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SECTION 02721 - DRAIN LINES

PART 1 GENERAL

1.1 SCOPE

The work provided by this Section consist of furnishing all plant, labor, materials, and equipment for the installation of the drain lines which are to be connected to the concrete drainage structures all as specified including flanges, wyes, miter joints, couplings reducers, anchor bolts, thrust rods, lugs, bolts, and all other items necessary to complete the steel drain line work. The Contractor shall be responsible for field measurements to verify pipe lengths required to accomplish the layout required.

1.2 RELATED WORK SPECIFIED ELSEWHERE

SUBMITTAL PROCEDURES, Section 01330

CONTRACTOR QUALITY CONTROL, Section 01451

STRUCTURAL EXCAVATION AND BACKFILL, Section 02320

TEMPORARY RETAINING STRUCTURE, Section 02252

1.3 BIDDING SCHEDULE LINE ITEMS

1.3.1 Excavation

Excavation required by this Section will be included in the Bidding Schedule Line Item for "Excavation".

1.3.2 Backfill for Drainage Structures

Backfill required by this Section will be included in the applicable Bidding Schedule Line Item as specified in paragraph 02320-1.3.4 for the appropriate backfill material.

1.3.3 Sheeting and Bracing

Sheeting and bracing and other temporary retaining structures shall be included in the Bidding Schedule Line Item for "Temporary Retaining Structure".

1.3.4 Timbers

Bidding Schedule Line Item for "Drainage Structure Timbers" shall constitute full compensation for furnishing all plant, labor, materials, and equipment to complete the work as specified herein.

1.3.5 Bedding

Bidding Schedule Line Item for "Drainage Structure Bedding" shall constitute full compensation for furnishing all plant, labor, materials, and equipment to complete the work as specified herein. Quantities shall be based on in-place dimensions.

1.3.6 Geotextile

Bidding Schedule Line Item for "Drainage Structure Geotextile" shall constitute full compensation for furnishing all plant, labor, materials, and equipment to complete the work as specified herein.

1.3.7 Drain Lines

Bidding Schedule Line Item for "12-inch RCP," "15-inch RCP", "18-inch RCP", "24-inch RCP", "30-inch RCP", "36-inch RCP", "48-inch RCP", "26 5/8" X 43 3/4" RCAP", "18-inch CMP" and "30-inch CMP" shall include pipe furnishing and installation, including any joint materials and preparation where required herein and shall constitute full compensation for furnishing all plant, labor, materials, and equipment to complete the work as specified herein

1.3.8 Steel Drain Lines

Bidding Schedule Line Item for "12-inch Steel Drainage Pipe", "24-inch Steel Drainage Pipe", "30-inch Steel Drainage Pipe", "36-inch Steel Drainage Pipe", and "48-inch Steel Drainage Pipe" shall include pipe furnishing and installation and shall constitute full compensation for furnishing all plant, labor, materials, and equipment to complete the work as specified herein.

1.3.9 Steel Drain Line Dresser Fittings

Bidding Schedule Line Item for "12-inch Steel Drainage Pipe Dresser Fitting", "24-inch Steel Drainage Pipe Dresser Fitting", "30-inch Steel Drainage Pipe Dresser Fitting", and "36-inch Steel Drainage Pipe Dresser Fitting" shall include Dresser fitting furnishing and installation and shall constitute full compensation for furnishing all plant, labor, materials, and equipment to complete the work as specified herein.

1.3.10 Steel Drain Line Fittings

Bidding Schedule Line Item for “12-inch Steel Drainage Pipe Fitting”, “24-inch Steel Drainage Pipe Fitting”, “30-inch Steel Drainage Pipe Fitting”, and “36-inch Steel Drainage Pipe Fitting” shall include pipe furnishing and installation and shall constitute full compensation for furnishing all plant, labor, materials, and equipment to complete the work as specified herein.

1.3.11 Fabricated Wye

Bidding Schedule Line Items for “Fabricated Wye 30” X 2-24”” and ”Fabricated Wye 36” X 2-24”” shall include pipe furnishing and installation shall constitute full compensation for furnishing all plant, labor, materials, and equipment to complete the work as specified herein.

1.3.12 Drainage Pipe Jacking

Bidding Schedule Line Item for “Drainage Pipe Jacking” shall constitute full compensation for furnishing all plant, labor, materials, and equipment to complete the work as specified herein.

1.4 REFERENCES

The following publications, referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the references thereto:

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

A 53	(2006) Pipe, Steel, Black and Hot Dipped, Zinc Coated, Welded and Seamless
A 153	(2005) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
A 760	(2006) Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
A 849	(2000(2005)) Post-Applied Coatings, Pavings, and Linings for Corrugated Steel Sewer and Drainage Pipe
C 76	(2005b) Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
C 88	(2005) Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate

- C 117 (2004) Materials Finer Than 75 micrometer (No. 200) Sieve in Mineral Aggregates by Washing
- C 131 (2003) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
- C 136 (2006) Sieve Analysis of Fine and Coarse Aggregates
- C 443 (2005a) Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
- C 506 (2005a) Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe
- C 990 (2003a) Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
- D 883 (2000) Terminology Relating to Plastics
- D 4318 (2005) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- D 4491 (1999a(2004)) Water Permeability of Geotextiles By Permittivity
- D 4632 (1991(2003)) Grab Breaking Load and Elongation of Geotextiles
- D 4751 (2004) Determining Apparent Opening Size of a Geotextile

U.S. ARMY CORPS OF ENGINEERS ENGINEER MANUAL

- EM 385-1-1 (Nov. 2003) Safety and Health Requirements Manual

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRAFFIC OFFICIALS (AASHTO)

- M-36 (2003) Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
- M-190 (2004) Bituminous Coated. Corrugated Metal Culvert Pipe and Pipe Arches

M-243 (1996(2004)) Field Applied Coating of Corrugated Metal Structural Plate for Pipe, Pipe-Arches, and Arches.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

C200 (1997) Steel Water Pipe – 6 in. (150mm) and Larger

C207 (2001) Pipe Flanges for Waterworks Service Sizes 4 Inch Through 144 Inch (100 MM Through 3,600 MM)

C208 (2001) Dimensions for Fabricated Steel Water Pipe Fittings

C210 (2003) Liquid- Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines

1.5 QUALITY CONTROL

1.5.1 General

The Contractor shall establish and maintain quality control for excavation, backfill and installation of the new pipes and appurtenances. It shall maintain records of his quality control for all construction operations and shall check materials to be used. This includes but is not limited to the following:

- 1). A check of construction operations to certify compliance with applicable sections of the specifications.
- 2). A check of materials used for installation of each pipe, including gasket material, coupling bands and geotextile. The Contractor shall certify that all materials are in compliance with applicable regulations.

