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SECTION 02100

DIVERSION AND CONTROL OF WATER

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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 shall provide water diversion to the existing pump outlet structures during the construction period.

1.2 DEWATERING AND GROUNDWATER

Permanent construction work is located inside and outside the river channel. Soil explorations have indicated only randomly located perched water near the ground surface. At two drill sites south of this project groundwater was encountered within 7 and 8 feet of the invert (MTA Light Rail Bridge and Willow Street Bridge). Groundwater was at 18 and 25 feet depth below invert at the Union Pacific Railroad (downstream of Compton Creek) and Del Amo Bridges and was not encountered in any other boreholes throughout the rest of the project area. No significant amount of groundwater is anticipated during construction. However, if groundwater is encountered during construction, the construction area shall be dewatered prior to commencement of the work, and all subgrades, whether for earthfill, or concrete, shall be kept drained and free of water throughout the working period.

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.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

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SECTION 02150

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SECTION 02150

CLEAR SITE AND REMOVE OBSTRUCTIONS

PART 1 GENERAL

1.1 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.

1.2 ENVIRONMENTAL PROTECTION

All work and Contractor operations shall comply with the requirements of SECTION: ENVIRONMENTAL PROTECTION.

1.3 BURNING

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

1.4 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. 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 structures, inverts or linings 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 wall 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 C881, Class C as specified in the SECTION 03210: STEEL BARS AND WELDED WIRE FABRIC FOR CONCRETE REINFORCEMENT, specially manufactured for the intended purpose, and be applied in accordance with the manufacturer's directions. One-inch (1") thick premolded expansion joint material shall be used to separate the faces of the existing and new wall.

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

Grouted stone, stone, concrete channel lining, concrete walls, asphalt concrete, guard rail, gaging station, miscellaneous structures, and fencing shall be removed, where indicated. Existing trail signs shall be removed, delivered to Los Angeles County Department of Public Works for anti-graffiti treatment, returned to site and replaced at locations approved by the Contracting Officer.

3.4.3 Utilities

Prior to removing an obstruction, all applicable utility relocations shall have been coordinated in accordance with SECTION: 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: FILLS AND SUBGRADE PREPARATION.

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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PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

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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	(1992) Classification of Soils for Engineering Purposes (Unified Soil Classification System)
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1.2 GENERAL

Excavation shall consist of the removal of every type of material encountered except materials covered by the provisions of the SECTION: 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 1/2 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

1.5.1 Bracing/Shoring

The Contractor shall submit shop drawings showing proposed method of bracing which he intends to use.

1.6 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 will be at the Contractor's option.

1.7 EXCAVATION FOR SIDE DRAINS

All side drain excavations shall be made in accordance with the SECTION: SIDE DRAINS.

1.8 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.

1.9 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: FILLS AND SUBGRADE PREPARATION.

1.10 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 SECTIONS: GENERAL REQUIREMENTS, ENVIRONMENTAL PROTECTION, AND CLEAR SITE AND REMOVE OBSTRUCTIONS.

1.11 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: FILLS AND SUBGRADE PREPARATION, or concrete conforming to the SECTION: CAST-IN-PLACE STRUCTURAL CONCRETE. 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.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

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GEOTEXTILES USED AS FILTERS

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SECTION 02215

GEOTEXTILES USED AS FILTERS

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 123	(1993) Standard Terminology of Terms Related to Textiles
ASTM D 1683	(1990) Failure in Sewn Seams of Woven Fabrics
ASTM D 3786	(1987) Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics - Diaphragm Bursting Strength Tester Method
ASTM D 3884	(1992) Abrasion Resistance of Textile Fabrics (Rotary Platform, Double-Head Method)
ASTM D 4354	(1989) Sampling of Geosynthetic for Testing
ASTM D 4355	(1992) Deterioration of Geotextile from Exposure to Ultraviolet light and Water (Xenon-Arc Type Apparatus)
ASTM D 4491	(1992) Water Permeability of Geotextiles By Permittivity
ASTM D 4533	(1991) Trapezoid Tearing Strength of Geotextile
ASTM D 4632	(1991) Grab Breaking Load and Elongation of Geotextiles
ASTM D 4751	(1993) Determining the Apparent Opening Size of a Geotextile
ASTM D 4833	(1988) Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
ASTM D 4873	(1988) Guide for Identification, Storage, and Handling of Geotextiles
ASTM D 4884	(1990) Seam Strength of Sewn Geotextiles

1.2 SHIPMENT AND STORAGE

During all periods of shipment and storage, the geotextile shall be protected from direct sunlight, ultra-violet rays, temperatures greater than 140 degrees F, mud, dirt, dust and debris. To the extent possible, the fabric shall be maintained wrapped in a heavy duty protective covering.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Geotextile

The geotextile shall be a non-woven pervious sheet of plastic yarn as defined by ASTM D 123. The geotextile shall equal or exceed the minimum average roll values listed in TABLE 1, MINIMUM PHYSICAL REQUIREMENTS FOR DRAINAGE GEOTEXTILE. Strength values indicated in the table are for the weaker principal direction.

TABLE 1
MINIMUM PHYSICAL REQUIREMENTS FOR DRAINAGE GEOTEXTILE

Physical Property	Test Procedure	Acceptable Values
Tensile Strength (unaged geotextile) Note 1	ASTM D 4632 Grab Test Method using 1 inch square jaws and a 12 inch per minute constant rate of traverse.	200 pound minimum in any principle direction.
Puncture Strength (unaged geotextile)	ASTM D 4833 except polished steel ball replaced with a 5/16-inch diameter solid steel cylinder with a hemispherical tip centered within the ring clamp.	50 pound minimum
Abrasion Resistance	ASTM D 3884 Rubber-base abrasive wheels equal to CS-17 "Calibrase" by Taber Instrument Co; 1000 revolutions, determine residual breaking load.	55 pound minimum Residual Breaking Load in any principal direction
Apparent Opening Size	ASTM 4751 Determining Apparent Opening Size of a geotextile.	No finer than the U.S. Standard Sieve No. 120 and no coarser than U.S. Standard Sieve No.50
Ultraviolet Degradation	ASTM D 4355 Deterioration of Geotextile from Exposure to Ultraviolet Light and Water	50 at 500 hours.

Note 1: Unaged geotextile is defined as geotextile in the condition received from the manufacturer or distributor

2.1.2 Geotextile Fiber

Fibers used in the manufacturing of the geotextile shall consist of a long-chain synthetic polymer composed of at least 85 percent by weight of polyolefins, polyesters, or polyamides. Stabilizers and/or inhibitors shall be added to the base polymer if necessary to make the filaments resistant to deterioration caused by ultraviolet light and heat exposure. Reclaimed or recycled fibers or polymer shall not be added to the formulation. Geotextile shall be formed into a network such that the filaments or yarns retain dimensional stability relative to each other, including the edges. The edges of the geotextile shall be finished to prevent the outer fiber from pulling away from the geotextile.

2.1.3 Seams

The seams of the geotextile shall be sewn with thread of a material meeting the chemical requirements given above for geotextile yarn or shall be bonded by cementing or by heat. The sheets of geotextile shall be attached at the factory or another approved location, if necessary, to form sections not less than 12 feet wide. Seams shall be tested in accordance with method ASTM D 1683. The strength of the seam shall be not less than 90 percent of the required grab tensile strength of the unaged geotextile in any principal direction.

2.1.4 Acceptance Requirements

All brands of geotextile and all seams to be used shall be accepted on the following basis. The Contractor shall furnish the Contracting Officer, in duplicate, a mill certificate or affidavit signed by a legally authorized official from the company manufacturing the geotextile. The mill certificate or affidavit shall attest that the geotextile meets the chemical, physical and manufacturing requirements stated in this specification. If requested by the Contracting Officer, the Contractor shall provide to the Government geotextile samples for testing to determine compliance with any or all of the requirements in this specification. When samples are to be provided, they shall be submitted a minimum of 60 days prior to the beginning of installation of the same geotextile. All samples provided shall be from the same production lot as will be supplied for the contract, and shall be the full manufactured width of the geotextile by at least 10 feet long, except that samples for seam strength may be a full width sample folded over and the edges stitched for a length of at least 5 feet. Samples submitted for testing shall be identified by manufacturers lot designation.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

Subgrade for geotextile shall conform to the provisions of SECTION: FILLS AND SUBGRADE PREPARATION. The surface on which the geotextile is placed shall be prepared to a relatively smooth surface condition, and shall be free from obstructions, debris, depressions, erosion features, or vegetation. Any irregularities, loose material, soft or low density pockets of material, shall be removed and replaced with approved material and well compacted. A continuous, intimate contact of the geotextile with all the surface shall be insured. No additional payment shall be made for any material thus required. Immediately prior to placing geotextile, the prepared base shall be inspected by the Contracting

Officer, and no geotextile shall be placed thereon, until that area has been approved.

3.2 INSTALLATION OF THE GEOTEXTILE

3.2.1 General

The geotextile shall be placed in the manner and at the locations shown on the drawings. At the time of installation, the geotextile shall be rejected if it has defects, rips, holes, flaws, deterioration or damage incurred during manufacture, transportation or storage.

3.2.2 Placement

Temporary pinning of the geotextile to help hold it in place until the bedding layer is placed shall be allowed. The temporary pins shall be removed as the bedding is placed to relieve high tensile stress which may occur during placement of material on the geotextile. Trimming shall be performed in such a manner that the geotextile shall not be damaged in any way.

3.2.3 Protection

The geotextile shall be protected at all times during construction from contamination by surface runoff and any geotextile so contaminated shall be removed and replaced with uncontaminated geotextile. Any damage to the geotextile during its installation or during placement of bedding materials or riprap shall be replaced by the Contractor at no cost to the Government. The work shall be scheduled so that the covering of the geotextile with a layer of the specified material is accomplished within 7 calendar days after placement of the geotextile. Failure to comply shall require replacement of geotextile. Before placement of bedding materials or riprap, the Contractor shall demonstrate that the placement technique will not cause damage to the geotextile. In no case shall any type of equipment be allowed on the unprotected geotextile.

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SECTION 02250

FILLS AND SUBGRADE PREPARATION

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	(1989) Resistance to Degradation of Small-Sized Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1984a) Sieve Analysis of Fine and Coarse Aggregates.
ASTM D 75	(1987; R 1992) Sampling Aggregates.
ASTM D 422	(1963; R 1990) Particle-Size Analysis of Soils
ASTM D 1556	(1990) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu.ft. (2,700 kN-m/cu.m.))
ASTM D 2216	(1992) Laboratory Determination of Water (Moisture) Content of Soil, Rock
ASTM D 2487	(1992) Classification of Soils for Engineering Purposes (Unified Soil Classification System)

1.2 COMPACTION EQUIPMENTS

1.2.1 General

Compaction shall be accomplished by tamping roller, rubber tired roller, sheeps 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 GENERAL REQUIREMENTS FOR COMPACTED FILLS AND COMPACTED BACKFILLS

1.3.1 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 10 field density tests. 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 (sand cone and nuclear) with accompanying field moisture contents, supported by raw data, shall be submitted in a spreadsheet format on a computer disk to the Contracting Officer.

1.3.1.1 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.

1.3.1.1.1 A separate batch of materials will be used for each compaction test specimen. No materials will be re-used.

1.3.1.1.2 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.

1.3.1.2 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 2216.

1.3.1.3 In-Place Densities

1.3.1.3.1 One test per 1,000 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.

1.3.1.3.2 One test per 300 cubic yards, or fraction thereof, of each lift of fill or backfill areas compacted by hand-operated machines.

1.3.1.4 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.

1.3.1.5 One Point Maximum Density Test

A one-point maximum density test shall be performed at every field density test. This point will be used by the Contractor to determine: the type of soil, the maximum density of the soil, and if the specified density in the soil is being obtained. The one-point maximum density test shall follow the procedure detailed in paragraph: One-Point Compaction Method.

1.3.1.5.1 One-Point Compaction Method

The material from the field density tests is allowed to dry to a water content on the dry side of estimated optimum, and then compacted using the same equipment and procedure used in the five-point compaction test. Thorough mixing is required to obtain uniform drying; otherwise, results obtained may be erroneous. The water content and dry density of the compacted sample are determined and then used to estimate its optimum water content and maximum dry density as illustrated in Figure 1 at the end of this section. In Figure 1, the line of optimums is well defined and the compaction curves are approximately parallel to each other consequently, the one point compaction method could be used with a relatively high degree of confidence. However, in Figure 2 at the end of this section, the optimums do not define a line, but a broad band. Also, the compaction curves are not parallel to each other and in several instances will cross if extended on the dry side. Consequently, the correct curve cannot be determined from the one-point method, therefore, the two-point compaction method should be used. The one-point method should be used only when the data define a relatively good line of optimums. See paragraph: Two-Point Compaction Method.

1.3.1.5.2 Two-Point Compaction Method

In the two-point test, one sample of material from the location of the field density test is compacted at the fill water content if thought to be at or on the dry side of optimum water content (otherwise, reduced by drying to this condition) using the same equipment and procedures used in the five-point compaction test. A second sample of material is allowed to dry back about 2 to 3 percentage points dry of the water content of the first sample and then compacted in the same manner. At least one point shall fall within 3 percent of the line of optimums. After compaction, the water contents and dry densities of the two samples are determined. The results are used to identify the appropriate compaction curve for the material being tested as shown in Figure 2 at the end of this section. The data shown in Figure 2 warrant the use of the two-point compaction test because the five-point test method, would

result in appreciable error as the shape of the curve would not be defined. The estimated compaction curve can be more accurately defined by two compaction points.

1.3.2 Settling of Fills or Backfills with Water

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

1.3.3 Fill and Backfill Material

Fill and backfill material shall be obtained from both the required excavations and from approved sources selected by the Contractor. Materials considered unsatisfactory for use as compacted fill include but are not limited to those materials containing roots and other organic matter, trash, debris, and stones larger than $\frac{3}{4}$ of the compacted layer thickness, and materials classified in ASTM D 2487 as MH, CH, PT, OH, and OL.

1.3.4 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: CAST-IN-PLACE STRUCTURAL CONCRETE. Heavy equipment shall not be operated over pipes and 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 BACKFILLS in this section. Compacted fill and backfill shall be placed with suitable equipment in horizontal layers which after compaction, shall not exceed 12 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. Rubber-tired dozers are not considered suitable equipment for compacting fill and backfill. 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.

1.3.5 Placement in Landscaped Areas

Placement of fill and backfill material in and around the areas designated to be landscaped by the planting plans shall be agronomically tested and shall meet the requirements of this SECTION 02250 and SECTION 02950: TREES, SHRUBS, GROUNDCOVER AND VINES.

1.3.6 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.

1.3.7 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 one foot of channel or structure walls. Rollers will not be permitted to operate 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 compaction of fill material adjacent to structures where rolling equipment is impracticable for use in compaction. Rolling compaction equipment shall be operated in the longitudinal direction along the levee control line.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Filter and Drain Materials for Subdrainage System

The filter and drain materials shall be placed within the limits as shown on the project drawings.

The compositions of filter and drain blanket materials shall conform to the grading requirements in Part 4.

PART 3 EXECUTION

3.1 COMPACTED FILL, LEVEE

3.1.1 Preparation for Placing

Before placing material for a compacted fill, the foundation surface shall be cleared of all existing obstructions, vegetation, and debris. Unsuitable material not meeting the requirements for fill material shall be removed where directed. The existing surfaces shall be proof-rolled by 4 passes of the compaction equipment, and scarified to a depth of 6 inches before placing the fill. Sloped ground surfaces steeper than 1 vertical to 4 horizontal, on which fill or compacted backfill is to be placed, shall be stepped in an approved manner.

3.1.2 Compaction

Each layer of the materials shall be compacted to not less than 90 percent of maximum density, per ASTM D 1557.

3.1.3 Trimming

The top of fill shall be trimmed to the lines indicated on the drawings with a tolerance of plus or minus one inch. Any material loosened by trimming shall be recompacted and the berm area moistened and compacted with one pass of a smooth-wheeled roller. Tolerances shall apply after rolling.

3.2 COMPACTED FILL, ROAD

3.2.1 Location

Compacted road fill shall consist of fill placed for the levee access road.

3.2.2 Compaction

Each layer of the road shall be compacted to not less than 90 percent of maximum density, except the upper 12 inches of fill shall be compacted to not less than 95 percent of maximum density, per ASTM D 1557.

3.2.3 Trimming

The top of fill shall be trimmed to the lines indicated on the drawings with a tolerance of plus or minus one inch. Any material loosened by trimming shall be recompacted and the berm area moistened and compacted with one pass of a smooth-wheeled roller. Tolerances shall apply after rolling.

3.3 COMPACTED FILL, RETAINING WALLS AND PARAPET WALLS

3.3.1 Limitations on Equipment

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 walls shall not exceed 35,000 pounds, including dynamic forces produced by vibratory equipment.

3.3.2 Compaction

Each layer of fill behind walls shall be compacted to not less than 90 percent of maximum density, per ASTM D 1557.

3.3.3 Trimming

The top of fill shall be trimmed to the lines indicated on the drawings with a tolerance of plus or minus one inch. Any material loosened by trimming shall be recompacted and the berm area moistened and compacted with one pass of a smooth-wheeled roller. Tolerances shall apply after rolling.

3.4 COMPACTED FILL, SIDE DRAINS

Bedding and backfill for side drains shall conform to the requirements of the SECTION: STORM DRAINAGE SYSTEM.

3.5 BACKFILLS

3.5.1 Backfill About Structures

3.5.1.1 Location

Backfill shall consist of all fill against and/or around structures, except backfill for side drains.

3.5.1.2 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 or pavement, boulders and other objectionable material shall not be used.

3.5.1.3 Placing

3.5.1.3.1 Backfill Against Concrete

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: CAST-IN-PLACE STRUCTURAL CONCRETE. Backfill shall be placed in 4-inch layers.

3.5.1.4 Compaction

Except as specified hereinbefore, compaction shall not be less than 90 percent, per ASTM D 1557.

3.5.2 Backfill, Side Drain Trenches

Backfill for side drains shall conform to the requirements of the SECTION: STORM DRAINAGE SYSTEM.

3.6 SUBGRADE PREPARATION

3.6.1 Subgrade for Parapet Walls or Retaining Walls

After excavation to rough grade, the entire subgrade for the parapet wall 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. 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 90 percent of maximum density, per ASTM D 1557. The finished surface of the subgrade shall not be more than 1 inch from the indicated grade at any point when tested with a 10-foot straightedge.

3.6.2 Subgrade for Levee Slope

Fills for levee slopes shall be trimmed to the lines and grades indicated on the drawings. The finished surface of the subgrade shall be smooth and shall not vary more than $\frac{1}{2}$ inch from the indicated grade at any point when tested with a 10-foot straightedge.

