel in a pile are stretched simultaneously.

#### 2.2.7 Detensioning

Releasing of prestressing force in pretensioned piles shall be performed in a manner that minimizes eccentricity of prestress. Tension in the strands shall be released from the anchorage gradually. In no case shall the stress be released after casting without approval. The transfer of prestressing force shall be done when the concrete has reached a compressive strength of not less than 5500 psi. The prestressing steel shall be cut or ground flush with the pile ends.

#### 2.2.8 Curing of Piles

Curing of piles shall be in accordance with the provisions contained in PCI Mnl-116S except as follows. The maximum rate of heat gain shall not exceed 40 degrees F per hour and the maximum concrete temperature shall not exceed 165 degrees F during the curing cycle. Curing shall be continued until the concrete has attained a minimum compressive strength of 3500 psi as determined by the concrete test cylinders.

#### 2.2.9 Splices

Splices will not be permitted.

#### 2.2.10 Build-Ups

Build-ups will not be permitted.

### 2.3 TESTS, INSPECTIONS, AND VERIFICATIONS

Testing during manufacture shall be performed by an approved commercial testing laboratory or by an approved laboratory maintained by the manufacturer of the material. Minimum requirements for testing during manufacture shall be as required in PCI Mnl-116S except as modified.

### 2.3.1 Concrete Cylinders

A minimum of four concrete cylinders prepared in accordance with ASTM C 31/C 31M and tested in accordance with ASTM C 39 to indicate transfer and 28-day strengths. The test cylinders may be 4-inch by 8-inch in lieu of the standard 6 inch by 12 inch cylinders when the required 28-day strength of the concrete is 8000 psi or above.

### 2.3.2 Testing by Government

Facilities shall be made available to the Contracting Officer for making and testing any additional test cylinders desired.

### 2.3.3 Certificates of Compliance

The Contractor shall certify and submit Certificates of Compliance that admixtures, aggregates, cement, and pozzolan used conform with the requirements of the specifications. Manufacturer's literature indicating conformance may be submitted for admixtures.

## PART 3 EXECUTION

### 3.1 PILE DRIVING EQUIPMENT

The Contractor shall select the proposed pile driving equipment as specified and submit descriptions of the proposed equipment for approval. Equipment approval will be based on wave equation analysis and the engineering judgment of the Contracting Officer. Stresses predicted by wave equation analysis shall not exceed 0.85 times the concrete compressive strength minus the effective prestress in compression and the effective prestress in tension. Final approval of the proposed equipment is subject to the satisfactory completion and approval of pile tests. Changes in the selected pile driving equipment will not be allowed after the equipment has been approved by the Contracting Officer except as directed by the Contracting Officer. No additional contract time will be allowed for Contractor proposed changes in the equipment.

#### 3.1.1 Pile Driving Hammers

Pile driving hammers shall be of the impact type and capable of satisfying the requirement of paragraph INSTALLATION, subparagraph PENETRATION CRITERIA. Hammers shall be steam, air, or diesel hammers of the single acting, double-acting, or differential acting type. The size or capacity of hammers shall be as recommended by the manufacturer for the pile type, weight, and soil formation to be penetrated. Boiler, compressor, or engine capacity shall be sufficient to operate hammers continuously at the full rated speed so that a single-acting hammer obtains a full upward stroke of the ram, a double-acting hammer operates at or near the blows per minute at which the hammer is rated, and a differential type hammer obtains a slight rise of the hammer base during each upward stroke. Single-acting hammers shall have a scale (in inches) fixed to the hammer's ram guide and a pointed indicator fixed on the ram to allow reading of the hammer's stroke.

Both the scale and indicator shall be easily legible to observers on the ground. Hammers shall have a gage to monitor hammer bounce chamber

pressure for diesel hammers or pressure at the hammer for air and steam hammers. This gage shall be operational during the driving of piles and shall be mounted in an accessible location for monitoring by the Contractor and the Contracting Officer. Two spare operational bounce chamber read-out units shall be available on site. The Contractor shall provide bounce chamber pressure gage correction tables and charts for the type and length of hose to be used with the pressure gage to the Contracting Officer. The following information for each hammer proposed shall be submitted:

- a. Make and model.
- b. Ram weight (pounds).
- c. Anvil weight (pounds).
- d. Mass Weight of the moving parts of the hammer.
- e. Rated stroke (inches).
- f. Rated energy range (foot-pounds).
- g. Rated speed (blows per minute).
- h. Steam or air pressure, hammer, and boiler and/or compressor (psi).
- i. Rated bounce chamber pressure curves or charts, including pressure correction chart for type and length of hose used with pressure gage (psi).
- j. Power pack description.

### 3.1.2 Pile Driving Leads

Leads shall align the pile and hammer concentrically, and maintain the pile in proper position and alignment throughout driving. Hammers shall be supported and guided with fixed extended leads or fixed underhung leads. The leads shall be of sufficient length to fully accommodate the combined length of the pile and hammer. Two intermediate pile supports shall be provided in the leads to reduce the unbraced length of the pile during driving and pulling.

### 3.1.3 Driving Helmets and Pile Cushions

A driving helmet including a pile cushion shall be used between the top of the pile and the ram to prevent impact damage to the pile. The driving helmet and pile cushion combination shall be capable of protecting the head of the pile, minimize energy absorption and dissipation, transmit hammer energy uniformly over the top of the pile and prevent excessive tensile stresses from developing in the concrete during driving. The driving helmet shall fit loosely around the top of the pile so that the pile is not restrained by the helmet if the pile tends to rotate during driving. The pile cushion may be of solid wood or of laminated construction, completely cover the top surface of the pile, and be retained by the driving helmet. Minimum thickness of the pile cushion shall be 3 inches and the thickness shall be increased so as to be suitable for the size and length of pile, character of subsurface material to be encountered, hammer characteristics, and the required driving resistance.

The following information for each hammer proposed shall be submitted:

- a. Pile driving helmet, make, and weight (pounds).
- b. Pile cushion material, type, proposed thickness, modulus of elasticity, and coefficient of restitution.

### 3.1.4 Cap Blocks

The cap block (hammer cushion) used between the driving cap and the hammer ram may be of solid hardwood block with grain parallel to the pile axis and enclosed in a close-fitting steel housing or may consist of aluminum and approved industrial type plastic laminate disks stacked alternately in a steel housing. Steel plates shall be used at the top and the bottom of the cap block. The cap block shall be replaced if it has been damaged, highly compressed, charred, or burned or has become spongy or deteriorated in any manner. If a wood cap block is used, it shall not be replaced during the final driving of any pile. Under no circumstances will the use of small wood blocks, wood chips, rope, or other material permitting excessive loss of hammer energy be permitted.

### 3.1.5 Pile Extractors

Impact hammers are required for pulling piles.

### 3.1.6 Preboring Equipment

The auger of the preboring equipment shall be sufficiently rigid to drill the pilot hole within the tolerances for pile driving specified in paragraph INSTALLATION, subparagraph PILE PLACEMENT AND TOLERANCES. Auger diameter shall not exceed two-thirds the diameter of the pile.

## 3.2 INSTALLATION

### 3.2.1 Lengths of Permanent Piles

The lengths of piles required are indicated on the drawings.

### 3.2.2 Pile Placement and Tolerances

A pile placement plan and tolerances shall be developed to show the installation sequence and the methods proposed for controlling the location and alignment of piles and submitted for approval. Piles shall be placed accurately in the correct location and alignments, both laterally and longitudinally, and to the vertical lines indicated. The Contractor shall establish a permanent baseline during pile driving operations to provide for inspection of pile placement by the Contracting Officer. The baseline shall be established prior to driving permanent piles and shall be maintained during the installation of the permanent piles. Prior to driving and with the pile head seated in the hammer, the Contractor shall check each pile for correct alignment. A vertical deviation from the correct cutoff elevations shown on the drawing of not more than 2 inches will be permitted. A final variation in alignment of not more than 1/8 inch per foot of pile above finished ground, except that the maximum deviation of the top of the pile from the plan location shall be 2 inches in the direction of the structure centerline and 4 inches in the direction along the centerline of the bent. A final variation in rotation of the pile about its center line of not more than 7.5 degrees will be permitted. The correct relative position of all piles shall be maintained by the use of templates or by other approved means. Piles not located properly or

exceeding the maximum limits for rotation, lateral deviation, and/or variation in alignment shall be pulled and redriven at a directed location.

### 3.2.3 Pile Driving

Piles shall not be driven within 150 feet of concrete that is less than 24 hours old. If piles are driven within 150 feet of concrete which has not reached its desired 28 day strength the distances indicated in the following table, based on the concrete strength and pile hammer rated energy, shall be maintained between the concrete and the nearest pile. Driving shall not result in cracking, crushing, or spalling of concrete. The sequence of installation shall be such that pile heave is minimized. Where heave is anticipated, pile driving shall start at the center of the group and proceed outward. The Contracting Officer shall be notified 30 days prior to the date driving is to begin.

Percent of 28 Day Strength	Distance to Concrete (in feet)		
	Energy less than 40,000 ft-lb	Energy 40,000 ft-lb to 60,000 ft-lb	Energy 60,000 ft-lb or greater
20	60 feet	70 feet	85 feet
40	35 feet	45 feet	50 feet
60	24 feet	25 feet	30 feet
80	10 feet	15 feet	15 feet

#### 3.2.3.1 Driving Records

The Contractor shall develop a driving records form for recording the pile driving operations, obtain approval of this form, and compile complete records of the operations. Pile driving records shall include pile dimensions and location, pile identification number, casting date, date driven, original pile length, cutoff and tip elevations, description of hammer used, rated hammer energy, observed stroke and rate of hammer operation (blows per minute), air or steam pressure at the hammer or bounce chamber pressure, length of pressure hose, penetration under the combined weight of the pile and hammer, number of blows required for each foot of penetration throughout the entire length of each pile and for each inch of penetration in the last foot of penetration, time for start and finish of driving, total driving time in minutes and seconds for each pile, cushion information including changes during driving, and any other information as required or requested. Record shall also include information such as unusual driving conditions, interruptions or delays during driving, observed pile damage, heave detected in adjacent piles, records of restriking, depth and description of voids formed adjacent to the pile, and any other pertinent information.

#### 3.2.3.2 Penetration Criteria

Piles shall be driven to the required depth of penetration as shown or until the maximum permissible blow count is exceeded. The maximum permissible blow count shall be established from wave equation analyses so that stresses in the pile are limited to 0 psi in tension and 0.85 times

the compressive strength in compression.

#### 3.2.3.3 Driving

Permanent and test piles shall be driven with hammers of the same model and manufacturer, same energy and efficiency, and using the same driving system. The hammer shall be operated at all times at the speed and under the conditions recommended by the manufacturer subject to the approval. Once pile driving has begun, conditions such as alignment and batter shall be kept constant. Each pile shall be driven continuously and without interruption until the required depth of penetration has been attained. Deviation from this procedure will be permitted only for necessary changes to the pile cushion or whenever driving is stopped by causes that reasonably could not have been anticipated. Pile cushion changes will be considered necessary whenever the cushion has become highly compressed, charred, burned, or deteriorated. Changes to the cushion will not be allowed near the end of driving. A pile that cannot be driven to the required depth because of an obstruction, as indicated by a sudden unexplained change in blow count and drifting, shall be pulled and redriven or shall be cut off and abandoned, whichever is directed. A pile that has reached the required depth of penetration, but has blowcounts of less than 5 blows per inch in the last foot of driving, shall be reported to the Contracting Officer. The Contracting Officer will direct the Contractor to drive a replacement pile at an adjacent location or pull the pile and drive a longer pile in its place. A pile which cannot be driven to the required tip elevation because the maximum permissible blow count is exceeded shall be reported to the Contracting Officer. The Contracting Officer will direct the Contractor to cut off the pile, pull and re-drive the pile, or perform other corrective measures. Corrective measures may consist of adding a pile at an adjacent location or requiring the Contractor to utilize preboring when re-driving the pile. Preboring to assist pile driving is specified in paragraph PREBORING. Observations shall be made to detect heave in accordance with paragraph HEAVED PILES. After piles are driven, the driving head or any excess pile above the cutoff elevation shall be removed in accordance with paragraph CUTTING OF PILES. Voids occurring around piles as a result of pile driving shall be backfilled using an approved thick tremie-placed slurry consisting of sand, bentonite, and portland cement, except the upper 3 feet of the void shall be earth filled and densified to the same density as the surrounding soil.

#### 3.2.3.4 Heaved Piles

When driving piles in clusters or under conditions of relatively close spacing, observations shall be made to detect heave of adjacent piles. Heaved piles shall be restruck sufficiently to relieve soil setup and driven to the original penetration criteria.

#### 3.2.3.5 Pulled Piles

Piles damaged or impaired for use during driving shall be pulled and replaced with new piles, or shall be cut off and abandoned and new piles driven as directed. The Contracting Officer may require that any pile be pulled for inspection. Piles pulled at the direction of the Contracting Officer and found to be in suitable condition shall be redriven at a

directed location. The abandoned hole for any pile that is pulled and moved to an adjacent location shall be filled with an approved thick tremie-placed slurry consisting of sand, Bentonite, and parts Portland cement.

#### 3.2.3.6 Jetting

Jetting of piles will not be permitted.

#### 3.2.3.7 Preboring

Preboring shall be required for all piles placed within three pile diameters of the nearest channel removal line. Preboring shall be to a minimum depth of 5 feet below the channel invert or filter invert, whichever is lower. The maximum preboring will be to 5 feet above the "calculated" pile tip elevation. The diameter of the hole should not exceed two-thirds the width of the pile.

#### 3.2.4 Cutting of Piles

The proposed method for cutting of piles for removal of driving heads must be approved and shall not damage the pile concrete or reinforcement steel left in place. The use of explosives will not be permitted. Driving heads shall not be removed until heaved piles are redriven to the original penetration criteria. Cut off sections of piles shall be removed from the site upon completion of the work.

#### 3.2.5 Splicing

Splicing of piles will not be permitted.

### 3.3 PILE TESTS

Pile driving tests shall be performed as specified and shown or directed. The Contracting Officer will develop the correlation between pile driving resistance and pile capacity during the pile driving tests for the selected pile driving system. Based on the correlations developed, the Contracting Officer will determine the refusal blow count for the permanent piles. Changes in the approved pile driving system during or after completion of tests will not be allowed unless additional tests are performed as directed to establish the correlation between driving resistance and pile capacity for the proposed changed system. For changes in the approved pile driving system proposed by the Contractor, required additional pile driving tests shall be performed at Contractor's expense and no additional contract time will be allowed. The Contractor shall develop and submit for approval a detailed pile test plan which shall include drawings as appropriate and contain the following information:

- a. Method of attaching and supporting dial gages for measuring pile movements and strain signals.
- b. Method of setup of secondary measurement system (surveyor's level, laser beam, etc.).
- c. Calibration curves for the load cell and readout device.

Approval of the plan shall not relieve the Contractor of the responsibility for structural and operational adequacies of the testing system.

### 3.3.1 Test Piles

Test piles shall be of the indicated lengths and shall be placed at the indicated or directed locations. Test piles shall be driven with the same equipment specified in paragraph PILE DRIVING EQUIPMENT and in the same manner specified in paragraph DRIVING for permanent piles. The driving record data shall be recorded for each test pile driven.

### 3.3.2 Pile Driving Tests

Three pile driving tests shall be performed. The Contracting Officer will be present during each pile driving test. Pile driving tests shall be carried to completion without interruption. Any pile driving test not accomplished in accordance with this specification shall be redone at no additional cost to the Government. Test piles may become permanent piles with the approval of the Contracting Officer. Test piles not approved shall be pulled and disposed of by the Contractor. No payment shall be made for test piles not approved.

### 3.3.3 Dynamic Testing of Piles

The Contractor shall provide employ a specialty engineering firm to perform dynamic testing on all test piles to determine velocity of stress wave propagation, acceleration, monitor hammer and drive system performance, assess pile installation stresses and integrity, and to evaluate pile capacity. Personnel experienced in performing wave equation analysis, dynamic testing, and interpretation of results shall be furnished to install and operate the testing equipment, and to furnished to install and operate the testing equipment, and to interpret its results. Equipment to obtain dynamic measurements, record, reduce and display its data shall be furnished and meet the requirement of ASTM D 4945. The equipment shall have been calibrated within 12 months thereafter throughout the contract duration. All power requirements for operating the equipment shall be supplied by the Contractor. Prior to commencing pile driving, a wave equation analysis shall be performed and the results submitted.

#### 3.3.3.1 Test Piles

Dynamic testing shall be performed on the test piles as indicated. Testing shall be performed during the full length of pile driving. Piles which are statically load tested shall be restruck within 48 hours after completion of static load test to correlate static and dynamic test results. Piles installed as part of pile driving test shall be restruck after a minimum waiting period of 24 hours, or as directed by the Contracting Officer. The hammer shall be warmed up prior to restriking. Restriking shall consist of restriking the pile for 50 blows or until the pile penetrates an additional 3 inches, whichever occurs first. In the event the pile movement is less than 1/4 inch during restrrike, the restrrike may be terminated after 20 blows.

#### 3.3.3.2 Reports

A summary report of dynamic test results for test piles shall be prepared and submitted in accordance with paragraph SUBMITTALS. The report shall discuss pile capacity obtained from dynamic testing, and also include velocity of stress wave propagation, acceleration, evaluation of hammer and driving system performance, driving stress levels, and pile integrity. A CAPWAPC, or similar, analysis of the dynamic test data shall be performed on data obtained from the end of initial driving and the beginning of restrike for the test piles as directed. The analysis shall be used to predict pile capacity, establish resistance distribution, and predict quake and damping factors. Refined wave equation analyses incorporating the results of dynamic testing and analysis shall be included. The report for the test piles shall include the pile driving record as an attachment and also address the items listed in paragraph "7.1.5 Dynamic Testing" of ASTM D 4945.

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## SECTION 02600

## STONE PROTECTION

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification, to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 33	(1999a) Concrete Aggregates
ASTM C 88	(1999a) Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C 127	(1988; R 1993) Specific Gravity and Absorption of Coarse Aggregate
ASTM C 295	(1990) Petrographic Examination of Aggregates for Concrete
ASTM C 535	(1996) Resistance to Degradation of Large-Size Coarse Aggregate, by Abrasion and Impact in the Angeles Machine
ASTM D 1141	(1998) Substitute Ocean Water
ASTM D 5519	(1994) Particle Size Analysis of Natural and Man-Made Riprap Materials
ASTM E 548	(1994) General Criteria Used for Evaluating Laboratory Competence

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted, in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Source of Stone; GA.

The submittal shall include the name and location of the Contractor's proposed quarry source, in accordance with paragraph: Source Authorization.

Testing Facilities; GA

The submittal shall include the name of the Contractor's gradation sampling and testing laboratory, in accordance with paragraph: Gradation Sampling and Testing.

#### SD-08 Statements

Method of Placement; GA

The submittal shall include a detailed description of the proposed method of placement of grouted stone, including the equipment to be used and logistical considerations.

#### SD-09 Reports

Gradation Testing; FIO

Results of required gradation tests, in accordance with paragraph: Gradation Sampling and Testing, shall be submitted, prior to placement of grouted stone.

#### SD-14 Samples

Stone Quality; FIO

Samples of stone for testing, in accordance with paragraph: Quality Compliance Testing, shall be submitted 45 days in advance of the time when the stone will be used.

#### SD-18 Records

Waybills and Delivery Tickets; FIO

Copies of waybills or delivery tickets shall be submitted, in accordance with paragraph: Waybills and Delivery Tickets.

## PART 2 PRODUCTS

### 2.1 MATERIALS

#### 2.1.1 Definitions

##### 2.1.1.1 Rounded Stone

Stone which is obtained from alluvial deposits and is nearly spherical and well-rounded.

##### 2.1.1.2 Angular Stone

Stone which is obtained from bedrock deposits and is angular in shape.

#### 2.1.2 General

The Contractor shall make all arrangements, pay all royalties, and secure

all permits for the procurement, furnishing, and transporting of stone. The Contractor shall vary the quarrying, processing, loading and placing operations, to produce the sizes and quality of stone specified. If the stone being furnished by the Contractor does not fully meet all the requirements of these specifications, the Contractor shall furnish, at no additional cost to the Government, other stone meeting the requirements of these specifications.

### 2.1.3 Stone Sources

#### 2.1.3.1 Stone from Project Excavation

Stone conforming to these specifications will not be available from the required excavation(s). The required stone will need to be obtained from off-site sources.

#### 2.1.3.2 Salvaged Stone

Existing stone protection may be salvaged, where indicated. Salvaged stone, that is reused, shall meet all the requirements of these specifications. Salvaged stone, that does not meet the requirements of these specifications, shall be disposed-of, as directed. Salvaged stone, in excess of the amount required for the work, shall be disposed-of.

#### 2.1.3.3 Source Authorization

Before any stone is produced from a source for completion of the work, under this contract, the source of stone must be authorized, by the Contracting Officer's Representative (COR). Authorization of a stone source shall not be construed as a waiver of the right of the Government to require the Contractor to furnish stone, that complies with these specifications. Materials produced from localized areas, zones, or strata will be rejected, when such materials do not comply with the specifications.