1.5.2 Reporting

The original and two (2) copies of these records of inspections and tests, as well as the records of corrective action taken, shall be furnished to the Government daily. Format of the report shall be as prescribed in Section 01451, "CONTRACTOR QUALITY CONTROL".

1.6 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "SUBMITTAL PROCEDURES".

1.6.1 Certificates

The Contractor shall submit certificates showing the pipe, joint gaskets, plastic sealant, coupling bands, geotextile, bedding, etc. comply with the requirement of this specification. The certificate shall include as a minimum the following:

- 1). Test results, including chemical compositions, for the sheet manufacturer.
- 2). Test data from the producer.
- 3). Specified sheet thickness.
- 4). Specified coating thickness.
- 5). Gasket and Sealant.

1.6.2 Samples

Samples of the joint gaskets and sealant shall be submitted to the Contracting Officer and approved before work is started.

1.6.3 Manufacturer's Recommendations

Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the Contracting Officer prior to installation. Installation of the item will not be allowed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.

1.6.4 Field Test Data

Hydrostatic and Infiltration Test Reports shall be submitted within twenty-four (24) hours after testing is performed.

1.7 DELIVERY, STORAGE, AND HANDLING

1.7.1 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. Before, during, and after installation, fittings shall be protected from any environment that would result in damage or deterioration to the material. The Contractor shall have a copy of the

manufacturer's instructions available at the construction site at all times and shall follow these instructions unless directed otherwise by the Contracting Officer. Solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install shall be stored in accordance with the manufacturer's recommendations and shall be discarded if the storage period exceeds the recommended shelf life. Solvents in use shall be discarded when the recommended pot life is exceeded.

1.7.2 Handling

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

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Reinforced Concrete Pipe

2.1.1.1 Pipe

Reinforced concrete pipe shall conform to ASTM C 76, Class IV, Wall B type.

2.1.1.2 Joints

The joint shall be of the bell and spigot type. The joint shall be so designed as to provide for self-centering and, when assembled, to compress the gasket to form a watertight seal. The gasket, when assembled, shall be confined on all sides so that movement of the pipe or hydrostatic pressure cannot displace the gasket.

2.1.1.3 Gasket

The gasket shall be of the circular rubber type and shall be the sole element depended upon to make the joint watertight and assure a permanent seal. The gasket shall be a continuous ring made of a special composition rubber of such size and cross section as to substantially fill the spigot recess provided for it, conforming in all respects to ASTM C 443. Gaskets shall have not more than one (1) factory-fabricated splice, except that two (2) factory-fabricated splices of the rubber-type gasket are permitted if the nominal diameter of the pipe being gasketed exceeds fifty-four (54) inches.

2.1.2 Reinforced Concrete Arch Pipe

2.1.2.1 Pipe

Reinforced concrete pipe shall conform to ASTM C 506, Class A-III.

2.1.2.2 Joints

The joint shall be of the tongue and groove type. The joint shall be so designed as to provide for self-centering and, when assembled, to compress the gasket to form a watertight seal. The gasket, when assembled, shall be confined on all sides so that movement of the pipe or hydrostatic pressure cannot displace the gasket.

2.1.2.3 Gasket

The gasket shall be of the rubber type and shall be the sole element depended upon to make the joint watertight and assure a permanent seal. The gasket shall be a continuous ring made of a special composition rubber of such size and cross section as to substantially fill the recess provided for it, conforming in all respects to ASTM C 990. Gaskets shall have not more than one (1) factory-fabricated splice, except that two (2) factory-fabricated splices of the rubber-type gasket are permitted if the nominal diameter of the pipe being gasketed exceeds fifty-four (54) inches.

2.1.3 Steel Pipe

2.1.3.1 Pipe

Drain lines up to and including twenty-four (24) inches in diameter shall conform to ASTM A 35/A 53, Grade B, Schedule 40. Larger diameter pipe and wyes shall be steel pipe and plates conforming to AWWA C200, except factory hydrostatic testing is not required. Material for larger diameter pipe and wyes shall have a minimum yield stress of 35 kips per square inch. Larger pipe and wyes shall be 3/4 inch wall thickness. The pipe shall be plain end with the weld bead ground flush along the internal surface and at the ends for connection to the other pipe sections. In order to minimize damage to the factory applied protective coatings, field welding shall be held to a minimum and shall be performed only with the approval of the Contracting Officer.

2.1.3.2 Flanges

Steel pipe flanges shall be fabricated in accordance with the requirement of AWWA C207, Class D, except that the minimum thickness shall be two (2) inches. Design flanges for connection to the discharge pipe by at least two (2) continuous fillet welds. One weld shall connect the inside diameter of the flange to the pipe and the other shall connect the outside diameter of pipe to the flange. Final design of welds rests with manufacturer, and specified welds are the minimum requirement. Flange mating surfaces shall be machined to a 125 micro-inch finish or better.

2.1.3.2.1 Flanged Joints

Flanged joints shall be designed to be air and water-tight, without the use of preformed gaskets, against positive and negative operating pressures that will be experienced, except that "PERMATEX" or an approved equal gasketing compound will be permitted.

2.1.3.2.2 Miter Joints

Bends in the steel pipe shall be accomplished with five (5) piece four (4) weld miter joints.

2.1.3.2.3 Nuts and Bolts

Bolts used in assembling the discharge pipe and its supporting members, including anchor bolts shall be of the 300 series stainless steel. Bronze nuts and hexagonal bolts and nuts shall be used. Washers shall be of the 300 series stainless steel.