3.6.3 Subgrade Preparation for Levee Access Road

The subgrade shall be alternately watered and scarified until the material is uniformly moistened throughout for a depth of not less than 12 inches. All stones larger than 4 inches in diameter, and hard ribs of earth shall be removed. The

amount of water to be applied shall be that which is required to provide optimum results in compaction under rolling. Following the above operations, the roadbed shall be shaped to a true cross section sufficiently higher than the specified grade to allow for subsequent compaction and then be thoroughly compacted to not less than 95 percent of maximum density as determined by ASTM D 1557. After the subgrade has been prepared and completed, the surface shall be firm, hard, unyielding, with a true, even, and uniform surface conforming to the grade and cross section indicated on the drawings. All points of the finished subgrade shall be not more than 1/4 inch below or above true subgrade.

PART 4 DRAINAGE SYSTEMS

4.1 GENERAL

4.1.1 Locations

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

4.1.2 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 and concrete manholes shall be protected in place.

4.2 MATERIALS

4.2.1 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.

4.2.1.1 Sand Filter Material

Sand filter material or sand blanket 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:

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

4.2.1.2 Gravel Drain Material

Gravel drain material or gravel blanket 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:

<u>Sieve Size</u>	<u>Percent by Weight Passing</u>
2 inch	100
1-1/2 inch	95-100
3/4 inch	35-70
3/8 inch	10-30
No. 4	0-5

4.2.1.3 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.

4.2.1.4 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, C 136, and D 75. Sampling and testing shall be performed at regular intervals with at least one test being made for each 500 cubic yards of material.

4.3 INSTALLATION

4.3.1 Behind Retaining Walls

4.3.1.1 Gravel Drain and Sand Filter Materials

Materials shall be moistened and evenly spread until a uniform density is achieved. Limitations on equipment as specified in Paragraph 3.3.1 shall be followed.

4.3.2 Beneath Channel Invert

4.3.2.1 Sand Filter Material

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.

4.3.2.2 Gravel Drain Material

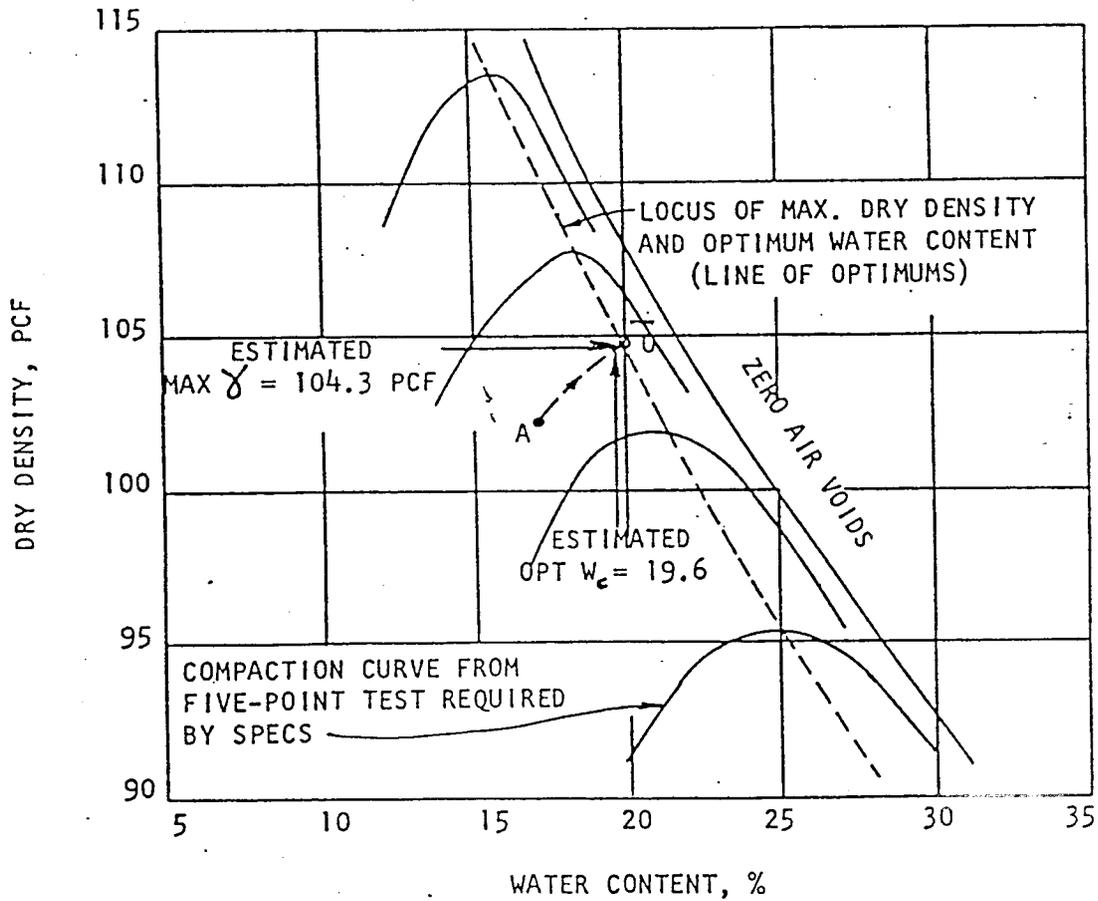
Gravel drain material shall be placed over the sand filter material, moistened and spread to a uniform grade to the elevations indicated. Following spreading, the surface of the gravel drain material shall be compacted with one pass of a vibratory roller or tamper. Gravel drain material contaminated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

Drain material for weep holes shall be wrapped completely in geotextile, with an apparent opening size no finer than the No. 100 sieve and no coarser than the No. 50 sieve, and placed immediately against the wall, covering the opening of the weep hole.

4.3.2.3 Preparation Prior to Channel Invert Construction

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: CAST-IN-PLACE STRUCTURAL CONCRETE. The required amounts of water to be applied during moistening operations shall be as directed and shall be applied with approved equipment.

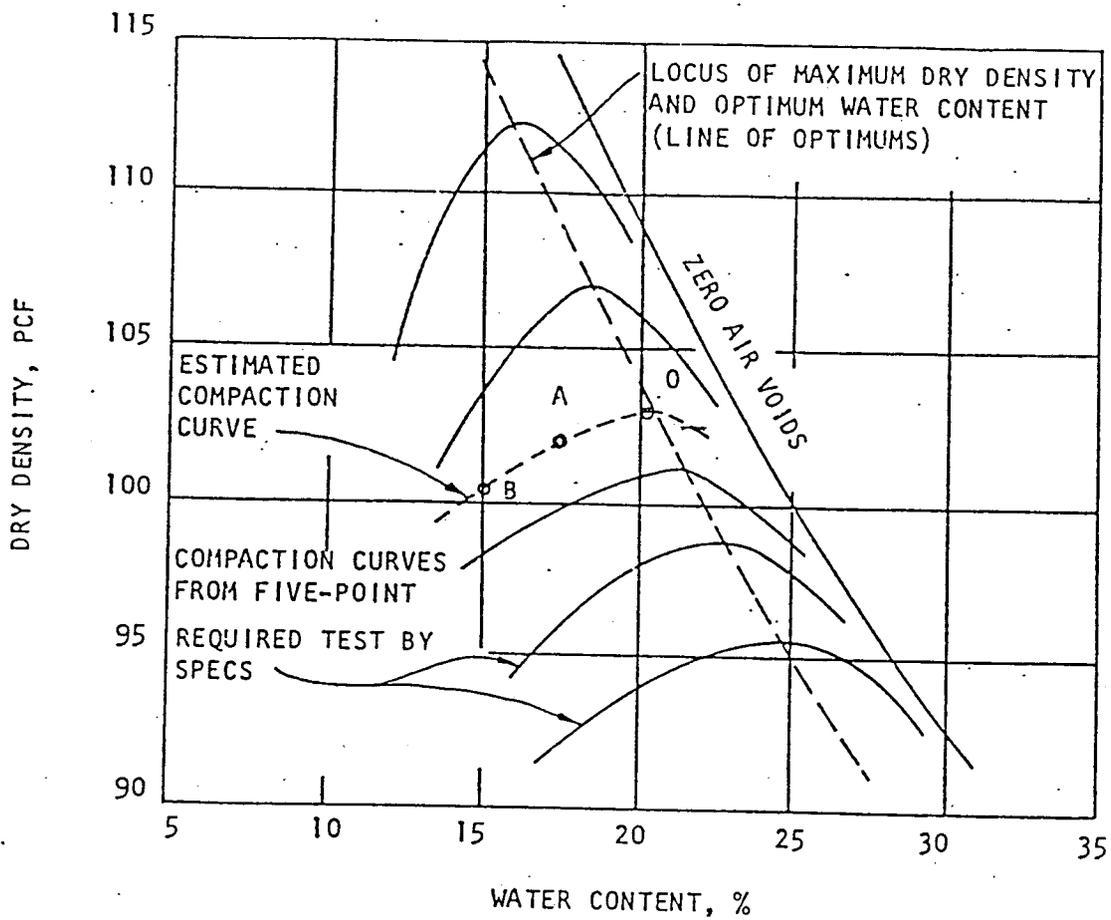
-- End of Section --



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 γ 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 02316

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 1990) Particle-Size Analysis of Soils
ASTM D 1556	(1990) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu.ft. (2,700 kN-m/cu.m.))
ASTM D 2167	(1994) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D 2487	(1992) Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 2922	(1996) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	(1988; R 1993) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

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: SUBMITTAL PROCEDURES.

1.3.1 SD-09, Reports

Field Density Tests; GA. Testing of Backfill Materials; FI0.

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, GM, GC, SW, SP, SM, SC, ML, and CL.

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 CH, PT, OH, MH, and OL. Unsatisfactory materials also include man-made fills, refuse, or backfills 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 $\frac{1}{2}$ 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 $\frac{1}{2}$ 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 3 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 1-1/2 inch, or the maximum size recommended by the pipe manufacturer, whichever is smaller.

2.1.8 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

Red:	Electric
Yellow:	Gas, Oil, Dangerous Materials
Orange:	Telephone Telegraph, Television, Police, and Fire Communications
Blue:	Water Systems
Sewer:	Sewer Systems

PART 3 EXECUTION

3.1 EXCAVATION

Excavation shall be performed to the lines and grades indicated. During excavation, material satisfactory for backfilling shall be stockpiled in an orderly manner at a distance from the banks of the trench equal to ½ 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 overdepth is not indicated and 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. 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 areas, 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.

3.1.2 Stockpiles

Stockpiles of satisfactory, unsatisfactory, 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 or select granular 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.

3.2.1 Trench Backfill

Trenches shall be backfilled to the grade shown. 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.

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. Select granular 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 shall be filled with satisfactory material. Backfill material shall be placed and compacted as follows:

a. Turfed or Seeded Areas and Miscellaneous Areas: Backfill shall be deposited in layers of a maximum of 12-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 Electrical Distribution System

Direct burial cable and conduit or duct line shall have a minimum cover of 24 inches from the finished grade, unless otherwise indicated. Special trenching requirements for direct-burial electrical cables and conduits are specified in SECTION: ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND.

3.2.3 Plastic Marking Tape

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

3.3 TESTING

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

3.3.1 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.

3.3.2 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.

3.3.3 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 200 feet of installation shall be performed. One moisture density relationship shall be determined for every 1,500 cubic yards of material used. 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.

-- End of Section --

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SECTION 02551

BITUMINOUS PAVING FOR ROADS, STREETS AND OPEN STORAGE AREAS

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 29	(1991a) Unit Weight and Voids in Aggregate
ASTM C 88	(1990) Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C 117	(1990) Materials Finer than 75-micrometer (No 200) Sieve in Mineral Aggregates by Washing
ASTM C 127	(1988) Specific Gravity and Absorption of Coarse Aggregate
ASTM C 128	(1988) Specific Gravity and Absorption of Fine Aggregate
ASTM C 131	(1989) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1984a) Sieve Analysis of Fine and Coarse Aggregates
ASTM C 183	(1995) Sampling and the Amount of Testing Of Hydraulic Cement
ASTM D 5	(1994) Penetration of Bituminous Materials
ASTM D 75	(1987; R 1992) Sampling Aggregates
ASTM D 140	(1993) Sampling Bituminous Materials
ASTM D 242	(1985; R 1990) Mineral Filler for Bituminous Paving Mixtures
ASTM D 422	(1963; R 1990) Particle-Size Analysis of Soils

ASTM D 946	(1982; R 1993) Penetration-Graded Asphalt Cement for Use in Pavement Construction
ASTM D 1250	(1980; R 1990) Petroleum Measurement Tables
ASTM D 1559	(1989) Resistance to Plastic Flow of Bituminous Mixtures using Marshall Apparatus
ASTM D 1856	(1979; R 1984) Recovery of Asphalt from Solution By Abson Method."
ASTM D 2041	(1991) Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
ASTM D 2172	(1992) Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
ASTM D 2216	(1990) Laboratory Determination of Water (Moisture) Content of Soil, and Rock
ASTM D 3381	(1983) Viscosity-Graded Asphalt Cement for Use in Pavement Construction
ASTM D 3515	(1989) Hot-Mixed, Hot-Laid Bituminous Paving Mixtures
ASTM D 4791	(1995) Flat or Elongated Particles in Coarse Aggregate

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 1330: SUBMITTAL PROCEDURES:

1.2.1 SD-09, Reports

Bituminous Pavement; GA.

Copies of test results.

SD-14 Samples

Bituminous Pavement; GA.

Samples of the materials in the quantities indicated below for the job mix formula.

Aggregate and mineral filler (if needed) 100 kg

to be blended in approximately the same proportions as used in the project

Asphalt Cement	20 liters
Aggregate and mineral filler (if needed)	200 pounds

to be blended in approximately the same proportions as used in the project

Asphalt Cement	5 gallons
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Aggregate samples when new sources are developed, with a plan for operation, 15 days before starting production. Samples of the asphalt cement specified, not less than 15 days before production.

1.2.2 SD-18, Records

Waybills and Delivery Tickets; GA.

Waybills and delivery tickets, during progress of the work.

1.3 PLANT, EQUIPMENT, MACHINES, AND TOOLS

1.3.1 General

The bituminous plant shall be of such capacity to produce the quantities of bituminous mixtures required. Hauling equipment, paving machines, rollers, miscellaneous equipment, and tools shall be provided in sufficient numbers and capacity and in proper working condition to place the bituminous paving mixtures at a rate equal to the plant output.

1.3.2 Mixing Plants

The mixing plant shall be an automatic or semiautomatic controlled commercially manufactured unit designed and operated to consistently produce a mixture within the job-mix formula (JMF). The plant shall have a minimum capacity of 100 metric tons per hour. Drum mixers shall be prequalified at the production rate to be used during actual mix production. The prequalification tests will include extraction and recovery of the asphalt cement in accordance with ASTM D 2172 and ASTM D 1856. The penetration of the recovered asphalt binder shall not be less than 60 percent of the original penetration, as measured in accordance with ASTM D 5.

1.3.3 Straightedge

The Contractor shall furnish and maintain at the site, in good condition, one 3.05 m (12-foot) straightedge for each bituminous paver. 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 insure rigidity and accuracy. Straightedges shall have handles to facilitate movement on pavement.

1.4 WEATHER LIMITATIONS

Unless otherwise directed, bituminous courses shall not be constructed when temperature of the surface of the existing pavement or base course is below 5 degrees C. (40 degrees F.)

1.5 PROTECTION OF PAVEMENT

After final rolling, no vehicular traffic of any kind shall be permitted on the pavement until the pavement has cooled to 60 degrees C. (140 degrees F.)

1.6 GRADE AND SURFACE-SMOOTHNESS REQUIREMENTS

Finished surface of bituminous courses, shall conform to gradeline and elevations shown and to surface-smoothness requirements specified.

1.6.1 Plan Grade

The grade of the completed surface shall not deviate more than 0.05 foot (15.2mm) from the plan grade.

1.6.2 Surface Smoothness

When a 3.05 m (12-foot) straightedge is laid on the surface parallel with the centerline of the paved area or transverse to the pavement edge, the surface shall vary not more than 6.4 mm (1/4 inch) from the straightedge.

1.7 GRADE CONTROL

Lines and grades shall be established and maintained by means of line and grade stakes placed at site of work. Elevations of bench marks used by the Contractor for controlling pavement operations at the site of work will be determined, established, and maintained by the Government. Finished pavement elevations shall be established and controlled at the site of work by the Contractor in accordance with bench mark elevations furnished by the Contracting Officer.

1.8 SAMPLING AND TESTING

1.8.1 Aggregate Sources

1.8.1.1 General

Samples of aggregates shall be obtained by the Contractor for approval of aggregate sources and stockpiles prior to the start of production and at times during production of the bituminous mixtures. Times and points of sampling will be designated by the Contracting Officer. Samples will be the basis of approval of specific sources of stockpiles of aggregates for aggregate requirements. Unless otherwise directed, ASTM D 75 shall be used in sampling coarse and fine aggregate, and ASTM C 183 shall be used in sampling mineral filler. All tests necessary to determine compliance with requirements specified herein will be made by the Government.

1.8.1.2 Sources

Sources of aggregates shall be selected well in advance of the time the materials are required in the work. If a previously developed source is selected, evidence shall be submitted 15 days before starting production, indicating that the central-plant hot-mix bituminous pavements constructed with the aggregates have had a satisfactory service record of at least five years under similar climatic and traffic conditions. The Contracting Officer will make such tests and other investigations as necessary to determine whether aggregates meeting requirements specified herein can be produced from proposed sources. If a sample of material from a new source fails to meet specification requirements, the material represented by the sample shall be replaced, and the cost of testing the replaced sample will be at the expense of the Contractor. Approval of the source of aggregate does not relieve the Contractor of responsibility for delivery at the jobsite of aggregates that meet the requirements specified herein.

1.8.2 Bituminous Materials

Bituminous materials shall be sampled in accordance with ASTM D 140. Tests necessary to determine conformance with requirements specified herein shall be performed by the Contractor. Sources where bituminous materials are obtained shall be selected in advance of the time when materials will be required in the work. Samples shall be taken before and during construction when shipments of bituminous materials are received or when necessary to assure some condition of handling or storage has not been detrimental to the bituminous material. The samples will be taken by the Contractor and tested by the Contracting Officer.

1.8.3 Sampling and testing of bituminous materials will be performed by the Contractor.

1.9 DELIVERY, STORAGE, AND HANDLING OF MATERIALS

1.9.1 Mineral Aggregates

Mineral aggregates shall be delivered to the site of the bituminous mixing plant and stockpiled in such manner as to preclude fracturing of aggregate particles, segregation, contamination, or intermingling of different materials in the stockpiles or cold-feed hoppers. Mineral filler shall be delivered, stored, and introduced into the mixing plant in a manner to preclude exposure to moisture or other detrimental conditions.

1.9.2 Bituminous Materials

Bituminous materials shall be maintained at appropriate temperature during storage but shall not be heated by application of direct flame to walls of storage tanks or transfer lines. Storage tanks, transfer lines, and weigh buckets shall be thoroughly cleaned before a different type or grade of bitumen is introduced into the system. The asphalt cement shall be heated sufficiently to allow satisfactory pumping of the material; however, the storage temperature shall be maintained below 150 degrees C. (300 degrees F.)