#### 2.1.3.4 Source Development

Before a proposed source or sources of stone will be considered for sampling and testing, the Contractor must demonstrate that the source has sufficient stone to fulfill the contract requirements. If sufficient amounts of stone, conforming to these specifications, are not available from a source or sources used in the work, the Contractor shall submit stone from another source, for authorization.

#### 2.1.3.5 Source Documentation

Authorization of a proposed stone source will be based on test results and/or service records. In general, current Corps of Engineers test results shall be required, as outlined in paragraph: Quality Compliance Testing, below. In special cases, however, the COR may elect to use either past Corps of Engineers test results, test results from other agencies or private laboratories, or service records. A service record is considered to be acceptable, if stone from the proposed source has remained sound and functional, after at least 10 years of exposure, on a project similar to the one to be constructed, under these specifications.

#### 2.1.3.6 Potential Stone Sources

The following are a few of the sources in the project area, that have either undergone recent quality compliance testing, for use on Corps of Engineers projects or have acceptable service records:

<u>Source Name</u>	<u>Nearest City</u>
All-American Asphalt	Corona
Ormond (Atkinson)	Riverside
Corona-Pacific	Corona
Pebbly Beach	Catalina
Harlow	Corona
Slover Mountain (Colton Portland Cement)	Colton
Pyrite Street	Riverside
3M	Corona
Eagle Valley	Corona
Fish Canyon	Azusa

Listing of a stone source is not to be construed as to current or future availability of the source, authorization of all materials from the source, nor as a waiver of inspection and testing of the source. Stone produced from any listed source must meet all the requirements set forth in these specifications. Listing of a stone source is also not to be construed as an indication that the source can produce the total quantity of stone required for the project. Stone may be furnished from other sources, designated by the Contractor and authorized by the COR, subject to the conditions stated herein.

#### 2.1.4 Stone Quality

##### 2.1.4.1 Quality Compliance Testing

Samples for Corps of Engineers testing, as specified in paragraph: Stone Quality Testing Requirements, shall be submitted a minimum of 45 days in advance of the time, when the stone will be required in the work. Stone from a proposed source will be tested by the Government, for quality compliance. The first test shall be at Government expense. However, if the stone fails the tests, or if the Contractor desires to utilize more than one source, additional testing will be performed by the Government, at the Contractor's expense. The cost of additional testing will be deducted from payment due the Contractor, in the amount of \$4500, for each sample tested. All test samples (300 pounds minimum) shall be representative of the stone source and shall be obtained by the Contractor, under the supervision of the COR, and delivered (at the Contractor's expense) to a testing laboratory, approved by the COR. The laboratory shall be under the supervision of a registered civil engineer or geologist.

##### 2.1.5 Stone Quality Testing Requirements

Stone shall be subjected to such tests, as are necessary, to demonstrate (to the satisfaction of the COR), that the materials are acceptable for use in the work. At a minimum, the stone shall meet the following test

requirements:

<u>Test</u>	<u>Test Method</u>	<u>Requirement</u>
Specific Gravity (Bulk SSD)	ASTM C 127	2.60 minimum
Absorption	ASTM C 127	2.0% maximum
Wetting and Drying fracturing <sup>(3)</sup>	SPD Test Procedure <sup>(1)</sup>	No
Sulfate Soundness (4)	ASTM C 88 <sup>(2)</sup>	10% max. loss
Abrasion Loss (4)	ASTM C 535	50% max. loss

In addition to the above tests, the stone shall be subjected to a petrographic and X-ray diffraction analysis, in accordance with ASTM C 295<sup>(5)</sup>. The stone must not contain any expansive clays. Stone for grouted stone protection shall not contain excessive amounts of deleterious minerals, associated with alkali-silica or alkali-carbonate reactions, as described in ASTM C 33.

NOTE (1): The test procedure for wetting and drying test is as follows: The entire sample is carefully examined, and representative test specimens are selected. The sample should be large enough to produce two cut slabs, each one being 1-inch thick (+/- 1/4-inch), with a minimum surface area of 30 square inches, on one side. Two chunks, approximately three by four inches, are also chosen. The slabs and chunks are carefully examined, under a low-power microscope, and all visible surface features are noted and recorded. The specimens are then oven-dried, at 140 degrees F., for eight hours, cooled and weighed, to the nearest tenth of a gram. The test specimens are photographed, to show all surface features, before the test. The chunks and slabs are then subjected to fifteen cycles of wetting and drying. One slab and one chunk are soaked in fresh tap water. The other slab and chunk are soaked in salt water, prepared in accordance with ASTM D 1141. Each cycle consists of soaking for sixteen hours, at room temperature, and then drying in an oven, for eight hours at 140 degrees F. After each cycle, the specimens are examined with the low-power microscope, to check for opening or movement of fractures, flaking along edges, swelling of clays, softening of rock surfaces, heaving of micaceous minerals, breakdown of matrix material, and any other evidence of weakness developing in the rock. The cycle in which any of these actions occurs is recorded. After fifteen cycles, the slabs and chunks are again carefully examined, and all changes in the rocks are noted and recorded. The test specimens, together with all particles broken-off during the test, are oven-dried, weighed, and photographed.

NOTE (2): The test shall be made on 50 particles, each weighing 100 grams (+/- 25 grams), in lieu of the gradation given in ASTM C 88.

NOTE (3): Weakening and loss of individual surface particles is

permissible, unless bonding of the surface grains softens and causes general disintegration of the surface material.

NOTE (4): Stone which has a loss greater than the specified limit will be accepted, if the Contractor demonstrates that the stone has a satisfactory service record.

NOTE (5): The test procedure for Petrographic and X-ray Diffraction is performed according to ASTM C 295, except for the following:

(a) A color, microscopic photograph shall be made of each stone type, and the individual minerals within the stone shall be identified by labels and arrows upon the photograph.

(b) A very detailed macroscopic and microscopic description shall be made of the stone, to include all the mineral constituents, individual sizes, their approximate percentages, and mineralogical histories. A description of stone hardness, texture, weathering, and durability factors shall also be discussed.

(c) A written summary of the suitability of stone for use as grouted stone, based on the Petrographic and X-ray tests and the results of ASTM C 535, shall be presented in the final laboratory report on stone quality.

#### 2.1.5.1 Stone Acceptance Criteria

Prior to placement, all stone shall be subject to acceptance by the COR. Acceptance of any stone, shall not constitute acceptance of all stone from a source. All accepted stone shall be as follows:

- a. of the same lithology as the original stone, from which test results or service records were taken, as a basis for authorization of the source;
- b. sound, durable, and hard, and free from laminations, weak cleavages, undesirable weathering, or blasting or handling-induced fractures (or fracture zones, which subtend more than 1/3 of the total circumference of the stone, along the plane of fracturing);
- c. of such character, that it will not disintegrate from the action of air, water, or the conditions of handling and placing; and,
- d. clean and free from earth, clay, refuse, or adherent coatings.

#### 2.1.5.2 Stone for Grouted Stone

Stone for grouted stone protection may be either rounded stone or angular quarried material, with a shape which assures reasonable adhesion with cement grout, yet allows flow of grout throughout the layer, to ensure adequate bonding. The greatest dimension of each piece shall be not greater than 3 times the least dimension.

## 2.1.6 Gradation

### 2.1.6.1 General

All points on individual grading curves shall be between the boundary limits, as defined by smooth curves drawn through specified grading limits, plotted on a mechanical analysis diagram. The individual grading curves shall not exhibit abrupt changes in slope, denoting skip-grading or scalping of certain sizes. Specified grading of all material shall be met both at the source and as-delivered to the project. In addition, material not meeting the required grading, because of segregation or degradation, during placement, shall be rejected. If test results show that stone does not meet the required grading, the hauling operation will be stopped immediately and will not resume, until processing procedures are adjusted, and a gradation test is completed, showing gradation requirements are met. All gradation tests shall be at the expense of the Contractor. For the size-weight relationships used during gradation tests, within-specification weights will be determined, based on a stone specific gravity of 2.60 and stone sizes (diameters), that result for stone shapes midway between that of a sphere and a cube.

- a. Stone for grouted stone may be obtained from a source authorized by the COR and shall be reasonably well-graded, between the limits specified below, when tested in accordance with ASTM D 5519, Test Method A. The grouted stone layer will be 12 inches thick. The stone will be reasonably well-graded, between 4 and 12 inches (in diameter), with not less than 40 percent nor more than 70 percent of the stone 6 inches in diameter.

### 2.1.6.2 Gradation Sampling and Testing

Testing shall be the responsibility of the Contractor and shall be performed at no additional cost to the Government. Tests shall be performed by an approved testing laboratory, on samples selected by the COR. Testing may be done by the Contractor, subject to approval by the COR. If the Contractor elects to establish testing facilities, approval of such facilities shall be based on compliance with ASTM E 548, and no work requiring testing will be permitted, until the Contractor's facilities have been inspected and approved by the COR. Testing shall be supervised by a registered Civil Engineer, experienced in rock-testing. The Government reserves the right to perform check-tests and to use the Contractor's sampling and testing facilities to make the tests. One gradation test shall be required at the beginning of production prior to delivery of stone, from the source to the project site, and results (including gradation plots) submitted, prior to placement. The sample shall consist of not less than 1 ton of stone, selected at random, from the production run for the first test or from stone placed on grade or stockpiled on-site, for required additional tests. All sampling and gradation tests performed by the Contractor shall be under the supervision of the COR.

### 2.1.7 Rejected Stone

Stone of unsuitable quality or size distribution, as required by these specifications, shall be rejected. Any rejected stone shall be promptly

removed from the project, at no expense to the Government. Any portions of the work covered by these specifications, containing rejected stone, will be considered incomplete.

### PART 3 EXECUTION

#### 3.1 FOUNDATION PREPARATION

##### 3.1.1 General

Subgrade preparation, for material placement, shall conform to the provisions of Section 02250 FILLS AND SUBGRADE PREPARATION, AND DRAINAGE SYSTEMS. Areas on which bedding material or stone is to be placed shall be trimmed and dressed, to conform to cross-sections (indicated or directed), within an allowable tolerance of plus or minus 1-inch, from the theoretical slope-lines and grades. Where such areas are below the allowable minus tolerance limit, they shall be brought to grade by filling with earth, similar to the adjacent material and well-compacted, or by filling with approved material. No additional payment will be made for any material, thus required. Immediately prior to placing the stone, the prepared base shall be inspected by the COR, and no material shall be placed thereon, until that area has been approved.

#### 3.2 PLACEMENT

##### 3.2.1 General

Except as otherwise specified, the limits of stone in-place shall follow, with reasonable variation, the indicated lines and slopes, without continuous under or overbuilding. Templates shall be placed at adequate intervals, as determined by the COR, to accurately delineate the surface of the work being placed. For all stonework, the Contractor shall submit the method of placement to the COR, for approval, before placement begins.

##### 3.2.2 Stone for Grouted Stone

Stone for grouted stone shall be placed in such a manner, to produce a reasonably well-graded mass and to ensure that all individual stones can be satisfactorily embedded in grout. The method of placement shall be submitted to COR, for approval, prior to commencement of placement operations. Stone shall be placed, to its full-course thickness, in one operation and in such a manner, to avoid displacing the underlying material. Material shall not be dropped from a height of more than 18 inches. The Contractor shall maintain the stone-protection, until accepted, and any material displaced, by any cause, shall be replaced, at his expense, to the lines and grades indicated. Self-propelled equipment shall not be used on the levee slopes. Hand-placing, barring, or placing by crane will be required, only to the extent necessary, to secure the results specified. Placing stone by dumping into chutes or by similar methods, likely to cause segregation, will not be permitted. A tolerance of minus 1 to plus 2 inches, from the indicated slope-lines and grades, will be allowed in the finished surface, except that either extreme of such tolerance shall not be continuous over an area greater than 200 square feet. Double-decking of thin, flat stones, to bring the surface up to

grade, will not be permitted.

### 3.3 DEMONSTRATION SECTION

#### 3.3.1 General

Prior to placement of stonework, the Contractor shall construct a section of bank- protection, consisting of grouted stone, to demonstrate his proposed operations for production placement. The section shall demonstrate procedure and capability of grading, placing stone and bank-protection, placing grout, and curing of the grouted stone, within the tolerances specified. The demonstration section shall be 100 feet in length and shall conform to all applicable specifications.

#### 3.3.2 Methods and Equipment

Methods and equipment employed for placement shall demonstrate the adequacy, for use in placement of grouted stone, and shall conform with the requirements specified herein. The quantities of all materials, placed within the section, shall be accurately tabulated and provided immediately to the COR, for comparison with the computed quantities.

#### 3.3.3 Demonstration Section Evaluation

The Contractor shall not proceed placing stonework, prior to the approval of the demonstration section. Within a period of 7 days, after completion of the section, the COR shall determine the adequacy of the section to function as part of the permanent construction. The Contractor shall be notified, as to the acceptability

of the section and may be directed to modify his methods of construction and mix design, and remove the section (if necessary).

#### 3.3.4 Removal of Demonstration Section

If removal of the demonstration section is required, it shall be conducted in such a manner, as to maintain the integrity of the underlying subgrade. The Contractor shall make his own arrangements for disposal, in areas not located on the site.

### 3.4 DELIVERY

All stone delivered by rail or truck shall be weighed, and the scale tickets shall be certified by authorized weighers. All railroad cars and trucks, used for delivering stone, shall be plainly numbered.

#### 3.4.1 Scales

Scales used for measurement shall, at the option of the Contractor, be either public scales or approved scales, provided by the Contractor. Weighing shall be at the point nearest the work, at which the public scale is available or at which it is practicable for the Contractor to provide a scale. Scales shall be standard truck scales of the beam-type. The scales shall be of sufficient size and capacity, to accommodate all trucks used in

hauling the material. Scales shall be tested, approved, and sealed by an inspector of the State Inspection Bureau, charged with scales inspection, within the state in which the project is located. Scales shall be calibrated and resealed, as often as necessary, to ensure continuous accuracy. The necessary number of standard weights for testing the scales shall be on hand, at all times, and (if an official inspection bureau of the state is not available) the scales will be tested by the COR.

#### 3.4.2 Waybills and Delivery Tickets

Copies of waybills or delivery tickets shall be submitted to the COR, during the progress of the work. The Contractor shall furnish the COR with scale tickets, for each load of material weighed. These tickets shall include tare weight, identification mark of each vehicle weighed, date, time, and location of the loading. Tickets shall be furnished, at the point and time individual loads arrive at the work site. A master log of all vehicle loading shall be furnished for each day of loading operation. The Contractor shall file, with the COR, the master log of loadings, certified waybills, and certified tickets, within 24 hours of material delivery. Prior to the final payment, the Contractor shall furnish written certification that the material recorded on the submitted waybills and certified tickets was actually used in the construction covered by the contract.

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## SECTION 02630

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## SECTION 02630

## STORM-DRAINAGE SYSTEM

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 76	(1997) Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C 231	(1997) Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 270	(1997a) Mortar for Unit Masonry
ASTM D 1557	(1998) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu.m.))
ASTM D 1751	(1999) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1752	(1984; R 1996) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D 2167	(1994) Density and Unit Weight of Soil in Place by the Rubber Balloon Method

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with SECTION 01330 SUBMITTAL PROCEDURES:

SD-08 Statements

Placing Pipe; FIO.

Printed copies of the manufacturer's recommendations for installation

procedures of the material being placed, prior to installation.

SD-13 Certificates

Pipeline Testing; FIO.

SD-14 Samples

Pipe for Culverts and Storm Drains; FIO.

1.3 DELIVERY, STORAGE, AND HANDLING

1.3.1 Delivery and Storage

Materials delivered to site shall be inspected for damage, unloaded, and stored with a minimum of handling. Materials shall not be stored directly on the ground. The inside of pipes and fittings shall be kept free of dirt and debris. The Contractor shall have a copy of the manufacturer's instructions available at the construction site at all times and shall follow these instructions unless directed otherwise by the Contracting Officer.

1.3.2 Handling

Materials shall be handled in a manner that ensures delivery to the trench in sound, undamaged condition. Pipe shall be carried to the trench, not dragged.

PART 2 PRODUCTS

2.1 PIPE FOR CULVERTS AND STORM DRAINS

Pipe for culverts and storm drains shall be of the sizes indicated and shall conform to the requirements specified.

2.1.1 Reinforced Concrete Culvert, or Storm Drain Pipe

ASTM C 76, Class III.

2.2 DRAINAGE STRUCTURES

2.2.1 Flared End Sections

Sections shall be of a standard design fabricated reinforced concrete meeting requirements of ASTM C 76.

2.3 MISCELLANEOUS MATERIALS

2.3.1 Concrete

Unless otherwise specified, concrete and reinforced concrete shall conform to the requirements for 3,000 psi concrete under Section 03307 CONCRETE FOR MINOR STRUCTURES. The concrete mixture shall have air content by volume of

concrete, based on measurements made immediately after discharge from the mixer, of 5 to 7 percent when maximum size of coarse aggregate exceeds 1-1/2 inches. Air content shall be determined in accordance with ASTM C 231.

The concrete covering over steel reinforcing shall not be less than 1 inch thick for covers and not less than 1-1/2 inches thick for walls and flooring. Concrete covering deposited directly against the ground shall have a thickness of at least 3 inches between steel and ground. Expansion-joint filler material shall conform to ASTM D 1751, or ASTM D 1752, or shall be resin-impregnated fiberboard conforming to the physical requirements of ASTM D 1752.

### 2.3.2 Mortar

Mortar for pipe joints, connections to other drainage structures, and brick or block construction shall conform to ASTM C 270, Type M, except that the maximum placement time shall be 1 hour. The quantity of water in the mixture shall be sufficient to produce a stiff workable mortar. Water shall be clean and free of harmful acids, alkalies, and organic impurities.

The mortar shall be used within 30 minutes after the ingredients are mixed with water. The inside of the joint shall be wiped clean and finished smooth. The mortar head on the outside shall be protected from air and sun with a proper covering until satisfactorily cured.

## PART 3 EXECUTION

### 3.1 EXCAVATION FOR PIPE CULVERTS, STORM DRAINS, AND DRAINAGE STRUCTURES

Excavation of trenches, and for appurtenances and backfilling for culverts and storm drains, shall be in accordance with the applicable portions of Section 02222 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS and the requirements specified below.

#### 3.1.1 Trenching

The width of trenches at any point below the top of the pipe shall be not greater than the outside diameter of the pipe plus 24 inches to permit satisfactory jointing and thorough tamping of the bedding material under and around the pipe. Sheeting and bracing, where required, shall be placed within the trench width as specified. Contractor shall not overexcavate. Where trench widths are exceeded, redesign with a resultant increase in cost of stronger pipe or special installation procedures will be necessary.

Cost of this redesign and increased cost of pipe or installation shall be borne by the Contractor without additional cost to the Government.

#### 3.1.2 Removal of Rock

Rock in either ledge or boulder formation shall be replaced with suitable materials to provide a compacted earth cushion having a thickness between unremoved rock and the pipe of at least 8 inches or 1/2 inch for each foot of fill over the top of the pipe, whichever is greater, but not more than three-fourths the nominal diameter of the pipe. Where bell-and-spigot pipe is used, the cushion shall be maintained under the bell as well as under the straight portion of the pipe. Rock excavation shall be as specified and defined in Section 02222 EXCAVATION, TRENCHING, AND BACKFILLING FOR

## UTILITIES SYSTEMS.

## 3.1.3 Removal of Unstable Material

Where wet or otherwise unstable soil incapable of properly supporting the pipe, as determined by the Contracting Officer, is unexpectedly encountered in the bottom of a trench, such material shall be removed to the depth required and replaced to the proper grade with select granular material, compacted as provided in paragraph BACKFILLING. When removal of unstable material is due to the fault or neglect of the Contractor in his performance of shoring and sheeting, water removal, or other specified requirements, such removal and replacement shall be performed at no additional cost to the government.

## 3.2 BEDDING

The bedding surface for the pipe shall provide a firm foundation of uniform density throughout the entire length of the pipe.

## 3.2.1 Concrete Pipe Requirements

When no bedding class is specified or detailed on the drawings, concrete pipe shall be bedded in a soil foundation accurately shaped and rounded to conform to the lowest one-fourth of the outside portion of circular pipe or to the lower curved portion of pipe arch for the entire length of the pipe or pipe arch. When necessary, the bedding shall be tamped. Bell holes and depressions for joints shall be not more than the length, depth, and width required for properly making the particular type of joint.

## 3.3 PLACING PIPE

Each pipe shall be thoroughly examined before being laid; defective or damaged pipe shall not be used. Pipelines shall be laid to the grades and alignment indicated. Proper facilities shall be provided for lowering sections of pipe into trenches. Pipe shall not be laid in water, and pipe shall not be laid when trench conditions or weather are unsuitable for such work. Diversion of drainage or dewatering of trenches during construction shall be provided as necessary.

## 3.3.1 Reinforced Concrete Culvert, or Storm Drain Pipe

Laying shall proceed upgrade with spigot ends of bell-and-spigot pipe and tongue ends of tongue-and-groove pipe pointing in the direction of the flow.