2.1.3.3 Protective Coating

The interior and exterior surfaces of the steel discharge pipe and wall thimbles shall be protectively covered with a coal tar epoxy system in accordance with AWWA C210 and the Section 09940, "PAINTING".

2.1.3.4 Flexible Coupling

Couplings shall be Dresser Coupling with Star Lug Restraint or approved equal.

2.1.4 Corrugated Metal Pipe (CMP)

2.1.4.1 Pipe

2.1.4.1.1 18 Inch CMP

The pipe shall be fabricated in accordance with ASTM A 760. The sheet thickness, including the zinc coating shall be 0.109 inches (12 gage). The corrugations for the culvert shall be spaced at 2-2/3 inch by 1/2 inch, as specified in Table 1 of ASTM A 760. The individual lengths of culvert segments required shall be determined by the Contractor to provide the overall length of culvert specified. Pipe shall have a painted or otherwise applied label inside the pipe indicating sheet thickness of the pipe.

2.1.4.1.2 30 Inch CMP

The pipe shall be fabricated in accordance with ASTM A 760 and ASTM A 849. The corrugated metal pipe shall be Type II Classification. The sheet thickness, including the zinc and aramid fiber composite coating and excluding the bituminous coating,

shall be 0.109 inches (12 gage). The bituminous coating shall be applied in accordance with the requirements of AASHTO M-190, Type A. The corrugations for the culvert shall be spaced at 2-2/3 inch by 1/2 inch, as specified in Table 1 of ASTM A 760. The individual lengths of culvert segments required shall be determined by the Contractor to provide the overall length of culvert specified. Each pipe segment shall be handled with lifting lugs, which have been attached to the pipe by the pipe manufacturer. Pipe shall have a painted or otherwise applied label inside the pipe indicating sheet thickness of the pipe. Vertical elongation, where indicated, shall be accomplished by factory elongation. Suitable markings or properly placed lifting lugs shall be provided to ensure placement of factory elongated pipe in a vertical plane.

2.1.4.2 Coupling Bands

2.1.4.2.1 18 Inch CMP Coupling Bands

Coupling bands shall conform to the requirements of AASHTO M-36 and shall be made from the same material as the pipe.

2.1.4.2.2 30 Inch CMP Coupling Bands

Coupling bands shall conform to the requirements of AASHTO M-36 and shall be made from the same material as the pipe. Circumferential rods, lugs, bolts, and nuts shall be hot-dip galvanized after fabrication in accordance with ASTM A 153. The bolts shall be torqued to a minimum of forty (40) foot-pounds. Each bolt shall be checked for torque in the presence of the Contracting Officer prior to backfilling. After installation of connecting bands, the entire exterior of each joint assembly, including bands, rods, lugs, bolts and nuts shall be given one (1) coat of cold applied bituminous compound conforming to AASHTO M-243.

2.1.4.3 Gasket

The gasket shall be of the circular rubber type and shall be the sole element depended upon to make the joint watertight and assure a permanent seal. The gasket shall be a continuous ring made of a special composition rubber of such size and cross section as to substantially seal the joint. Gaskets shall have not more than one (1) factory-fabricated splice, except that two (2) factory-fabricated splices of the rubber-type gasket are permitted if the nominal diameter of the pipe being gasketed exceeds fifty-four (54) inches. Gaskets shall conform in all respects to ASTM C 443. Flexible plastic gaskets for the 30-inch CMP shall conform to ASTM C 990.

2.1.5 Timber

The timber foundation shall be rough cut No. 2 common yellow pine, oak, gum, or equal and suitable for the purpose and shall be installed for all pipe bedding. Wood shall be Use Category UC4A as specified by AWPAs.

2.1.6 Bedding

Crushed stone from the sources listed in Section 01100, "GENERAL PROVISIONS", paragraph entitled "STONE SOURCES" shall consist of one hundred percent (100%) stone and shall meet the following requirements when tested in accordance with ASTM C 136 and ASTM C 117, Procedure B:

<u>U.S. Sieve</u>	<u>Percent Passing (by weight)</u>
1 ½"	100
¾"	50 – 100
No. 4	35 – 65
No. 40	10 – 32
No. 200	3 – 15

The fraction of material passing the No. 40 sieve shall conform to the following requirements when tested in accordance with ASTM D 4318:

Liquid Limit (Max.)	25
Plasticity Index (Max.)	4

Crushed stone shall show an abrasion loss of not more than forty percent (40%) when tested in accordance with ASTM C 131 and a soundness loss of not more than fifteen percent (15%) when subjected to five (5) cycles of the magnesium sulfate soundness test in accordance with ASTM C 88.

2.1.7 Backfill

All backfill material shall conform to Section 02320, "STRUCTURAL EXCAVATION AND BACKFILL" and the type required.

2.1.8 Geotextile Fabric

The geotextile shall be a woven pervious sheet made with plastic yarn as defined by ASTM D 883. The geotextile shall meet the requirements listed in Table No. 1. The geotextile fiber shall consist of a long- chain synthetic polymer composed of at least eighty-five percent (85%) by weight of propylene, ethylene, amide, or vinylidene-chloride, and shall contain stabilizers and/or inhibitors added to the base plastic, if necessary, to make the filaments resistant to deterioration due to ultra-violet exposure. The Contractor shall use a geotextile that is chemically compatible with the material that will be placed on or in the vicinity of the geotextile. Leachate from the material shall not deteriorate the geotextile. The edges of the geotextile shall be selvaged.

TABLE NO. 1

REQUIREMENTS FOR SEPARATOR GEOTEXTILE

<u>Property</u>	<u>Test Procedure</u>	<u>Acceptable Values</u>
Grab Breaking Load (*)	ASTM D 4632	200 pounds minimum in any principle direction
Seam Strength (**)	ASTM D 4632	100 pounds minimum
Elongation at Break	ASTM D 4632	15 % minimum in any principle direction
Apparent Opening Size (AOS)	ASTM D 4751	No finer than the U.S. Standard Sieve No. 70 and no coarser than the U.S. Standard Sieve No. 30.
Permittivity	ASTM D 4491	0.35 per second minimum
Flow Rate	ASTM D 4491	40 gallons per minute per square foot minimum

(*) Value represents minimum average roll value of new geotextile received from the manufacturer or distributor (i.e., any roll in a lot shall meet or exceed the minimum value in the table).