1.10 ACCESS TO PLANT AND EQUIPMENT

The Contracting Officer shall have access at all times to all parts of the paving plant for checking adequacy of the equipment in use; inspecting operation of the

plant; verifying weights, proportions, and character of materials; and checking temperatures maintained in preparation of the mixtures.

1.11 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 aggregates and bituminous materials actually used in construction.

PART 2 PRODUCTS

2.1 BITUMINOUS HOT MIX

Bituminous hot mix shall consist of coarse aggregate, fine aggregate, mineral filler, bituminous material, and approved additives, if required, of the qualities and in the proportions specified and shall conform to the requirements contained in paragraphs: PROPORTIONING OF MIXTURE and ACCEPTABILITY OF WORK.

2.1.1 Aggregates

Aggregates shall consist of crushed stone, crushed gravel, screening, sand, and mineral filler, as required. The portion of materials retained on the 4.75 mm (No. 4) sieve shall be known as coarse aggregate, the portion passing the 4.75 mm (No. 4) sieve and retained on the 0.075 millimeter (No. 200) sieve as fine aggregate, and the portion passing the 0.075 millimeter (No. 200) sieve as mineral filler. Aggregate gradation shall conform to gradation(s) specified in TABLE I. TABLE I is based on aggregates of uniform specific gravity; the percentage passing various sieves may be changed by the Contracting Officer when aggregates of varying specific gravities are used. Adjustments of percentage passing various sieves may be changed by the Contracting Officer when aggregates vary by more than 0.2 in specific gravity.

TABLE I. AGGREGATE GRADATION

<u>Sieve Size</u>	<u>Limits of Proposed Gradation</u>	<u>Operation Range</u>	<u>Contract Compliance</u>
(3/4 inch)		100	100
(1/2 inch)		95-100	89-100
(3/8 inch)		80-95	75-100
No. 4	59-66	x ± 5	x ± 8
No. 8	43-49	x ± 5	x ± 8
No. 30	22-27	x ± 5	x ± 8
No. 200		3 - 8	0 - 11"

In TABLE I above, the symbol "x" is the gradation which the Contractor proposed to furnish for the specific sieve. The proposed gradation shall meet the gradation shown in the table under "Limits of the Proposed Gradation". Changes from the one mix design to another shall not be made during the progress work unless permitted by the Contracting Officer. However, changes in proportions to conform to the approved mix design shall not be changes in the mix design.

2.1.1.1 Coarse Aggregate

Coarse aggregate shall consist of clean, sound, durable particles meeting the following requirements.

a. Percentage of loss shall not exceed 40 after 500 revolutions, as determined in accordance with ASTM C 131.

b. Percentage of loss shall not exceed 18 after five cycles performed in accordance with ASTM C 88, using magnesium sulfate.

c. Crushed gravel retained on the 4.75 mm No. 4 sieve and each coarser sieve shall contain at least 75 percent by weight of crushed pieces having one or more fractured faces with the area of each face equal to at least 75 percent of the smallest midsectional area of piece. When two fractures are contiguous, the angle between planes of fractures shall be at least 30 degrees to count as two fractured faces.

2.1.1.2 Fine Aggregate

Fine aggregate shall consist of clean, sound, durable particles including natural sand or crushed stone, slag, or gravel that meets requirements for wear and soundness specified for coarse aggregate. The fine aggregate shall have a plasticity index of 2 percent or less and a liquid limit of 35 percent or less when tested in accordance with ASTM D 4318. Fine aggregate produced by crushing gravel shall have at least 90 percent by weight of crushed particles having two or more fractured faces in the portion retained on the 0.600 millimeter (No. 30) sieve. This requirement shall apply to the material before blending with natural sand when blending is necessary. Quantity of natural sand to be added to the mixture shall not exceed 25 percent by weight of coarse and fine aggregate and material passing the 0.075 millimeter (No. 200) sieve. Natural sand shall be clean and free from clay and organic matter. Percentage of loss shall not exceed 18 after five cycles of the soundness test performed in accordance with ASTM C 88, using magnesium sulfate.

2.1.1.3 Mineral Filler

Mineral filler shall conform to ASTM D 242.

<u>Grain size in mm</u>	<u>Percent Finer</u>
0.05	70-100
0.02	35-65
0.005	10-22

Grain size shall be determined in accordance with ASTM D 422.

2.1.2 Bituminous Material

Asphalt cement shall conform to ASTM D 3381, Grade AR-8,000 or AR-4,000.

2.1.3 Additives

The use of additives such as antistripping and antifoaming agents is subject to approval.

2.2 PROPORTIONING OF MIXTURE

2.2.1 Job Mix Formula

The JMF for the bituminous mixture shall be submitted by the Contractor and no bituminous shall be manufactured until it has been approved by the Contracting Officer. Blending of the aggregates will be accomplished by the Government. No payment will be made for mixtures produced prior to the approval of the JMF. The formula will indicate the percentage of each sieve fraction of aggregate, the percentage of asphalt, and the temperature of the completed mixture when discharged from the mixer. Tolerances are given in TABLE II for asphalt content, temperature, and aggregate grading for tests conducted on the mix as discharged from the mixing plant; however, the final evaluation of aggregate gradation and asphalt content will be based on paragraph: ACCEPTABILITY OF WORK. Bituminous mix that deviates more than 25 degrees F from the JMF shall be rejected. The JMF may be adjusted during construction to improve paving mixtures. Adjustments to the JMF are subject to the approval of the Contracting Officer. The percentage of asphalt in the job-mix formula shall be between 4 and 6.

TABLE II-A. JOB-MIX TOLERANCES (Metric)

<u>Material</u>	<u>Tolerance, Plus or Minus</u>
Aggregate passing 4.75 mm sieve or larger	5 percent
Aggregate passing 2.36, 1.18, 0.6, and 0.3 mm sieves	4 percent
Aggregate passing 150 and 75 micrometer sieves	2 percent
Temperature of mixing	14 degrees C

TABLE II-B. JOB-MIX TOLERANCES

<u>Material</u>	<u>Tolerance, Plus or Minus</u>
Aggregate passing No. 4 sieve or larger	5 percent
Aggregate passing Nos. 8, 16, 30, and 50 sieves	4 percent
Aggregate passing Nos. 100 and 200 sieves	2 percent
Bitumen	0.25 percent
Temperature of mixing	25 degrees F

2.2.2 Test Properties of Bituminous Mixtures

Finished mixture shall meet requirements described below when tested in accordance with ASTM D 1559. All samples will be compacted with 50 blows of specified hammer on each side of sample. When bituminous mixture fails to meet the requirements specified below, the paving operation shall be stopped until the cause of noncompliance is determined and corrected.

2.2.2.1 Stability, Flow, and Voids

Requirements for stability, flow, and voids are shown in TABLES III and IV for nonabsorptive and absorptive aggregates, respectively.

TABLE III-A. NONABSORPTIVE-AGGREGATE MIXTURE (Metric)

	<u>Asphalt Mix</u>
Stability minimum, newtons	2200
Flow maximum, 25/100-millimeter units	20
Voids total mix, percent (1)	3-5
Voids filled with bitumen, percent (2)	75-85

TABLE III-B. NONABSORPTIVE-AGGREGATE MIXTURE

	<u>Asphalt Mix</u>
Stability minimum, pounds	500
Flow maximum, 1/100-inch units	20
Voids total mix, percent (1)	3-5
Voids filled with bitumen, percent (2)	75-85

(1) The Contracting Officer may permit deviations from limits specified when gyratory method of design is used to develop the JMF.

(2) The Contracting Officer may permit deviation from limits specified for voids filled with bitumen in order to stay within limits for percent voids total mix.

TABLE IV-A. ABSORPTIVE-AGGREGATE MIXTURE (Metric)

	<u>Asphalt Mix</u>
Stability minimum, newtons	2200
Flow maximum, 25/100-millimeter units	20
Voids total mix, percent (1)	2-4
Voids filled with bitumen, percent (2)	80-90

TABLE IV-B. ABSORPTIVE-AGGREGATE MIXTURE

	<u>Asphalt Mix</u>
Stability minimum, pounds	500
Flow maximum, 1/100-inch units	20
Voids total mix, percent (1)	2-4
Voids filled with bitumen, percent (2)	80-90

(1) The Contracting Officer may permit deviations from limits specified when gyratory method of design is used to develop the JMF.

(2) The Contracting Officer may permit deviation from limits specified for voids filled with bitumen in order to stay within limits for percent voids total mix.

a. When the water-absorption value of the entire blend of aggregate does not exceed 2.5 percent as determined in accordance with ASTM C 127 and ASTM C 128, the aggregate is designated as nonabsorptive. The theoretical specific gravity computed from the apparent specific gravity or ASTM D 2041 will be used in computing voids total mix and voids filled with bitumen, and the mixture shall meet requirements in TABLE III.

b. When the water-absorption value of the entire blend of aggregate exceeds 2.5 percent as determined in accordance with ASTM C 127 and ASTM C 128, the aggregate is designated as absorptive. The theoretical specific gravity computed from the bulk-impregnated specific gravity method contained in ASTM D 2041 shall be used in computing percentages of voids total mix and voids filled with bitumen; the mixture shall meet requirements in TABLE IV.

2.2.2.2 Stability

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.

PART 3 EXECUTION

3.1 BASE COURSE CONDITIONING

The surface of the base course will be inspected for adequate compaction and surface tolerances specified in Section 02551 . Unsatisfactory areas shall be corrected.

3.2 EXISTING PAVEMENT CONDITIONING

The existing asphalt pavement shall be removed and disposed off-site by the Contractor prior to raising the levees to the elevation indicated in the drawings. The disposed asphalt shall be the responsibility of the Contractor and shall comply with the local and federal environmental laws.

3.3 PREPARATION OF BITUMINOUS MIXTURES

Rates of feed of aggregates shall be regulated so that the moisture content and temperature of aggregates will be within specified tolerances. Aggregates, mineral filler, and bitumen shall be conveyed into the mixer in proportionate quantities required to meet the JMF. Mixing time shall be as required to obtain a uniform coating of the aggregate with the bituminous material. Temperature of bitumen at time of mixing shall not exceed 300 degrees F. Temperature of aggregate and mineral filler in the mixer shall not exceed 325 degrees F when bitumen is added. Overheated and carbonized mixtures or mixtures that foam shall not be used.

3.4 WATER CONTENT OF AGGREGATES

Drying operations shall reduce the water content of mixture to less than 0.75 percent. The water content test will be conducted in accordance with ASTM D 2216; the weight of the sample shall be at least 500 grams. If the water content is determined on hot bin samples, the water content will be a weighted average based on composition of blend.

3.5 STORAGE OF BITUMINOUS PAVING MIXTURE

Storage shall conform to the applicable requirements of ASTM D 3515; however, in no case shall the mixture be stored for more than 4 hours.

3.6 TRANSPORTATION OF BITUMINOUS MIXTURE

Transportation from paving plant to site shall be in trucks having tight, clean, smooth beds lightly coated with an approved releasing agent to prevent adhesion of the mixture to the truck bodies. Excessive releasing agent shall be drained prior to loading. Each load shall be covered with canvas or other approved material of ample size to protect mixture from weather and to prevent loss of heat. Loads that have crusts of cold, unworkable material or that have become wet will be rejected. Hauling over freshly placed material will not be permitted.

3.7 SURFACE PREPARATION OF UNDERLYING COURSE

Prior to placing of the asphalt concrete, the underlying course shall be cleaned of all foreign or objectionable matter with power brooms and hand brooms.

3.8 TACK COATING

Contact surfaces of previously constructed pavement, curbs, manholes, and other structures shall be sprayed with a thin coat of bituminous material conforming to SECTION 02558: BITUMINOUS TACK COAT.

3.9 PLACING

Bituminous courses shall be constructed only when the base course or existing pavement has no free water on the surface. Bituminous mixtures shall not be placed without ample time to complete spreading and rolling during daylight hours, unless approved satisfactory artificial lighting is provided.

3.9.1 General Requirements for Use of Mechanical Spreader

Range of temperatures of mixtures, when dumped into the mechanical spreader, shall be as determined by the Contracting Officer. Mixtures having temperatures less than 110 degrees C (225 degrees F) when dumped into the mechanical spreader shall not be used. The mechanical spreader shall be adjusted and the speed regulated so that the surface of the course being laid will be smooth and continuous without tears and pulls, and of such depth that, when compacted, the surface will conform to the cross section indicated. Placing with respect to center line areas one may slope or high side of areas with one-way slope shall be as directed. Placing of the mixture shall be as nearly continuous as possible, and speed of placing shall be adjusted, as directed, to permit proper rolling. When segregation occurs in

the mixture during placing, the spreading operation shall be suspended until the cause is determined and corrected.

3.9.2 Placing Strips Succeeding Initial Strips

In placing each succeeding strip after initial strip has been spread and compacted as specified below, the screed of the mechanical spreader shall overlap the previously placed strip 2 to 3 inches and be sufficiently high so that compaction produces a smooth dense joint. Mixture placed on the edge of a previously placed strip by the mechanical spreader shall be pushed back to the edge of the strip by use of a lute. Excess mixture shall be removed and wasted.

3.9.3 Handspreading in Lieu of Machine Spreading

In areas where the use of machine spreading is impractical, the mixture shall be spread by hand. Spreading shall be in a manner to prevent segregation. The mixture shall be spread uniformly with hot rakes in a loose layer of thickness that, when compacted, will conform to required grade, density, and thickness.

3.10 COMPACTION OF MIXTURE

Rolling shall begin as soon after placing as the mixture will bear a roller without undue displacement. Delays in rolling freshly spread mixture will not be permitted. After initial rolling, preliminary tests of crown, grade, and smoothness shall be made by the Contractor. Deficiencies shall be corrected so that the finished course will conform to requirements for grade and smoothness specified herein. Grade and smoothness will be checked in each section of completed pavement by the Contracting Officer for compliance and will be evaluated as specified in paragraph: ACCEPTABILITY OF WORK. After the Contractor is assured of meeting grade and smoothness requirements, rolling shall be continued until a mat density of 97.0 to 100.0 percent and a joint density of 95.0 to 100.0 percent of density of laboratory-compacted specimens of the same mixture is obtained. The density will be determined and evaluated as specified in paragraph: ACCEPTABILITY OF WORK. Places inaccessible to rollers shall be thoroughly compacted with hot hand tampers.

3.10.1 Testing of Mixture

At the start of the plant operation, a quantity of mixture shall be prepared that is sufficient to construct a test section at least 50 feet long, two spreader widths wide and of thickness to be used in the project. Mixture shall be placed, spread, and rolled with equipment to be used in the project and in accordance with the requirements specified above. This test section shall be tested and evaluated as a section and shall conform to all specified requirements. If test results are satisfactory, the test section shall remain in place as part of the completed pavement. If tests indicate that the pavement does not conform to specification requirements, necessary adjustments to plant operations and rolling procedures shall be made immediately, and test section will be evaluated as specified in paragraph: ACCEPTABILITY OF WORK. Additional test sections, as directed, shall be constructed and sampled for conformance to specification requirements. In no case shall the Contractor start full production of a bituminous course mixture without approval.

3.10.2 Correcting Deficient Areas

Mixtures that become contaminated or are defective shall be removed to the full thickness of the course. Edges of the area to be removed shall be cut so that sides are perpendicular and parallel to the direction of traffic and so that the edges are vertical. Edges shall be sprayed with bituminous materials conforming to SECTION 02558: BITUMINOUS TACK COAT. Fresh paving mixture shall be placed in the excavated areas in sufficient quantity so that the finished surface will conform to grade and smoothness requirements. Paving mixture shall be compacted to the density specified herein. Skin patching of an area that has been rolled shall not be permitted.

3.11 JOINTS

3.11.1 General

Joints between old and new pavements, between successive work days, or joints that have become cold (less than 175 degrees F) shall be made to insure continuous bond between the old and new sections of the course. All joints shall have the same texture and smoothness as other sections of the course. Contact surfaces of previously constructed pavements coated by dust, sand, or other objectionable material shall be cleaned by brushing or shall be cut back as directed. When directed by the Contracting Officer, the surface against which new material is placed shall be sprayed with a thin, uniform coat of bituminous material conforming to SECTION 02558: BITUMINOUS TACK COAT. Material shall be applied far enough in advance of placement of a fresh mixture to insure adequate curing. Care shall be taken to prevent damage or contamination of the sprayed surface.

3.11.2 Transverse Joints

The roller shall pass over the unprotected end of a strip of freshly placed material only when placing is discontinued or delivery of the mixture is interrupted to the extent that the material in place may become cold. In all cases, prior to continuing placement, the edge of previously placed pavement shall be cut back to expose an even vertical surface for full thickness of the course. In continuing placement of a strip, the mechanical spreader shall be positioned on the transverse joint so that sufficient hot mixture will be spread to obtain a joint after rolling that conforms to the required density and smoothness specified herein.

3.11.3 Longitudinal Joints

Edges of a previously placed strip shall be prepared such that the pavement immediately adjacent to the joint between this strip and the succeeding strip meets the requirements for grade, smoothness, and density specified in paragraph ACCEPTABILITY OF WORK.

3.12 ACCEPTABILITY OF WORK

3.12.1 General

3.12.1.1 Section Evaluation

In order to evaluate aggregate gradation, asphalt content, and density, one random sample shall be taken from the middle of a section and one taken from the joint. A coring machine will be used for taking samples from the completed pavement. Core samples will be taken with the coring machine centered over the joint. After air drying to a constant weight, random samples obtained from the area shall be used for density determination in accordance with ASTM D 1559. Samples for determining asphalt content and aggregate gradation shall be taken from loaded trucks within each section placed. Asphalt content shall be determined in accordance with ASTM D 2172, Method A or B. Aggregate gradation shall be determined for the mix by testing the recovered aggregate in accordance with ASTM C 136 and ASTM C 117.

3.12.1.2 Section Failure

When a section of material fails to meet the specification requirements, that section shall be removed and replaced or accepted at a reduced price. The lowest percent payment for any pavement characteristic (i.e., gradation, asphalt content, density, grade, and smoothness) defined below shall be the percent payment for that section. The percent payment is based on the pavement characteristics and the contract unit price.

3.12.1.3 Optional Sampling and Testing

The Contracting Officer reserves the right to sample and test any area which appears to deviate from the specification requirements. Testing in these areas will be in addition to the section testing, and the requirements for these areas will be the same as those for a section.