## 3.4 JOINTING

## 3.4.1 Reinforced Concrete Culvert, or Storm Drain Pipe

## 3.4.1.1 Cement-Mortar Bell-and-Spigot Joint

The first pipe shall be bedded to the established gradeline, with the bell end placed upstream. The interior surface of the bell shall be thoroughly cleaned with a wet brush and the lower portion of the bell filled with mortar as required to bring inner surfaces of abutting pipes flush and

even. The spigot end of each subsequent pipe shall be cleaned with a wet brush and uniformly matched into a bell so that sections are closely fitted. After each section is laid, the remainder of the joint shall be filled with mortar, and a bead shall be formed around the outside of the joint with sufficient additional mortar. If mortar is not sufficiently stiff to prevent appreciable slump before setting, the outside of the joint shall be wrapped or bandaged with cheesecloth to hold mortar in place.

#### 3.4.1.2 Cement-Mortar Oakum Joint for Bell-and-Spigot Pipe

A closely twisted gasket shall be made of jute or oakum of the diameter required to support the spigot end of the pipe at the proper grade and to make the joint concentric. Joint packing shall be in one piece of sufficient length to pass around the pipe and lap at top. This gasket shall be thoroughly saturated with neat cement grout. The bell of the pipe shall be thoroughly cleaned with a wet brush, and the gasket shall be laid in the bell for the lower third of the circumference and covered with mortar. The spigot of the pipe shall be thoroughly cleaned with a wet brush, inserted in the bell, and carefully driven home. A small amount of mortar shall be inserted in the annular space for the upper two-thirds of the circumference. The gasket shall be lapped at the top of the pipe and driven home in the annular space with a caulking tool. The remainder of the annular space shall be filled completely with mortar and beveled at an angle of approximately 45 degrees with the outside of the bell. If mortar is not sufficiently stiff to prevent appreciable slump before setting, the outside of the joint thus made shall be wrapped with cheesecloth. Placing of this type of joint shall be kept at least five joints behind laying operations.

#### 3.4.1.3 Cement-Mortar Diaper Joint for Bell-and-Spigot Pipe

The pipe shall be centered so that the annular space is uniform. The annular space shall be caulked with jute or oakum. Before caulking, the inside of the bell and the outside of the spigot shall be cleaned.

a. Diaper Bands: Diaper bands shall consist of heavy cloth fabric to hold grout in place at joints and shall be cut in lengths that extend one-eighth of the circumference of pipe above the spring line on one side of the pipe and up to the spring line on the other side of the pipe. Longitudinal edges of fabric bands shall be rolled and stitched around two pieces of wire. Width of fabric bands shall be such that after fabric has been securely stitched around both edges on wires, the wires will be uniformly spaced not less than 8 inches apart. Wires shall be cut into lengths to pass around pipe with sufficient extra length for the ends to be twisted at top of pipe to hold the band securely in place; bands shall be accurately centered around lower portion of joint.

b. Grout: Grout shall be poured between band and pipe from the high side of band only, until grout rises to the top of band at the spring line of pipe, or as nearly so as possible, on the opposite side of pipe, to ensure a thorough sealing of joint around the portion of pipe covered by the band. Silt, slush, water, or polluted mortar grout forced up on the lower side shall be forced out by pouring, and

removed.

c. Remainder of Joint: The remaining unfilled upper portion of the joint shall be filled with mortar and a bead formed around the outside of this upper portion of the joint with a sufficient amount of additional mortar. The diaper shall be left in place. Placing of this type of joint shall be kept at least five joints behind actual laying of pipe. No backfilling around joints shall be done until joints have been fully inspected and approved.

#### 3.4.1.4 Cement-Mortar Tongue-and-Groove Joint

The first pipe shall be bedded carefully to the established gradeline with the groove upstream. A shallow excavation shall be made underneath the pipe at the joint and filled with mortar to provide a bed for the pipe. The grooved end of the first pipe shall be thoroughly cleaned with a wet brush, and a layer of soft mortar applied to the lower half of the groove. The tongue of the second pipe shall be cleaned with a wet brush; while in horizontal position, a layer of soft mortar shall be applied to the upper half of the tongue. The tongue end of the second pipe shall be inserted in the grooved end of the first pipe until mortar is squeezed out on interior and exterior surfaces. Sufficient mortar shall be used to fill the joint completely and to form a bead on the outside.

#### 3.4.1.5 Cement-Mortar Diaper Joint for Tongue-and-Groove Pipe

The joint shall be of the type described for cement-mortar tongue-and-groove joint in this paragraph, except that the shallow excavation directly beneath the joint shall not be filled with mortar until after a gauze or cheesecloth band dipped in cement mortar has been wrapped around the outside of the joint. The cement-mortar bead at the joint shall be at least 1/2 inch thick and the width of the diaper band shall be at least 8 inches. The diaper shall be left in place. Placing of this type of joint shall be kept at least five joints behind the actual laying of the pipe. Backfilling around the joints shall not be done until the joints have been fully inspected and approved.

### 3.5 DRAINAGE STRUCTURES

#### 3.5.1 Inlets

Construction shall be of reinforced concrete per plans.

#### 3.5.2 Drainage Pan

Construction shall be as indicated per plans.

### 3.6 BACKFILLING

#### 3.6.1 Backfilling Pipe in Trenches

After the pipe has been properly bedded, selected material from excavation or borrow, at a moisture content that will facilitate compaction, shall be placed along both sides of pipe in layers not exceeding 6 inches in

compacted depth. The backfill shall be brought up evenly on both sides of pipe for the full length of pipe. The fill shall be thoroughly compacted under the haunches of the pipe. Each layer shall be thoroughly compacted with mechanical tampers or rammers. This method of filling and compacting shall continue until the fill has reached an elevation of at least 12 inches above the top of the pipe. The remainder of the trench shall be backfilled and compacted by spreading and rolling or compacted by mechanical rammers or tampers in layers not exceeding 6 inches. Tests for density shall be made as necessary to ensure conformance to the compaction requirements specified below. Where it is necessary, in the opinion of the Contracting Officer, that sheeting or portions of bracing used be left in place, the contract will be adjusted accordingly. Untreated sheeting shall not be left in place beneath structures or pavements.

### 3.6.2 Movement of Construction Machinery

When compacting by rolling or operating heavy equipment parallel with the pipe, displacement of or injury to the pipe shall be avoided. Movement of construction machinery over a culvert or storm drain at any stage of construction shall be at the Contractor's risk. Any damaged pipe shall be repaired or replaced.

### 3.6.3 Compaction

#### 3.6.3.1 General Requirements

Cohesionless materials include gravels, gravel-sand mixtures, sands, and gravelly sands. Cohesive materials include clayey and silty gravels, gravel-silt mixtures, clayey and silty sands, sand-clay mixtures, clays, silts, and very fine sands. When results of compaction tests for moisture-density relations are recorded on graphs, cohesionless soils will show straight lines or reverse-shaped moisture-density curves, and cohesive soils will show normal moisture-density curves.

#### 3.6.3.2 Minimum Density

Backfill over and around the pipe and backfill around and adjacent to drainage structures shall be compacted at the approved moisture content to the following applicable minimum density, which will be determined as specified below.

a. Under paved roads, and similar-use pavements including adjacent shoulder areas, the density shall be not less than 90 percent of maximum density for cohesive material and 95 percent of maximum density for cohesionless material, up to the elevation where requirements for pavement subgrade materials and compaction shall control.

b. Under nontraffic areas, density shall be not less than that of the surrounding material.

#### 3.6.4 Determination of Density

Testing shall be the responsibility of the Contractor and performed at no

additional cost to the Government. Testing shall be performed by an approved commercial testing laboratory or by the Contractor subject to approval. Tests shall be performed in sufficient number to ensure that specified density is being obtained. Laboratory tests for moisture-density relations shall be made in accordance with ASTM D 1557 except that mechanical tampers may be used provided the results are correlated with those obtained with the specified hand tamper. Field density tests shall be determined in accordance with ASTM D 2167. Test results shall be furnished the Contracting Officer. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job on each different type of material encountered and at intervals as directed.

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## SECTION 02650

## GROUTING STONE PROTECTION

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 33	(1999a) Concrete Aggregates
ASTM C 143	(1998) Slump of Hydraulic Cement Concrete
ASTM C 150	(1998a) Portland Cement
ASTM C 172	(1999) Sampling Freshly Mixed Concrete
ASTM C 309	(1998a) Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 494	(1999) Chemical Admixtures for Concrete

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL DESCRIPTIONS.

## SD-09 Reports

Aggregates; GA.

Thirty days prior to placement of grout, the contractor shall submit to the Contracting Officer the reports of aggregate quality tests.

Grout Mix Design; GA.

Fifteen days prior to placement of grout, the contractor shall submit to the Contracting Officer the detailed mixture proportions for the specified grout.

## SD-13 Certificates

Portland Cement; GA

Certificates of compliance attesting that the concrete materials meet the

requirements of the specifications shall be submitted to the Contracting Officer for approval. Cement will be accepted on the basis of a manufacturer's certificate of compliance, accompanied by mill test reports that the material meets the requirements of the specifications under which it is furnished.

#### Curing Materials; GA

Certificates of compliance attesting that the curing materials meet the requirements of the specifications shall be submitted to the Contracting Officer for approval. Curing materials will be accepted on the basis of a manufacturer's certificate of compliance.

### 1.3 PROTECTION OF COMPLETED WORK

After completion of any panel, no workman or other load shall be permitted on the grouted surface for a period of 24 hours. The grouted surface shall be protected from injurious action of the sun; shall be protected from rain, flowing water, and mechanical injury and shall be moist cured or membrane cured at the Contractor's option.

### 1.4 DELIVERY, STORAGE, AND HANDLING OF MATERIALS

#### 1.4.1 Aggregates

Aggregates shall be delivered to the site of the grout batching and mixing plant and stockpiled in such manner as to preclude intermingling of different materials or the inclusion of foreign materials in the stockpiles or batching operations. Sufficient aggregates shall be maintained at the site at all times to permit continuous placement and completion of any lift or section of grout started.

#### 1.4.2 Portland Cement

Cement may be supplied in bulk or in bags. When transported in a bulk form the carriers and systems for distribution of the cement will be accomplished in adequately designed weather-tight trucks, conveyors, or other means that will protect the material from exposure to moisture. All storage facilities shall permit easy access for inspection and identification. Sufficient materials shall be in storage to complete any placement of grout started.

### 1.5 ACCESS TO PLANT AND EQUIPMENT

The Contracting Officer shall have access at all times to all parts of the placing operation and grout production plant for checking the adequacy of the equipment in use; inspecting operation of the plant; verifying weights, proportions, and character of materials; and installation of the grout and application of curing materials.

### 1.6 WAYBILLS AND DELIVERY TICKETS

Before the final statement is allowed, the Contractor shall file with the Contracting Officer certified waybills and certified delivery tickets for

all cement and grout actually used in the construction.

## PART 2 MATERIALS

### 2.1 AGGREGATE

Aggregate shall conform to the requirements specified for fine aggregate of the SECTION 03307 CONCRETE FOR MINOR STRUCTURES.

#### 2.1.1 Fine Aggregate Gradation

Fine aggregate shall conform to the gradation requirements of ASTM C 33 for Fine Aggregate.

#### 2.1.2 Coarse Aggregate Gradation

Coarse aggregate shall conform to the following gradation:

Sieve Designation	Cumulative Percentage By Weight Passing
1/2 inch	100
3/8 inch	85-100
No. 4	10-30
No. 8	0-10
No. 16	0-5

### 2.2 PORTLAND CEMENT

Portland cement shall conform to the requirements of ASTM C 150, Type II. The alkali content of the cement shall not exceed 0.6 percent.

### 2.3 WATER

Water shall be fresh, clean, and potable.

### 2.4 MEMBRANE CURING COMPOUND

Membrane curing compound shall conform to ASTM C 309, Type 1-D, Class B. Non-pigmented compound shall contain a fugitive dye. The loss of water for both pigmented and non-pigmented curing compound when tested shall be not more than 0.03 pounds per square foot in 24 hours nor more than 0.09 pounds per square foot in 72 hours. In hot weather, grout cured with non-pigmented curing compound shall be shaded from the direct rays of the sun for the first 3 days of the curing period.

## PART 3 EXECUTION

### 3.1 MIXING

Grout shall be composed of cement, sand, and water. The cement content requirement per cubic yard of grout shall be 7-1/2 sacks. The water content of the mix shall not exceed 8-1/2 gallons per sack of cement. In calculating total water content of the mix, the amount of moisture carried

on the surfaces of aggregate particles shall be included. Slump of grout mix shall be 7 inches. Alterations of slump to produce adequate penetration between the stone voids shall be determined by the Contracting Officer in the field during the placement of the demonstration section. The grout shall be mixed in a concrete mixer in the manner specified for concrete, except that time of mixing shall be as long as is required to produce a satisfactory mixture. The grout shall be used in the work within a period of 30 minutes after mixing. Retempering of grout will not be permitted. The consistency of the grout shall be such as to permit gravity flow into the interstices of the stones with the help of spading, rodding, and brooming. Grout batches in the same course shall be uniform in mix, size, and consistency.

### 3.2 PLACING

#### 3.2.1 Demonstration Section

The Contractor shall provide a demonstration section of the stonework as indicated in SECTION 02600 STONE PROTECTION prior to the grouted stone production. Prior to grouting, the stone shall be thoroughly washed with water to wash down the fines and to prevent the stone from absorbing water from the grout. The stone shall be kept wet just ahead of the actual placing of grout. Existing stone protection to be grouted shall be cleaned of all soil, vegetation, and debris to a minimum depth of 12 inches prior to washing.

#### 3.2.2 Transportation and Placement

The grout shall be brought to the place of final deposit by approved means and discharged directly on the stone with a concrete pump. The use of a concrete chute in placing grout will not be allowed. The grout shall be placed in one course for both invert and side slopes. Grout shall be placed from the toe of slope to the top of side slope and shall fully penetrate the stone blanket. A splash plate of metal or wood shall be used where necessary to prevent displacement of stone directly under discharge. The flow of grout into the stone voids shall be controlled by the grout operator to assure that all voids are adequately penetrated. When necessary, grout shall be directed with brooms or other approved baffles to cover the entire area and stone voids. Sufficient barring shall be done to loosen tight pockets of stone and otherwise aid the penetration of grout. On side slopes, all brooming shall be uphill.

#### 3.2.3 Surface Finishing

Except for smooth ramp surfaces, placement and brooming of the grouted surface shall be such that the outer layer of rock projects 1/3 to 1/4 their diameter above the grouted surface. After the top course has stiffened the entire surface shall be rebroomed to eliminate runs in the top course and to fill voids caused by sloughing of the layers of grout.

#### 3.2.4 Protection

After completion of any strip or panel, no workmen or other load shall be permitted on the grouted surface for a period of 24 hours. The grouted

surface shall be protected from injurious action of the sun; shall be protected from rain, flowing water, and mechanical injury; and shall be moist cured or membrane cured at the Contractor's option.

### 3.3 WEATHER LIMITATIONS

#### 3.3.1 Hot Weather Placing

The temperature of the grout when deposited in the proper location shall not exceed 85 degrees F except as directed by the Contracting Officer.

#### 3.3.2 Cold Weather Placing

No grout shall be prepared except when the air temperature is at least 40 degrees F. in the shade and rising. Materials entering the mixer shall be free from ice, snow, and frozen lumps. A non-chloride based accelerating admixture, conforming to the requirements of ASTM C 494, may be used when approved in advance, by the Contracting Officer.

### 3.4 CURING AND PROTECTION

Curing of the grouted surface shall be accomplished by the following methods.

#### 3.4.1 Moist Curing

Moist curing shall consist of covering the grout with a uniform thickness of 6 inches of sand that shall be kept continuously saturated for a period of 14 days.

#### 3.4.2 Curing Compounds

After final brooming, curing compounds shall be applied as soon as the free water disappears and shall be applied in a 2-coat continuous operation by approved power-spraying equipment at a rate of not to exceed 200 square feet per gallon for the combined coats. The second coat shall be applied to overlap the first coat in a direction approximately at right angles to the direction of the first application.

### 3.5 CONTRACTOR QUALITY CONTROL

#### 3.5.1 General

The individuals who sample and test grout as required in this specification shall have demonstrated a knowledge and ability to perform the necessary test procedures equivalent to the ACI minimum guidelines for certification of Concrete Field Testing Technicians, Grade I.

#### 3.5.2 Inspection Details and Frequency of Testing

##### 3.5.2.1 Preparations for Placing

Stone and embedded items shall be inspected in sufficient time prior to each grout placement by the Contractor to certify to the Contracting

Officer that it is ready to receive grout.

#### 3.5.2.2 Slump

Slump shall be checked at least twice during each shift that grout is produced. Samples shall be obtained in accordance with ASTM C 172 and tested in accordance with ASTM C 143.

#### 3.5.2.3 Consolidation and Protection

The Contractor shall ensure that the grout is properly installed, finished, protected, and cured.

#### 3.5.3 Action Required

##### 3.5.3.1 Placing

The placing foreman shall not permit placing to begin until he has verified that there is an adequate number of men with appropriate bars and other such tools are available for the necessary barring and adjustment of stone as required above.

##### 3.5.3.2 Slump

Whenever a test is outside the specification limits, the results of the test shall be reported to the Contracting Officer and another test shall be immediately taken. If the results of the subsequent test indicates that the slump is not being met. The placement will cease and the contractor will readjust the mix design to achieve the proper slump. The adjusted mix will continue to meet the requirements specified above.

#### 3.5.4 Reports

The results of all tests and inspections conducted at the project site shall be reported informally at the end of each shift and in writing weekly and shall be delivered to the Contracting Officer within 3 days after the end of each weekly reporting period.

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## SECTION 02722

## AGGREGATE BASE COURSE

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 127	(1988; R 1993) Specific Gravity and Absorption of Coarse Aggregate
ASTM C 128	(1993) Specific Gravity and Absorption of Fine Aggregate
ASTM C 131	(1996) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates
ASTM D 75	(1987; R 1992) Sampling Aggregates
ASTM D 422	(1963; R 1998) Particle-Size Analysis of Soils
ASTM D 1556	(1990; R 1996) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1998) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu.m.))
ASTM D 2216	(1998) Laboratory Determination of Water (Moisture) Content of Soil and Rock
ASTM D 2217	(1985; R 1998) Wet Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants
ASTM D 2922	(1996) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	(1996) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

ASTM D 4318 (1998) Liquid Limit, Plastic Limit, and Plasticity Index of Soils

ASTM E 11 (1995) Wire-Cloth Sieves for Testing Purposes

## 1.2 DEFINITIONS

### 1.2.1 Aggregate Base

Aggregate base as used herein is well graded, durable aggregate uniformly moistened and mechanically stabilized by compaction.

### 1.2.2 Degree of Compaction

Degree of compaction is the ratio of the field dry density to the maximum dry density determined in the laboratory, expressed as a percentage of the maximum density. The field dry density shall be determined by ASTM D 1556.

The laboratory maximum density shall be determined by ASTM D 1557, Procedure A or B.

### 1.2.3 Moisture Content

Moisture content is the ratio of the weight of the water to the weight of the solid matter expressed as percentage and is determined by ASTM D 2216.

## 1.3 GENERAL

The work specified herein consists of the construction of an aggregate base course. The work shall be performed in accordance with this specification and shall conform to the lines, grades, notes and typical sections shown in the plans. Sources of all materials shall be selected well in advance of the time that materials will be required in the work.

## 1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with SECTION 01330 SUBMITTAL PROCEDURES.

### SD-01 Data

Plant, Equipment, Machines, and Tools; FIO.

List of proposed equipment to be used in performance of construction work including descriptive data.

### SD-09 Reports

Sampling and Testing; FIO. Field Density; FIO.

Copies of field test results shall be submitted to the Contracting Officer

within 24 hours after the tests are performed.

#### SD-18 Records

Waybills and Delivery Tickets; FIO. Coarse Aggregate; FIO.

Copies of certified waybills and delivery tickets shall be submitted during the progress of the work for all materials actually used. Before the final payment is allowed, waybills and certified delivery tickets shall be furnished for all aggregates actually used in the construction. A notification stating which type of coarse aggregate is to be used.

### 1.5 WEATHER LIMITATIONS

Base shall not be constructed when the atmospheric temperature is less than 2 degrees C. (35 degrees F). Base shall not be constructed on subgrade that is frozen or contain frost. If the temperature falls below 2 degrees C. (35 degrees F), completed areas shall be protected against any detrimental effects of freezing.

### 1.6 PLANT, EQUIPMENT, MACHINES, AND TOOLS

#### 1.6.1 General Requirements

Plant, equipment, machines, and tools used in the work shall be subject to approval and shall be maintained in satisfactory working condition at all times. Other compacting equipment may be used in lieu of that specified, where it can be demonstrated that the results are equivalent. The equipment shall be adequate and have the capability of producing the results specified.