(**) All of the samples shall yield test values that are greater than the minimum value that is specified.

2.1.9 Fabricated Wye

Fabricated wye shall convert either one (1) thirty (30) inch diameter pipe to two (2) twenty-four (24) inch diameter pipes or one (1) thirty-six (36) inch diameter pipe to two (2) twenty-four (24) inch diameter pipes in order to install steel drain pipe under the railroad track. Wye shall consist of approximately thirty (30) inches of straight thirty (30) inch diameter pipe and then through wyes and 45 degree elbows transition to two (2) twenty-four (24) inch pipes. Bottoms of pipe shall remain at the same elevation. Transition shall be within 3.83 feet and twenty-four (24) inch pipe shall have a center to center dimension of 4.83 feet. Details for the one (1) thirty (30) inch diameter pipe to two (2) twenty-four (24) inch diameter pipes are shown on the drawing attached at the end of this Section. The one (1) thirty-six (36) inch diameter pipe to two (2) twenty-four (24) inch diameter pipes is similar. Fabrication of wye shall be in accordance with Section 05501, "Section 05501, "METALWORK FABRICATION, MACHINE WORK, AND MISCELLANEOUS PROVISIONS".

PART 3 EXECUTION

Excavation shall be open cuts with vertical sides to sufficient depths to allow for the utility, bedding, and cover. No pipe shall be installed in a wet trench. The trench shall

be dry prior to and during installation of drain lines. The excavation bottoms shall be cleared of all debris, water, muck, foreign matter, and loose soil and approved by the Contracting Officer prior to placement of the separator geotextile and crushed stone. Areas requiring over excavation shall be backfilled with additional crushed stone. Pipe shall not be dropped to the ground, or be allowed to roll free down slopes. Any section of pipe that is damaged or becomes damaged in the course of the Contractor's operations, or that is not to line and grade shall be removed and replaced or relaid, as required, at no cost to the Government. The pipe shall be laid with ends fully and closely joined and true to grade. The width of trenches at any point below the top of the pipe or structure shall be not greater than the outside diameter of the pipe or the largest dimension of the structure plus twenty-four (24) inches to permit satisfactory jointing and thorough tamping of the bedding material under and around the pipe or structure. Contractor shall not over excavate. 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.

3.1.1 Sheeting and Bracing

Sheeting and bracing required to maintain the integrity of the installation shall be included in the Contractor's price for this work, including any sheeting required by federal regulations governed by EM 385-1-1. Any sheeting left in place must be cut-off at least three (3) feet below the ground surface after backfilling and tamping has reach this level and all rangers and braces above this level must be removed.

3.1.2 Timber Foundation

Prior to installing the separator fabric, the Contractor shall place the timber foundation. The foundation shall run continuously along the length of the drainage pipe. A support shall span the trench width and shall be placed perpendicular to the pipe at each pipe joint location.

3.1.3 Separator Fabric

Prior to placing the crushed stone bedding, material separation shall be provided between the natural subgrade and the crushed stone to prevent infiltration of foreign materials. Material separation at the base of the prepared excavation shall be provided by a geotextile fabric specified in paragraph 2.1.7 above.

3.1.4 Bedding

Crushed stone for pipe bedding shall be placed to the excavation limits as specified in paragraph 3.1.1, above (outside diameter of the pipe plus twenty-four (24) inches). Crushed stone shall be placed over the geotextile to provide a stable working platform for construction and to provide support for the drainage structures. The bedding surface for the pipe or structure shall provide a firm foundation of uniform density throughout the entire length of the pipe or structure. A minimum of fourteen (14)

inches of crushed stone shall be used for pipes having outside diameters (OD) between twenty-four (24) and thirty-six (36) inches. A minimum of twelve (12) inches of crushed stone shall be used for pipes having an OD less than twenty-four (24) inches. The crushed stone shall have a minimum width equal to the width of the base of the excavation. For pipes, the compacted crushed stone material shall extend upward from the excavation bottom along the haunches and sides of the pipe up to the horizontal plane halfway up the barrel of the pipe. Separator geotextile shall also be placed between the crushed stone and backfill to prevent clogging of the crushed stones with fines. The crushed stone shall be spread in loose lifts of six (6) to eight (8) inches. Each lift shall be compacted to a minimum ninety-five percent (95%) of its maximum dry density at a moisture content of plus three percent to minus two percent (+3% to -2%) of optimum water content. Compaction of bedding used to replace weak soils below the minimum bedding depth may be reduced to a minimum of ninety-three percent (93%) of the maximum dry density in accordance with ASTM D 698 at a moisture content of plus three percent to minus two percent (+3% to -2%) of optimum water content. The bedding may be compacted using vibratory compactors mounted on or pulled by lightweight low ground pressure vehicles. Bell holes shall be dug so that the entire length of pipe is uniformly bedded.

3.1.5 Pipe Laying

The pipes and fittings shall be so laid in the trench that after the drain is completed. The invert thereof shall conform accurately to the grades and alignment as required. At any stage of construction, the full barrel or end of the pipe shall be clearly visible on looking through the interior of the pipe at each drainage structure. Before setting in place, each pipe must be thoroughly cleaned and freed of all dirt. For 30-inch CMP, lifting lugs shall be used to facilitate moving pipe without damage to exterior or interior coatings. During installation, pipe or pipe arch shall be handled with care to preclude damage to the bituminous coating.

3.1.6 Gasket Installation

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 twenty-four (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.

3.1.7 Coupling Bands

The coupling bands shall lap an equal portion on each section joined, and the bands shall be drawn up tight to insure a watertight joint. Ends of adjacent pipe sections shall be spaced so that the corrugations of the coupling bands mesh with those of the pipe. Coupling band bolts and damaged areas of the coupling bands and pipes shall be given a coating of asphalt prior to backfilling. Any unprotected metal in the joints shall be coated with bituminous material specified in AASHTO M-190 or AASHTO-M 243. Interior coating shall be protected against damage from insertion or removal of struts or tie wires.