3.12.2 Aggregate Gradation

The mean absolute deviation of a section aggregate gradations from the JMF for each sieve size will be evaluated and compared with TABLE V. The percent payment based on aggregate gradation shall be the lowest value determined for any sieve size in TABLE V. All tests for aggregate gradation will be completed and reported within 24 hours after completion of construction of each section. The computation of mean absolute deviation for one sieve size is illustrated below:

Example: Assume the following JMF and section test results for aggregate gradation

<u>Percent by Weight Passing Sieves (Metric)</u>						
<u>Sieve Size</u>	<u>JMF</u>	<u>Test No. 1</u>	<u>Test No. 2</u>	<u>Test No. 3</u>	<u>Test No. 4</u>	
19 mm	100	100	100	100	100	100
12.5 mm	88	87	88	90	88	88
9.5 mm	75	72	77	78	74	74
4.75 mm	64	60	65	67	62	62
2.36 mm	53	50	56	57	52	52
1.18 mm	42	39	44	45	41	41

0.600 mm	32	30	34	35	32
0.300 mm	20	17	20	22	21
0.150 mm	10	8	10	10	11
0.075 mm	6	4	7	8	6

Percent by Weight Passing Sieves

<u>Sieve Size</u>	<u>JMF</u>	<u>Test No. 1</u>	<u>Test No. 2</u>	<u>Test No. 3</u>	<u>Test No. 4</u>
3/4 inch	100	100	100	100	100
1/2 inch	88	87	88	90	88
3/8 inch	75	72	77	78	74
No. 4	64	60	65	67	62
No. 8	53	50	56	57	52
No. 16	42	39	44	45	41
No. 30	32	30	34	35	32
No. 50	20	17	20	22	21
No. 100	10	8	10	10	11
No. 200	6	4	7	8	6

Mean Absolute Deviation (for 75 micrometer (No. 200) sieve) = ((Absolute value of 4-6) + (Absolute value of 7-6) + (Absolute value of 8-6) + (Absolute value of 6-6))/4 = (2 + 1 + 2 + 0)/4 = 1.25

The mean absolute deviation for other sieve sizes can be determined in a similar way for this example to be:

<u>Sieve Size</u>	<u>19 mm</u>	<u>12.5 mm</u>	<u>9.5 mm</u>	<u>4.75 mm</u>	<u>2.36 mm</u>	<u>1.18 mm</u>	<u>0.600 mm</u>	<u>0.300 mm</u>	<u>0.075 mm</u>
Mean Absolute Deviation	0	0.75	2.25	2.50	2.75	2.25	1.75	1.50	0.75

<u>Sieve Size</u>	<u>3/4 inch</u>	<u>1/2 inch</u>	<u>3/8 inch</u>	<u>No. 4</u>	<u>No. 8</u>	<u>No. 16</u>	<u>No. 30</u>	<u>No. 50</u>	<u>No. 100</u>
Mean Absolute Deviation	0	0.75	2.25	2.50	2.75	2.25	1.75	1.50	0.75

The least percent payment based on any sieve size listed in TABLE V would be 98 percent for the 75 micrometer (No. 200) sieve. Therefore, for this example the percent payment based on aggregate gradation is 98 percent.

TABLE V-A. PERCENT PAYMENT BASED ON MEAN ABSOLUTE DEVIATION OF AGGREGATE GRADATIONS FROM JMF (Metric)

<u>Sieve Size</u>	<u>Percent Payment Based On Mean Absolute Deviation from JMF</u>							
	<u>0.0-1.0</u>	<u>1.1-2.0</u>	<u>2.1-3.0</u>	<u>3.1-4.0</u>	<u>4.1-5.0</u>	<u>5.1-6.0</u>	<u>Above 6.0</u>	
19 mm	100	100	100	100	98	95	90	

12.5 mm	100	100	100	100	98	95	90
9.5 mm	100	100	100	100	98	95	90
4.75 mm	100	100	100	100	98	95	90
2.36 mm	100	100	100	98	95	90	reject
1.18 mm	100	100	100	98	95	90	reject
0.600 mm	100	100	100	98	95	90	reject
0.300 mm	100	100	100	98	95	90	reject
0.150 mm	100	98	95	90	90	reject	reject
0.075 mm	100	98	90	reject	reject	reject	reject

TABLE V-B. PERCENT PAYMENT BASED ON MEAN ABSOLUTE DEVIATION OF AGGREGATE GRADATIONS FROM JMF

Sieve Size	Percent Payment Based On Mean Absolute Deviation from JMF						
	<u>0.0-1.0</u>	<u>1.1-2.0</u>	<u>2.1-3.0</u>	<u>3.1-4.0</u>	<u>4.1-5.0</u>	<u>5.1-6.0</u>	<u>Above 6.0</u>
3/4 inch	100	100	100	100	98	95	90
1/2 inch	100	100	100	100	98	95	90
3/8 inch	100	100	100	100	98	95	90
No. 4	100	100	100	100	98	95	90
No. 8	100	100	100	98	95	90	reject
No. 16	100	100	100	98	95	90	reject
No. 30	100	100	100	98	95	90	reject
No. 50	100	100	100	98	95	90	reject
No. 100	100	98	95	90	90	reject	reject
No. 200	100	98	90	reject	reject	reject	reject

3.12.3 Asphalt Content

The mean absolute deviation of a section asphalt contents from the JMF will be evaluated and compared with TABLE VI. The percent payment based on asphalt content shall be the value determined in TABLE VI. Asphalt content tests shall be completed and reported within 24 hours after construction of the section.

TABLE VI. PERCENT PAYMENT BASED ON ASPHALT CONTENT

<u>Mean Absolute Deviation of Extracted Asphalt Content from JMF</u>	<u>Percent Payment</u>
less than 0.25	100
0.25-0.30	98
0.31-0.35	95
0.36-0.40	90
above 0.40	reject

3.12.4 Density

The average density will be expressed as a percentage of the laboratory density. The laboratory density for each area will be determined in accordance with ASTM D 1559. Laboratory samples will be prepared from asphalt mixture which has not been reheated. Samples will be compacted at 250 degrees F within 2 hours of the time the mixture was prepared at the asphalt plant. Laboratory samples will be prepared in accordance with ASTM D 1559.

3.12.4.1 Field Density

The field density will be determined and compared with TABLE VII. The percent payment based on density shall be the lowest value determined from TABLE VII. The percent payment based on area density will be for all of the material placed in the area.

TABLE VII. PERCENT PAYMENT BASED ON DENSITY

Average Section Density (4 Cores)	Percent Payment
97.0-100.0	100.0
96.9	100.0
96.8-100.1	99.9
96.7	99.8
96.6-100.2	99.6
96.5	99.4
96.4-100.3	99.1
96.3	98.7
96.2-100.4	98.3
96.1	97.8
96.0-100.5	97.3
95.9	96.3
95.8-100.6	94.1
95.7	92.2
95.6-100.7	90.3
95.5	87.9
95.4-100.8	85.7
95.3	83.3
95.2-100.9	80.6
95.1	78.0
95.0-101.0	75.0
below 95.0, above 101.0	reject

3.12.4.2 Section Density

All density results on a section will be completed and reported within 24 hours after construction of that lot. When the Contracting Officer considers it necessary to take additional samples for density measurements, samples will be taken in groups of four cored samples. The percent payment will be determined for each additional group of four samples and averaged with the percent payment for the original group to determine the final percent payment. The Contractor shall fill all sample holes with hot mix and compact.

3.12.5 Grade

Grade-conformance tests will be conducted by the Government. The finished surface of the pavement will be tested for conformance with plan-grade requirements. Within 5 working days after completion, the Contracting Officer will inform the Contractor in writing of results of grade-conformance tests. The finished grade of each pavement area shall be determined by running lines of levels at intervals of 8 m (25 feet) or less longitudinally and transversely to determine the elevation of the completed pavement. When more than 5 percent of all measurements

made within an area are outside the tolerances specified in paragraph: GRADE AND SURFACE-SMOOTHNESS REQUIREMENTS, the payment for that lot will not exceed 95 percent of the bid price. In areas where the grade exceeds the plan-grade tolerances given in paragraph: GRADE AND SURFACE-SMOOTHNESS REQUIREMENTS by more than 50 percent, the Contractor shall remove the deficient area and replace with fresh paving mixture at no additional cost to the Government. Sufficient material shall be removed to allow at least 1 inch of asphalt concrete to be placed. Skin patching for correcting low areas or planing for correcting high areas shall not be permitted.

3.12.6 Surface Smoothness

After completion of final rolling of a area, the compacted surface will be tested by the Contracting Officer with a 12-foot straightedge. Measurements will be made perpendicular to and across all pavement sections at distances spread 8 m. (25 feet) apart. Location and deviation from straightedge of all measurements will be recorded. When more than 5 percent of all measurements in a section exceed the specified tolerance, the unit price for that section shall not exceed 95 percent of the bid price. The Contractor shall remove the deficient area and replace with fresh paving mixture at no additional cost to the Government. Sufficient material shall be removed to allow at least 1 inch of asphalt concrete to be placed. Skin patching for correcting low areas or planing for correcting high areas shall not be permitted.

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SECTION 02558

BITUMINOUS TACK COAT

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 OF TESTING AND MATERIALS (ASTM)

ASTM D 140	(1993) Sampling Bituminous Materials
ASTM D 977	(1991) Emulsified Asphalt
ASTM D 2995	(1993) Determining Application Rate of Bituminous Distributors

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 1330: SUBMITTAL PROCEDURES.

1.2.1 SD-09, Reports

Tests; GA.

Copies of all test results, within 24 hours of completion of tests. Certified copies of the manufacturer's test reports indicating compliance with applicable specified requirements, not less than 30 days before the material is required in the work.

1.2.2 SD-18, Records

Waybills and Delivery Tickets; GA.

Waybills and delivery tickets, during progress of the work. Before the final statement is allowed, certified waybills and certified delivery tickets for all bituminous material used in the construction of the pavement covered by the contract shall be filed.

1.3 PLANT, EQUIPMENT, MACHINES AND TOOLS

1.3.1 General Requirements

All plant, equipment, machines and tools used in the work shall be subject to approval and shall be maintained in a satisfactory working condition at all times.

1.3.2 Bituminous Distributor

The distributor shall have pneumatic tires of such size and number to prevent rutting, shoving or otherwise damaging the base surface or other layers in the pavement structure. The distributor shall be designed and equipped to spray the bituminous material in a uniform coverage at the specified temperature, at readily determined and controlled rates with an allowable variation from the specified rate of not more than plus or minus 5 percent, and at variable widths.

Distributor equipment shall include a separate power unit for the bitumen pump, full-circulation spray bars, tachometer, pressure gauges, volume-measuring devices, adequate heaters for heating of materials to the proper application temperature, a thermometer for reading the temperature of tank contents, and a hand hose attachment suitable for applying bituminous material manually to areas inaccessible to the distributor. The distributor shall be equipped to circulate and agitate the bituminous material during the heating process.

1.3.3 Power Brooms and Power Blowers

Power brooms and power blowers shall be suitable for cleaning the surfaces to which the tack coat is to be applied.

1.4 WEATHER LIMITATIONS

Tack coat shall be applied only when the surface to receive the tack coat is dry. Tack coat shall be applied only when the atmospheric temperature in the shade is 50 degrees F or above and when the temperature has not been below 35 degrees F for the 12 hours prior to application.

PART 2 PRODUCTS

2.1 BITUMINOUS MATERIAL

Emulsified asphalt shall conform to ASTM D 977, Grade SS-1h.

PART 3 EXECUTION

3.1 PREPARATION OF SURFACE

Immediately before applying the tack coat all loose material, dirt, clay, or other objectionable material shall be removed from the surface to be treated. The area to be tacked shall also be dry and clean.

3.2 APPLICATION RATE

Bituminous material for the tack coat shall be applied in quantities of not less than 0.05 gallon nor more than 0.18 gallon per square yard of pavement surface. The exact quantities within the range specified, which may be varied to suit field conditions, will be determined by the Contracting Officer.

3.3 APPLICATION TEMPERATURE

Asphalt application temperature shall provide an application viscosity between 20 and 100 seconds, Saybolt Furol, or between 40 and 200 centistokes, kinematic. The temperature viscosity relation shall be furnished to the Contracting Officer.

Emulsions

SS-1h 70-160 degrees F

3.4 APPLICATION

Following preparation and subsequent inspection of the surface, the tack coat shall be applied at the specified rate with uniform distribution over the surface to be treated. All areas and spots missed by the distributor shall be properly treated with the hand spray. Following application of the tack material and prior to application of the succeeding layer of pavement, the tack shall be allowed to cure and to obtain evaporation of any volatiles or moisture. Until the succeeding layer of pavement is placed, the tacked area shall be maintained by protecting the surface against damage and by repairing and retacking deficient areas at no additional cost to the Government. If required, clean dry sand shall be spread to effectively blot up any excess bituminous material. No smoking, fires, or flames other than the heaters that are a part of the equipment shall be permitted within 25 feet of heating, distributing, and transferring operations of bituminous material other than bituminous emulsions.

3.5 FIELD QUALITY CONTROL

Samples of the bituminous material shall be tested for compliance with the applicable specified requirements. A sample shall be obtained and tested by the Contractor for every 2500 gallons of bituminous material used.

3.6 SAMPLING AND TESTING

3.6.1 General Requirements

Sampling and testing shall be performed by an approved commercial testing laboratory or by facilities furnished by the Contractor. No work requiring testing will be permitted until the facilities have been inspected and approved.

3.6.2 Sampling

The samples of bituminous material, unless otherwise specified, shall be in accordance with ASTM D 140.

3.6.3 Initial Sampling and Testing

3.6.3.1 Bituminous Materials

Sources from which bituminous materials are to be obtained shall be selected and notification thereof furnished the Contracting Officer within 15 days after the award of the contract.

3.6.3.2 Calibration Test

The Contractor shall furnish all equipment, materials, and labor necessary to calibrate the bituminous distributor. Calibration shall be made with the approved job material and prior to applying the tack coat material to the prepared surface. Calibration of the bituminous distributor shall be in accordance with ASTM D 2995.

3.6.3.3 Trial Applications

As a preliminary to providing the complete tack coat, three lengths of at least 100 feet for the full width of the distributor bar shall be tacked to evaluate the amount of tack that can be satisfactorily applied. Unless otherwise authorized, the trial application rate of bituminous materials shall be applied in the amount of 0.05 gallon per square yard. Other trial applications shall be made using various amounts of material as may be deemed necessary.

3.6.4 Sampling and Testing During Construction

Quality control sampling and testing shall be performed as required in paragraph:
FIELD QUALITY CONTROL.

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SECTION 02580

PAVEMENT MARKINGS

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 792	(1991) Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM E 28	(1992) Softening Point by Ring-and-Ball Apparatus

FEDERAL SPECIFICATIONS (FS)

FS TT-P-1952	(Rev D) Paint, Traffic and Airfield Marking
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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 1330: SUBMITTAL PROCEDURES.

1.2.1 SD-01, Data

Equipment Lists; GA.

Lists of proposed equipment to be used in performance of construction work, including descriptive data, and notification of proposed Contractor actions as specified in this section.

SD-06 Instructions

Mixing, Thinning and Application; GA.

Manufacturer's current printed product description and Material Safety Data Sheets (MSDS) for each type paint/color proposed for use.

SD-09 Reports

Material Tests; GA.

Certified copies of the test reports, prior to the use of the materials at the jobsite. Testing shall be performed in an approved independent laboratory.

SD-13 Certificates

Volatile Organic Compound (VOC) Content; GA.

Certificate stating that the proposed pavement marking paint meets the VOC regulations of the local Air Pollution Control District having jurisdiction over the geographical area in which the project is located.

1.3 DELIVERY AND STORAGE

All materials shall be delivered and stored in sealed containers that plainly show the designated name, formula or specification number, batch number, color, date of manufacture, manufacturer's name, and directions, all of which shall be plainly legible at time of use.

1.4 EQUIPMENT

All machines, tools and equipment used in the performance of the work shall be approved and maintained in satisfactory operating condition. Equipment operating on roads will display low speed traffic markings and traffic warning lights.

1.5 PAINT APPLICATION EQUIPMENT

The equipment to apply centerlines, edgelines and other longitudinal type markings to the pavement shall be a self-propelled or mobile-drawn pneumatic spraying machine with suitable arrangements of atomizing nozzles and controls to obtain the specified results. The machine shall have a speed during application not less than 5 mph, and shall be capable of applying the stripe widths indicated, at the paint coverage rate specified in paragraph: APPLICATION, and of even uniform thickness with clear cut edges. The paint applicator shall have paint reservoirs or tanks of sufficient capacity and suitable gages to apply paint in accordance with requirements specified. Tanks shall be equipped with suitable air-driven mechanical agitators. The spray mechanism shall be equipped with quick-action valves conveniently located, and shall include necessary pressure regulators and gages in full view and reach of the operator. Paint strainers shall be installed in paint supply lines to insure freedom from residue and foreign matter that may cause malfunction of the spray guns. The paint applicator shall be readily adaptable for attachment of an air-actuated dispenser for the reflective media approved for use. Pneumatic spray guns shall be provided for hand application of paint in areas where the mobile paint applicator cannot be used.

1.6 SURFACE PREPARATION EQUIPMENT

1.6.1 Sandblasting Equipment

Sandblasting equipment shall include an air compressor, hoses, and nozzles of proper size and capacity as required for cleaning surfaces to be painted. The compressor shall be capable of furnishing not less than 150 cfm of air at a pressure of not less than 90 psi at each nozzle used, and shall be equipped with traps that will maintain the compressed air free of oil and water.

1.6.2 Waterblasting Equipment

The water pressure shall be specified at 2600 psi at 140 degrees F in order to adequately clean the surfaces to be marked.

PART 2 PRODUCTS

2.1 PAINT

The paint shall be homogeneous, easily stirred to smooth consistency and shall show no hard settlement or other objectionable characteristics during a storage period of 6 months. Paint shall conform to FS TT-P-1952, color as indicated on the plans.

2.1.1 Drying Time

When installed at 70 degrees F and in thicknesses between 1/8 and 3/16 inch, the composition shall be completely solid and shall show no damaging effect from traffic after curing 15 minutes.

2.1.1.1 Softening Point

The composition shall have a softening point of not less than 194 degrees F when tested in accordance with ASTM E 28.

2.1.1.2 Specific Gravity

The specific gravity of the composition shall be between 1.9 and 2.2 as determined in accordance with ASTM D 792.

2.1.2 Asphalt Concrete Primer

The primer for asphalt concrete pavements shall be a thermosetting adhesive with a solids content of pigment reinforced synthetic rubber and synthetic plastic resin dissolved and/or dispersed in a volatile organic solvent. The solids content shall not be less than 10 percent by weight at 70 degrees F and 60 percent relative humidity. A wet film thickness of 0.005 inch plus or minus 0.001 inch, shall dry to a tack-free condition in less than 5 minutes.

2.1.3 Portland Cement Concrete Primer

The primer for Portland cement concrete pavements shall be an epoxy resin primer. The primer shall be of the type recommended by the manufacturer of the thermoplastic composition.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

Surfaces to be marked shall be thoroughly cleared before application of the pavement marking material. Dust, dirt, and other granular surface deposits shall be removed by sweeping, blowing, with compressed air, rinsing with water or a combination of these methods as required. Pavement surfaces shall be allowed to dry, when water is used for cleaning, prior to striping or marking. Rubber deposits, surface laitance, existing paint markings, and other coatings adhering

to the pavement shall be completely removed. Surfaces shall be recleaned when work has been stopped due to rain.