#### 1.6.2 Steel-Wheeled Rollers

Steel-wheeled rollers shall be the self-propelled type weighing not less than 9.1 metric tons (10 tons), with a minimum weight of 260 kilogram per cm (300 pounds per inch) width of rear wheel. Wheels of the rollers shall be equipped with adjustable scrapers. The use of vibratory rollers is optional.

#### 1.6.3 Pneumatic-Tired Rollers

Pneumatic-tired rollers shall have four or more tires, each loaded to a minimum of 66,150 kilograms (30,000 )pounds and inflated to a minimum pressure of 1 Mpa (150 psi). The loading shall be equally distributed to all wheels, and the tires shall be uniformly inflated. Towing equipment shall also be pneumatic-tired.

#### 1.6.4 Mechanical Spreader

Mechanical spreader shall be self-propelled or attached to a propelling unit capable of moving the spreader and material truck. The device shall be steerable and shall have variable speeds forward and reverse. The spreader and propelling unit shall be carried on tracks, rubber tires, or drum-type steel rollers that will not disturb the underlying material. The

spreader shall contain a hopper, an adjustable screed, and outboard bumper rolls and be designed to have a uniform, steady flow of material from the hopper. The spreader shall be capable of laying material without segregation across the full width of the lane to a uniform thickness and to a uniform loose density so that when compacted, the layer or layers shall conform to thickness and grade requirements indicated. The Contracting Officer may require a demonstration of the spreader prior to approving use in performance of the work.

#### 1.6.5 Sprinkling Equipment

Sprinkling equipment shall consist of tank trucks, pressure distributors, or other approved equipment designed to apply controlled quantities of water uniformly over variable widths of surface.

#### 1.6.6 Tampers

Tampers shall be of an approved mechanical type, operated by either pneumatic pressure or internal combustion, and shall have sufficient weight and striking power to produce the compaction required.

#### 1.6.7 Straightedge

The Contractor shall furnish and maintain at the site, in good condition, one 3.05 m (10 foot) straightedge, for use in the testing of the finished surface. Straightedge shall be made available for Government use. Straightedges shall be constructed of aluminum or other lightweight metal and shall have blades of box or box-girder cross section with flat bottom reinforced to ensure rigidity and accuracy. Straightedges shall have handles to facilitate movement on prepared base course.

### 1.7 STOCKPILING MATERIALS

Materials, including approved material available from excavation and grading, shall be stockpiled in the manner and at locations designated. Before stockpiling of material, storage sites shall be cleared, and sloped to drain. Materials obtained from different sources shall be stockpiled separately.

### 1.8 SAMPLING AND TESTING

#### 1.8.1 General Requirements

Sampling and testing shall be performed by an approved commercial testing laboratory. No work requiring testing shall be permitted until the facilities have been inspected and approved by the Contracting Officer. The first inspection shall be at the expense of the Government. Cost incurred for any subsequent inspection required because of failure of the facilities to pass the first inspection will be charged to the Contractor. Tests shall be performed in sufficient numbers and at the locations and times directed to ensure that materials and compaction meet specified requirements. Copies of test results shall be furnished to the Contracting Officer for approval 7 days prior to starting work, and thereafter at regular intervals during production as specified hereinafter.

### 1.8.2 Test Results

Results shall verify that materials comply with this specification. When a material source is changed, the new material will be tested for compliance.

When deficiencies are found, the initial analysis shall be repeated and the material already placed shall be retested to determine the extent of unacceptable material. All in-place unacceptable material shall be replaced or modified as directed by the Contracting Officer.

### 1.8.3 Sampling

Aggregate samples for laboratory tests shall be taken in accordance with ASTM D 75.

### 1.8.4 Sieve Analysis

Before starting work, at least one sample of material shall be tested in accordance with ASTM C 136 and ASTM D 422 on sieves conforming to ASTM E 11.

After the initial test, a minimum of one analysis shall be performed for each 907 metric tons (1000 tons) of material placed, with a minimum of three analyses for each day's run until the course is completed.

### 1.8.5 Liquid Limit and Plasticity Index

One liquid limit and plasticity index shall be performed for each sieve analysis. Liquid limit and plasticity index shall be in accordance with ASTM D 4318, Method A, on samples prepared in accordance with ASTM D 2217.

### 1.8.6 Laboratory Density

Tests shall provide a moisture-density relationship for the aggregate. Tests shall be conducted in accordance with ASTM D 1557, Procedure C.

### 1.8.7 Wear Tests

Wear tests shall be performed in accordance with ASTM C 131. One test shall be run per 418 square meters (500 square yards) of completed base course. A minimum of one test per aggregate source shall be run.

## PART 2 PRODUCTS

### 2.1 MATERIALS

#### 2.1.1 Aggregates

Aggregates shall consist of crushed stone, crushed gravel, gravel, angular sand, or other approved material. Aggregates shall be durable and sound, free from lumps of clay, organic matter, objectionable coatings, and other foreign material. Material retained on a No. 4 sieve shall be known as coarse aggregate and that passing the No. 4 sieve shall be known as binder material.

##### 2.1.1.1 Coarse Aggregate

Only one type of coarse aggregate shall be used on the project and a notification stating which aggregate is to be used shall be submitted. Coarse aggregates, consisting of angular fragments of uniform density and quality, shall have a percentage of wear not to exceed 40 percent after 500 revolutions when tested in accordance with ASTM C 131. The minimum specific gravity for the coarse aggregate shall be 2.65. The amount of flat and elongated particles shall not exceed 30 percent. A flat particle is one having a ratio of width to thickness greater than 3, and an elongated particle is one having a ratio of length to width greater than 3.

a. Crushed Gravel: Crushed gravel shall be manufactured from gravel particles 50 percent of which by weight are retained on the maximum size gradation sieve specified.

b. Crushed Stone: Crushed stone retained on each sieve specified shall contain at least 50 percent by weight of crushed pieces having two or more freshly fractured faces with the area of each face being at least equal to 75 percent of the smallest mid-sectional area of the piece. When two fractures are adjacent, the angle between the planes of the fractures must be at least 30 degrees to count as two fractured faces.

#### 2.1.2 Binder Material

Binder material shall consist of screenings, angular sand, or other finely divided mineral matter processed or naturally combined with the coarse aggregate. Liquid-limit and plasticity-index requirements shall apply to any component that is blended to meet the required gradation and shall also apply to the completed course. The portion of any component or of the completed course passing the No. 40 sieve shall be either nonplastic or have a liquid limit not greater than 25 and a plasticity index not greater than 5, when determined in accordance with ASTM D 4318, Method A, on samples prepared in accordance with ASTM D 2217.

#### 2.1.3 Gradation

Requirements for gradation specified shall apply to the completed base course. The aggregates shall have a 1 inch maximum size and shall be continuously graded within the following limits:

Sieve Designation	Percentage by Weight Passing Square-mesh Sieve
25 mm (1 inch)	100
19 mm (3/4 inch)	90-100
4.75 mm (No. 4)	35-60
0.06 mm No. 30	10-30
0.075 mm (No. 200)	2-9

(a) Particles having diameters less than 0.02 millimeter shall not be in excess of 3 percent by weight of the total sample tested.

(b) The values are based on aggregates of uniform specific gravity, and the percentages passing the various sieves are subject to appropriate correction in accordance with ASTM C 127 and ASTM C 128 when aggregates of varying specific gravities are used.

### PART 3 EXECUTION

#### 3.1 GENERAL REQUIREMENTS

Adequate drainage shall be provided during the entire period of construction to prevent water from collecting or standing on the working area. Line and grade stakes shall be provided as necessary for control (not greater than 30.5 meters (100 feet) on center). Grade stakes shall be in lines parallel to the centerline of the area under construction and suitably spaced for string lining.

#### 3.2 AGGREGATE SOURCES

Aggregate sources shall be shall be obtained from off-site sources.

#### 3.3 PREPARATION OF UNDERLYING COURSE

##### 3.3.1 General Requirements

Before constructing aggregate base course, the previously constructed underlying course shall be cleaned of foreign substances. Surface of underlying course shall meet the specified compaction and surface tolerances. Subgrade shall conform to Section 02250 FILLS, SUBGRADE PREPARATION AND DRAINAGE SYSTEMS however, the top 305 mm (12 inches) of the subgrade for pavement shall be compacted to 95 percent compaction in accordance to ASTM D 1557 test method. The compacted lift thickness shall not be more than 6 inches. Ruts or soft, yielding spots that may appear in the underlying course, areas having inadequate compaction, and deviations of the surface from requirements specified shall be corrected. For cohesionless underlying materials containing sands, sand gravels, or any other cohesionless material in harmful quantities, the surface shall be mechanically stabilized with aggregate prior to placement of the aggregate course. Stabilization may be accomplished by mixing base course material into the underlying course and compacting by approved methods. Properly compacted material will be considered as part of the underlying course and shall meet all requirements for the underlying course. Finished underlying course shall not be disturbed by traffic or other operations and shall be maintained in a satisfactory condition until base course is placed.

##### 3.3.2 Grade Control

Underlying material shall be excavated to sufficient depth for the required base course thickness so that the finished base course with the subsequent surface course will meet the fixed grade. Finished and completed area shall conform to the lines, grades, cross section, and dimensions indicated.

#### 3.4 INSTALLATION

#### 3.4.1 Mixing and Placing

Materials shall be mixed by the stationary plant, traveling plant, or road mix method and placed in such a manner as to obtain uniformity of the aggregate base course material between plus and minus 2 percent of optimum water content for compaction. The Contractor shall make such adjustments in mixing or placing procedures or in equipment to obtain the true grades, to minimize segregation and degradation, to reduce or accelerate loss or increase of water, and to insure a satisfactory base course.

#### 3.4.2 Edges of Base Course

Approved material shall be placed along edges of aggregate base course in such quantities as will compact to thickness of the course being constructed, or to the thickness of each layer in a multiple layer course, allowing in each operation at least a 1 foot width of the shoulder to be rolled and compacted simultaneously with rolling and compacting of each layer of base course.

#### 3.4.3 Compaction

Each layer of aggregate base course including shoulders shall be compacted. Water content shall be maintained near optimum (plus or minus 2 percent). Density of compacted mixture shall be at least 100 percent of laboratory maximum density. Rolling shall begin at the outside edge of the surface and proceed to the center, overlapping on successive trips at least one-half the width of the roller. Alternate trips of the roller shall be slightly different lengths. Speed of the roller shall be such that displacement of the aggregate does not occur. Areas inaccessible to the rollers shall be compacted with mechanical tampers, and shall be shaped and finished by hand methods.

#### 3.4.4 Layer Thickness

Compacted thickness of the aggregate course shall be as indicated. No layer shall be in excess of 152 mm (6 inches) nor less than 102 mm (4 inches) in compacted thickness.

#### 3.4.5 Finishing

The surface of the top layer shall be finished to grade and cross section shown. Finished surface shall be of uniform texture. Light blading during compaction may be necessary for the finished surface to conform to the lines, grades, and cross sections. Should the surface for any reason become rough, corrugated, uneven in texture, or traffic marked prior to completion, such unsatisfactory portion shall be scarified, reworked, recompacted, or replaced as directed.

##### 3.4.5.1 Smoothness

Surface of each layer shall show no deviations in excess of 10 mm (3/8 inch) when tested with the 10 foot straightedge. Deviations exceeding this amount shall be corrected by removing material and replacing with new material, or by reworking existing material and compacting, as directed.

#### 3.4.5.2 Thickness Control

Compacted thickness of the base course shall be within 12.5 mm (1/2 inch) of the thickness indicated. Where the measured thickness is more than 12.5 mm (1/2 inch) deficient, such areas shall be corrected by scarifying, adding new material of proper gradation, reblading, and recompacting as directed. Where the measured thickness is more than 12.5 mm (1/2 inch) thicker than indicated, the course shall be considered as conforming to the specified thickness requirements. Average job thickness shall be the average of all thickness measurements taken for the job, but shall be within 6 mm (1/2 inch) of the thickness indicated on the contract drawings.

### 3.5 FIELD QUALITY CONTROL

#### 3.5.1 Field Density

Field in-place density shall be determined in accordance with ASTM D 1556 or ASTM D 2922. When ASTM D 2922 is used, the calibration curves shall be checked, and adjusted if necessary, using the sand cone method as described in paragraph Calibration of the ASTM publication. ASTM D 2922 results in a wet unit weight of soil, and when using this method, ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall be checked along with density calibration checks as described in ASTM D 3017. If ASTM D 2922 is used, in-place densities shall be checked by ASTM D 1556 at least once per five density tests. Calibration curves and calibration test results shall be furnished within 24 hours of the conclusion of the tests. At least one field density test shall be performed for each 209 square meters (250 square yards) of each layer of base material.

#### 3.5.2 Testing Frequency

Results of tests to determine particle shape, presence of objectionable and foreign matter, percentage of wear, fracture count, gradation, liquid limit and plasticity index, specific gravity, and other specification requirements for determination of the acceptability of the source shall be submitted for approval at least 7 days prior to starting of manufacture of the base course materials. Production testing for material gradation, liquid limit, plasticity index shall be performed at regular intervals with at least one test being made for each 380 cubic meters (500 cubic yards) or fraction thereof, of the material produced and results shall be submitted on a daily basis. Deviations from specification requirements shall be corrected immediately upon discovery. After the materials have been placed and compacted, one field density test for each 836 square meters (1,000 square yards) or fraction thereof of finished base course and one additional gradation, liquid limit, and plasticity index test for each 2,508 square meters (3,000 square yards) of base course or fraction thereof shall be performed. Maximum-density moisture relations shall be established for each 4,180 square meters (5,000 square yards) of base course material. The location of the after-placement tests shall be as directed by the Contracting Officer. One copy of the density data (less dry weight determinations) shall be provided on the day each test is taken. The completed test report shall be provided with the Contractor Quality

Report on the following work day. Results of tests made shall be submitted for approval on a daily basis and subsequent paving operations shall not commence until final approval has been obtained. Failure of any test shall be reported verbally, by the most expeditious means and followed promptly by written report. Contractor field operations shall immediately reflect corrective measures. For every failure test, retesting after completion of corrective measures have been taken will be required.

### 3.5.3 Smoothness

Measurements for deviation from grade and cross section shown shall be taken in successive positions parallel to the road centerline with a 3.05 meters (10 foot) straightedge. Measurements shall also be taken perpendicular to the road centerline at 15.3 meters (50 foot) intervals.

### 3.5.4 Thickness

Thickness of the base course shall be measured at intervals in such a manner as to ensure one measurement for each 420 square meters (500 square yards) of base course. Measurements shall be made in 76 mm (3 inch diameter) test holes penetrating the base course.

### 3.6 TRAFFIC

Completed portions of the area may be opened to traffic, provided there is no marring or distorting of the surface by the traffic. Heavy equipment shall not be permitted except when necessary to construction, and then the area shall be protected against marring or damage to the completed work.

### 3.7 MAINTENANCE

The aggregate base course shall be maintained in a satisfactory condition until accepted. Maintenance shall include immediate repairs to any defects and shall be repeated as often as necessary to keep the area intact.

### 3.8 DISPOSAL OF UNSATISFACTORY MATERIALS

Removed in-place materials that are unsuitable for the base course material that is removed for the required correction of defective areas, and waste material and debris shall be disposed of off-site.

-- End of Section --

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## SECTION 02745

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## SECTION 02745

## ASPHALTIC CONCRETE PAVING

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS  
(AASHTO)

AASHTO M 247	(1981; R 1996) Glass Beads Used in Traffic Paint
AASHTO M 248	(1991; R 1996) Ready-Mixed White and Yellow Traffic Paints
AASHTO T 30	(1993) Mechanical Analysis of Extracted Aggregate
AASHTO T 166	(1993) Bulk Specific Gravity of Compacted Bituminous Mixtures Using Saturated Surface-Dry Specimens

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 150	(1998a) Portland Cement
ASTM D 692	(1994a) Coarse Aggregate for Bituminous Paving Mixtures
ASTM D 977	(1997) Emulsified Asphalt
ASTM D 979	(1996) Sampling Bituminous Paving Mixtures
ASTM D 1073	(1994) Fine Aggregate for Bituminous Paving Mixtures
ASTM D 1559	(1989) Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
ASTM D 1856	(1995a) Recovery of Asphalt from Solution by Abson Method
ASTM D 2172	(1995) Quantitative Extraction of Bitumen from Bituminous Paving Mixtures

ASTM D 3381 (1992) Viscosity-Graded Asphalt Cement for  
Use in Pavement Construction

FEDERAL HIGHWAY ADMINISTRATION (FHWA)

FHWA SA-89-006 (1988) Manual on Uniform Traffic Control  
Devices for Streets and Highways

1.2 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Bituminous Concrete; FIO.

Mix Designs for Bituminous Concrete shall be submitted.

Asphalt Cement; FIO. Bituminous Tack Coat; FIO. Paint; FIO. Reflective Beads; FIO.

Manufacturer's Catalog Data shall be submitted showing description, mixing, and application instructions.

SD-09 Reports

Test reports; FIO.

Test Reports shall be submitted in accordance with the paragraph entitled, "Quality Control Testing During Construction," of this section.

SD-13 Certificates

Bituminous Concrete; FIO. Asphalt Concrete; FIO. Bituminous Tack Coat; FIO. Paint; FIO. Reflective Beads; FIO.

Certificates of compliance for the following items shall be submitted and meet the performance requirements of the paragraph entitled, "Performance Requirements," and applicable standards contained within this section.

SD-14 Samples

White Paint; FIO. Yellow Paint; FIO.

Submit samples in one quart containers.

Glass Beads; FIO.

Submit 500 Gram (18 Ounces) sample.

PART 2 PRODUCTS

2.1 BITUMINOUS CONCRETE

2.1.1 Aggregate for Bituminous-Concrete

Coarse aggregate shall conform to ASTM D 692.

Fine aggregate shall conform to ASTM D 1073. Sand equivalent value shall be not less than 30.

2.1.2 Mineral Filler

Filler shall be portland cement conforming to ASTM C 150.

2.2 ASPHALT CEMENT

Bituminous materials shall conform to ASTM D 3381, Table 3, Grade AR-4000 or AR-8000.

2.3 BITUMINOUS TACK COAT

Bituminous tack coat shall be an emulsified asphalt conforming to ASTM D 977, designation SS-1h.

2.4 JOB-MIX FORMULAS

A job-mix formula for each bituminous-concrete mixture proposed for use in the work shall be submitted for approval prior to start of work.

2.5 PERFORMANCE REQUIREMENTS

Bituminous-concrete mixtures shall meet the performance requirements described when sampled, and tested. Calculations shall be made for density and voids analyses.

PERFORMANCE REQUIREMENTS

<u>TEST PROPERTY</u>	<u>ASPHALT COURSE</u>
Marshall stability, pounds (minimum)	500
Marshall flow, 1/100-inch units	8 minimum 20 maximum
Percent air void	4 minimum 6 maximum
Percent of voids filled with bitumen	65 to 75

The index of retained stability must be greater than 75 percent as determined by ASTM D 1559. When the index of retained stability is less than 75, the aggregate stripping tendencies may be countered by the use of

hydrated lime or by treating the bitumen with an approved antistripping agent. The hydrated lime is considered as mineral filler and should be considered in the gradation requirements. The amount of hydrated lime or antistripping agent added to bitumen shall be sufficient, as approved, to produce an index of retained stability of not less than 75 percent. No additional payment will be made to the Contractor for addition of antistripping agent required.

## 2.6 PAVEMENT MARKING

### 2.6.1 Paint

Paint shall conform to AASHTO M 248, Type S, and FHWA SA-89-006, Part III.

### 2.6.2 Reflective Beads

Glass beads for reflectorized paint shall conform to AASHTO M 247, Type 1.

## PART 3 EXECUTION

### 3.1 PREPARATION OF SUBGRADE OR BASE COURSE

The subbase and the base course shall be prepared in accordance with the requirements of Section 02722 AGGREGATE BASE COURSE and 02250 FILLS, SUBGRADE PREPARATION AND DRAINAGE SYSTEM.

### 3.2 ASPHALT CONCRETE SURFACE COURSE

#### 3.2.1 Weather Limitations

Bituminous and tack coats shall be applied only when the ambient temperature in the shade is above 10 degrees Celsius (50 degrees F) or when the temperature has not been below 2 degrees Celsius (35 degrees F) for 12 hours immediately prior to application. Application may commence when the aggregate base course is dry or contains moisture not in excess of the amount that will permit uniform distribution and the required penetration. Bituminous-concrete courses shall be constructed only when the ambient temperature is above 4 degrees Celsius (40 degrees F) and the underlying base course is dry.

#### 3.2.2 Transportation of Mixtures

Bituminous-concrete mixtures shall be transported from the mixing plant to the project site in trucks having tight, clean, smooth beds that have been coated with a minimum amount of a concentrated solution of hydrated lime and water to prevent adhesion of the mixture to the truck beds.

Each load of mixture shall be covered with canvas or similar material of sufficient size and weight to retard heat loss and to protect the mixture from the weather.

In cool weather or for long hauls, the entire contact area of each truck bed shall be insulated. Covers shall be securely fastened.