3.1.8 Steel Drain Line Pipe Joints

Pipe welding, when required, shall be in accordance with Section 05501, "METALWORK FABRICATION, MACHINE WORK, AND MISCELLANEOUS PROVISIONS".

3.1.9 Geotextile Filter Cloth Joint Wrap

The Contractor shall use geotextile filter cloth wrap around the joints of concrete and corrugated metal drain lines for all new construction or repair work of an existing line. Edges of fabric shall be finished to prevent the outer yarn from pulling away from fabric. For pipe diameters thirty-six (36) inches in diameter, pipe joints shall be wrapped with filter cloth twelve (12) inches on each side of the joint and lapped ten (10) inches. For pipe diameters greater than thirty-six (36) inches in diameter, pipe joints shall be wrapped with a thirty-six (36) inch wide piece of filter cloth and centered on the joint and lapped thirty-six (36) inches.

3.1.10 Pipe Jacking

All pipe placed by jacking within the railroad right-of-way shall be placed as per AREMA Standards. The top of pipe jacked under the railroad tracks shall be a minimum of one and one half (1.5) foot below the bottom of the railroad ties.

3.1.11 Drainage Structures

After drain pipe and culverts are in place, the Contractor shall install all drainage structures. Approximately twenty-four (24) hours after concrete is poured, forms may be removed and backfilling operations may commence. Pipe connections to concrete manholes and inlets shall be made with flexible, watertight connectors.

3.1.12 Testing

3.1.12.1 Infiltration Test

An infiltration test, that does not exceed a rate of twenty-five (25) gallons per inch of diameter per mile per twenty-four (24) hours, shall be conducted by the Contractor and observed by the Jefferson or Plaquemines Parish Drainage Department and the Contracting Officer. This test shall be performed only after the backfilled trench has remained flooded for at least twelve (12) hours prior to the test and the trench shall remain flooded during the test. The Contractor shall furnish all material, labor, and equipment that is necessary for this test

3.1.12.2 Hydrostatic Test

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 shall conform to either ASTM C 990 or ASTM C 443 as applicable. The pipe joint must pass the ten (10) pounds per square inch hydrostatic pressure test before being approved.

3.1.13 Backfilling

3.1.13.1 General

All drain line trenches shall be backfilled with the material specified in Section 02320, "STRUCTURAL EXCAVATION AND BACKFILL". Excess excavated material shall be hauled and spread at other locations on the project site, or removed from project site except as noted in Section 02320, "STRUCTURAL EXCAVATION AND BACKFILL". There shall be no separate payment for handling, hauling, or spreading this material, and the cost should be included in the unit price bid for the type of material used. Prior to placing backfill on the 30-inch CMP, damaged areas of coupling bands and pipe shall be given a coating of bituminous material, specified in AASHTO M-243. Pipe which bituminous coating has been damaged to such an extent that satisfactory field repairs cannot be made, shall be removed and replaced.

3.1.13.2 Backfilling Pipe in Trenches

After the pipe or structure has been tested, bedding material shall be placed up to the center of the pipe in layers not exceeding six (6) inches in compacted depth. The fill shall be thoroughly compacted under the haunches of the pipe. After the bedding is placed, specified material either from excavation or borrow, at a moisture content that

will facilitate compaction, shall be placed along both sides of pipe or structure in layers not exceeding six (6) inches in compacted depth. The backfill shall be brought up evenly on both sides of pipe or structure for the full length. 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 twelve (12) inches above the top of the pipe or structure. 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 six (6) inches. Tests for density shall be made as necessary to ensure conformance to the compaction requirements specified below. It may be necessary, in the opinion of the Contracting Officer, that sheeting or portions of bracing used be left in place. There will be no direct payment for this item. Untreated sheeting shall not be left in place beneath structures or pavements.

3.1.13.3 Backfilling Pipe in Fill Sections

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

3.1.13.4 Movement of Construction Machinery

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

3.1.13.5 Compaction

3.1.13.5.1 General Requirements

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

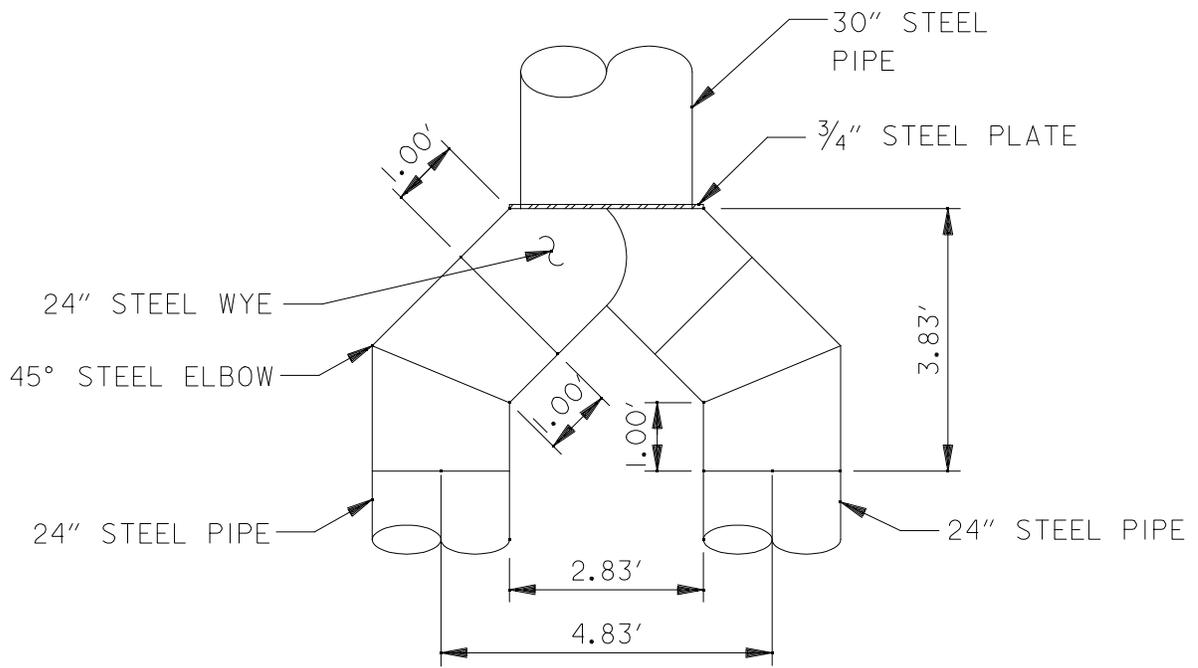
3.1.13.5.2 Minimum Density

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

- a). Under airfield and heliport pavements, paved roads, streets, parking areas, and similar-use pavements including adjacent shoulder areas, the density shall be not less than ninety percent (90%) of maximum density for cohesive material and ninety-five percent (95%) 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 ninety percent (90%) of maximum density for cohesive material and ninety-five percent (95%) of maximum density for cohesionless material.
- c). Under nontraffic areas, density shall be not less than that of the surrounding material.