3.2 APPLICATION

3.2.1 General

All pavement markings and patterns shall be placed as indicated. The Contractor shall provide guide lines and templates as necessary to control paint application. Special precautions shall be taken in marking numbers, letters, and symbols. Edges of markings shall be sharply outlined.

3.2.2 Paint

Paint shall be applied to clean, dry surfaces, and only when air and pavement temperatures are above 40 degrees F and less than 95 degrees F. Paint temperature shall be maintained within these same limits. New asphalt pavement surfaces and new Portland concrete cement shall be allowed to cure for a period of not less than 30 days before applications of paint. Paint shall be applied pneumatically with approved equipment at rate of coverage specified herein.

3.2.3 Rate of Application

Nonreflective Markings: Paint shall be applied evenly to the pavement surface to be coated at a rate of 105 plus or minus 5 square feet per gallon.

3.2.4 Drying

The maximum drying time requirements of the paint specifications will be strictly enforced to prevent undue softening of bitumen, and pickup, displacement, or discoloration by tires of traffic. If there is a delay in drying of the markings, painting operations shall be discontinued until cause of the slow drying is determined and corrected.

3.2.4.1 Longitudinal Markings

All centerlines, edgelines, and other longitudinal type markings shall be applied with a mobile applicator. All special markings shall be placed with a portable applicator, using the extrusion method.

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SECTION 2600

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 88	(1990) Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C 127	(1988) Specific Gravity and Absorption of Coarse Aggregate
ASTM C 136	(1992) Sieve Analysis of Fine and Coarse Aggregates
ASTM C 535	(1989) Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM D 1141	(1980) Substitute Ocean Water

U.S. ARMY CORPS OF ENGINEERS HANDBOOK FOR CEMENT AND CONCRETE (CRD)

COE CRD-C 148	Method of Testing Stone for Expansive Breakdown on Soaking in Ethylene Glycol
---------------	-------------------------------------------------------------------------------

U.S. ARMY CORPS OF ENGINEERS, LOS ANGELES DISTRICT TESTING POLICY

SPD TESTING PROCEDURE	Wetting and Drying
SPD TESTING PROCEDURE	Petrographic and X-Ray Diffraction

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Definition

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 from Project Excavation

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

2.1.4 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. 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.

2.1.4.1 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.

2.1.4.2 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 Contracting Officer may elect to use either past Corps of Engineers test results or a combination of service records, along with test results from other agencies or private laboratories. 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.

2.1.4.3 Potential Stone Sources

The following are a few of the sources reasonably near 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
Atkinson	Riverside
Corona-Pacific	Corona
Pebbly Beach	Avalon (Santa Catalina Island)
Slover Mountain	Colton
Pyrite Street	Riverside
3M	Corona

Fish Canyon

Azusa

Listing of a stone source is not to be construed as 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.

2.1.4.4 Quality Compliance Testing

Samples for Corps of Engineers testing, as specified in paragraph: Source Documentation, 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 or sources will be tested by the Government for quality compliance. The first test shall be at Government expense. However, if the stone fails the test, 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 \$4,500 for each sample tested. All test samples (500 pounds minimum) shall be representative of the stone source and shall be obtained by the Contractor, under the supervision of the Contracting Officer's Representative and delivered at the Contractor's expense to a testing laboratory approved by the Contracting Officer's Representative.

2.1.4.5 Stone Quality

Stone shall meet the following test requirements:

<u>Test</u>	<u>Test Method</u>	<u>Requirement</u>
Specific Gravity (Bulk SSD)	ASTM C 127	2.50 minimum
Absorption	ASTM C 127	2.0% maximum
Wetting and Drying	SPD Test Procedure ⁽¹⁾	No fracturing ⁽³⁾
Sulfate Soundness	ASTM C 88 ⁽²⁾	10% max. loss ⁽⁴⁾
Abrasion Loss	ASTM C 535	50% max. loss
Accelerated Expansion	COE CRD C 148	15% max. loss
Petrographic and X-Ray Diffraction	ASTM C 295 ⁽⁵⁾	no expansive clays, fresh, etc. ⁽⁵⁾

NOTE: (1): Test procedure for wetting and drying test. The entire sample is carefully examined, and representative test specimens are selected. The sample should be large enough to produce two cut slabs, each 1-inch thick (+/-1/4 inch), with a minimum surface area of 30 square inches on each 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, then 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 each 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, or 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 sawed-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): Test procedure for Petrographic and X-ray Diffraction is performed according to ASTM C 295, except for the following additional requirements:

(a) A colored petrographic and stereoscopic photograph is made of each stone type (whether igneous, sedimentary, and/or metamorphic). The individual minerals within the stone type are identified by labels and arrows upon the photograph.

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

(c) A written summary of the suitability of stone for use as rip-rap based on the Petrographic and X-ray tests is presented in the final laboratory report on stone quality.

2.1.5 Stone Acceptance

Prior to placement, all stone shall be subject to acceptance by the Contracting Officer's Representative. Acceptance of any stone shall not constitute acceptance of all stone from a source. All accepted stone shall have the following characteristics:

a. have same lithology as the original stone, from which test results or service records were taken, as a basis for authorization of the source;

b. be sound, durable, and hard, and free from laminations, weak cleavages, undesirable weathering, or blasting or handling-induced fractures (or fracture zones that subtend more than 1/3 of the total circumference of the stone, along the plane of fracturing);

c. have such character that it will not disintegrate from the action of air, water, or the conditions of handling and placing;

d. be clean and free from earth, clay, refuse, or adherent coatings;

e. be angular quarried material, with a shape which assures interlocking with adjacent stone, and with the greatest dimension of each piece not greater than 3 times the least dimension.

2.1.6 Rejected Stone

Stone of unsuitable quality and/or size distribution, as required by these specifications. 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.

2.1.7 Salvaged Stone

Salvaged stone shall become the property of the Contractor and removed from the site.

2.1.8 Gradation Sampling and Testing

2.1.8.1 Tests will be performed by an approved testing laboratory on samples selected by the Contracting Officer. The Government reserves the right to perform check-tests and to use the Contractor's sampling and testing facilities to make the tests. All sampling and gradation tests performed by the Contractor shall be under the supervision of the Contracting Officer.

2.1.8.2 Stone

One gradation test for each type of stone shall be required at the beginning of production, prior to the delivery of stone from the source to the project site. A minimum of one additional test shall be required for each 1000 tons of each type of stone placed. Each gradation sample shall consist of not less than 5 tons of stone, selected at random from the production run for the first test of each type of stone or from stone placed on grade or stockpiled on-site for required additional tests.

2.1.9 Gradation

2.1.9.1 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 that gradation requirements are met. All gradation tests shall be at the expense of the Contractor.

2.1.9.2 Drain Blanket Material

Drain blanket material shall be reasonably well graded, between the limits specified below, when tested in accordance with ASTM C 136.

Drain Blanket Material

<u>Sieve Size</u>	<u>Percent Finer (by weight)</u>
1½ inch	90-100
3/8 inch	40-55
No. 16	15-25
No. 100	0-5

2.1.9.3 Stone for Grouted Stone Protection

Stone for grouted stone protection shall be reasonably well-graded between 6 and 12 inches with not less than 40 percent nor more than 70 percent 9 inches in size.

PART 3 EXECUTION

3.1 FOUNDATION PREPARATION

3.1.1 General

Subgrade preparation for stone protection overlying geotextile shall conform to the provisions of SECTION 2250: FILLS AND SUBGRADE PREPARATION AND DRAINAGE SYSTEMS and SECTION 02215: GEOTEXTILES USED AS FILTERS. For areas adjacent to parapet walls where existing filter material and rip-rap is to be removed and replaced, the subgrade shall be trimmed and dressed to conform to cross-sections indicated or directed, within an allowable tolerance of plus or minus one 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, and 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 Contracting Officer, and no material shall be placed thereon until that area has been approved.

3.2 PLACEMENT

3.2.1 Stone

Stone shall be placed in a manner to produce a reasonably well-graded mass, with the minimum practicable percentage of voids, and shall be constructed to the lines and grades indicated or directed. Stone shall be placed to its full course thickness in one operation and in a manner to avoid displacing the underlying material. Method of placement shall be submitted to the Contracting Officer for approval prior to commencement of placement operations. 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 shown on the drawings. Self-propelled equipment shall not be used on the levee slopes and/or toe-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 3 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.

3.2.2 Stone for grouted stone shall be placed to produce a surface in which the tops of the individual stones do not vary more than 1½ inches from final grade. Double-decking thin flat stones to bring the surface up to the required grade will not be permitted.

3.3 DELIVERY

3.3.1 Scales

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. If an official inspection bureau of the state is not available, the scales will be tested by the Contracting Officer.

3.3.2 Waybills and Delivery Tickets

Copies of waybills or delivery tickets shall be submitted to the Contracting Officer during the progress of the work. Before the final statement is allowed, the Contractor shall file with the Contracting Officer certified waybills and/or certified delivery tickets for all stone actually used in the construction covered by the contract.

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SECTION 2605

LANDSCAPE STONE

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 88	(1990) Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C 127	(1988) Specific Gravity and Absorption of Coarse Aggregate
ASTM C 131	(1989) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1984a) Sieve Analysis of Fine and Coarse Aggregates
ASTM C 295	(1990) Petrographic Examination of Aggregates for Concrete
ASTM C 535	(1989) Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM D 1141	(1980) Substitute Ocean Water

1.2 SUBMITTALS

Government approval is required for submittals with a **AGA** designation; submittals having an **AFIO** designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES.

1.2.1 SD-01 Field Sample(s)

Landscape Stone; GA.

An in-place field sample with a minimum size of ten foot (10=) by twenty foot (20=) shall be prepared on a portion of the slope for approval by the Contracting Officer as to size, variation, color, and placement.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Definitions

Landscape stone shall be angular, quarried stone. The landscape stone shall conform to rock type characteristics specified in this section.

2.1.2 General

Contractor shall make all arrangements, pay all royalties, and secure all permits for the procurements, furnishing, and transporting of landscape stone. Contractor shall vary the quarrying, processing, loading, and placing operations to produce the sizes and quality of landscape stone specified. If the landscape stone being furnished does not fully meet all the requirements of these specifications, the Contractor shall furnish, at no additional cost to the government, other landscape stone meeting the requirements of these specifications.

2.1.3 Source Authorization

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

2.1.3.1 Source Development

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

2.1.3.2 Source Documentation

Authorization of a proposed landscape stone source will be based on test results and/or service records. For unlisted sources, Corps of Engineers test results shall be required as outlined in paragraph: Quality Compliance Testing, below. The Contracting Officer would use either past Corps of Engineers test results or a combination of service records along with test results from other agencies or private laboratories for quality compliance. A service record is considered to be acceptable if landscape stone from the proposed source has remained sound and functional after at least ten (10) years of exposure on a project similar to the one to be constructed under these specifications.

2.1.3.3 Stone Sources

The sources listed in Section 02600, Stone Protection, have either undergone recent quality compliance testing for use on Corps of Engineers projects or have

acceptable service records. Listing of a landscape stone source is not to be construed as authorization of all materials from the source, nor as a waiver of inspection and testing of the source. Landscape 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. All landscape stone utilized on the project shall be obtained from a single source unless otherwise authorized by the Contracting Officer.

2.1.3.4 Quality Compliance Testing

Samples for Corps of Engineers testing as specified in paragraph: Source Documentation shall be submitted a minimum of forty-five (45) calendar days in advance of the time when the landscape stone will be required in the work. Landscape stone from a proposed source or sources will be tested by the Government for quality compliance. The first two (2) tests shall be at Government expense; however, if the stone fails the tests, or if the Contractor desires to utilize more than two (2) sources, 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 \$3,500 for each sample tested.

All test samples (350 pounds minimum) shall be representative of the landscape stone source and shall be obtained by the Contractor under the supervision of the Contracting Officer and delivered at the Contractor's expense to a commercial laboratory which has been selected by the Contracting Officer and has performed satisfactory testing in the past for the Government.

2.1.3.5 Landscape Stone Quality

Landscape 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	SPD Test Procedure ⁽¹⁾	No fracturing ⁽³⁾
Sulfate Soundness	ASTM C 88 ⁽²⁾	10% maximum loss ⁽⁴⁾
Abrasion Loss	ASTM C 535	45% maximum loss

NOTE (1): Test procedure for wetting and drying test. The entire sample is carefully examined and representative test specimens are selected. The sample should be large enough to produce two (2) cut slabs, one inch (1@) thick (+/- 1/4@) with a minimum surface area of thirty (30) square inches on one side. Two (2) chunks approximately three inches (3@) by four inches (4@) 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 140E F, for eight (8) hours, cooled and weighed to the nearest tenth (0.01) 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 (15) cycles of setting and drying. One (1) slab and one (1) 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 (16) hours at room

temperature and then drying in an oven for eight (8) hours at 140E F. After each cycle, the specimens are examined with the low-power microscope to check for opening of 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 (15) 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 fifty (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): Landscape stone which has a loss greater than the specified limit will be accepted if the Contractor demonstrates that the landscape stone has a satisfactory service record.

2.1.4 Stone Acceptance

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

- a. of the same lithology as the original stone from test results or service records were taken as a basis for authorization of the source;
- b. sound, durable and hard, and free from lamination, weak cleavages, undesirable weathering, or blasting or handling-induced fractures;
- c. of such character that it will not disintegrate from the action of air, water, or the conditions of handling and placing;
- d. clean and free from earth, clay, refuse, or adherent coatings; and
- e. rounded riverine material.

2.1.5 Rejected Landscape Stone

Landscape stone of unsuitable quality as required by these specifications will be rejected. Any rejected landscape stone shall be promptly removed from the project at no expense to the Government.

2.1.6 Gradation, Sampling, and Testing for Stone Protection

Gradation testing shall be required for landscape stone. Tests shall be performed by an approved testing laboratory on samples selected by the Contracting Officer.

The Government reserves the right to perform check tests and to use the Contractor's sampling and testing facilities to make the tests. One (1) gradation

test shall be required at the beginning of production prior to delivery of landscape stone from the source to the project site. A minimum of one (1) additional test shall be required for each 5,000 tons of landscape stone placed. Each gradation sample shall consist of not less than five (5) tons of stone, selected at random from the production run for the first test or from landscape 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 Contracting Officer.

2.1.7 Gradation

2.1.7.1 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 due to segregation or degradation during placement shall be rejected. If test results show that landscape 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.

2.1.7.2 Landscape Stone

Gradation shall be as follows:

- a. Seventy percent (70%) to 100 percent (100%) of landscape stone utilized on the project shall be between twelve inches (12@) in diameter minimum in any dimension and fifteen inches (15@) in diameter maximum in any dimension.
- b. Twenty percent (20%) of landscape stone utilized on the project may be smaller than twelve inches (12@) in diameter, but shall not be less than eight inches (8@) in diameter in any dimension.
- c. Ten percent (10%) of landscape stone utilized on the project may be larger than fifteen inches (18@) in diameter, but shall not exceed eighteen inches (24@) in diameter in any dimension.
- d. Zero percent (0%) of the landscape stone utilized on the project may be less than 8" in diameter in any dimension.

2.1.7.3 Stone for Grouted Landscape Stone

Stone for grouted stone protection shall be reasonably well-graded between 6 and 12 inches with not less than 40 percent nor more than 70 percent 9 inches in size.

PART 3 EXECUTION

3.1 PLACEMENT

Method of placement shall be submitted to Contracting Officer for approval prior to commencement of placement operations.

3.1.1 Landscape Stone

Landscape stone shall be placed in a manner to produce a reasonably well graded mass with the minimum practicable percentage of voids. Stone shall be placed to its full course thickness in one (1) operation and in a manner to avoid displacing the underlying material. Material shall not be dropped from a height of more than eighteen inches (18@). Contractor shall maintain the landscape stone protection until accepted and any material displaced by any cause shall be replaced at Contractor's 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 landscape stone by dumping into chutes or by similar methods likely to cause segregation will not be permitted.

3.1.2 Landscape Stone Layer

All ground (soil) surfaces throughout landscape stone layer areas shall be completely covered with geotextile. The landscape stone layer shall consist of at least one (1) layer of twelve inch (12@) diameter minimum size landscape stone up to a maximum of two (2) layers of landscape stone not exceeding thirty inches (30@) in depth, resulting in a stone layer surface elevation varying between irregular and consistent. Landscape stone shall be arranged in stable positions nestled with or buttressed against adjacent landscape stone. The edges of the landscape stone layer shall be tapered present an irregular line horizontally, as shown on the drawings.

3.2 DELIVERY

3.2.1 Rail and Truck Delivery

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

3.2.2 Scales

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 insure 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 Contracting Officer. Where scales are found to be defective or questionable, landscape stone deliveries shall immediately cease and shall not resume until approved scales are available.

3.2.3 Scale Tickets

Copies of scale tickets and/or records of weights including displacement weight date, shall be submitted to the Contracting Officer during the progress of the work. The Contracting Officer will determine from the displacement weight date, the weight of landscape and ornamental stone shipped by barge and will certify displacement weight records. Each scale ticket and/or record shall include the gross, rate, dunnage, and net weight of landscape stone. The weight of dunnage for each load, will be determined, recorded, and certified by the Contracting Officer. Deliveries and numbered scale tickets and/or records using an approved system will be used to maintain delivery control. Copies of scale ticket and/or records shall accompany each load of landscape stone for all methods of transportation and a copy shall be delivered to the Contracting Officer on delivery of the landscape stone. Before the final statement is allowed, the Contractor shall file with the Contracting Officer certified scale tickets and/or certified records for landscape stone used in the construction covered by the contract.

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SECTION 2650

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	(1990) Concrete Aggregates
ASTM C 150	(1992) Portland Cement
ASTM C 143	(1990a) Slump of Portland Cement Concrete
ASTM C 172	(1990) Sampling of Freshly Mixed Concrete
ASTM C 309	(1991) Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 494	(1986) 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 1330: SUBMITTAL PROCEDURES:

1.2.1 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 reports of aggregate quality tests.

1.2.2 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 quality requirements specified in ASTM C 33. Gradation requirements are as follows.

2.1.1 Fine Aggregate Gradation

Fine aggregate shall conform to the quality requirements specified in ASTM C 33 for Fine Aggregate.

2.1.2 Coarse Aggregate Gradation

Coarse aggregate shall conform to the following gradation:

<u>Sieve Designation</u>	<u>Cumulative Percentage By Weight Passing</u>
½ 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 the requirements of ASTM C 309, Type 1 or 2, 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, grouted 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 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.