Mixture shall be delivered in a such manner that the temperature of the mixture at the time of dumping into the paver will be not less than 110 degrees Celsius (230 degrees F).

Trucks shall not travel on the mixture until compaction is complete and the bituminous-concrete pavement surface will support traffic without measurable deformation.

### 3.3 PREPARATION OF AREA TO BE PAVED

#### 3.3.1 Surface Preparation

Immediately before application of a bituminous mixture is laid down on the aggregate base-course surface or other contact surface, loose material or other objectionable substances shall be removed, to the satisfaction of the Contracting Officer.

#### 3.3.2 Tack Coat Application

Contact surfaces of curbs, gutters, manholes, and other structures projecting into or abutting the concrete pavement shall be coated with a thin, uniform coating of bituminous tack-coat material prior to the bituminous-concrete mixture being placed against such structures. Following the application of the tack coat, the surface shall be allowed to dry until it is in a condition of tackiness to receive the bituminous-concrete mixture. Excess tack-coat material shall be squeegeed from the surface.

### 3.4 PLACING BITUMINOUS-CONCRETE COURSES

#### 3.4.1 General

Bituminous-concrete mixture shall be placed on the prepared surface, uniformly spread and struck off. Bituminous-concrete thickness shall be 50 mm (2-inches) after compaction.

#### 3.4.2 Pavement Placing

Placing shall begin along the centerline of areas to be paved on a crowned section, at the high side of a section with a one-way slope and in the direction of the traffic flow. The mixture for each course shall be placed in strips not less than 3.05 m (10-feet) wide. Progressive strip placement shall commence after rolling of the first strip. Rolling shall be extended to overlap the preceding strips. Placing the bituminous-concrete mixture shall be continuous.

#### 3.4.3 Hand Placing

In areas where the use of machine spreading is not practicable, the mixture shall be spread and finished by the use of heated hand tools. Mixture shall be dumped on approved dump boards and distributed into place from the dump boards in a uniformly loose layer of a thickness that will, when compacted, conform to required grade and thickness. Mixture shall be dumped no faster than it can be handled properly by the shovelers and

rakers.

#### 3.4.4 Joints

Joints shall have the same texture, density, and smoothness as other sections of the course. Joints between old and new pavements, or between successive days' work, shall be made to ensure a continuous bond between the old and new sections of the pavement.

The edge of the previously placed course shall be cut back to expose an even vertical surface over the full thickness of the course. When the edges of longitudinal joints are irregular or do not conform to the specifications, the edge shall be cut back to expose an even vertical surface over the full thickness of the course.

### 3.5 COMPACTION

#### 3.5.1 General

Compaction shall commence as soon after placing as the bituminous-concrete mixture will bear the weight of the roller without undue displacement. During rolling, the wheels shall be kept moist with the minimum amount of water required to avoid picking up the bituminous-concrete mixture. In places not accessible to the rollers, the mixture shall be compacted with hot hand tampers.

#### 3.5.2 Rolling Procedure

Rolling shall commence longitudinally at the extreme side of lanes and proceed toward the center of the pavement. Rolling shall overlapping on successive trips by at least one-half the width of the rear wheel of the roller.

Alternate trips of the roller shall be of slightly different lengths.

Rollers shall move at a slow but uniform speed with the drive roll or wheel nearest the paver. Speed of the rollers shall not exceed 5 km per hour (3 miles per hour) for steel-wheeled rollers or 8 km per hour (5 miles per hour) for pneumatic-tired rollers.

#### 3.5.3 Initial Rolling

The initial rolling shall immediately follow the rolling of the longitudinal joint and edges. Rollers shall be operated as close to the paver as possible without causing undue displacement. Preliminary tests of crown, grade and smoothness shall be made immediately after the initial rolling.

#### 3.5.4 Second Rolling

Second rolling shall follow the initial rolling as closely as possible, while the mixture is hot and in condition suitable for proper compaction. Rolling shall be continuous (at least 3 complete coverages) after the initial rolling until the mixture has been compacted.

Causing undue displacement will not be permitted.

### 3.5.5 Finish Rolling

Finish rolling shall be done while the mixture is warm enough for the removal of roller marks. Rolling shall continue until all roller marks are eliminated and the course has the specified density.

### 3.5.6 Patching Deficient Areas

Bituminous-concrete mixtures that become mixed with foreign material or that are defective, such as low areas or "bird-baths," shall be removed, replaced with fresh bituminous-concrete mixture to obtain the required grade and smoothness for the finished surface, and compacted to the specified density.

Pavement in deficient areas shall be removed to the full thickness of the bituminous-concrete course and so cut that the sides are perpendicular and parallel to the direction of traffic and the edges are vertical. Edges shall be sprayed with bituminous tack-coat material.

Skin patching an area that has been rolled will not be permitted.

### 3.5.7 Protection of Pavement

After final rolling, vehicular traffic shall not be permitted on the pavement until the pavement has cooled and hardened and in no case sooner than 6 hours.

## 3.6 QUALITY CONTROL TESTING DURING CONSTRUCTION

Bituminous-concrete mixtures shall be sampled and tested for quality control during construction of the bituminous-concrete courses as follows:

MATERIAL	REQUIREMENT	TEST METHOD	NUMBER OF TESTS
Uncompacted bituminous-concrete mix	Sampling	ASTM D 979	One for each mixture or day of operation
	Asphalt cement content	ASTM D 2172	
	Mechanical analysis extracted aggregates	AASHTO T 30	One for 500 square yards of placed course
Compacted bituminous-concrete	Recovery of asphalt cement by Abson Method	ASTM D 1856	Same as specified for uncompacted mix
	Bulk density	AASHTO T 166	
	Marshall Stabil-	ASTM D 1559	

Marshall samples	ity and Flow Tests		
In-place pavement	Density and thickness	As specified for	One specimen each 500 square yards of com- pleted bitumi- nous-concrete course

Test results shall be reported in writing on the same day that tests are made.

### 3.7 ACCEPTANCE PROVISIONS

#### 3.7.1 General

Density, surface smoothness, and thickness of completed bituminous-concrete shall be tested to verify compliance with the specified requirements.

#### 3.7.2 Density and Thickness Requirements

Pavement specimens of the completed bituminous-concrete shall be extracted. Diameter of pavement specimens shall be not less than 76 mm (3 inches). Locations for the removal of pavement specimens shall be directed by the Contract Officer. Test holes shall be repaired. Thickness shall not vary from plan thickness by more than 6 mm (1/4 inch) for the bituminous pavement.

#### 3.7.3 Surface Requirements

The finished surface of the bituminous-concrete shall be tested for smoothness with a 10-foot straightedge applied parallel with, and at right angles to, the centerline of the paved area. The entire paved area shall be checked from one side to the other. Advancement along the pavement shall be in successive stages of not more than half the length of the straightedge.

Bituminous-concrete surfaces shall not vary more than 3 mm (1/8 inch) from the straightedge.

Grade of the pavement shall be tested for conformance to the required cross section with a grade control instrument, from edge to edge and along the entire length. Finished grade surface of the pavement shall not vary more than 6 mm (1/4 inch) for the required cross section. Final surface shall have a uniform texture and shall conform to the required cross section. Low or defective areas shall be immediately corrected by cutting out the faulty areas and replacing them

### 3.8 PAVEMENT STRIPING

#### 3.8.1 Surface Preparation

New pavement surfaces shall be cured for 28 days before application of

marking materials. Where oil or grease are present on old pavements, the affected areas shall be scrubbed with approved detergent or degreaser, and rinsed thoroughly.

### 3.8.2 Traffic Control

Traffic control markers shall be placed along newly painted lines to prevent damage to newly painted surfaces.

### 3.8.3 Application

Paint shall be applied at a rate recommended by the manufacturer, and when the air and pavement temperatures are between 4 and 35 degrees Celsius (40 and 95 degrees F), and the relative humidity is not higher than 85 percent at time of application.

Where reflectorized paint is specified, glass beads shall be uniformly dispensed at the rate of 0.72 kilogram per liter (6 pounds per gallon) of paint.

Markings shall be sharply outlined, with uniform thickness, and stripe widths shall be as indicated.

If there is a deficiency in drying of the markings, painting operations shall be discontinued until the cause of the slow drying time is determined and corrected.

If discoloration of the paint occurs due to bleeding of bituminous materials, the paint shall be applied in 2 coats.

-- End of Section --

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## SECTION 02811

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## SECTION 02811

## IRRIGATION SYSTEMS

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

## ASME INTERNATIONAL (ASME)

- ASME B1.2 (1983; R 1991; Errata May 1992) Gages and Gaging for Unified Inch Screw Threads
- ASME B16.15 (1985; R 1994) Cast Bronze Threaded Fittings Classes 125 and 250

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- ASTM A 53 (1999b) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
- ASTM B 43 (1996) Seamless Red Brass Pipe, Standard Sizes
- ASTM D 635 (1998) Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position
- ASTM D 1784 (1996) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
- ASTM D 1785 (1996a) Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
- ASTM D 2241 (1996a) Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
- ASTM D 2466 (1996a) Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
- ASTM D 2564 (1996a) Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
- ASTM D 2774 (1994) Underground Installation of Thermoplastic Pressure Piping
- ASTM D 2855 (1996) Making Solvent-Cemented Joints with

Poly(Vinyl Chloride) (PVC) Pipe and  
Fittings

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS  
INDUSTRY (MSS)

MSS SP-80 (1997) Bronze Gate, Globe, Angle and Check  
Valves

UNDERWRITERS LABORATORIES (UL)

UL 94 (1996; Rev thru Jul 1998) Tests for  
Flammability of Plastic Materials for  
Parts in Devices and Appliances

### 1.2 PERFORMANCE REQUIREMENTS

This Irrigation System is designed with a minimum water pressure of 70 psi at connection to backflow prevention device and 25 psi at the last bubbler head and 30 psi at each drip line electric control valve. Provide system pressure calculations and irrigation requirements of the area.

### 1.3 SUBMITTALS

Government approval is required for submittals with a GA designation; submittals having an FIO designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Manufacturer's Catalog Data.

- a. Piping materials, dripline tubing, and fittings.
- b. Valves, pressure regulators, air/vacuum relief units.
- c. Sprinkler heads.
- e. Solvent cement.

Detailed procedures defining the Contractor's provisions for accident prevention, health protection, and other safety precautions for the work to be done.

SD-09 Reports

Field Tests; FIO. Valves and Accessories; GA

Submit performance test reports in booklet form by an authorized official of a testing laboratory showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall indicate the final position of

control valves.

#### SD-18 Records

Pressure Test; FIO. Operation Test; FIO.

Submit record of tests conducted on recording gauge not more than 3 days after test.

### 1.4 DELIVERY, STORAGE, AND HANDLING

Deliver materials in original rolls, packages, cartons and containers with the name of manufacturer, brand and model. All equipment delivered and placed in storage shall be protected from the weather; excessive humidity and temperature variation; direct sunlight (in the case of plastic or rubber materials); and dirt, dust, or other contaminants. Do not store materials directly on ground. Do not drag pipe on ground.

### 1.5 FIELD MEASUREMENTS

The Contractor shall verify all dimensions in the field and shall advise the Contracting Officer of any discrepancy before performing the work.

## PART 2 PRODUCTS

### 2.1 GENERAL MATERIALS AND EQUIPMENT REQUIREMENTS

#### 2.1.1 Standard Products

Materials and equipment shall be the standard products of a manufacturer who has produced similar systems which have performed well for a minimum period of 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

#### 2.1.2 Nameplates

Each item of equipment shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

#### 2.1.3 Extra Stock

The following extra stock shall be provided: Two bubbler heads of each size and type, one wrenches for removing and installing each type of head, one flushing assembly ball valves, and one wye filter assembly filter elements.

### 2.2 PIPING MATERIALS

#### 2.2.1 Red Brass Pipe and Associated Fittings

##### 2.2.1.1 Pipe

Pipe shall conform to requirements of ASTM B 43, regular.

### 2.2.1.2 Fittings

Fittings shall be Class 250, cast bronze threaded conforming to the requirements of ASME B16.15.

### 2.2.2 Galvanized Steel Pipe and Associated Fittings

#### 2.2.2.1 Pipe

Galvanized steel pipe shall be mild steel pipe and shall conform to requirements of ASTM A 53, Schedule 40. All galvanized pipe installed below grade shall wrapped with 2 mm thick, black plastic, insulating tape as manufactured by 3M Company or equal. Connection between galvanized pipe and PVC shall be made a minimum of 12" below grade.

#### 2.2.2.2 Fittings

Fittings shall be medium galvanized screwed beaded malleable iron. Galvanized couplings may be merchant coupling. Use non-hardening, non-toxic pipe joint sealant formulated for use on water-carrying pipes on metal connections.

### 2.2.3 Polyvinyl Chloride (PVC) Pipe, Fittings and Solvent Cement

#### 2.2.3.1 Pipe

Pressure main line piping for sizes 2-inches and larger, shall be PVC Class 315. Class 315 pipe shall be made from an approved Type I, Grade I, PVC compound conforming to ASTM D 1784 compound specification.

Pressure main line piping for sizes 1-1/2-inches and smaller, and lateral line piping, shall be PVC Schedule 40 with solvent welded joints.

Schedule 40 pipe shall be made from approved Type I, Grade I, PVC compound conforming to ASTM D 1785 compound specification.

All PVC pipe must bear the following markings:

- a. Manufacturer's name.
- b. Nominal pipe size.
- c. Schedule or class.
- d. Pressure rating in PSI.
- e. NSF (National Sanitation Foundation) approval.
- f. Date of extrusion.

Pipe shall conform to the requirements of ASTM D 1785, PVC 1120 Schedule 40; or ASTM D 2241.

Non-rigid lateral line piping (PVC flexible hose) shall be uniformly black in color, homogeneous throughout, and smooth inside and outside, free from foreign materials, cracks, holes, dents, wrinkles, and blisters. The hose shall have the following dimensions.

Size (In)	Inside Dia. (In)	Wall Thickness Dia. (In.)	Outside Dia. (In)
3/8 (IPS)	0.50	0.090	0.680
??? (IPS)	0.50	0.140	0.840
3/4 (IPS)	0.75	0.150	1.050
1 (IPS)	1.00	0.158	1.315

#### 2.2.3.2 Fittings

PVC solvent-weld fittings shall be Schedule 40, 1-2, II-I NSF approved conforming to ASTM D 2466 test procedure.

Solvent cement and primer for PVC solvent-weld pipe and fittings shall be of type and installation methods prescribed by the manufacturer.

#### 2.2.3.3 Solvent Cement

Solvent cement shall conform to the requirements of ASTM D 2564.

PVC class and schedule piping shall be solvent-welded to PVC fittings with Christy's Red-Hot (blue) glue, or approved equal.

Non-rigid lateral line piping shall be solvent-welded to PVC fittings with IPS model #795 (clear) glue, or approved equal.

### 2.3 BUBBLER HEADS, DRIPLINE EMITTER TUBING, DRIPLINE EQUIPMENT

#### 2.3.1 Bubblers Heads

Heads shall be flood bubbler with non-adjustable flow and designed for permanent mounting on threaded pipe risers.

Provide bubbler heads with the discharge flow rate of .25 GPM (gallons per minute) provide two (2) per tree. Place bubblers heads in emitter box and install per Los Angeles County details for Rio Hondo/Los Angeles River Project.

#### 2.3.2 Dripline Emitter Tubing (Dripline)

The dripline emitter tubing is a low volume, linear, low density polyethylene (PE) tubing, housing turbulent flow, and integral spaced pressure compensating drip emitters. The tubing shall have an outside diameter (O.D.) of approximately .670 inches (17 mm) and an inside diameter (I.D.) of approximately .570 inches. The turbulent flow path emitters shall be molded from plastic, with a hard plastic diaphragm retailer and soft rubber diaphragm.

The turbulent flow path emitters shall have an nominal discharge rate of 0.6 gallon per hour (GPH) at 20 pounds per square inch (PSI), and with a coefficient of variation (Cv of .03). The dripline tubing shall operate with a minimum pressure of 10 psi. The dripline shall be molded with a spacing of 18-inches on center for drip emitters.

Dripline emitter tubing shall be Techline series, model number T17-05-18-, as manufactured by Netafim irrigation, Inc., Fresno, CA.

### 2.3.3 Dripline Fittings

Dripline fittings shall be male, barb end connections, ready for pipe insertion. Barb fitting series shall include versions for connections to standard female and male PVC tapered pipe threads.

Fittings shall be constructed of molded brown plastic, with a nominal outside dimension of 17 mm or .570), and shall be clean and free of burrs, and uneven casting edges.

Fitting connections shall be mated with dripline tubing by pushing the tubing and twisting side to side until the tubing butts to either adjoining tubing or a fitting stop.

Dripline barb fittings shall be the Techline series, with model numbers TLTEE, TLCOUP, TLELL, TL075MA, TL075TEE, for the various combinations. Dripline fittings shall be as manufactured by Netafim Irrigation, Fresno, CA.

### 2.3.4 Flush Valve Assembly

The flush valve assembly shall consist of a line flushing valve and related PVC fittings. Line flushing valve shall be brown in color and include a 1/2-inch MIPT inlet connection.

Line flushing valve shall be as manufactured by Netafim, or approved equal.

## 2.4 VALVES

### 2.4.1 Gate Valves

Gate valves shall conform to the requirements of MSS SP-80, Type 1, Class B, 150 PSI steam to 406 degree pressure rating. Gate valves shall have bronze body, threaded ends, threaded bonnet, non-rising stem, integral seat, and solid wedge disc. Gate valves shall include bronze cross handles, unless otherwise shown on drawings. No aluminum alloy handles shall be allowed.

Gate valve shall be model series IB 646, as manufactured by Hammond Valve Corp. or approved equal.

### 2.4.2 PVC Ball Valves

PVC ball valve shall be constructed of gray Schedule 80 PVC material with full port flow through design, and include teflon ball seats, pressure rating to 235 PSI, and safety shear stem. Valve shall provide a Cv factor the same as equal length Schedule 80 piping.

PVC ball valves shall be as manufactured by Spears, or approved equal.

### 2.4.3 Quick Coupling Valves

Quick coupling valves shall have two-piece brass bodies consisting of a coupler water seal valve assembly, a removable upper body to allow spring, key track to be serviced without shutdown of main, and stainless steel internal parts.

Quick coupling valves shall be 1-inch in size and include lockable vinyl lids with a spring for positive closure on key removal.

#### 2.4.4 Electrical Control Valves

Electric control valves shall be solenoid actuated globe valves of (1 to 2 inch) size. Electrical control valves shall be sized as shown on drawings. suitable for 24 volts, 60 cycle with a holding current not to exceed .5 amps, and designed to provide for shut-off in event of power failure. Valve shall be glass filled nylon body and bonnet suitable for commercial grade service at 200 psi operating pressure with external flow control adjustment for shut-off capability. Provide both internal and external plug at diaphragm chamber to enable manual operation, durable nylon reinforced nitrile rubber diaphragm, and accessibility to internal parts without removing valve from system. The valve should open or close in less than 30 seconds at 20 psi.

Electric control valve shall be as manufactured by Rain Bird Sales, Inc. or approved equal.

#### 2.5 ACCESSORIES AND APPURTENANCES

##### 2.5.1 Wye Filter Assembly

Wye filter assembly shall include one plastic body filter, 1 in size, with color-coded Filter element rated at 120 mesh. Filter shall flow a minimum of 18 gpm at 2 psi pressure loss and 30 gpm at 5 psi pressure loss. Wye filter shall be as manufactured by Netafim, or approved equal.

Wye filter assembly shall include glycerin filled pressure gauges, 2 1/2 in diameter, with polycarbonate face, 1/4 inch NPT connection, and 0-100 psi pressure scale. Pressure gauges shall be as manufactured by Irrometer Co., or approved equal.

##### 2.5.2 Pressure Regulator

Pressure regulator shall be provided at each dripline system. The pressure regulator shall be mounted inline, preset at the factory for 25 psi outlet pressure, and rate for 150 psi inlet pressure. Pressure regulator indicated as a medium flow (MF) model provides operation between 2 and 20 gpm and shall include 1 inch (NPT) threaded inlet and outlets. Pressure regulator identified as a high flow (HF) model provides operation between 10 and 32 gpm and shall include 1 1/4 inch (NPT) inlet size, and 1 inch (NPT) outlet size.

Pressure regulators shall be as manufactured by Senninger Irrigation Inc, Salco Products, or approved equal.

##### 2.5.3 Check Valve (Inline)

Check valves shall be inline swing check valves, with solvent welded slip-fit connections to PVC piping. Check valves shall be constructed of high-impact Schedule 40 PVC type II material, with stainless steel internal spring components and positive sealing when there is no flow back pressure.

Swing check valve shall be line sized and as manufactured by King Bros. Industries (KBI) series KSC, or approved equal.

#### 2.5.4 Valve Boxes

##### 2.5.4.1 Valve Boxes

Valve boxes shall be structural foam molded with polyofin plastic with bolt-down locking devices, for each gate valve, flow meter assembly, quick coupling valve, WYE filter assembly, air/vacuum relief assembly, flush valve assembly, wire splices, and electric control valves. The flood bubbler box shall be non-bolt-locking. The electric control valve box shall be provide a attached hinged cover.