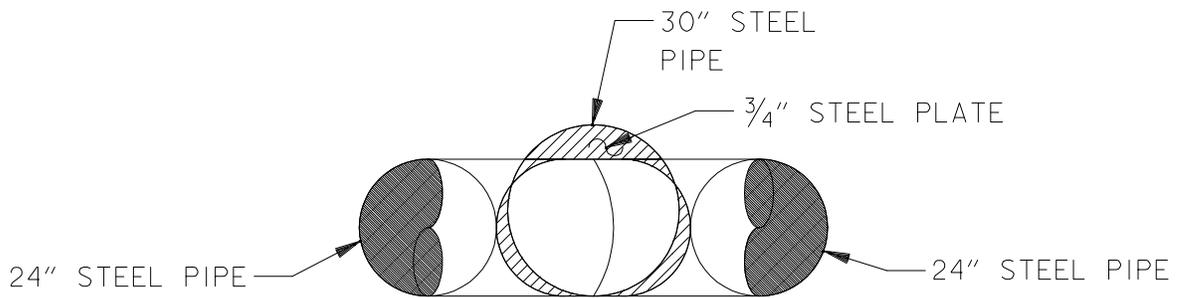
3.1.13.5.3 Determination of Density

Density shall be determined as specified in Section 02320, "STRUCTURAL EXCAVATION AND BACKFILL".



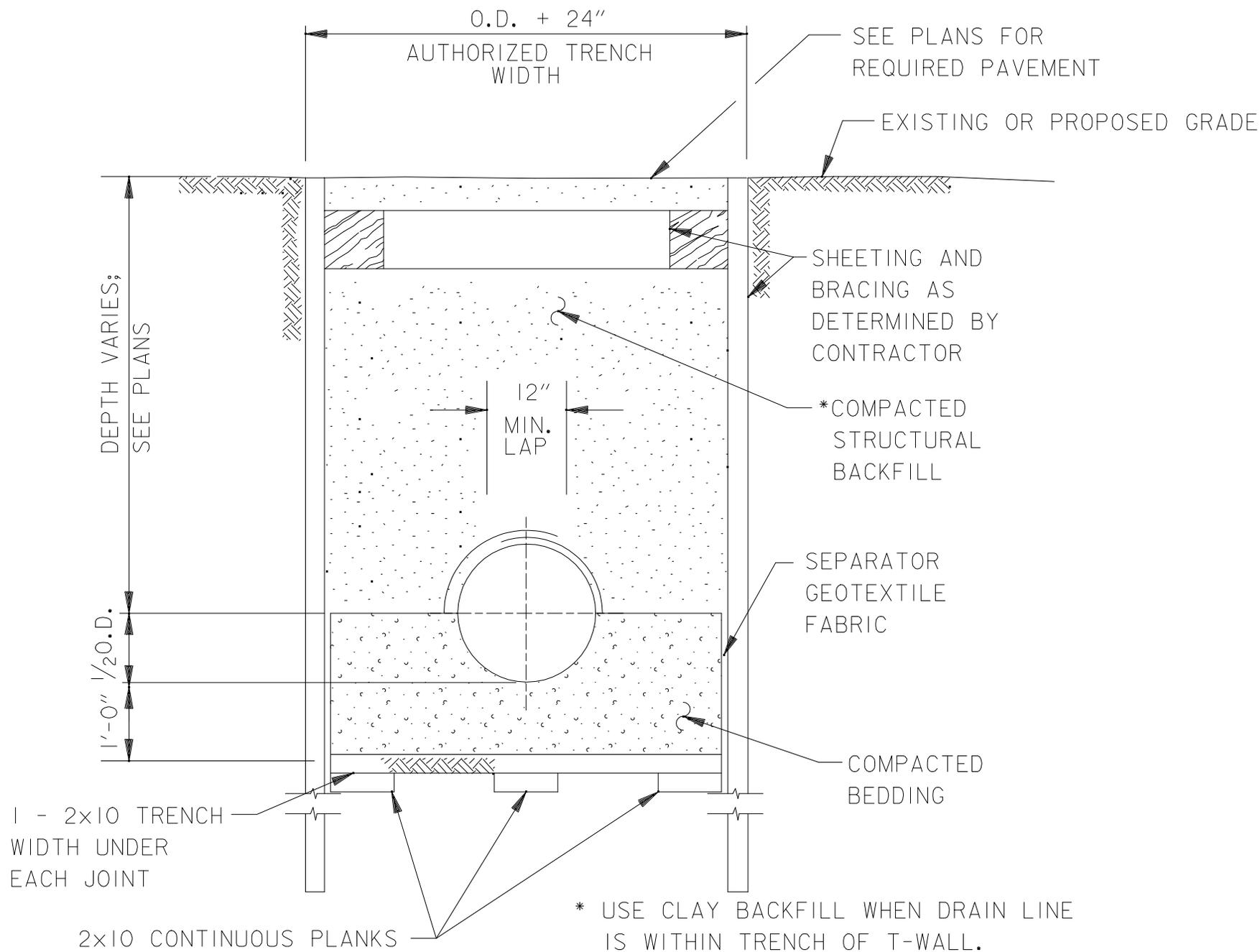
FABRICATED WYE

SCALE: 1/2" = 1'-0"



SECTION OF FABRICATED WYE

SCALE: N.T.S.



PIPE BEDDING DETAIL

SCALE: N.T.S.