3.2.2 Placing

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 maximum diameter of a grout discharge hose shall be 5 inches and free fall shall not exceed 3 feet in height. 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. The course shall fully penetrate the stone blanket, extending from toe of slope to top of side slopes. 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 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 of Completed Work

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 of 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 which shall be kept continuously 17 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 adequate personnel 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 indicate 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 02720

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 ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 198	(1994) Joints for Circular Concrete Sewer and Culvert Pipe Using Flexible Watertight Gaskets
AASHTO M 294	(1994) Corrugated Polyethylene Pipe, 305- to 915-mm 12- to 36-in. Diameter
AASHTO M 304	(1994) Poly(Vinyl Chloride) (PVC) Profile Wall Drain Pipe and Fittings Based on Controlled Inside Diameter

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 48	(1994a) Gray Iron Castings
ASTM A 123	(1989a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 444	(1989) Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process for Storm Sewer and Drainage Pipe
ASTM A 536	(1984; R 1993) Ductile Iron Castings
ASTM A 760	(1993a) Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
ASTM A 798	(1994) Installing Factory-Made, Corrugated Steel Pipe for Sewers and Other Applications
ASTM B 26	(1992a) Aluminum-Alloy Sand Castings
ASTM B 745	(1993) Corrugated Aluminum Pipe for Sewers and Drains

ASTM C 14	(1995) Concrete Sewer, Storm Drain, and Culvert Pipe
ASTM C 76	(1995) Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C 231	(1991b) Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 270	(1996a) Mortar for Unit Masonry
ASTM C 425	(1996) Compression Joints for Vitrified Clay Pipe and Fittings
ASTM C 433	(1994) Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
ASTM C 478	(1994) Precast Reinforced Concrete Manhole Sections
ASTM C 655	(1994) Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe
ASTM C 789	(1994) Precast Reinforced Concrete Box Sections
ASTM D 1056	(1991) Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D 1171	(1994) Rubber Deterioration - Surface Ozone Cracking Outdoors or Chamber (Triangular Specimens)
ASTM D 1557	(1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu.ft. (2,700 kN-m/cu.m.))
ASTM D 1751	(1983; R 1991) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1752	(1984; R 1992) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D 1784	(1996) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 2167	(1994) Density and Unit Weight of Soil in Place by the Rubber Balloon Method

ASTM D 2321	(1989) Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D 2922	(1991) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	(1988; R 1993) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D 3034	(1994) Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D 3212	(1992) Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D 3350	(1993) Polyethylene Plastics Pipe and Fittings Materials
ASTM F 477	(1995) Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F 679	(1995) Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer and Fittings
ASTM F 714	(1994) Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
ASTM F 794	(1997) Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter
ASTM F 894	(1995) Polyethylene (PE) Large-Diameter Profile Wall Sewer and Drain Pipe
ASTM F 949	(1994) Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings

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 01300: SUBMITTAL PROCEDURES:

SD-06 Instructions

Placing Pipe; GA

Printed copies of the manufacturer's recommendations for installation procedures of the material being placed, prior to installation.

SD-13 Certificates

Pipeline Testing; GA. Hydrostatic Test on Watertight Joints; GA. Determination of Density; GA.

Certified copies of test reports demonstrating conformance to applicable pipe specifications, before pipe is installed. Certification on the ability of frame and cover or gratings to carry the imposed live load.

SD-14 Samples

Pipe for Culverts and Storm Drains; GA.

Frame and Cover for Gratings; GA.

Certification on the suitability of gratings for bicycle traffic.

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. Gasket materials and plastic materials shall be protected from exposure to the direct sunlight over extended periods.

1.3.2 Handling

Materials shall be handled in such a manner as to ensure 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 Concrete Pipe

ASTM C 655, 2000 D-Load minimum or as shown on the plans.

2.1.2 Corrugated Steel Pipe

ASTM A 760, zinc coated pipe of either Type I or II pipe with annular or helical corrugations.

a. Type II pipe with helical corrugations.

b. Type IIA pipe with helical corrugations fabricated with a smooth steel liner of Type C precast sheet with a polymeric coating on both sides of not less than 0.25 mm (0.010 inch) 0.010 inch thick conforming to ASTM A 742.

c. Type IIR pipe with helical corrugations.

2.1.3 Corrugated Aluminum Alloy Pipe

ASTM B 745 corrugated aluminum alloy pipe of Type II pipe with helical corrugations.

2.1.4 Ductile Iron Culvert Pipe

ASTM A 716

2.1.5 PVC Pipe

The pipe manufacturer's resin certification, indicated the cell classification of PVC used to manufacture the pipe in accordance with AASHTO M 304, shall be submitted prior to installation of the pipe.

2.1.5.1 Type PSM PVC Pipe

ASTM D 3034, Type PSM, maximum SDR 35, produced from PVC certified by the compounder as meeting the requirements of ASTM D 1784, minimum cell class 12454-B.

2.1.5.2 Profile PVC Pipe

ASTM F 794, Series 46, produced from PVC certified by the compounder as meeting the requirements of ASTM D 1784, minimum cell class 12454-B.

2.1.5.3 Smooth Wall PVC Pipe

ASTM F 679 produced from PVC certified by the compounder as meeting the requirements of ASTM D 1784, minimum cell class 12454-B.

2.1.5.4 Corrugated PVC Pipe

ASTM F 949 produced from PVC certified by the compounder as meeting the requirements of ASTM D 1784, minimum cell class 12454-B.

2.2 MISCELLANEOUS MATERIALS

2.2.1 Concrete

Unless otherwise specified, concrete and reinforced concrete shall conform to the requirements for 3000 psi concrete under Section 03301 CAST IN PLACE STRUCTURAL CONCRETE. 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.

2.2.2 Mortar

Mortar for pipe joints, connections to other drainage structures, and brick or block construction shall conform to ASTM C 270, Type M, except the maximum placement time shall be 1 hour. The quantity of water in the mixture shall be sufficient to produce a stiff workable mortar but in no case shall exceed 8 gallons of water per sack of cement. 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.

2.2.3 Frame and Cover for Gratings

Frame and cover for gratings shall be cast gray iron, ASTM A 48, Class 35B; cast ductile iron, ASTM A 536, Grade 65-45-12; or cast aluminum, ASTM B 26, Alloy 356.OT6. Weight, shape, size, and waterway openings for grates and curb inlets shall be as indicated on the plans.

2.2.4 Automatic Drainage Gates

Automatic drainage gates shall be of the size indicated on the plans. All gates shall be the product of the same manufacture. Frames and covers shall be cast-iron or cast steel. Seating surface shall be bronze or ductile iron. Links may be cast-iron, cast steel, or high strength maleable iron. Bushings shall be bronze. Fasteners shall be galvanized steel, bronze, or corrosion-resistant steel. Gates shall have fully adjustable linkage. Installation of gates shall be as recommended by the gate manufacturer.

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 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS.

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 12 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. Care shall be taken not to overexcavate. Where trench widths are exceeded, redesign with a resultant increase in cost of stronger pipe or special installation procedures shall 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 200 mm 8 inches of 85 mm ½ inch for each meter 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 in SECTION 02316 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 Corrugated Metal Pipe

Bedding for corrugated metal pipe and pipe arch shall be in accordance with ASTM A 798.

3.2.2 Concrete Pipe

When no bedding class is specified or detailed on the drawings, concrete pipe shall be bedded carefully 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 the 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 only of such length, depth, and width as required for properly making the particular type of joint.

3.2.3 Ductile Iron Pipe

Bedding for ductile iron pipe shall be as shown on the drawings.

3.2.4 Plastic Pipe

Bedding for PVC and PE pipe shall meet the requirements of ASTM D 2321. Bedding, haunching, and initial backfill shall be either Class IB or II material.

3.3 PLACING PIPE

Each pipe shall be carefully examined before being laid, and 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. Lifting lugs in vertically elongated metal pipe shall be placed in the

same vertical plane as the major axis of the pipe. Under no circumstances shall pipe be laid in water, and no pipe shall 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. All pipe in place shall be inspected before backfilling, and those pipes damaged during placement shall be removed and replaced.

3.3.1 Corrugated Metal Pipe and Pipe Arch

Laying shall be with the separate sections joined firmly together, with the outside laps of circumferential joints pointing upstream, and with longitudinal laps on the sides.

3.3.2 Concrete, Clay, PVC, Ribbed PVC and Ductile Iron 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.

3.3.3 Multiple Culverts

Where multiple lines of pipe are installed, adjacent sides of pipe shall be at least half the nominal pipe diameter or 1 meter 3 feet apart, whichever is less.

3.3.4 Jacking Pipe Through Fills

Jacking pipe through fills shall not be allowed.

3.4 JOINTS

3.4.1 Concrete and Clay 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 carefully cleaned with a wet brush and the lower portion of the bell filled with mortar to such depth as 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 then 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 then 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 such lengths that they will 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 200 mm 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 only the high side of band, 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 carefully forced out by pouring and removed.

c. Remainder of Joint: The remaining unfilled upper portion of the joint shall then 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 carefully 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 carefully 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 then 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. No backfilling around the joints shall be done until the joints have been fully inspected and approved.

3.4.1.6 Plastic Sealing Compound Joints for Tongue-and-Grooved Pipe

Sealing compounds shall follow the recommendation of the particular manufacturer in regard to special installation requirements. Surfaces to receive lubricants, primers, or adhesives shall be dry and clean. Sealing compounds shall be affixed to the pipe not more than 3 hours prior to installation of the pipe, and shall be protected from the sun, blowing dust, and other deleterious agents at all times. Sealing compounds shall be inspected before installation of the pipe, and any loose or improperly affixed sealing compound shall be removed and replaced. The pipe shall be aligned with the previously installed pipe, and the joint pulled together. If, while making the joint with mastic-type sealant, a slight protrusion of the material is not visible along the entire inner and outer circumference of the joint when the joint is pulled up, the pipe shall be removed and the joint remade. After the joint is made, all inner protrusions will be cut off flush with the inner surface of the pipe. If nonmastic-type sealant material is used, the "Squeeze-Out" requirement above shall be waived.

3.4.1.7 Flexible Watertight Joints

Gaskets and jointing materials shall be as recommended by the particular manufacturer in regard to use of lubricants, cements, adhesives, and other special installation requirements. Surfaces to receive lubricants, cements, or adhesives shall be clean and dry. Gaskets and jointing materials shall be affixed to the pipe not more than 24 hours prior to the installation of the pipe, and shall be protected from the sun, blowing dust, and other deleterious agents at all times. Gaskets and jointing materials shall be inspected before installing the pipe; any loose or improperly affixed gaskets and jointing materials shall be removed and replaced. The pipe shall be aligned with the previously installed pipe, and the joint pushed home. If, while the joint is being made the gasket becomes visibly dislocated the pipe shall be removed and the joint remade.

a. Materials: Flexible watertight joints shall be made with plastic or rubber-type gaskets for concrete pipe and with factory-fabricated resilient materials for clay pipe. The design of joints and the physical requirements for plastic gaskets shall conform to AASHTO M 198, and rubber-type gaskets shall conform to ASTM C 443. Factory-fabricated resilient joint materials shall conform to ASTM C 425. Gaskets shall have not more than one factory-fabricated splice, except that two factory-fabricated splices of the rubber-type gasket are permitted if the nominal diameter of the pipe being gasketed exceeds 54 inches.

b. Test Requirements: Watertight joints shall be tested and shall meet test requirements of paragraph HYDROSTATIC TEST ON WATERTIGHT JOINTS. Rubber gaskets shall comply with the oil resistant gasket requirements of ASTM C 443. Certified copies of test results shall be delivered to the Contracting Officer before gaskets or jointing materials are installed. Alternate types of watertight joint may be furnished if specifically approved.

3.4.1.8 External Sealing Bands

Requirements for external sealing bands shall conform to ASTM C 877.

3.4.1.9 Flexible Watertight, Gasketed Joints

a. Gaskets: When infiltration or exfiltration is a concern for pipe lines, the couplings may be required to have gaskets. The closed-cell expanded rubber gaskets shall be a continuous band approximately 7 inches wide and approximately 3/8 inch thick, meeting the requirements of ASTM D 1056, and shall have a quality retention rating of not less than 70 percent when tested for weather resistance by ozone chamber exposure, Method B of ASTM D 1171. Rubber O-ring gaskets shall be 13/16 inch in diameter for pipe diameters of 36 inches or smaller and 7/8 inch in diameter for larger pipe having 1/2 inch deep end corrugation. Rubber O-ring gaskets shall be 1-3/8 inches in diameter for pipe having 1 inch deep end corrugations. O-rings shall meet the requirements of AASHTO M 198 or ASTM C 443. Flexible plastic gaskets shall conform to requirements of AASHTO M 198, Type B.

b. Connecting Bands: Connecting bands shall be of the type, size and sheet thickness of band, and the size of angles, bolts, rods and lugs as indicated or where not indicated as specified in the applicable standards or specifications for the pipe. Exterior rivet heads in the longitudinal seam under the connecting band shall be countersunk or the rivets shall be omitted and the seam welded. Watertight joints shall be tested and shall meet the test requirements of paragraph HYDROSTATIC TEST ON WATERTIGHT JOINTS.

3.4.2 PVC Plastic Pipes

Joints shall be solvent cement or elastomeric gasket type in accordance with the specification for the pipe and as recommended by the pipe manufacturer.

3.4.3 Smooth Wall PE Plastic Pipe

Pipe shall be joined using butt fusion method as recommended by the pipe manufacturer.

3.4.4 Ductile Iron Pipe

Couplings and fittings shall be as recommended by the pipe manufacturer.

3.4.5 Corrugated Metal Pipe

3.4.5.1 Field Joints

Transverse field joints shall be of such design that the successive connection of pipe sections will form a continuous line free of appreciable irregularities in the flow line. In addition, the joints shall meet the general performance requirements described in ASTM A 798. Suitable transverse field joints which satisfy the requirements for one or more of the joint performance categories can be obtained with the following types of connecting bands furnished with suitable band-end fastening devices: corrugated bands, bands with projections, flat bands, and bands of special design that engage factory reformed ends of corrugated pipe. The space between the pipe and connecting bands shall be kept free from dirt and grit so that corrugations fit snugly. The connecting band, while being tightened, shall be tapped with a soft-head mallet of wood, rubber or plastic, to take up slack and ensure a tight joint. Field joints for each type of corrugated metal pipe shall maintain pipe alignment during construction and prevent infiltration of fill material during the life of the installations. The type, size, and sheet thickness of the band and the size of angles or lugs and bolts shall be as indicated or where not indicated, shall be as specified in the applicable standards or specifications for the pipe.

3.5 STEEL LADDER

Steel ladder shall be provided where the depth of the manhole exceeds 12 feet. These ladders will be not less than 16 inches in width, with 3/4 inch diameter rungs spaced 12 inches apart. The two stringers shall be a minimum 3/8 inch thick and 2-1/2 inches wide. Ladders and inserts shall be galvanized after fabrication in conformance with ASTM A 123.

3.6 HYDROSTATIC TEST ON WATERTIGHT JOINTS

3.6.1 Concrete, Clay, PVC and PE Pipe

A hydrostatic test shall be made on the watertight joint types as proposed. Only one sample joint of each type needs testing; however, if the sample joint fails because of faulty design or workmanship, an additional sample joint may be tested. During the test period, gaskets or other jointing material shall be protected from extreme temperatures which might adversely affect the performance of such materials. Performance requirements for joints in reinforced and nonreinforced concrete pipe shall conform to AASHTO M 198 or ASTM C 443. Test requirements for joints in clay pipe shall conform to ASTM C 425. Test requirements for joints in PVC and PE plastic pipe shall conform to ASTM D 3212.

3.7 DRAINAGE STRUCTURES

3.7.1 Manholes and Inlets

Construction shall be of reinforced concrete, precast reinforced concrete, complete with frames and covers or gratings and with fixed galvanized steel ladders where indicated.

3.7.2 Walls and Headwalls

Construction shall be as indicated.

3.7.3 Steel Ladder Installation

Ladder shall be adequately anchored to the wall by means of steel inserts spaced not more than 6 feet vertically, and shall be so installed as to provide at least 6 inches of space between the wall and the rungs. The wall along the line of the ladder shall be vertical for its entire length.

3.8 BACKFILLING

3.8.1 Backfilling Pipe in Trenches

After the pipe has been properly bedded, 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. Care shall be taken to ensure thorough compaction of the fill 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 6 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 will be made as necessary to ensure conformance to the compaction requirements specified elsewhere in this paragraph.

3.8.2 Backfilling Pipe in Fill Sections

For pipe placed in fill sections, backfill material and the placement and compaction procedures shall be as specified elsewhere in this paragraph. The fill material shall be uniformly spread in layers longitudinally on both sides of the pipe, not exceeding 6 inches in compacted depth, and shall be compacted by rolling parallel with pipe or by mechanical tamping or ramming. Prior to commencing normal filling operations, the crown width of the fill at a height of 12 inches above the top of the pipe shall extend a distance of not less than twice the outside pipe diameter on each side of the pipe or 12 feet, whichever is less. After the backfill has reached at least 12 inches above the top of the pipe, the remainder of the fill shall be placed and thoroughly compacted in layers not exceeding 6 inches.

3.8.3 Movement of Construction Machinery.

In 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.

3.8.4 Compaction

3.8.4.1 General

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.

3.8.4.2 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 (densities) which will be determined as specified in this paragraph.

a. Under paved roads, streets, parking areas, 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 unpaved or turfed traffic areas, density shall not be less than 90 percent of maximum density for cohesive material and 95 percent of maximum density for cohesionless material.

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

3.8.5 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 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 referenced publications. 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 or ASTM D 2922. 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.

3.9 PIPELINE TESTING

Lines shall be tested for leakage by exfiltration tests. Prior to testing for leakage the trench shall be backfilled up to at least the lower half of the pipe. If required, sufficient additional backfill shall be placed to prevent pipe movement during testing, leaving the joints uncovered to permit inspection.

Visible leaks encountered shall be corrected regardless of leakage test results. When the water table is 2 feet or more above the top of the pipe at the upper end of the pipeline section to be tested, infiltration shall be measured using a suitable weir or other device acceptable to the Contracting Officer. An exfiltration test shall be made by filling the line to be tested with water so that a head of at least 2 feet is provided above both the water table and the top of the pipe at the upper end of the pipeline to be tested. The filled line shall be allowed to stand until the pipe has reached its maximum absorption, but not less than 4 hours. After absorption, the head shall be reestablished. The amount of water required to maintain this water level during a 2-hour test period shall be measured. Leakage as measured by the exfiltration test shall not exceed 0.2 gallons per inch in diameter per 100 feet of pipeline per hour. When leakage exceeds the maximum amount specified, satisfactory correction shall be made and retesting accomplished. Testing, correcting, and retesting shall be made at no additional cost to the Government.