Box sizes shall be selected for valve used as shown on valve box size schedule listed below. The words "IRRIGATION CONTROL VALVE" shall be factory casted on each rectangular box cover. The words emitter shall be factory casted on each 5 3/4 inch valve box as listed for flood bubbler, Detail A, Sheet L-17.

Valve boxes for flood bubbler shall be black in color. Valve boxes for other irrigation equipment shall be tan in color. Green color valve boxes shall not be allowed. Allow sufficient lead time to special order tan colored valve boxes.

Valve boxes shall comply to ASTM D 635 SD- or UL 94 and be as manufactured by Carson-Brooks Plastics, LTD. or Applied Engineering Products, or approved equal.

##### 2.5.4.2 Valve Box Cover Identification

Valve box covers shall be head branded with 2-inch tall metal branding letters. Arrange from the same viewing position (no upside down box covers in box groups). Contractor shall not be allowed to use a hot knife for branding purposes. Refer to details for specific valve box cover identifications.

Branding unit recommended for use is as manufactured by Ever Hot Mfg., Chicago, IL. Phone number (708) 865-7070, or contact Hydro-Scape Products, Inc. Phone number (714) 639-1850 or approved equal.

##### 2.5.4.3 Valve Box Size Schedule

Box Size: 10 in. Round (x 10 1/4 in. Deep)- tan

Gate Valves  
Quick Coupling Valves  
Flush Valve Assemblies

#### Wire Splices

Box Size: 15 in. Wide x 21 in. Long Jumbo Rectangular (x 12 in. Deep)- tan

#### Wye Filter Assembly

Box Size: 5 3/4 in. Round (x 8 3/4 in. Deep) - black

#### Flood Bubbler Heads

### 2.5.5 Valve Identification Tags

Identification tags for electrical control valves shall be manufactured from Polyurethane Behr Desopan. Use Christy's standard tag hot stamped with black letters on yellow background. The tags shall be numbered to match programming as indicated on the Drawings. Provide one (1) tag of each electric control valve.

Special order tags from T. Christy Enterprises, (714) 771-4142, or approved equal.

### 2.5.6 Valve Keys for Manually Operated Valves

Valve keys shall be 1/2 inch diameter by 3 feet long, tee handles and keyed to fit valves.

### 2.5.7 Control Wiring

Connections between the automatic controllers and the electric control valves shall be made with direct burial copper wire AWG-UF 600 volt. Pilot wires shall be a different color wire for each automatic controller. Common wires shall be white with a different color stripe for each automatic controller. Install wires in accordance with the valve manufacturer's specifications and wire charts. In no case shall wire size be less than 14 gauge for control wires and no less than #12 gauge for common wire.

Wiring shall occupy the same trench and shall be installed along the same route as pressure supply or lateral lines wherever possible. Where more than one wire is placed in a trench, the wires shall be taped together at intervals of 10-feet.

An expansion curl shall be provided within 3-feet of each wire connection. Expansion curl shall be of sufficient length at each splice connection at each electric control, so that in case of repair, the valve bonnet may be brought to the surface without disconnecting the control wires. Control wires shall be laid loosely in the trench without stress or stretching of the control wire conductors.

All wire splices shall be made with either Scotch-Lok #3576 Connector Sealing Packs, Rain Bird Snap-Tite wire connectors, or approved equal. Use one splice per connector sealing pack.

Field wire splices between the automatic controller and the electrical

control valves shall not be allowed without prior approval of the contracting officer. All field wire splices shall include a 18 loop coil and be covered within a round valve box. Identify wire splices on lid of round splice box with the letters AWS.

Wire color shall be continuous over its entire length. Use a different color (except for the color blue for each automatic controller). Use white for common ground wire.

Spare control wires shall be different in color than the control wire color assigned to each automatic controller. Spare control wires shall be blue in color. Provide one spare common ground wire for each controller. Spare common ground wire shall be white with blue stripe in color for all automatic controllers.

Warning Tape:

Inert plastic film highly resistant to alkalis, acids, or other destructive chemical components likely to be encountered in soils. 3-inches wide, colored yellow, and imprinted with CAUTION: BURIED ELECTRIC LINE BELOW. When control wiring is trenched separately from mainline trenches, continuous warning tape shall be installed with the wiring.

Provide a 36-inch excess length of wire in and 8-inch diameter loop at each 90 degree change of direction, at both ends of sleeves, and at 100-foot intervals along continuous runs of wiring. Do not tie wiring loop. Install common ground wire and one control wire for each remote control valve. Multiple valves on a single control wire are not permitted. Install one common wire for each controller. Multiple controllers with one common wire will not be permitted.

## 2.6 SLEEVING

Install a separate sleeve beneath paved areas to route each run of irrigation pipe or wiring bundle.

Sleeving material beneath pedestrian pavement shall be PVC Schedule 40 pipe with solvent welded joints.

Sleeving beneath driveways, sidewalks, and streets shall be PVC Schedule 40 pipe with solvent welded joints.

Sleeving diameter: Equal to twice that of the pipe or wiring bundle. Minimum sleeving diameter shall be 2-inches.

Marking Stakes: 2-inches x 2-inches x 24-inch wood stake.

## PART 3 EXECUTION

### 3.1 INSTALLATION

The permanent and temporary sprinkler systems shall be installed after site grading has been completed. Excavation, trenching, and backfilling for sprinkler system shall be in accordance with the applicable provisions of

Section 02222 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS, except as modified herein. The contractor shall provide a temporary above ground automatic irrigation system to water all hydro seeded areas with temporary irrigation lines. Using quick couplers as a temporary irrigation system will not be permitted. The contractor shall provide for contracting officer approval design calculations, detailed drawings laying out valves, lines, sprinklers heads and any other items necessary for the temporary irrigation system. The contractor shall maintain the temporary irrigation system throughout the contract period replacing sprinkler heads, lines and valves as directed by the Contracting Officer. The contractor shall remove the temporary irrigation system after completion of the plant establishment period. The contractor shall also be responsible for watering hydro seeded areas not provided with a permanent or temporary irrigation system either by truck watering or other means approved by the contracting officer.

### 3.1.1 Trenching

Trenches around roots shall be hand excavated to pipe grade when roots of 2 inches diameter or greater are encountered. Trench width shall be 4 inches minimum or 1-1/2 times diameter of pipe, whichever is wider. Backfill shall be hand tamped over excavation. When rock is encountered, trench shall be excavated 4 inches deeper and backfilled with silty sand (SM) or well-graded sand (SW) to pipe grade. Trenches shall be kept free of obstructions and debris that would damage pipe. Subsoil shall not be mixed with topsoil. Existing concrete walks, drives and other obstacles shall be bored at a depth conforming to bottom of adjacent trenches. Pipe sleeves for bored pipe shall be two pipe diameters larger than PVC pipe.

Dig trenches straight and support pipe continuously on bottom of trench. Lay pipe to an even grade. Trenching excavation shall follow the layout as indicated on drawings.

Where piping is shown on the drawings under paved areas, but running parallel and adjacent to planting areas, install the piping in planting areas.

### 3.1.2 Piping System

#### 3.1.2.1 Soil Cover

Underground piping shall be installed as to meet the minimum depth of backfill soil cover for item specified.

Item	Depth of cover
Piping under traffic loads	36-inches
Mainline piping	18 to 24 inches
Control wire	18-inches
Non-pressure piping	12-inches
Dripline emitter tubing	4-inches

#### 3.1.2.2 Clearances

Minimum horizontal clearances between PVC lines shall be 4 inches for pipe

2 inches and less; 12 inches for 2-1/2 inches and larger. Minimum vertical clearances between lines shall be 1 inch.

### 3.1.3 Piping Installation

#### 3.1.3.1 Polyvinyl Chloride (PVC)

Polyvinyl Chloride (PVC) Pipe Solvent-cemented joints shall conform to the requirements of ASTM D 2855.

Threaded joints shall be full cut with a maximum of three threads remaining exposed on pipe and nipples. Threaded joints shall be made tight without recourse to wicks or fillers, other than polytetrafluoroethylene thread tape.

Piping shall be joined to conform with requirements of ASTM D 2774 or ASTM D 2855, and pipe manufacturer's instructions. Pipe shall be installed in a serpentine (snaked) manner to allow for expansion and contraction in trench before backfilling. Pipes shall be installed at temperatures over 5 degrees C. (40 degrees F.)

IPS flexible hose solvent-cemented joints shall conform to the requirements of ASTM D 2855.

Install pipe with all markings pointing up for visual inspection and verification.

Keep pipe free from dirt and pipe scale. Cut pipe ends square and debur.

Keep ends of assembled pipe capped. Remove caps only when necessary to continue assembly.

#### 3.1.3.2 Threaded Brass or Galvanized Steel Pipe

Prior to installation, pipe shall be reamed. Threads shall be cut in conformance with ASME B1.2. Pipe joint compound shall be applied to male end only.

### 3.1.4 Valves and Valve Boxes

Install Gate, Ball, and Quick Coupling valves as shown on drawings.

#### Electric Control and Master Valves

Install Electric Control and Master Valves as indicated on the Drawings. Install each electric control valve in a separate valve box. Provide each Electric Control and Master Valve with its own Identification tag as indicated on the drawings.

#### 3.1.4.1 Valve Boxes

Install Valve Boxes as indicated on the Drawings. Arrange Control valve boxes a minimum of 1-foot apart when located side by side and install with hinged covers opening in the direction as identified on the drawings.

Install valve boxes within 2-feet of planting area boundaries or edges.

### 3.1.5 Bubblers Heads

Bubbler Heads shall be installed plumb and level with terrain.

### 3.1.6 Dripline Emitter Tubing Installation

#### 3.1.6.1 Dripline

- a. Verify dripline inlet pressure as noted on plans.
- b. Place dripline tubing below grade per details.
- c. Dripline installation shall be coordinated with plant material installation for location and orientation of planting rows.

Install swing check valves as indicated in the drawings. Provide 2-inch square x 24-inches wood marking stakes for field location identification. Remove staking after review and approval of check valve installation.

- d. Install air/vacuum relief assemblies at high elevation points of dripline tubing in each planting zone as shown on drawings.
- e. Install pressure regulator downstream of electric control valve, size shall be indicated as noted on drawings.
- f. Install Wye filter assembly; size based on flow as noted on drawings. Clean out filters elements of debris, gravel and soil prior to connection of dripline tubing systems.
- g. Flush all PVC piping and dripline tubing prior to connections.
- h. Provide flushing assemblies as indicated on drawings. Open flush valves to clear PVC piping of debris, gravel and soil.
- i. Contractor shall insure that dripline tubing aligns to the planting row layout. Provide irrigation via dripline tubing to all plant material indicated on drawings.

#### 3.1.6.2 Flushing of Dripline Systems

After new dripline tubing are in place and connected, all necessary diversion work has been completed, the control valves shall be opened and full head of water used to flush out the system. Contractor shall be responsible for flushing the existing system if the system become clog or unworkable. The entire system shall be flushed with clean water until lines and emitters are free of all foreign materials.

### 3.1.7 Control Wire and Conduit

#### 3.1.7.1 Control Wires

Low voltage wires may be buried beside pipe in same trench. Rigid conduit

shall be provided where wires run under paving. Wires shall be number tagged at key locations along main to facilitate service.

One control conductor shall be provided for each zone and a conductor to every control sprinkler system.

#### 3.1.7.2 Loops

A 12 inch loop of wire shall be provided at each valve where controls are connected.

#### 3.1.7.3 Expansion and Contraction

Multiple tubes or wires shall be bundled and taped together at 10-foot intervals with 12-inch loop for expansion and contraction.

#### 3.1.7.4 Splices

Electrical splices shall be waterproof and shall be located within round splice boxes. Provide 36-inch expansion loop.

#### 3.1.8 Sleeving

Extend sleeve ends a minimum of 12-inches beyond the edge of the paved surface. Cover pipe ends and mark with stakes. Route wire through and tie and each end to stakes.

Provide and install sleeving for all control wiring under paving regardless if plans do not indicate specific locations.

Where two or more lateral lines are installed adjacently under paving, one larger 4-inch PVC sleeve may be installed to house both lateral lines.

#### 3.1.9 Backfill

##### 3.1.9.1 Compaction

Remainder of trench or pipe cover shall be filled to within 3-inches of top with excavated soil, and compact soil with plate hand-held compactors to same density as undisturbed adjacent soil.

##### 3.1.9.2 Backfill Requirements

The trenches shall not be backfilled until all required tests are performed. Trenches shall be carefully backfilled with the sandy clay, sand, or other approved materials, free from large clods of earth or stones. Backfill shall be mechanically compacted landscape areas to a dry density equal to adjacent undisturbed soil in planting areas. Backfill shall conform to adjacent grades without dips, sunken areas, humps, or other surface irregularities.

A fine granular material backfill shall be initially placed over all lines. No foreign matter larger than one-half inch in size will be permitted in the initial backfill.

Flooding of trenches will be permitted only with the approval of the Contracting Officer.

The required adjustments when settlement occurs and subsequent adjustments in piping, valves, sprinkler heads, planting material, or other construction elements are necessary, is the Contractor's responsibility. All required adjustments will be performed without cost to the Owner.

#### 3.1.10 Restoration

Top 3 inches shall be filled with topsoil and compacted with same density as surrounding soil. Plants shall be restored in accordance with Section 02950 TREES, SHRUBS, GROUND COVERS AND VINES. Pavements shall be restored in accordance within this Section.

#### 3.1.11 Adjustment of Irrigation System

Flush piping and adjust irrigation heads, and valves for proper operation as recommended by the valve manufacturer.

#### 3.1.12 Cleaning of Piping

Prior to the hydrostatic and operation tests, the interior of the pipe shall be flushed with clean water until pipe is free of all foreign materials. If the existing lines and emitters become clog the entire system shall be flushed with clean water until lines and emitters are free of all foreign materials.

Flushing and cleaning out of system pipe, valves, bubblers and dripline components shall not be considered completed until witnessed and accepted by Contracting Officer.

### 3.2 FIELD TESTS

All instruments, equipment, facilities, and labor required to conduct the tests shall be provided by Contractor.

#### 3.2.1 Hydrostatic Pressure Test

Piping shall be tested hydrostatically before backfilling and proved tight at a hydrostatic pressure of 1034 kPa (150 psi) without pumping for a period of one hour with an allowable pressure drop of 35 kPa (5 psi). If hydrostatic pressure cannot be held for a minimum of 4 hours, Contractor shall make adjustments or replacements and the tests repeated until satisfactory results are achieved and accepted by the Contracting Officer.

#### 3.2.2 Operation Test

At conclusion of pressure test, bubbler heads, dripline tubing, quick coupling assemblies, and all valves assemblies shall be installed and the entire system shall be tested for operation under normal operating pressure. Operation test consists of the system operating through at least one complete programmed cycle for all areas to be sprinkled. Test shall be

conducted at the beginning of the plant establishment period and at the end of the establishment period.

### 3.2.3 Cover Test

The temporary irrigation system shall be tested for coverage to insure that all hydro seeded areas are watered. The coverage test shall consist of the system operating through at least one complete programmed cycle for all areas to be sprinkled (where applicable). The contractor shall not space the sprinkler heads beyond the manufacturers recommendation for the prevailing wind conditions for the project. The contractor shall make adjustments, or replacements and repeat the test until satisfactory results are achieved and accepted by contracting officer. Coverage test shall be conducted prior to hydruseeding and before landscape acceptance.

### 3.3 CLEANUP

Upon completion of the irrigation system, all debris and surplus materials resulting from the work shall be removed.

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## SECTION 02831

## FENCE, CHAIN-LINK

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 153/A 153M	(1998) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 392	(1996) Zinc-Coated Steel Chain-Link Fence Fabric
ASTM A 491	(1996) Aluminum-Coated Steel Chain-Link Fence Fabric
ASTM C 94	(1999) Ready-Mixed Concrete
ASTM F 626	(1996) Fence Fittings
ASTM F 883	(1997) Padlocks
ASTM F 900	(1994) Industrial and Commercial Swing Gates
ASTM F 1043	(1998a) Strength and Protective Coatings on Metal Industrial Chain-Link Fence Framework
ASTM F 1083	(1997) Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures
ASTM F 1184	(1994) Industrial and Commercial Horizontal Slide Gates

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-13 Certificates

Chain Link Fence; FIO.

Statement signed by an official authorized to certify on behalf of the manufacturer attesting that the chain link fence and component materials meet the specified requirements.

## PART 2 PRODUCTS

### 2.1 MATERIALS

Materials shall conform to the following.

#### 2.1.1 Chain Link Fence Fabric

ASTM A 392, Class 2, zinc-coated steel wire with minimum coating weight of 2.0 ounces of zinc per square foot of coated surface, or ASTM A 491, Type I, aluminum-coated steel wire. Fabric shall be fabricated of 9-gauge wire woven in 2-inch mesh. Fabric height shall be as indicated. The fabric shall be knuckled at both selvages.

#### 2.1.2 Gates

ASTM F 900 and/or ASTM F 1184. Gate shall be the type and swing shown. Gate frames shall conform to strength and coating requirements of ASTM F 1083 for Group IA, steel pipe, with external coating Type A, nominal pipe size (NPS) 1-1/2. Gate frames shall conform to strength and coating requirements of ASTM F 1043, for Group IC, steel pipe with external coating Type A or Type B, nominal pipe size (NPS) 1-1/2. Gate fabric shall be as specified for chain-link fabric. Gate leaves more than 8 feet wide shall have either intermediate members and diagonal truss rods or shall have tubular members as necessary to provide rigid construction, free from sag or twist. Gate leaves less than 8 feet wide shall have truss rods or intermediate braces. Intermediate braces shall be provided on all gate frames with an electro-mechanical lock. Gate fabric shall be attached to the gate frame by method standard with the manufacturer except that welding will not be permitted. Latches, hinges, stops, keepers, rollers, and other hardware items shall be furnished as required for the operation of the gate. Latches shall be arranged for padlocking so that the padlock will be accessible from both sides of the gate. Stops shall be provided for holding the gates in the open position.

#### 2.1.3 Posts

ASTM F 1083, zinc-coated. Group IA, with external coating Type A steel pipe. Group IC steel pipe, zinc-coated with external coating Type A or Type B and Group II, formed steel sections, shall meet the strength and coating requirements of ASTM F 1043. Sizes shall be as shown on the drawings. Line posts and terminal (corner, gate, and pull) posts selected shall be of the same designation throughout the fence. Gate post shall be for the gate type specified subject to the limitation specified in ASTM F 900 and/or ASTM F 1184.

#### 2.1.4 Rails and Braces

ASTM F 1083, zinc-coated, Group IA, steel pipe, size NPS 1-1/4. Group IC steel pipe, zinc-coated, shall meet the strength and coating requirements of ASTM F 1043. Group II, formed steel sections, size 1.66 inch, conforming to ASTM F 1043, may be used as braces and rails if Group II line posts are furnished.

#### 2.1.5 Accessories

ASTM F 626. Ferrous accessories shall be zinc or aluminum coated. Truss rods shall be furnished for each terminal post. Truss rods shall be provided with turnbuckles or other equivalent provisions for adjustment. Tie wire for attaching fabric to rails, braces, and posts shall be 9 gauge steel wire and match the coating of the fence fabric. Miscellaneous hardware coatings shall conform to ASTM A 153/A 153M unless modified herein.

#### 2.1.6 Concrete

ASTM C 94, using 3/4-inch maximum-size aggregate, and having minimum compressive strength of 3000 psi at 28 days. Grout shall consist of one part Portland cement to three parts clean, well-graded sand and the minimum amount of water to produce a workable mix.

#### 2.1.7 Padlocks

ASTM F 883, Type PO1, Grade 2, Size 1-3/4 inch. Padlocks shall be keyed alike and each lock shall be furnished with two keys.

### PART 3 EXECUTION

#### 3.1 FENCE INSTALLATION

Fence shall be installed per manufacturers instructions and to the lines and grades indicated. The area on either side of the fence line shall be cleared to the extent indicated. Line post shall be spaced equidistant at intervals not exceeding 10 feet. Terminal (corner, gate, and pull) posts shall be set at abrupt changes in vertical and horizontal alignment. Fabric shall be continuous between terminal posts; however, runs between terminal posts shall not exceed 500 feet.

#### 3.2 EXCAVATION

Post holes shall be cleared of loose material. Waste material shall be spread where directed. The ground surface irregularities along the fence line shall be eliminated to the extent necessary to maintain a 2-inch clearance between the bottom of the fabric and finish grade.