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SECTION 02722 – DRAINAGE STRUCTURES

PART 1 GENERAL

1.1 SCOPE

The work covered by this Section consists of furnishing all plants, materials, equipment and labor and performing all operations required to construct the storm drainage system, including pipe, drain inlets, junction boxes, concrete head walls, trench drain structure, catch basins, gate valves, knife gate valves, supports, and associated hardware.

1.2 RELATED WORK SPECIFIED ELSEWHERE

SUBMITTAL PROCEDURES, Section 01330

CONTRACTOR QUALITY CONTROL, Section 01451

STRUCTURAL EXCAVATION AND BACKFILL, Section 02320

DRAIN LINES, Section 02721

CAST-IN-PLACE STRUCTURAL CONCRETE, Section 03301

1.3 BIDDING SCHEDULE LINE ITEMS

1.3.1 Excavation for Drainage Structures

Excavation required by this Section will be included in the Bidding Schedule Line Item for "Excavation" as stated in paragraph 02320-1.3.1.

1.3.2 Backfill for Drainage Structures

Backfill required by this Section will be included in the applicable Bidding Schedule Line Item stated in paragraph 02320-1.3.4 for the appropriate backfill material.

1.3.3 Sheeting and Bracing

Sheeting and bracing and other temporary retaining structures shall be included in the Bidding Schedule Line Item for "Temporary Retaining Structure".

1.3.4 Timbers

Bidding Schedule Line Item for “Drainage Structure Timbers” shall constitute full compensation for furnishing all plant, labor, materials, and equipment to complete the work as specified herein.

1.3.5 Bedding

Bidding Schedule Line Item for “Drainage Structure Bedding” shall constitute full compensation for furnishing all plant, labor, materials, and equipment to complete the work as specified herein. Quantities shall be based on in-place dimensions.

1.3.6 Geotextile

Bidding Schedule Line Item for “Drainage Structure Geotextile” shall constitute full compensation for furnishing all plant, labor, materials, and equipment to complete the work as specified herein.

1.3.7 Catch Basins

Bidding Schedule Line Item for “Catch Basin, CB-01”, “Catch Basin, CB-02“, “Catch Basin, CB-01(Brick Option)” and “Catch Basin, CB-02 (Brick Option)” shall constitute full compensation for furnishing all plant, labor, materials and equipment to complete the work including concrete, reinforcement, and all pipe tie-ins to the catch basins as specified herein

1.3.8 Gate Valves

Bidding Schedule Line Item for “24-inch Gate Valve”, “30-inch Gate Valve”, and “36-inch Gate Valve” shall constitute full compensation for furnishing all plant, labor, materials and equipment to complete the work including all pipe tie-ins to the gate valves as specified herein.

1.3.9 Knife Gate Valves

Measurement for payment for knife gate valves listed herein will be made per each. Payment will be made at the applicable contract unit price per each for “36-inch Knife Gate Valve” and “48-inch Knife Gate Valve. Price and payment shall constitute full compensation for furnishing all plant, labor, materials and equipment to complete the work including all pipe tie-ins to the gate valves as specified herein.

1.3.10 Concrete Headwalls, Valve Vaults, Manholes and Other Miscellaneous Drainage Structures

Bidding Schedule Line Item for “Concrete Headwalls, Manholes and Other Drainage Structures” shall constitute full compensation for furnishing all plant, labor, materials

and equipment to complete the work including concrete, reinforcement, and all pipe tie-ins to the concrete headwalls, valve vaults, manholes and other miscellaneous drainage structures as specified herein.

1.3.11 Miscellaneous Metals

Bidding Schedule Line Item for miscellaneous carbon steel, galvanized steel, or castings shall be made at the applicable Bidding Schedule Line Item specified in Section 05500, "MISCELLANEOUS METALWORK".

1.3.12 Precast Concrete Valve Box Lids

Bidding Schedule Line Item for "Precast Concrete Valve Box Lids" shall constitute full compensation for furnishing all plant, labor, materials and equipment to complete the work including concrete, reinforcement, manhole cover and frame, floor box frame and lid, lifting lugs, steel angles and studs, and other miscellaneous items as shown on drawing attached at the end of this section.

1.3.13 Inline Drains

Bidding Schedule Line Item for "Inline Drain 15" X 12" shall constitute full compensation for furnishing all plant, labor, materials and equipment to complete the work including PVC spool piece, 90-degree elbow, riser pipe, inline drain, grate and drain, and other miscellaneous items as shown on drawing attached at the end of this section.

1.4 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)

A 48	(2003) Gray Iron Castings
A 185	(2006e1) Steel Welded Wire Reinforcement, Plain, for Concrete Reinforcement
A 536	(1984(2004)) for Ductile Iron Castings
A 615	(2006a) Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
C 88	(2005) Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate

C 117	(2004) Materials Finer Than 75 micrometer (No. 200) Sieve in Mineral Aggregates by Washing
C 136	(2006) Sieve Analysis of Fine and Coarse Aggregates
C 131	(2003) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
C 139	(2005) Concrete Masonry Units for Construction of Catch Basins and Manholes
C 231	(2004) Air Content of Freshly Mixed Concrete by the Pressure Method
C 270	(2006) Mortar for Unit Masonry
C 478	(2006b) Precast Reinforced Concrete Manhole Sections
D 698	(2000ae1) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft.)
D 3034	(2006) Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
D 3212	(1996a(2003)e1) Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
D 4318	(2005) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
F 1336	(2002) Poly(Vinyl Chloride) (PVC) Gasketed Sewer Fittings

LOUISIANA STANDARDS SPECIFICATIONS FOR ROADS AND BRIDGES
(LSSRB) 2000 EDITION, STATE OF LOUISIANA DEPARTMENT OF
TRANSPORTATION AND DEVELOPMENT (LDOTD)

702	Manholes, Junction Boxes, Catch Basins and End Treatments
1004.01	Sewer Brick

AMERICAN WATERWORKS ASSOCIATION (AWWA)

C550 (2005) Protective Interior Coatings for Valves and Hydrants

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

SP-81 (2006) Stainless Steel, Bonnetless, Flanged Knife Gate Valves

1.5 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "SUBMITTAL PROCEDURES".