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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 Course Aggregate
ASTM C 128	(1993) Specific Gravity and Absorption of Fine Aggregate
ASTM C 131	(1989) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1995a) Sieve Analysis of Fine and Coarse Aggregates
ASTM D 75	(1987; R 1992) Sampling Aggregates
ASTM D 422	(1963; R 1990) Particle-Size Analysis of Soils
ASTM D 1556	(1990) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu.ft. (2,700 kN-m/cu. m.))
ASTM D 2216	(1990) Laboratory Determination of Water (Moisture) Content of Soil and Rock.
ASTM D 2922	(1991) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	(1988; R 1993) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D 4318	(1993) 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 1330, SUBMITTAL PROCEDURES.

1.4.1 SD-01, Data

Plant, Equipment, Machines, and Tools; FIO.

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

1.4.2 SD-09, Reports

Sampling and Testing; GA. Field Density; GA.

Copies of field test results shall be submitted to the Contracting Officer within 24 hours after the tests are performed.

1.4.3 SD-18, Records

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

Copies of waybills and delivery tickets during the progress of the work. Certified waybills and delivery tickets for all materials actually used. A notification stating which type of coarse aggregate is to be used.

1.5 WAYBILLS AND DELIVERY TICKETS

Copies of waybills or delivery tickets shall be submitted during the progress of the work. Before the final payment is allowed, waybills and certified delivery tickets shall be furnished for all aggregates actually used in the construction.

1.6 WEATHER LIMITATIONS

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

1.7 PLANT, EQUIPMENT, MACHINES, AND TOOLS

1.7.1 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.

1.7.2 Steel-Wheeled Rollers

Steel-wheeled rollers shall be the self-propelled type weighing not less than 10 tons, with a minimum weight of 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.

1.7.3 Pneumatic-Tired Rollers

Pneumatic-tired rollers shall have four or more tires, each loaded to a minimum of 30,000 pounds and inflated to a minimum pressure of 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.

1.7.4 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.

1.7.5 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.

1.7.6 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.

1.7.7 Straightedge

The Contractor shall furnish and maintain at the site, in good condition, one 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.

1.8 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.

1.9 SAMPLING AND TESTING

1.9.1 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.

1.9.2 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.

1.9.3 Sampling

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

1.9.4 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 1000 tons of material placed, with a minimum of three analyses for each day's run until the course is completed.

1.9.5 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.

1.9.6 Laboratory Density

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

1.9.7 Wear Tests

Wear tests shall be performed in accordance with ASTM C 131. One test shall be run per 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 50 percent after 500 revolutions when tested in accordance with ASTM C 131. 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 midsectional 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:

<u>Sieve Designation</u>	<u>Percentage by Weight Passing Square-mesh Sieve</u>
1 inch	100
1/2 inch	40-70
No. 4	20-50
No. 10	15-40
No. 40	5-25
No. 200	0-10

(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. 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 AND SUBGRADE PREPARATION. 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 8 inches nor less than 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 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 1/2 inch of the thickness indicated. Where the measured thickness is more than 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 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 1/4 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 lift for each 250 yards of base material. 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 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 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 1,000 square yards or fraction thereof of finished base course and one additional gradation, liquid limit, and plasticity index test for each 3,000 square yards of base course or fraction thereof shall be performed. Maximum-density moisture relations shall be established for each 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 10 foot straightedge. Measurements shall also be taken perpendicular to the road centerline at 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 500 square yards of base course. Measurements shall be made in 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 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.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 53	(1990b) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM B 43	(1991) Seamless Red Brass Pipe, Standard Sizes
ASTM D 1785	(1991) Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2241	(1989) Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 2287	\&(1992)&\ Non-rigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2466	(1990a) Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D 2564	\&(1991a)&\ Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D 2774	(1972; R 1983) Underground Installation of Thermoplastic Pressure Piping
ASTM D 2855	(1990) Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D 3261	(1990) Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.2	(1983; R 1991; Errata May 1992) Gages and Gaging for Unified Inch Screw Threads
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- ASME B16.15 (1985) Cast Bronze Threaded Fittings Classes
125 and 250
- ASME B40.1 (1991) Gauges - Pressure Indicating Dial Type
- Elastic Element
- AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)
- ASSE 1013 (1988) Reduced Pressure Principle Backflow
Preventers
- AMERICAN WATER WORKS ASSOCIATION (AWWA)
- AWWA C506 1989 Reduced-Pressure Principle Backflow-
Prevention Assembly
- AWWA C509 (1987) Resilient-Seated Gate Valves for Water
and Sewerage Systems
- AWWA C901 (1988; Errata 1988) Polyethylene (PE)
Pressure Pipe and Tubing, 1/2 In. Through
3 In., for Water Service
- FEDERAL SPECIFICATIONS (FS)
- FS WW-H-001220 (Basic) Head, Sprinkler, (Underground
Connected)
- FOUNDATION FOR CROSS-CONNECTION CONTROL AND HYDRAULIC RESEARCH
(FCCHR)
- FCCHR-01 (1988) Manual of Cross-Connection Control
- MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS
INDUSTRY (MSS)
- MSS SP-80 (1987) Bronze Gate, Globe, Angle and Check
Valves
- NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)
- NEMA ICS 2 (1988; Rev 1) Industrial Control Devices,
Controllers and Assemblies
- NEMA ICS 6 (1988; Rev 1) Enclosures for Industrial
Control and Systems
- NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)
- NFPA 70 (1993) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL-94

(1996; Rev thru Jul 1997) 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. Contractor designed temporary overhead sprinkler systems are required to establish non-irrigated hydroseed areas.

1.3 SUBMITTALS

Government approval is required for submittals with a AGA® designation; submittals having an AFIO® designation are for information only.

The following shall be submitted in accordance with Section 01330: SUBMITTAL PROCEDURES:

SD-01 Data Framed Instructions; F.I.O.

Labels, permanent posted signs (per ARecycled Water Irrigation Users Guide® by Central Basin Municipal Water District), and templates of operating instructions that are required to be mounted or installed on or near the product for normal, safe operation.

SD-02

Manufacturer's Catalog Data.

- a. Piping materials, Dripline Emitter Tubing, and fittings.
- b. Valves; Electric Control, Master, Gate and Quick Coupling.
- c. Valve boxes.
- d. Automatic Controllers and Solar power assemblies.
- e. Flow Meter Assembly.
- f. Bubbler heads.
- g. Control wiring and signal cable.
- h. Backflow Preventer and Enclosure Assembly.
- i. Basket strainer.
- j. Solvent cement.

- k. Wye Filter Assemblies, Air/vacuum Relief and Flush Valve Assemblies.
- l. Pressure Regulator units, and Check Valves.
- m. Tracer Warning Tape.

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; Valves and Accessories Tested. G.A.

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-12 Field Test Reports

- a. Pressure test G.A.
- b. Operation test G.A.
- c. Coverage test G.A.

Submit record of pressure tests conducted on recording gauge.

SD-13 Certificates

Not required.

SD-19 Operation and Maintenance Manuals

Sprinkler System F.I.O.

Submit 3 copies of operation and 3 copies of maintenance manuals for the equipment furnished: one complete set prior to field testing and the remainder upon acceptance. Manuals shall be approved prior to the field training course. Operating manuals shall detail the step-by-step procedures required for system startup, operation, and shutdown. Operating manuals shall include the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features. Maintenance manuals shall list routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Maintenance manuals shall include piping and equipment layout, simplified wiring and control diagrams of the system as installed, and system programming schedule.

Temporary Irrigation System G.A.

Submit shop drawings for the temporary irrigation system, showing materials and layout.

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: 5% additional of each type of bubbler heads, two valve keys for operating gate valves, two wrenches for removing and installing each type of head, two quick coupler keys and hose swivels, two Air/vacuum Relief valves, two Flush Valves, two wye filters, two filter elements, and four irrigation controller housing keys.

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 ASA schedule 40 mild steel screwed pipe. Pipe shall conform to requirements of ASTM A 53, Schedule 40. All galvanized pipe to be installed below grade shall be painted with two (2) coats of koppers #50 bitumastic or wrapped with 2 mil. thick, black plastic, insulating tape as manufactured by 3M Company or equal.

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 NSF approved Type I, Grade I, PVC resin conforming to ASTM resin specification D1784. PVC pipe must meet requirements as set forth in Federal Specification PS-22-70 (Solvent-weld Pipe), with an appropriate standard dimension (S.D.R.).

Pressure main line piping for sizes 12 inches and smaller, and lateral line piping, shall be PVC Schedule 40 with solvent welded joints.

Schedule 40 pipe shall be made from NSF approved Type I, Grade I PVC compound conforming to ASTM compound specification D1785. PVC pipe must meet requirements as set forth in Federal Specification PS-21-70.

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.
- g. Purple reclaimed water pipe.

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

Reclaimed water mainline and lateral piping shall be identified with detectable underground marking tape. Warning on marking tape shall bear the words **CAUTION: RECLAIMED WATER LINE BELOW**. Marking tape shall be 2 inches wide with a 20-gauge solid aluminum foil core encapsulated polyethylene backing of 0.00255" (2.5 mil). Provide nylon fasteners and secure marking tape to piping at 10 foot intervals.

Marking tape shall be model number TA-DT-03-PRW, as manufactured by T. Christy Enterprises, or approved equal.

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:

<u>Size (In)</u>	<u>Inside Dia. (In)</u>	<u>Wall Thickness Dia. (In.)</u>	<u>Outside Dia. (In)</u>
3/8 (IPS)	0.50	0.090	0.680
1/2 (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 test procedure D2466.

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® (self priming) glue, or approved equal. The use of solvent primer is not required on piping 2 inches and smaller.

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 (trickle) type, with non-adjustable discharge flow, and 2-inch MPT threaded inlet.

Provide bubbler heads with the discharge flow rate of 0.25 GPM (gallons per minute), and pressure compensating, model number 1401, as manufactured by Rain Bird, Hendrickson Bros. or approved equal.

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 retainer 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 TL6-1810 (1,000 FT roll), as manufactured by Netafim Irrigation, Inc., Fresno, CA.

Dripline tubing shall be uniformly purple in color.

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 .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 abuts 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 shown on drawings. Dripline fittings shall be as manufactured by Netafim Irrigation, Fresno, CA.

2.3.4 Securing Stakes

Secure dripline tubing with plastic coated galvanized wire stakes. Metal stakes shall be 9-inches nominal length, coated with black in color, plasticized polyvinyl chloride, and provide 1.4-inch nominal inside stake clearance.

Securing stake shall be model number DTS-140-900, as manufactured by SALCO Products, Inc., Hawthorne, CA, or approved equal. Salco Products contact phone number: (310) 973-2400.

2.3.5 Air/Vacuum Relief Assembly

The air/vacuum relief assembly shall consist of a air/vacuum relief valve made of black or gray plastic, have a 1/2-inch MIPT inlet, and include fittings as required to connect to dripline tubing.

Provide reclaimed water warning tag for air relief assemblies installed on systems supplied with reclaimed water.

The air/vacuum relief valve shall be as manufactured by Netafim, or approved equal.

2.3.6 Flush Valve Assembly

The flush valve assembly shall consist of an automatically operated 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 automatic type 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, Fed Spec WW-V-54, 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 valves supplied with reclaimed water shall include a reclaimed water warning tag.

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.

Ball valves supplied with reclaimed water shall include a reclaimed water warning tag.

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.

Quick coupling valves supplied with reclaimed water shall include a reclaimed water warning tag.

2.4.4 Electric Control Valves

Electric control valves shall be normally closed, 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 valves installed for use with reclaimed water facilities shall incorporate a factory installed self-cleaning scrubber and stainless steel screen feature.

Electric control valves supplied with reclaimed water shall include a reclaimed water warning tag.

Electric control valve shall be series PEB and PESB (scrubber series, for use with reclaimed water), as manufactured by Rain Bird Sales, Inc. or approved equal.

The master valve shall conform to all requirements of the electric control valve, and shall be sized as shown on the drawings.

2.4.5 Backflow Preventers

Reduced pressure principle assemblies shall be tested, approved, and listed in accordance with FCCHR-01. Reduced pressure principle backflow preventers shall be in accordance with ASSE 1013.

Provide backflow preventer testing certification for each backflow preventer.

Backflow preventer shall be of type and manufacturer as approved by Los Angeles County Health Department.

2.4.5.1 Reduced Pressure Type Backflow Preventers

Backflow preventers shall be rated for maximum working pressure of 175 psi, bronze mounted ball valves, resilient seat shut-off valves, and strainer, stainless steel, internal parts. Total pressure drop through complete assembly shall be a maximum of 70 kPa (10 psi) at rated flow.

Piping shall be galvanized steel pipe and fittings. Wye strainers shall be NPT threaded bronze construction. Wye strainer shall be line-size and shall have 40-mesh 304 stainless steel screen elements. Back flow preventer assemblies shall be 2 inches in size.

2.4.5.2 Backflow Preventer Enclosure

Backflow preventer enclosure shall be constructed of 3/16-inch steel angle plate for frame welded construction, and shall include two lifting handles. The faces or side of the enclosure shall be constructed of number 9 expanded steel welded to frame. The overall dimensions shall be a minimum of 18 inches wide, 40 inches

long, and 30 inches high for enclosing a 2-inch reduced pressure backflow preventer assembly with Wye strainer.

The enclosure shall be of one-piece construction and shall hinge on one end, with the mounting device being 3/8-inch AU@-bolt construction for pad locking enclosure unit. The enclosure shall be factory-painted the color Atan.@

Backflow enclosures shall be as manufactured by Le Meur Manufacturing, V.I.T. Products, Inc., or approved equal.

2.4.5.3 Enclosure Lock Set

Pad lock sets shall be the same key coding for every lock provided. Information on key coding and source of lock sets shall be documented for ordering additional sets by others. Pad locks shall be of commercial-use grade and be weather proof.

2.4.6 Basket Strainer

Basket strainer shall be constructed with bronze housing, 1-1/2 inch threaded inlet and outlet, and 60 mesh stainless steel basket. Service of basket is performed with access from top of unit.

Basket strainer shall be model number 72, as manufactured by Hayward, or approved equal.

2.5 ACCESSORIES AND APPURTENANCES

2.5.1 Wye Filter Assembly

Wye filter assembly shall include one plastic body filter, 12 inch in size, with color-coded multiple disc filter element rated at 140 mesh (red). Filter shall flow a minimum of 26 gpm with less than 2 psi pressure loss.

Wye filter assembly shall include a reclaimed water warning tag for use on systems supplied with reclaimed water.

Wye filter assembly shall include glycerin filled pressure gauges, 22 inches in diameter, with polycarbonate face, 1/4 inch NPT connection, and 0-100 psig pressure scale. Pressure gauges shall be as manufactured by Irrometer Co., or approved equal.

Wye filter shall be as manufactured by Netafim, or approved equal.

2.5.2 Pressure Regulator for Dripline Systems

One pressure regulator shall be provided at each dripline system electric control valve. 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 Amedium 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 Ahigh 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 item listed in Valve Box Size Schedule, Section 2.5.4.3. The electric control valve box shall be provided an attached hinged cover. The flood bubbler box shall be non-bolt-locking.

The words "IRRIGATION CONTROL VALVE" shall be factory casted on each rectangular box cover. The words Aemitter® shall be factory casted on each 5 3/4 inch valve box as listed for flood bubbler.

Valve boxes for irrigation equipment shall be tan in color. Valve boxes for flood bubbler shall be black 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 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.

Identify valve box covers with approved reclaimed water nameplate, other markings, or purple in color for irrigation systems supplied with reclaimed water.

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.

2.5.4.3 Valve Box Size Schedule

Box Size: 11 3/4@ Wide x 17@ Long Rectangular (x 12@ Deep)- tan

Flow Meter Assembly
 Electric Control Valve
 Master Valve
 Flush Valve Assembly
 Gate Valve
 Quick Coupling Valve
 Air/Vacuum Relief Assembly
 Wire Splice

Box Size: 15@ Wide x 21@ Long AJumbo@ Rectangular (x 12@ Deep)- tan

Wye Filter Assembly

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

Flood Bubbler

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 (special ordered) as indicated on the Drawings. Provide one (1) tag of each electric control valve.

Reclaimed water warning tags shall be purple in color with the words **AWARNING**, reclaimed water, do not drink@ in English on one side and Spanish on the other side. Reclaimed water warning tags shall be of the same material and manufacturer as identification tags.

Provide valve identification tags, and reclaimed water warning tags as manufactured by T. Christy Enterprises, (714) 771-4142, or approved equal.

2.5.6 Valve Keys for Manually Operated Valves

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

2.6 AUTOMATIC CONTROLLERS, SOLAR POWER SUPPLY

2.6.1 Automatic Controller

Automatic controller shall be Calsense model series ET1, mounted within a **A**controller enclosure assembly@, pre-wired, and assembled by Pacific Technical Services, model number CA2-ET-RRA-RSE-FM1.5-LAR3. The controller enclosure assembly shall include, but not be limited to: the automatic controller listed above, sized with stations capacity as shown on the plans, one (1) radio remote receiver outlet and plug, one (1) rain gauge with gauge enclosure, one **12** inch flow meter, one solar power (three panel) supply system, and one (1) on-off switch

mounted in 2-inch electrical box, all pre-wired within a V.I.T. Products, Inc., vandal-resistant, stainless steel model number SB18-DSS, double door controller enclosure.

Controller enclosure assembly shall include a 5-year warranty, as provided by Pacific Technical Services. Contact phone number: (949) 837-4737.

2.6.2 Solar Power Supply

The solar power supply system shall be supplied as a part of the controller enclosure assembly, as listed in Section 2.6.1 above. The solar panel assembly shall include, but not be limited to: Siemens model #SP-75 polycrystalline electric module solar panels, Deka model #8G27 batteries (one battery per solar panel), Tumble Technologies model #ACG200 voltage inverter (providing 110 VAC output) power system, Morningstar model #ProStar 2 voltage regulator/system controller, fault protection circuit breakers, galvanized steel pipe mounting pole, mounting gimble, and conductor wiring system.

Two (2) solar power assemblies are utilized to energize irrigation controllers, based on the controller size (station capacity). The LAR3 (three panel) solar unit will serve 24 and 32 station controllers. The LAR2 (two panel) solar unit will serve 12 and 16 station controllers. Refer to plans for specific controller sizes to determine the correct solar power supply system required for each controller size.

The solar power supply system shall be LAR series, as manufactured by Electrosol, Inc., Phoenix, AZ, or approved equal.

The solar power supply assembly shall include a 5-year warranty as provided by Pacific Technical Services.

2.6.3 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 red in color. Common wires shall be white in color. Wire color shall be continuous over its entire length. 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 and 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 A Connector Sealing Packs®, Rain Bird A 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-inch loop coil and be covered within a round valve box. Identify wire splices on lid of round splice box with the letters AWS@.

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. Provide permanent labels at each end of spare wire group with controller designation for spare wires at control station location.

Warning Tape:

Where inert plastic film highly resistant to alkalis, acids, or other destructive chemical components is likely to be encountered in soils, a 3-inch wide tape, colored yellow, and imprinted with "CAUTION: BURIED ELECTRIC LINE BELOW@ shall be provided. 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.