#### 3.3 POSTS

Posts shall be set plumb and in alignment. Except where solid rock is encountered, posts shall be set in concrete to the depth indicated on the drawings. Where solid rock is encountered with no overburden, posts shall be set to a minimum depth of 18 inches in rock. Where solid rock is covered with an overburden of soil or loose rock, posts shall be set to the minimum depth indicated on the drawing unless a penetration of 18 inches in

solid rock is achieved before reaching the indicated depth, in which case depth of penetration shall terminate. All portions of posts set in rock shall be grouted. Portions of posts not set in rock shall be set in concrete from the rock to ground level. Posts set in concrete shall be set in holes not less than the diameter shown on the drawings. Diameters of holes in solid rock shall be at least 1 inch greater than the largest cross section of the post. Concrete and grout shall be thoroughly consolidated around each post, shall be free of voids and finished to form a dome. Concrete and grout shall be allowed to cure for 72 hours prior to attachment of any item to the posts. Group II line posts may be mechanically driven, for temporary fence construction only, if rock is not encountered. Driven posts shall be set to a minimum depth of 3 feet and shall be protected with drive caps when being set. Fence post rigidity shall be tested by applying a 50 pound force on the post, perpendicular to the fabric, at 5 feet above ground. Post movement measured at the point where the force is applied shall be less than or equal to 3/4 inch from the relaxed position. Every tenth post shall be tested for rigidity. When a post fails this test, further tests on the next four posts on either side of the failed post shall be made. All failed posts shall be removed, replaced, and retested at the Contractor's expense.

### 3.4 RAILS, BRACES AND TRUSS RODS

#### 3.4.1 Top Rail

Top rail shall be supported at each post to form a continuous brace between terminal posts. Where required, sections of top rail shall be joined using sleeves or couplings that will allow expansion or contraction of the rail. Bottom rail, if required for high security fence, shall be installed as indicated on the drawings.

#### 3.4.2 Bottom Rail

The bottom rail shall be bolted to double rail ends and double rail ends shall be securely fastened to the posts. Bolts shall be peened to prevent easy removal. Bottom rail shall be installed before chain link fabric.

#### 3.4.3 Braces and Truss Rods

Braces and truss rods shall be installed as indicated and in conformance with the standard practice for the fence furnished. Horizontal (compression) braces and diagonal truss (tension) rods shall be installed on fences over 6 feet in height. A center brace or 2 diagonal truss rods shall be installed on 12-foot fences. Braces and truss rods shall extend from terminal posts to line posts. Diagonal braces shall form an angle of approximately 40 to 50 degrees with the horizontal. No bracing is required on fences 6 feet high or less if a top rail is installed.

### 3.5 TENSION WIRES

Tension wires shall be installed along the top and bottom of the fence line and attached to the terminal posts of each stretch of the fence. Top tension wires shall be installed within the top 1 foot of the installed fabric. Bottom tension wire shall be installed within the bottom 6 inches

of the installed fabric. Tension wire shall be pulled taut and shall be free of sag.

### 3.6 CHAIN-LINK FABRIC

Chain-link fabric shall be installed on the side of the post indicated. Fabric shall be attached to terminal posts with stretcher bars and tension bands. Bands shall be spaced at approximately 15-inch intervals. The fabric shall be installed and pulled taut to provide a smooth uniform appearance free from sag, without permanently distorting the fabric diamond or reducing the fabric height. Fabric shall be fastened to line posts at approximately 15-inch intervals and fastened to tension wires at approximately 24-inch intervals. Fabric shall be cut by untwisting and removing pickets. Splicing shall be accomplished by weaving a single picket into the ends of the rolls to be joined. The bottom of the installed fabric shall be 2 inches (plus or minus 1/2-inch) above the ground.

### 3.7 GATES

Gates shall be installed at the locations shown. Hinged gates shall be mounted to swing as indicated. Latches, stops, and keepers shall be installed as required. Padlocks shall be attached to gates or gate posts with chains. Hinge pins, and hardware shall be welded or otherwise secured to prevent removal.

### 3.8 GROUNDING

Fences crossed by powerlines of 600 volts or more shall be grounded at or near the point of crossing and at distances not exceeding 150 feet on each side of crossing. Ground conductor shall consist of No. 8 AWG solid copper wire. Grounding electrodes shall be 3/4-inch by 10-foot long copper-clad steel rod. Electrodes shall be driven into the earth so that the top of the electrode is at least 6 inches below the grade. Where driving is impracticable electrodes shall be buried a minimum of 12 inches deep and radially from the fence. Top of electrode shall be not less than 2 feet or more than 8 feet from the fence. Ground conductor shall be clamped to the fence and electrodes with bronze grounding clamps so as to create electrical continuity between fence posts, fence fabric, and ground rods. After installation the total resistance of fence to ground shall not be greater than 25 ohms.

### 3.9 TEMPORARY FENCE

A temporary security fence required per Section 01200 GENERAL REQUIREMENTS shall be installed as required. Structural steel members and installation shall conform to the applicable requirements of Section 05500 MISCELLANEOUS METALS. Materials need not be new provided they are adequate for the intended purpose. Upon completion of the work, the fence materials shall become the property of the Contractor and shall be removed from the site.

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## SECTION 02935

## HYDROSEEDING

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AGRICULTURAL MARKETING SERVICE (AMS)

AMS Seed Act (1995) Federal Seed Act Regulations (Part 201)

## COMMERCIAL ITEM DESCRIPTIONS (CID)

CID A-A-1909 (Basic; Notice 1; Canc. Notice 2)  
Fertilizer

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-08 Statements

Delivery; FIO.

Delivery schedule, at least 10 days prior to the intended date of the first delivery.

Application of Pesticide; GA.

Pesticide Treatment Plan with proposed sequence of pesticide treatment work. The pesticide trade name, chemical composition, formulation, concentration, application rate of active ingredients and method of application for all materials shall be furnished; and the name and state license number of the state certified applicator shall be included.

Agronomical Soils and Growth Tests; GA.

Results of agronomical soils and plant growth tests, including recommended quantities of soil amendments, to be performed after the completion of grading and prior to soils prep. Contractor shall pay for the tests and submit the name, address and phone number of the testing lab for an approval prior to ordering the tests.

Maintenance Report; FIO.

Written record of maintenance work performed.

Hydroseed Establishment Period; FIO.

Written calendar time period for the turf establishment period. When there is more than one hydroseed establishment period, describe the boundaries of the seeded area covered for each period.

Endomycorrhizal Inoculant Instructions; FIO.

Manufacturer's written instructions for application rates for intended use.

#### SD-13 Certificates

Prior to the delivery of materials, certificates of compliance certifying that materials meet the requirements specified. Certified copies of the reports for the following materials shall be included.

Seed; GA.

For mixture, percent pure live seed, minimum percent germination and hard seed, maximum percent weed seed content, date tested and state certification.

Fertilizer; FIO.

For chemical analysis, composition percent.

Pesticide; GA.

For EPA registration number and registered uses.

Imported Top Soil; GA.

For pH, particle size, chemical analysis, and mechanical analysis.

Endomycorrhizal Inoculant; FIO.

For chemical analysis, composition percent.

### 1.3 DELIVERY, INSPECTION, STORAGE, AND HANDLING

#### 1.3.1 Delivery

##### 1.3.1.1 Soil Amendments

Soil amendments shall be delivered to the site in the original, unopened containers bearing the manufacturer's chemical analysis. In lieu of containers, soil amendments may be furnished in bulk. A chemical analysis shall be provided for bulk deliveries.

##### 1.3.1.2 Pesticide

Pesticide material shall be delivered to the site in the original, unopened containers bearing legible labels indicating the Environmental Protection Agency (EPA) registration number and the manufacturer's registered uses.

1.3.2 Inspection

Materials will be inspected upon arrival at the job site by the Contracting Officer for conformity to specifications. Unacceptable materials shall be removed from the job site.

1.3.3 Storage

Materials shall be stored in areas designated by the Contracting Officer. Seed and fertilizer shall be stored in cool, dry locations away from contaminants. Chemical treatment materials shall not be stored with other landscape materials.

1.3.4 Handling

Except for bulk deliveries, materials shall not be dropped or dumped from vehicles.

PART 2 PRODUCTS

2.1 SEED

2.1.1 Seed Classification

State-approved seed of the latest season's crop shall be provided in original sealed packages bearing the producer's guaranteed analysis for percentages of mixture, purity, germination, hard seed, weed seed content, and inert material. Labels shall be in conformance with AMS Seed Act and applicable state seed laws.

2.1.2 Seed Mixtures

Seed mixtures shall be proportioned by weight as follows:

Botanical Name	Common Name	Pure Live Seed(P.L.S.) in pounds per acre <u>Minimum</u>
Bromus Carinatus	California Brome	5.0 lbs/acre
Deschampsia caespitosa	Tufted Hairgrass	3.8 lbs/acre
Deschampsia elongatum	Hairgrass	2.2 lbs/acre
Eschscholzia californica	Calif. Poppy	2.0 lbs/acre
Hordeum c. prostrate	Calif. Barley	6.0 lbs/acre
Melica Imperfecta	Coast Range Melica	2.0 lbs/acre
Lupinus bicolor	Lupines	3.0 lbs/acre
Poa secunda	Bluegrass	1.3 lbs/acre
Stipa Lepida	Foothill NeedleGrass	1.0 lbs/acre
Vulpia microstacys	Zorro Fescue	4.3 lbs/acre

Total Pounds P.L.S. per acre = 30.6

2.1.3 Quality

Seed shall conform to AMS Seed Act. Weed seed shall not exceed 1 percent by weight of the total mixture. Wet, moldy, or otherwise damaged seed shall be rejected.

2.1.4 Seed Mixing

The field mixing of seed shall be performed onsite in the presence of the Contracting Officer.

2.2 SOIL AMENDMENTS

The following amendments shall conform to the following requirements.

2.2.1 Gypsum

The gypsum is to be supplied in a finely ground form. 100% of the ground material shall pass through a 10 mesh screen and 50% of the material shall pass through a 100 mesh screen. The gypsum shall be free-flowing, commercially packaged, minimum 92 percent calcium sulfate by volume, free of any toxic material.

2.2.2 Sulfur

The sulfur shall be applied in the flour of sulfur finely ground form, and shall be commercial grade.

2.2.3 Granular Fertilizer

Fertilizer shall be commercial grade, free flowing, uniform in composition and conforming to CID A-A-1909. Granular Fertilizer: Consists of nitrogen- phosphorous-potassium 5-3-1 and 14-4-9 ratio.

2.2.4 Organic Soil Amendments

a. Topsoil: Delivered topsoil shall be amended as recommended by a soil test provided by the contractor for the plants specified (subject to the Contract Officer's approval).

2.2.4.1 Decomposed Wood Derivatives

Decomposed wood derivatives shall be ground bark, sawdust, or other wood waste material free of stones, sticks, and toxic substances harmful to plants and stabilized with nitrogen and having the following properties:

Particle size	Minimum % by weight passing
No. 4 mesh screen	95
No. 8 mesh screen	80

	Minimum % based on dry weight
Nitrogen Content	
Redwood Sawdust	0.5
Fir Sawdust	0.7
Fir or Pine Bark	1.0

#### 2.2.5 Wood Cellulose Fiber

Wood cellulose fiber shall not contain any growth or germination-inhibiting factors and shall be dyed an appropriate color to facilitate visual metering during application. Composition on air-dry weight basis: 9 to 15 percent moisture, pH range from 4.5 to 6.0.

#### 2.2.6 Endomycorrhizal inoculant

Endomycorrhizal inoculant use as a soil amendment shall be a granular calcined clay-based product.

#### 2.2.7 Activated Charcoal

Activated charcoal shall be agricultural grade, commercially packaged, free of any toxic material and shall be incorporated into the soil at rates required by the soil tests.

### 2.3 EROSION CONTROL MATERIAL

Soil erosion control chemicals shall be hydrophilic colloids physiologically harmless to plant and animal life, without phytotoxic agents. Colloids shall be naturally occurring, silicate powder based, and shall form a water insoluble membrane after curing. Colloids must resist mold growth.

## PART 3 EXECUTION

### 3.1 SEEDING TIMES AND CONDITIONS

#### 3.1.1 Seeding Time

Seed shall be sown from October 1st to March 1st.

#### 3.1.2 Seeding Conditions

Hydroseed operations shall be performed only during periods when beneficial results can be obtained. When drought, excessive moisture or other unsatisfactory conditions prevail, the work shall be stopped when directed.

When special conditions warrant a variance to the seeding operations, proposed times shall be submitted to and approved by the Contracting Officer.

### 3.2 SITE PREPARATION

Prior to hydroseeding and after finish grading has been completed, the Contractor shall apply two cycles of pre-emergent weed control treatments for the hydroseed areas as follows:

a. Contractor shall operate the temporary irrigation system to keep hydroseed areas uniformly moist for a period of three (3) weeks. At the end of the three week period, Contractor shall spray all visible weeds with a contact herbicide. After spraying, the areas shall remain unwatered for a minimum of forty-eight (48) hours. Contractor shall then remove the weeds from the project.

b. Contractor shall water seven (7) days additional consecutive calendar days from the first application of herbicide, and apply a contact herbicide. After the second spraying, water shall not be applied for an additional forty-eight (48) hour period. Contractor shall then remove the weeds and commence hydroseeding operations.

### 3.2.1 Grading

The Contracting Officer shall verify the finished grades as indicated on drawings, and the placing of topsoil and the smooth grading has been completed.

### 3.2.2 Tillage

For slopes 2:1 and flatter, the soil shall be tilled to a depth of at least 4 inches. On slopes between 2 horizontal to 1 vertical and 1 horizontal to 1 vertical, tillage operation shall be approved by the Contracting Officer.

Tillage shall be accomplished by plowing, disking, harrowing, by the use of rototillage machinery or other approved operations until the condition of the soil is acceptable. Undulations or irregularities in the surface shall be compacted to 80-85 percent. During tillage operations, all sticks, roots and other objectionable material shall be removed and the soil restored to an even condition immediately before seeding.

### 3.2.3 Application of Soil Amendments and Fertilizer.

#### 3.2.3.1 Fertilizer

5-3-1 Fertilizer shall be applied at the rate of 150 pounds per 1,000 square feet Gypsum at the rate of 200 pounds per 1,000 square feet; and Decomposed Wood Derivative at the rate of 200 cubic yards per acre. Additional amendments required by the agronomic soils tests shall be provided and incorporated as necessary.

#### 3.2.3.2 Soil Amendments

All soil amendments, conditioners, and fertilizers shall be incorporated into the soil to a depth of at least the top 4 inches, as applicable, and may be incorporated as part of the tillage operation or as part of the topsoil fill operation, using a rotary tiller or similar type of equipment to obtain a uniform and well-pulverized soil mix.

#### 3.2.3.3 Endomycorrhizal Inoculant

Endomycorrhizal inoculant shall be applied at the rates recommended by the manufacturer's written instructions for its intended use. Endomycorrhizal

inoculant shall be incorporated into the soil to a depth of at least the top 4 inches, as applicable, and may be incorporated as part of the tillage operation. However, the inoculant shall not be incorporated into the ground more than six weeks prior to seeding operations and shall not be placed on top of the ground for more than six hours prior to incorporation into the soil.

### 3.2.4 Finished Grading

#### 3.2.4.1 Preparation

Seeded areas shall be filled as needed or have surplus soil removed to attain the finished grade. Drainage patterns shall be maintained as indicated on drawings. Seeded areas shall be completely pulverized by tillage. Soil used for repair of erosion or grade deficiencies shall conform to topsoil requirements. Finished grade shall be 2-inch below the adjoining grade of any paved area. New surfaces shall be blended to existing areas.

#### 3.2.4.2 Field Area Debris

Field areas shall have debris and stones larger than 3-inches in any dimension removed from the surface.

#### 3.2.4.3 Protection

Finished graded areas shall be protected from damage by vehicular or pedestrian traffic and erosion.

### 3.2.5 Application of Soil Treatment Chemicals.

When soil treatment becomes necessary to remove a pest, a state certified applicator shall apply required chemicals in accordance with EPA label restrictions and recommendations. Hydraulic equipment shall be provided for the liquid application of chemicals with a lead-proof tank, positive agitation methods, controlled application pressure, and metering gauges.

## 3.3 SEEDING

### 3.3.1 General

Prior to seeding, any previously prepared seeded areas compacted or damaged by interim rain, traffic or other cause, shall be reworked to restore the ground condition previously specified. Seeding operations shall not take place when the wind velocity will prevent uniform seed distribution.

### 3.3.2 Equipment Calibration

The equipment to be used and the methods of seeding shall be subject to the inspection and approval of the Contracting Officer prior to commencement of seeding operations. Immediately prior to the commencement of seeding operations, the Contractor shall conduct seeding equipment calibration tests in the presence of the Contracting Officer.

### 3.3.3 Hydroseeding

#### 3.3.3.1 Seed and Mulch

The seed and mulch shall be mixed in the required amount of water to provide a homogeneous slurry and then uniformly applied under pressure at the following rates per acre:

- a. Seed: Seed mixture 30.6 lbs. PLS/acre
- b. Wood: Wood cellulose fiber mulch -400 lbs.

#### 3.3.3.2 Hydroseeder

The seed shall not remain in the hydroseeder for longer than three (3) hours.

#### 3.3.3.3 Soil Moisture

Adequate soil moisture shall be maintained by spraying water on the entire hydroseeded area, moistening the soil to a depth of four (4) inches minimum. Do not roll the hydroseeded area.

### 3.3.4 Mulching

#### 3.3.4.1 Hydroseeded area

After the hydroseeding operation, fertilizer, erosion control material, and wood cellulose fiber mulch shall be mixed in the required amount to water to produce a homogeneous slurry and then hydromulched under pressure at the following rates per acre (dry weight).

- a. Wood cellulose fiber - 2,000 lbs.
- b. 14-4-9 commercial fertilizer - 300 lbs.
- c. Erosion Control material - 130 lbs.

### 3.4 APPLICATION OF PESTICIDE

A state-certified applicator shall apply required pesticides in accordance with EPA label restrictions and recommendations. Hydraulic equipment shall be provided for the liquid application of pesticides with a leak-proof tank, positive agitation methods, controlled application pressure and metering gauges.

### 3.5 RESTORATION AND CLEANUP

#### 3.5.1 Restoration

Existing planting areas, pavements and facilities that have been damaged from the seeding operation shall be restored to original condition at Contractor's expense.

### 3.5.2 Cleanup

Excess and waste material shall be removed from the planting operation and shall be disposed of off the site. Adjacent paved areas shall be restored to original conditions.

### 3.6 PROTECTION OF SEEDED AREAS

Immediately after seeding, the area shall be protected against traffic or other use by erecting barricades and providing signage as required.

### 3.7 ESTABLISHMENT PERIOD

#### 3.7.1 Commencement

The Establishment Period for establishing a healthy stand of plant material shall end three (3) months after the last day of seeding operations required by this contract, as approved by the Contracting Officer. Written calendar time period shall be furnished to the Contracting Officer for the Establishment Period. When there is more than one establishment period, describe the boundaries of the seeded area covered for each period.

#### 3.7.2 Satisfactory Stand of Plant Material

An acceptable seeded area from the seeding operation is defined as a solid soil surface ground covering of plants from the required seed mix. The total bare spots shall not exceed 2 percent of the total seeded area. No bare spots shall exceed 6 inch in diameter.

#### 3.7.3 Maintenance During Establishment Period

##### 3.7.3.1 General

Maintenance of the seeded areas shall include eradicating weeds, eradicating insects and diseases, weed whacking, protecting embankments and ditches from erosion, protecting seeded areas from traffic, maintaining mulch, watering, post-fertilization, and any other operation necessary to promote healthy plant establishment.

##### 3.7.3.2 Watering

Contractor shall provide a temporary overhead irrigation system for all hydroseed areas. Truck watering is not allowed. Watering shall be at intervals to obtain a moist soil condition to a minimum depth of 25 mm (2 inches). Frequency of watering and quantity of water shall be adjusted in accordance with the growth of the seeded material. Run-off, puddling and wilting shall be prevented. The contractor shall provide the Contracting Officer with a shop drawing of the layout design of the temporary irrigation system showing sprinkler heads with spray coverage, precipitation rates and water use requirements. The layout design shall be approved by the Contracting Officer prior to installation.

##### 3.7.3.3 Post-Fertilization

Granular fertilizer with the composition of 5% nitrogen, 3% phosphorous, 1% potassium shall be applied at the rate of 25 pounds per 1000 square feet 45 days after the commencement of the maintenance period. The application shall be timed prior to the advent of winter dormancy and shall avoid excessively high nitrogen levels.

#### 3.7.3.4 Pesticide Treatment

Treatment for disease or pest shall be in accordance with paragraph APPLICATION OF PESTICIDE.

#### 3.7.3.5 Repair

The Contractor shall re-establish as specified herein, eroded, damaged or barren areas. Mulch shall also be repaired or replaced as required.

#### 3.7.3.6 Maintenance Report

A written record shall be furnished to the Contracting Officer of the maintenance work performed.

### 3.8 FINAL ACCEPTANCE

#### 3.8.1 Preliminary Inspection

Prior to the completion of the Plant Establishment Period, a preliminary inspection will be held by the Contracting Officer. Time for the inspection will be established in writing. The acceptability of the seeded areas in accordance with the Plant Establishment Period shall be determined. An unacceptable stand of seeded planting, as determined by the Contracting Officer, shall be repaired as soon as seeding conditions permit.

#### 3.8.2 Final Inspection

A final inspection will be held by the Contracting Officer to determine that deficiencies noted in the preliminary inspection have been corrected. Time for the inspection will be established in writing.

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## SECTION 02950

## TREES, SHRUBS, GROUNDCOVERS, AND VINES

## PART 1 GENERAL

## 1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

## AMERICAN NURSERY AND LANDSCAPE ASSOCIATION (ANLA)

ANLA Z60.1 (1996) Nursery Stock

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 2607 (1969) Peats, Mosses, Humus, and Related Products

## COMMERCIAL ITEM DESCRIPTIONS (CID)

CID A-A-1909 (Basic; Notice 1; Canc. Notice 2)  
Fertilizer

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-01 Data

Erosion Control Material; FIO.

Manufacturer's literature discussing physical characteristics, application and installation instructions for erosion control material.

## SD-07 Schedules

Pesticide Material Application; GA.

A list of the proposed pesticide application equipment to be used in performance of the planting work, including descriptive data and calibration tests.

## SD-08 Statements

Delivery Schedule; FIO. Pesticide Treatment Plan; GA. Plant Material Acquisition Plan; GA.

The following work plans, before work is started.

- a. Delivery Schedule at least 10 days prior to the intended date of the first delivery.
- b. Pesticide Treatment Plan, giving proposed sequence of pesticide treatment work, before work is started. The pesticide trade name, chemical composition, formulation, concentration, application rate of active ingredients and methods of application for all materials furnished, and the name and state license number of the state certified applicator shall be included.
- c. Plant Material Acquisition Plan, within thirty (30) calendar days of contract award outlining proposed method(s) of obtaining the required plant material species, sizes, and quantities within the planting dates specified.

#### SD-09 Reports

Soil Test; FIO. Percolation Test; FIO.

Certified reports of inspections and laboratory tests, prepared by an independent testing agency, including analysis and interpretation of test results. Each report shall be properly identified. Test methods used and compliance with recognized test standards shall be described.

#### SD-13 Certificates

Topsoil; FIO. Soil Amendments; FIO. Plants; GA. Pesticide; GA.

Certificates of compliance certifying that materials meet the requirements specified, prior to the delivery of materials. Reports for the following materials shall be included.

- a. Topsoil: For pH, chemical analysis, mechanical analysis and particle size.
- b. Fertilizer: For chemical analysis and composition percent.
- c. Peat: For compliance with ASTM D 2607.
- d. Plant Materials: For botanical and common name, size, quantity by species, grade, nursery grown.
- e. Pesticide Material: For EPA registration number and registered uses.

#### SD-18 Records

Plant Establishment Period; FIO. Maintenance Report; FIO. Maintenance Instructions; FIO.

- a. Plant Establishment Period. Written calendar time period for the

beginning of the plant establishment period. When there is more than one establishment period, the boundaries of the planted areas covered for each period shall be described.

b. Maintenance Report. Written record of maintenance work performed and quantity of plant losses and replacements.

c. Maintenance Instructions. Written instructions for year-round care of installed plants.

### 1.3 SOURCE INSPECTIONS

#### 1.3.1 Plant Materials

Plant materials shall be subject to inspection at the growing site by the Contracting Officer.

#### 1.3.2 Delivered Topsoil

The source of topsoil shall be subject to inspection by the Contracting Officer.

### 1.4 SHIPMENT, DELIVERY, INSPECTION, STORAGE, AND HANDLING

#### 1.4.1 Shipment

##### 1.4.1.1 Preparation

a. Digging and preparation for shipment shall be done in a manner that will not cause shock or damage to branches, trunk, or root systems.

b. Container-Grown (C) Plants: Container size shall be provided as recommended by ANLA Z60.1. Plants shall be grown in a container sufficiently long for new fibrous roots to have developed and for root mass to retain its shape and hold together when removed from container. Container shall be sufficiently rigid to hold ball shape and protect root mass during shipping. Plant material shall not be root bound.

##### 1.4.1.2 Antidesiccant Application

Plants shall be sprayed with an antidesiccant as leaf budding occurs or when plant material has soft growth.

#### 1.4.2 Delivery

##### 1.4.2.1 Identification

Plants shall be identified with durable waterproof labels and weather-resistant ink. Plants shall have attached labels stating the correct plant name and size.

##### 1.4.2.2 Protection During Delivery

Plants shall be protected during delivery to prevent desiccation of the plant or damage to the roots or balls. Branches of plants shall be protected by tying-in the branches and covering all exposed branches.

#### 1.4.2.3 Topsoil

A soil test shall be provided for topsoil delivered to the site.

#### 1.4.2.4 Soil Amendments

Soil amendments shall be delivered to the site in the original, unopened containers bearing the manufacturer's chemical analysis. In lieu of containers, soil amendments may be furnished in bulk. A chemical analysis shall be provided for bulk deliveries.

#### 1.4.2.5 Pesticide

Pesticide materials shall be delivered to the site in the original unopened containers bearing legible labels indicating the Environmental Protection Agency (EPA) registration numbers and the registered uses.

#### 1.4.3 Inspection

Plant material shall be inspected upon arrival at the jobsite by the Contracting Officer for conformity to the paragraph PLANTS and paragraph SHIPMENT, and any unacceptable plant material shall be removed from the jobsite.

#### 1.4.4 Storage

##### 1.4.4.1 Plant Storage

Plants not installed on the day of arrival at the site shall be stored and protected in areas designated by the Contracting Officer. Plants shall be protected from exposure to wind and shall be shaded from the sun. Covering that will allow air to circulate and prevent internal heat from building up shall be provided. All plants shall be kept in a moist condition by watering with a fine mist spray until planted.

##### 1.4.4.2 Storage of Other Materials

Soil amendments shall be stored in dry locations away from contaminants. Pesticide materials shall not be stored with other landscape materials. Storage of materials shall be in areas designated or as approved by the Contracting Officer.

#### 1.4.5 Handling

Care shall be taken to avoid injury to plants. Materials shall not be dropped from vehicles. Plants shall not be handled by the trunk or stems.

#### 1.5 WARRANTY

Furnished plants shall be guaranteed to be in a vigorous growing condition for a period of twelve (12) months regardless of the contract time period. A written calendar time period for the guarantee of plant growth shall be furnished to the Contracting Officer.

## PART 2 PRODUCTS

### 2.1 PLANTS

#### 2.1.1 Acquisition

The Contractor shall be responsible for acquiring all plant material in the required sizes and quantities and within the planting dates specified, either from nursery stock on hand, by a Contract Growing, or by another means as approved by the Contracting Officer.

#### 2.1.2 Varieties

Plants shall be nursery grown stock conforming to ANLA Z60.1 and shall be of the varieties specified in the plant list bearing botanical names listed in one or more of the publications listed under "Nomenclature" in ANLA Z60.1.

#### 2.1.3 Substitutions

Substitutions will not be permitted without written request from the Contractor for approval by the Contracting Officer.

#### 2.1.4 Growing Conditions

Plants shall be grown under climatic conditions similar to those in the locality of the project.

#### 2.1.5 Quality

Well shaped, well grown, vigorous, healthy plants having healthy and well branched root systems shall be provided. Plants shall be provided free from disease, harmful insects and insect eggs, sun-scald injury, disfigurement and abrasion. Plants shall be provided that are typical of the species or variety and conforming to standards as set forth in ANLA Z60.1 and as specified herein.

##### 2.1.5.1 Trees

A height relationship to caliper shall be provided as recommended by ANLA Z60.1. Height of branching should bear a relationship to the size and variety of tree specified and with the crown in good balance with the trunk. Trees shall not be "poled" or the leader removed.

a. Single stem: Trunk shall be reasonably straight and symmetrical with crown and have a persistent main leader.

b. Multi-stem: All countable stems, in aggregate, shall average the size specified. To be considered a stem, there should be no division of the trunk which branches more than six inches from ground level.

There shall be a minimum of three (3) stems per multi-stem tree.

#### 2.1.5.2 Shrub

Plants shall be provided that have the height and number of primary stems as recommended by ANLA Z60.1. An acceptable plant shall be well shaped with sufficient well-spaced side branches recognized by the trade as typical for the variety grown in the region.

#### 2.1.5.3 Coniferous Evergreen

Trees shall be provided that have the height-to-spread ratio as recommended by ANLA Z60.1. Trees shall not be "poled" or the leader removed. An acceptable plant shall be exceptionally heavy, well shaped and trimmed to form a symmetrical and tightly knit plant. The form of growth desired shall be as indicated.

#### 2.1.5.4 Groundcovers and Vines

Plants shall be provided with the minimum number of runners and length of runner as recommended by ANLA Z60.1. Plants shall be furnished that have heavy, well developed and balanced top with vigorous well developed root system and shall be furnished in containers.

#### 2.1.6 Size

Plants shall be furnished in sizes indicated. Plants larger in size than specified may be provided at no additional cost to the Government.

#### 2.1.7 Measurement

Plant measurements shall be in accordance with ANLA Z60.1.

### 2.2 TOPSOIL

Additional topsoil, if required, shall be delivered. Delivered topsoil shall be amended as recommended by soil tests for the plants specified (Subject to the Contracting Officer's approval).

### 2.3 SOIL AMENDMENTS

Soil amendments for planting pits consist of fertilizer and soil conditioner.

#### 2.3.1 Fertilizer

Fertilizer shall be commercial grade, free flowing, uniform in composition and conforming to CID A-A-1909.

##### 2.3.1.1 Dry Fertilizer

- a. Granular fertilizer: Consists of nitrogen-phosphorous-potassium ratio: 5% nitrogen 3% phosphorous, and 1% potassium.

b. Controlled-Release Fertilizer: Consists of nitrogen-phosphorous-potassium ratio: 12% nitrogen 8% phosphorous, and 8% potassium. Controlled-release fertilizer may be in packet or tablet form.

#### 2.3.2 Soil Conditioner

For single use or in combination to meet requirements for topsoil.

##### 2.3.2.1 Gypsum

Gypsum shall be commercially packaged, free flowing, and a minimum of 92% calcium sulfate by volume. The gypsum shall be supplied in finely ground form. 100% of the ground material shall pass a 10-mesh screen and at least 50% of the material shall pass through a 100-mesh screen.

##### 2.3.2.2 Sulfur

The sulfur shall be applied in the flour of sulfur finely ground form, and shall be commercial grade.

#### 2.4 STAKING MATERIAL

##### 2.4.1 Stakes

Stakes for tree support shall be rough sawn wood, free from knots, rot, cross grain, or other defects that would impair the strength. Standard stakes shall be lodge pole pine treated with pentachlorophenol.

##### 2.4.1.1 Bracing Stakes

Bracing stakes shall be lodge pole pine, 2 inch diameter by 8 feet long and pointed at one end.

##### 2.4.1.2 Guying Wire

Guying wire shall be 12-gauge annealed galvanized steel wire.

##### 2.4.1.3 Chafing Guard

Hose chafing guards shall be new or used 2-ply reinforced rubber or plastic hose and shall be all the same color on the project. Length shall be 1-1/2 times the circumference of the plant at its base.

#### 2.5 WATER

Water shall not contain elements toxic to plant life.

#### 2.6 ANTIDESICCANT

Antidesiccant shall be an emulsion that will provide a film over plant surfaces permeable enough to permit transpiration, and shall not damage the plant.

## 2.7 EROSION CONTROL MATERIAL

### 2.7.1 Erosion Control Netting

Control net shall be heavy, twisted jute mesh weighing approximately 1.22 pounds per linear yard and 4 feet wide with mesh openings of approximately 1 inch square.

### 2.7.2 Anchors

Erosion control anchors shall be as recommended by the manufacturer.

## 2.8 PESTICIDE

Pesticide shall be insecticide and herbicide. Pesticide material shall be labeled for use and applied only as registered by EPA and approved herbicide and insecticide.

## PART 3 EXECUTION

### 3.1 EXAMINATION

#### 3.1.1 Verify Grades

The Contracting Officer shall verify the finished grades are as indicated on drawings, and the placing of topsoil and smooth grading has been completed in accordance with Section 02250 FILLS AND SUBGRADE PREPARATION, AND DRAINAGE SYSTEMS.

#### 3.1.2 Underground Obstructions to Planting

The location of underground utilities and facilities shall be verified. Damage to underground utilities and facilities shall be repaired at the Contractor's expense.

### 3.2 SITE PREPARATION

#### 3.2.1 Layout

Plant material locations, bed, and rock outlines shall be staked on the project site before any excavation is made. Plant material locations may be adjusted by the Contracting Officer to meet field conditions.

#### 3.2.2 Protection of Existing Vegetation

Existing trees, shrubbery, and beds that are to be preserved shall be barricaded in a manner that will effectively protect them during planting operations.

### 3.3 EXCAVATION

#### 3.3.1 Obstructions Below Ground or Poor Drainage

When obstructions below ground or poor drainage affect the contract

operation, proposed adjustments to plant location, type of plant and planting method or drainage correction shall be submitted to and approved by the Contracting Officer.

3.3.2 Plant Pits

Plant pits shall be dug to produce vertical sides and flat, uncompacted bottoms. When pits are dug with an auger and the sides of the pits become glazed, the glazed surface shall be scarified. The size of plant pits shall be as shown on drawings.

3.4 PERCOLATION TEST

Test for percolation shall be done to determine positive drainage of all plant pits. The Contracting Officer shall be notified in writing of all soil and drainage conditions detrimental to growth of plant material and shall submit proposal for correcting the condition.

3.5 PLANTING TIMES AND CONDITIONS

3.5.1 Planting Time

Install plants from October 1st to April 1st. Planting at times other than this recommended time shall be at the risk of the Contractor or as approved by the Contracting Officer.

3.5.2 Planting Conditions

Planting operations shall be performed only during periods when beneficial results can be obtained. When drought, excessive moisture or other unsatisfactory conditions prevail, the work shall be stopped when directed.

When special conditions warrant a variance to the planting operations, proposed planting times shall be submitted to and approved by the Contracting Officer.

3.6 INSTALLATION

3.6.1 Erosion Control

Where erosion control material is indicated, material shall be installed in accordance with manufacturer's instructions. Placement of the erosion control material shall be accomplished without damage to installed material or without deviation to finished grade.

3.6.2 Backfill Soil Mixture

The backfill soil mixture shall be a proportioned mixture of fertilizer and amendment thoroughly mixed with the native soil per the ratio as follows:

Container Size	Time Release		Gypsum	Sulfur
	5-3-1	12-8-8		
1 gal	1/2 cup	2 tbsp	1/4 cup	2 tbsp
5 gal	1 cup	3 tbsp	2 cup	1/4 cup
15 gal	1/2 cup	1/4 cup	1 cup	2 cup

### 3.6.3 Setting Plants

Plants shall be set plumb and held in position until sufficient soil has been firmly placed around roots or ball. Plants shall be set in relation to surrounding grade so that they are even with the depth at which they were grown in the nursery, or container.

### 3.6.4 Container-Grown

Non-biodegradable containers or platforms shall be removed without damage to the plant or root system. Biodegradable containers shall be split.

### 3.6.5 Staking

#### 3.6.5.1 Bracing Stakes

Trees shall be held in place with two bracing stakes placed on opposite sides. The tree shall be held firmly between the stakes with a double strand of wire. Chafing guards shall be used where the wire contacts the tree. Bracing stakes shall be driven vertically into firm ground and shall not injure the ball or roots.

## 3.7 FINISHING

### 3.7.1 Plant Beds

Planted areas shall be uniformly edged to a shape as indicated on the drawings. The entire planted area shall be raked and smoothed while maintaining the water basins. Erosion control materials shall be installed in accordance with manufacturer's recommendation or as directed by the contracting officer.

### 3.7.2 Pruning

The total amount of foliage shall be pruned by one-fourth to one-third on installed trees and shrubs to compensate for loss of roots and transplanting shock. The typical growth habit of individual plants shall be retained. Clean cuts shall be made flush with the parent trunk. Improper cuts, stubs, dead and broken branches shall be removed. "Headback" cuts at right angles to the line of growth shall not be permitted. Trees shall not be poled or the leader removed, nor shall the leader be pruned or "topped off." Remove dead limbs and criss-crossed branches.

### 3.7.3 Water

Plants shall be watered as necessary to maintain an adequate supply of moisture within the root zone. Run-off, puddling and wilting shall be prevented.

### 3.7.4 Antidesiccant Application

Plants requiring further protection, as directed by the Contracting

Officer, shall be sprayed with anti-desiccant in accordance with manufacturer's recommendations.

### 3.8 MAINTENANCE DURING PLANTING OPERATION

Installed plants shall be maintained in a healthy growing condition. Maintenance operations shall begin immediately after each plant is installed and shall continue until the plant establishment period commences. The maintenance includes watering, pruning, wound dressing, straightening and other necessary operations. Plant beds and earth saucers shall be kept free of weeds, grass and other undesired vegetation. Plants shall be checked for settlement and shall be reset proper grade as necessary. Run-off, puddling and wilting shall be prevented.

### 3.9 APPLICATION OF PESTICIDE MATERIAL

When pesticide becomes necessary to remove a disease or pest, a state-certified applicator shall apply required pesticide in accordance with State EPA label restrictions and recommendations. Hydraulic equipment shall be provided for the liquid application of pesticides with a leak-proof tank, positive agitation methods, controlled application pressure and metering gauges. A pesticide treatment plan shall be provided to the Contracting Officer as specified in paragraph SUBMITTALS.

### 3.10 RESTORATION AND CLEANUP

#### 3.10.1 Restoration

Planting areas, pavements, utilities and facilities that have been damaged from the planting operation shall be restored to original condition at the Contractor's expense.

#### 3.10.2 Cleanup

Excess and waste material from the planting operation shall be removed and disposed of off the site. Adjacent paved areas shall be cleared.

### 3.11 PLANT ESTABLISHMENT PERIOD

#### 3.11.1 Commencement

On completion of the last day of the planting operation, the plant establishment period for maintaining installed plants in a healthy growing condition shall commence and shall be in effect for 12 months. When the planting operation extends over more than one season or there is a variance to the planting times, plant establishment periods shall be established for the work completed, as directed. Written calendar time period shall be furnished to the Contracting Officer for the beginning of the plant establishment period. When there is more than one plant establishment period, describe the boundaries of the planted area covered for each period.

#### 3.11.2 Maintenance During Establishment Period

##### 3.11.2.1 General

Maintenance of plants shall include straightening plants, tightening stakes and guying material, protecting plant areas from erosion, maintaining erosion control material, supplementing mulch, accomplishing wound dressing, removing dead or broken tip growth by pruning, maintaining edging of beds, checking for girdling of plants and maintaining plant labels, watering, weeding, removing and replacing unhealthy plants.

#### 3.11.2.2 Water

The plants shall be watered as necessary to maintain an adequate supply of moisture within the root zone. Run-off, puddling and wilting shall be prevented.

#### 3.11.2.3 Weeding

Grass and weeds in all planted areas shall be kept weed free at all times during the Establishment/Maintenance period.

#### 3.11.2.4 Unhealthy Plants

A plant shall be considered unhealthy or dead when the main leader has died back, or 25% of the crown is dead. Determine the cause for an unhealthy plant. Unhealthy or dead plants shall be removed immediately and shall be replaced as soon as seasonal conditions permit.

#### 3.11.2.5 Fertilizing

The plants shall be topdressed at least once during the period of establishment with time release 12-8-8 dry fertilizer at the rate of 15 lbs/1,000 square feet of plant pit area. Dry fertilizer adhering to plants shall be flushed off. The application shall be timed prior to the advent of winter dormancy. The contracting officer shall be notified in writing two days prior to start of fertilizer application.

#### 3.11.2.6 Settlement

Topsoil shall be added to maintain grade and to maintain water basins. Serious settlement affecting the setting of the plant in relation to the depth at which it was grown requires replanting in accordance with paragraph 3.6, INSTALLATION.

#### 3.11.2.7 Pesticide Treatment

Treatment for diseases or pest shall be in accordance with paragraph APPLICATION OF PESTICIDE MATERIAL.

#### 3.11.2.8 Maintenance Report

A written record shall be furnished to the Contracting Officer of the maintenance work performed, the quality of plant losses, cause for plant loss and replacements made on each site visit.

#### 3.11.2.9 Maintenance Instructions

Written instructions shall be furnished to the Contracting Officer for year-round care of installed plants.

### 3.11.3 Replacement Plants

Plants shall be provided for replacement in accordance with paragraph PLANTS. Replacement plants shall be installed in accordance with paragraph 3.6, INSTALLATION. No extended plant establishment period shall be required for replacement plants. A plant shall be replaced as many times as necessary.

### 3.12 FINAL ACCEPTANCE

#### 3.12.1 Preliminary Inspection

Prior to the plant establishment period a preliminary inspection shall be held by the Contracting Officer. Time for the inspection will be established in writing. The quantity and type of plants installed and the acceptability of the plants in accordance with the plant establishment period shall be determined.

#### 3.12.2 Final Inspection

A final inspection shall be held by the Contracting Officer to determine that deficiencies noted in the preliminary inspection have been corrected. Time for the inspection shall be established in writing. Acceptance of the planting operation is subject to the guarantee of plant growth.

-- End of Section --