2.6.4 Flow Meter Assembly

Flow meter housings shall be made of Schedule 80 polyvinyl chloride (PVC) pipe and have a pulsing output rate which is proportional to the GPM flow rate of the piping system being measured.

The flow meter operates on 9 volts DC. The flow meter wires should be separated from other power wires when pulled up at the automatic irrigation controller enclosure location. If 24 volts AC is used to test field wires when determining proper sequencing, and is applied to the flow meter wires, the sensing unit will be permanently damaged. Flow meter shall include a factory installed waterproof fuse holder and include correct size fuses.

All splices for flow meter wiring shall be dry splices. Any water leaking into a splice will cause flow meter problems. Additionally buried splices in ground between the flow meter and automatic irrigation controller will not be allowed. Flow meter housing shall be factory modified PVC schedule 80 tee fitting and include a removable moisture proof sensor unit having a pulse output rate which is proportional to the GPM flow rate of the piping system being measured.

Provide reclaimed water warning tag for use with systems supplied with reclaimed water.

Flow meters shall be sized as indicated in the drawings and shall be as specified as a part of the controller enclosure assembly.

Flow meters shall be as manufactured by Data Industrial Corp and as provided by Calsense. Contact phone number: (800) 572-8608.

2.6.5 Signal Cable for Flow Meter

The signal cable shall be a multi-paired, direct burial, shielded cable designed to carry signals for the flow sensor assemblies. The cable shall include a 0.005 inch thick by 0.500 inch wide (type 304) stainless steel tape wrapped armor over the core (with a minimum of 25% overlap) and a direct burial, sunlight-resistant, 0.045- inch-thick PVC outer jacket conforming to ICEA S-61-402. The cable shall provide complete protection against gophers and other rodents.

The signal cable shall include a minimum of four (4), a maximum of six (6) stranded soft annealed tin coated solid copper conductors of 18 AWG size, seven (7) strands each conforming to ASTM B-33, and individually insulated with 0.015-inch-thick high density (PE) polyethylene. The conductors shall be paired and shall be identified with the following colors: pair #1 shall use black/red, pair #2 shall use a combination of orange/blue. When 3-pair cable is used in lieu of 2 pair cable, pairs #1 and #2 shall be as listed above, and pair #3 shall use purple/white.

The signal cable assembly shall require the insulated conductors to be twisted and paired off, then cabled together with the high density polyethylene jacket conforming to ICEA S-56-434. Also included in the assembly is a 0.00235 inch thick aluminum/mylar tape helically applied and a barrier of glass reinforced mylar tape applied over the shield. One drain wire of 20 AWG size and with tinned solid copper core shall be laid over the shield in contact with the aluminum side. The signal cable shall have an outside diameter of 0.410 inch and shall be round and smooth with no convolutions.

All splices for flow sensor signal cable shall be dry splices. Any water leaking into a splice will cause flow meter problems. Additionally, buried splices in the ground between the flow sensor and the irrigation controller enclosure will not be allowed.

Conductor connectors shall be 3M Series 3500 Scotch-loc Connector packs of 3M Series 7000 Epoxy Wire Connector kits. If one connector is used for both conductor connections, the wire splices shall be staggered to prevent shorting. All manufacturer's instructions on the package shall be followed.

The flow sensor signal cable shall be model number P-7195D as manufactured by Paige Electric Company of Paramount, California. The phone number is (310) 633-1414.

2.7 ELECTRICAL WORK

Contractor shall be responsible for the coordination of the solar powered electrical system for power supply of irrigation automatic controllers.

No 120 volt electrical power service is required for automatic sprinkler controllers.

Wiring and rigid conduit for solar power supply connection to automatic controllers shall be in accordance with NFPA 70.

2.8 CONCRETE MATERIALS

Provide concrete with minimum 2000-psi compressive concrete strength at 28 days. Ready-to-mix concrete prepared on-site by hand will be allowed for use with poured concrete controller bases and thrust blocking.

Spread concrete 12 inches beyond all four sides of controller pedestal and 6 inches deep.

2.9 WATER SUPPLY (POINT OF CONNECTION)

Contractor shall coordinate the installation of new domestic and reclaimed water meters for the irrigation water supply. All applications, permits, and fees required for establishing new water services shall be the responsibility of the Contractor, including all water costs until completion of the specified maintenance period for seeding and planting.

Contractor shall be responsible for submitting landscape plans and obtaining approval from the County health Department for irrigation systems using reclaimed water meters.

As a part of the end of the maintenance period, the contracting officer shall provide the Customer name for water services account and the related Federal Tax identification as required for processing the final transfer of the meter permit.

Contact: City of South Gate
Public Works Department
Located at: 8650 California Avenue.
South Gate, California 90280-3075
Phone Number: (323) 563-9537

Contact: Southern California Water Company
Bissell Plant@
Located at: 6612 Bissell Street.
Ball, California 90201
Phone Number: (323) 581-2950

Contractor shall be responsible for securing new water meter service address from the Cities of Long Beach, Paramount and South Gate prior to completion of water meter permit. Identify the water meters for A Irrigation use only@ and request that A no sewer fees@ are required.

Reclaimed water meter service shall comply with City, County and State of California rules and regulations for the use of reclaimed water.

2.10 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: Control wires -- Equal to twice that of the pipe or wiring bundle or a 2-inch minimum sleeving diameter, whichever is larger. Water lines: minimum size of 4 inches.

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

PART 3 EXECUTION

3.1 INSTALLATION

Sprinkler system 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.

Install permanent posted signs informing the public where reclaimed water use occurs at each public entrance. Provide signage type and quantity as directed by the responsible Governing Agency.

Contractor shall provide temporary irrigation of his own design as required to establish permanent non-irrigated hydroseed areas. Temporary irrigation gate valves and connections to pressure main line system are shown on drawings and shall remain on site when removal of temporary irrigation equipment is completed.

Contractor shall remove from site said irrigation equipment and piping at the end of maintenance period. Temporary irrigation systems shall not exceed peak gpm demands shown in point-of-connection notes on drawings.

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 12 times the 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.

<u>Item</u>	<u>Depth of cover</u>
Piping under traffic loads	36 inches
Mainline piping	24 inches
Control wire	18 inches
Flow meter signal cable	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 22 inches and larger. Minimum vertical clearances between lines shall be 1 inch. Parallel piping shall not be installed directly over one another.

Maintain a 10-foot minimum horizontal separation from potable water lines and reclaimed water piping. Where reclaimed water piping and potable water cross, the reclaimed water piping shall be installed below the potable water line in a PVC schedule 40 pipe sleeve. Pipe sleeve shall extend five (5) feet to either side of the potable water line. Provide a minimum vertical clearance of 6-inches.

3.1.3 Piping Installation

3.1.3.1 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 40 degrees F.

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

Install pipe with all markings pointing up for visual inspection and verification. Install reclaimed water warning tape on top of piping.

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

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

3.1.4.1 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.

3.1.4.2 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 Bubbler 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. Install dripline tubing below grade per details. Secure dripline tubing with one metal stake at 10-foot intervals and one at every barb fitting connection.
- c. Dripline installation shall be coordinated with plant material installation for location and orientation of planting rows.
- d. Install swing check valves as indicated in the drawings. Provide 2-inch square x 24-inch wood marking stakes for field location identification. Remove staking after review and approval of check valve installation.
- e. Install air/vacuum relief assemblies at high elevation points of dripline tubing in each planting zone as shown on drawings.
- f. Install pressure regulator downstream of electric control valve, size shall be indicated as noted on drawings.

g. Install Wye filter assembly; size based on flow as noted on drawings. Clean out filters and screen elements of debris, gravel and soil prior to connection of dripline tubing systems.

h. Flush all PVC piping and dripline tubing prior to connections.

i. Provide flushing assemblies as indicated on drawings. Open flush valves to clear PVC piping of debris, gravel and soil.

j. Contractor shall ensure 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, and all necessary diversion work has been completed, the control valves shall be opened and full head of water used to flush out the system.

3.1.7 Backflow Preventer Assemblies

Backflow preventer and enclosures shall be installed with new connections to water meters as indicated on plans. Verification of overall size of enclosure, manufacturer product dimensions, and final installation clearances over backflow preventer are the responsibility of the Contractor.

3.1.7.1 Reduced Pressure Type

Reduced pressure type shall be installed as follows: Flush pipe lines prior to installing device and protect device by a strainer located upstream. Device shall not be installed in pits or where any part of device could become submerged in standing water.

Location of backflow preventer and enclosure shall be approved by Contracting Officer prior to final permanent installation.

3.1.8 Basket Strainer

Basket strainer shall be installed as indicated on drawings.

Pressure mainline piping between the point of connection and basket strainer shall be installed as required by local code.

3.1.9 Control Wire and Sleeving

3.1.9.1 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 one common conductor for every control sprinkler system.

3.1.9.2 Expansion Loops

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

3.1.9.3 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.

3.1.9.4 Splices

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

3.1.10 Automatic Controller

Install automatic controller and controller enclosure assembly per the manufacturer's instructions and recommendations. Connect electric control valves to controller in numerical sequence as indicated on the drawings.

Program and calibrate the precipitation rate and irrigated area of coverage (in square feet) for control valve stations as required for the controller to perform automatic seasonal water scheduling calculations. Calculations are expressed in in/wk (inches per week), and as a percentage of the ETO (evapotranspiration) of the region.

Program and calibrate the flow meter function (based on flow meter size) to read operating station flows in GPM (gallons per minute), set high flow operating demands (in order to detect unauthorized high flows due to broken mainline or other pressure related equipment and leaking equipment), and no flow detection.

The above programming and calibrations, performed prior to final acceptance, are the responsibility of the Contractor.

Contact the local Calsense field support technician for on-site assistance, including limited training with controller data programming, and verification of correct automatic controller installation. Contact the local Pacific Technical Services field representative for verification of correct controller enclosure assembly installation. Notify Contracting Officer prior to the arrangement of said field support meetings.

Exact field location of controllers and orientation of hinged door for mounting pedestal enclosure shall be determined prior to installation. Submit 8-1/2 x 11-inch shop drawings with specific location and dimensions for review by Contracting officer prior to final permanent enclosure installation. Coordinate new electrical services to controller locations. Install in accordance with manufacturer's recommendations and NFPA 70.

3.1.10.1 Solar Power Supply

Connections between the automatic controllers and the solar power electrical panels assemblies shall be the responsibility of the Contractor.

Install solar power supply assembly as recommended by manufacturer and Pacific Technical Services warranty requirements. Install conductor wiring and conduit as shown in drawings.

3.1.11 Flow Meter and Signal Cable

3.1.11.1 Flow Meter

Install flow meter as indicated on the drawings.

3.1.11.2 Signal Cable

Install flow meter signal cable as indicated on the drawings.

3.1.12 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 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.

3.1.13 Backfill

3.1.13.1 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.

3.1.13.2 Backfill Requirements

The trenches shall not be backfilled until all required tests are performed. Trenches shall be carefully backfilled with the excavated materials approved for backfilling, consisting of earth, loam, 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 2 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, are the Contractor's responsibility. All required adjustments will be performed without cost to the Owner.

3.1.13.3 Restoration

Top 3 inches shall be filled with topsoil and compacted with same density as surrounding soil. Lawns and plants shall be restored in accordance with Section 02935, TURF, and Section 02950, TREES, SHRUBS, GROUND COVERS AND VINES. Pavements shall be restored in accordance within this Section.

3.1.14 Adjustment of Irrigation System

Adjust flow control feature of electric control valves for proper valve operation as recommended by the valve manufacturer.

3.1.15 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.

Flushing and cleaning out of system pipe, valves, 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) with pumping unit for a period of one hour with an allowable pressure drop of 35 kPa (5 psi). Center load piping with soil, expose fittings and pipe bell-end connections for observation and inspection.

If hydrostatic pressure cannot be held for a minimum of 4 hours, Contractor shall make adjustments or replacements to piping and fittings and repeat the tests 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 irrigated.

3.3 POSTING FRAMED INSTRUCTIONS

Framed instructions containing wiring and control diagrams under laminated plastic shall be posted where directed. Condensed operating instructions, prepared in typed form, shall be framed as specified above and posted beside the diagrams. The framed instructions shall be posted before acceptance testing of the system.

After as-built drawings are approved by Contracting Officer, controller charts and programming schedule shall be prepared. One chart for each controller shall be supplied. Chart shall be a reduced drawing of actual as-built system that will fit the maximum dimensions inside controller housing. Black line print for chart and a different pastel or transparent color shall indicate each station area of coverage.

After chart is completed and approved for final acceptance, chart shall be sealed between two 0.505 mm (20-mil) pieces of clear plastic.

3.4 FIELD TRAINING

A field training course shall be provided for designated operating and maintenance staff members. Training shall be provided for a total period of four hours of normal working time and shall start after the system is functionally complete but prior to final acceptance tests. Field training shall cover all of the items contained in the operating and maintenance manuals. Providing qualified people for the field training course is the responsibility of the Contractor. Contractor shall provide Contracting Officer with 7 days advance notice for approval of proposed field training scheduled time.

3.5 CLEANUP

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

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SECTION 02831

FENCE, CHAIN-LINK

I. PART GENERAL

A. 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 121	(1992a) Zinc-Coated (Galvanized) Steel Barbed Wire
ASTM A 153	(1996) Zinc-Coated (Hot Dip) on Iron and Steel Hardware
ASTM A 176	(1994) Stainless and Heat-Resisting Chromium Steel Plate, Sheet, and Strip
ASTM A 392	(1996) Zinc-Coated Steel Chain-Link Fence Fabric
ASTM A 478	(1995a) Chromium-Nickel Stainless and Heat-Resisting Steel Weaving and Knitting Wire
ASTM A 491	(1996) Aluminum-Coated Steel Chain-Link Fence Fabric
ASTM A 585	(1992) Aluminum-Coated Steel Barbed Wire
ASTM A 666	(1994) Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
ASTM A 780	(1993a) Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings
ASTM A 824	(1992) Metallic-Coated Steel Marcellled Tension Wire for Use With Chain Link Fence
ASTM C 94	(1996) Ready-Mixed Concrete
ASTM F 626	(1996) Fence Fittings
ASTM F 883	(1990) Padlocks
ASTM F 900	(1994) Industrial and Commercial Swing Gates
ASTM F 1043	(1995) Strength and Protective Coatings on Metal Industrial Chain-Link Fence Framework
ASTM F 1083	(1996) Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures
ASTM F 1184	(1994) Industrial and Commercial Horizontal Slide Gates

ASTM G 23	(1996) Operating Light-Exposure Apparatus (Carbon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials
ASTM G 26	(1995) Operating Light-Exposure Apparatus (Xenon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials
ASTM G 53	(1996) Operating Light- and Water-Exposure Apparatus (Fluorescent UV-Condensation Type) for Exposure of Nonmetallic Materials

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; GA.

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.

I. PART PRODUCTS

A. MATERIALS

Materials shall conform to the following.

1. Chain Link Fence

a) 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.

1. 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.

1. 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.

1. 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.

1. 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 unless modified herein.

1. 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.

1. Padlocks

ASTM F 883, Type P01, Grade 2, Size 1-3/4 inch. Padlocks shall be keyed alike and each lock shall be furnished with two keys.

I. PART EXECUTION

A. 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.

A. 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.

A. 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.

A. RAILS, BRACES AND TRUSS RODS

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.

1. 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.

1. 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.

A. 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.

A. 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.

A. 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.

A. 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.

A. TEMPORARY FENCE

A temporary security fence required per SECTION: GENERAL REQUIREMENTS shall be installed as required. Structural steel members and installation shall conform to the applicable requirements of SECTION: 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.

-- End of Section --

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SECTION 2935

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-01 (Amended thru: Aug 1988) Federal Seed Act Regulations (Part 201-202)

COMMERCIAL ITEM DESCRIPTIONS (CID)

CID A-A-1909 \&(Basic; Notice 1)\ 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 01300 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 Test; GA.

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

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-01 and applicable state seed laws.

2.1.2 Seed Mixtures

Seed mixtures shall be proportioned by weight as follows:

<u>Botanical Name</u>	<u>Common Name</u>	<u>Pure Live Seed(P.L.S.) in pounds per acre 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 lbs. p.l.s. per acre 30.6

2.1.3 Quality

Seed shall conform to FS JJJ-S-181. 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

Soil amendments shall consist of gypsum, sulfur, fertilizer, organic soil amendments, and endomycorrhizal inoculant meeting 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:

	Minimum % by <u>weight passing</u>
<u>Particle size</u>	
No. 4 mesh screen	95
No. 8 mesh screen	80
	Minimum % based <u>on dry weight</u>
<u>Nitrogen Content</u>	
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 supplied and incorporated into the soil as required by the soil conditions at a rate of ___ lbs per 100 sf.

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. Seeding at times other than this recommended time will be at the risk of the Contractor.

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, the Contractor shall apply two cycles of pre-emergent weed control treatments for the hydroseed areas.

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 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 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 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 ½-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 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 PLS/acre
- b. Wood: Wood cellulose fiber mulch -400 lbs.

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

3.3.3.3 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 - 1,400 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 twelve (12) 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 in dia.

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.

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 ASSOCIATION OF NURSERYMEN (AAN)

AAN-01 (1990) American Standard for 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) 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 01300 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

Application of Pesticide Material; 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; FIO. Application of Pesticide Material; 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.

Agronomical Soils Test; GA.

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

SD-09 Reports

Soil Test; GA. Percolation Test; GA.

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; GA. 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.

f. Mycorrhizal Fungi Inoculant: For nursery record of compliance.

SD-18 Records

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

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

b. 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.

c. Maintenance Instruction. 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 AAN-01. 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.

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 "Contract Growing", or by another means as approved by the Contracting Officer. Mycorrhizal fungi shall have been added to all containerized plant material at the nursery or by the contract grower prior to purchase.

2.1.2 Varieties

Plants shall be nursery grown stock conforming to AAN-01 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 AAN-01.

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 AAN-01 and as specified herein.

2.1.5.1 Trees

A height relationship to caliper shall be provided as recommended by AAN-01. 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 AAN-01. 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 AAN-01. 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 AAN-01. 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 AAN-01.

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.

2.3.5.1 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.

2.3.5.2 Sulfur

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

2.3.5.3 Activated Charcoal

Activated charcoal shall be supplied and incorporated into the soil as required by the soil conditions at a rate of ___ lbs per 100 sf.

2.4 STAKING MATERIAL

2.4.1 Stakes

Stakes for *Pinus torreyana* 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.

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.

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				Time Release
<u>Size</u>	<u>5-3-1</u>	<u>12-8-8</u>	<u>Gypsum</u>	<u>Sulfur</u>
1 gal	1/2 cup	2 tbsp	1/4 cup	2 tbsp
5 gal	1 cup	3 tbsp	1/2 cup	1/4 cup
15 gal	1½ cup	1/4 cup	1 cup	1/2 cup

Additional amendments required by the agronomic soils test shall be incorporated as required.

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

Pinus torreyana 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 and upon acceptance by the Contracting Officer. 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.

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 --