1.5.1 Calculations

The Contractor shall submit for approval structural calculations, stamped by a Louisiana Registered Civil Engineer, verifying that all precast structures can withstand HS-20 touch loading and horizontal soil loading.

1.5.2 Valve Literature

The Contractor shall submit knife gate valve and gate valve vendor's literature.

1.5.3 Descriptive Data

The Contractor shall prepare and submit for approval of the Contracting Officer complete details and descriptive data on the materials proposed for the pipe culvert and drain inlets, including plans for shoring.

1.5.4 Manufacturer's Recommendations

Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the Contracting Officer prior to installation. Installation of the item will not be allowed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.

1.5.5 Shop Drawings

The Contractor shall prepare and submit complete shop drawings to the Contracting Officer at least thirty (30) days prior to starting work. The drawings shall show complete details of materials and all other pertinent items.

1.6 QUALITY CONTROL

1.6.1 General

The Contractor shall establish and maintain quality control for excavation, backfill and installation of the new drainage structures (catch basins, etc) and appurtenances. It shall maintain records of his quality control for all construction operations and shall check materials to be used. This includes, but is not limited to, the following:

(1) A check of construction operations to certify compliance with applicable sections of the specifications.

(2) A check of materials used for installation of each pipe, including gasket material, coupling bands and filter cloth. The Contractor shall certify that all materials are in compliance with applicable regulations.

1.6.2 Reporting

The original and two (2) copies of these records of inspections and tests, as well as the records of corrective action taken, shall be furnished to the Government daily. Format of the report shall be as prescribed in Section 01451, "CONTRACTOR QUALITY CONTROL".

PART 2 PRODUCTS

2.1 MATERIALS

Brick or precast concrete shall be permitted for the catch basins.

2.1.1 Concrete

Concrete shall be in accordance with Section 03301, "CAST-IN-PLACE STRUCTURAL CONCRETE". Unless otherwise specified, concrete and reinforced concrete shall conform to the requirements for four thousand (4,000) pounds per square inch. The concrete mixture shall have air content by volume of concrete, based on measurements made immediately after discharge from the mixer, of five to seven percent (5% to 7%) 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 one (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 three (3) inches between steel and ground.

2.1.2 Reinforcing

Reinforcing steel shall be ASTM A 615, Grade 60. Welded wire fabric shall be ASTM A 185 and sizes as required.

2.1.3 Grates and Frames

Casting shall be true to pattern in form and dimensions and free from pouring faults, sponginess, cracks, blowholes and other defects in positions affecting their strength and value for service intended. Casting shall be boldly filleted at angles and rises shall be sharp and perfect. Casting shall be sandblasted or otherwise effectively cleaned of scale and sanded to a smooth, clean and uniform surface. Gray iron casting shall comply with ASTM A 48, Class 30.

2.1.4 Brick

Brick shall be in accordance with Section 1004.01 of the LSSRB.

2.1.5 Precast Concrete Segmental Blocks

Precast concrete segmental block shall conform to ASTM C 139, not more than eight (8) inches thick, not less than eight (8) inches long, and of such shape that joints can be sealed effectively and bonded with cement mortar.

2.1.6 Precast Reinforced Concrete Manholes

Precast reinforced concrete manholes shall conform to ASTM C 478. Joints between precast concrete risers and tops shall be full-bedded in cement mortar and shall be smoothed to a uniform surface on both interior and exterior of the structure.

2.1.7 Mortar

Mortar for brick or block construction shall conform to ASTM C 270, Type M, except that the maximum placement time shall be one (1) hour. The quantity of water in the mixture shall be sufficient to produce a stiff workable mortar. Water shall be clean and free of harmful acids, alkalies, and organic impurities. The mortar shall be used within thirty (30) minutes after the ingredients are mixed with water.

2.1.8 Valves

2.1.8.1 Gate Valves

Gate shall be a non-rising stem resilient wedge type rated 250 psig cold water working pressure. Valve body, bonnet, wedge, and operating nut shall be constructed of ductile iron. The exterior of the ductile iron wedge shall be fully encapsulated with rubber. The wedge shall be symmetrical and seal equally well with flow in either

direction. Operating nut shall be constructed of ductile iron and shall have four (4) flats at stem connection to assure even input torque to the stem. All gaskets shall be pressure energized O-rings. Stem shall be sealed. The seal shall be replaceable with valve fully open and while subject to full rated working pressure. O-rings set in a cartridge shall not be allowed. Valves shall have thrust washers located with one (1) above and one (1) below the thrust collar to assure trouble-free operation of the valve. All internal and external surfaces of the valve body and bonnet shall have a fusion bonded epoxy coating, complying with AWWA C550, applied electrostatically prior to assembly. The gate valve shall be a non-rising stem with spur gearing and a vertically mounted detachable operating wheel. Valves shall be America Flow Controls Series 2500 Ductile Iron Resilient Wedge Gate Valve or approved equal. Butterfly valves, sluice gates, etc. are not acceptable. An approved equal gate valve's body and operating apparatus dimensions shall be fully compatible with gate valve concrete vaults without requiring changing in the valve concrete vaults configuration and/or dimensions.

2.1.8.2 Knife Gate Valves

Knife Gate valves shall be of the bonneted knife gate valve type, rated for 125 psig cold water working pressure. Flanges shall be drilled and tapped to ANSI B16.5, 125 pound. Flange shall be raised face and machined with serrated-spiral or serrated-concentric grooves with a 125-250 RMS finish. Valve body shall have 304/316 stainless steel body liner, seat, packing box and raised faces (all wetted parts) and carbon steel body flanges, exterior stiffeners, packing gland and yoke. Seat and gate shall be machine finished for tight one way shutoff. Two gate wedges shall be provided to assist seating of the gate against the seat in the lower half of the valve body. On valves forty-eight (48) inches in diameter and above, the gate will be square bottom. The valve yoke shall be fabricated carbon steel. The valve stem shall be 304 stainless steel with full ACME threads. The stem nut shall be bronze. The stem nut retainer shall be of the enclosed type and shall be carbon steel. Manually operated valves shall be bevel gear operated. Valves shall be designed, manufactured and tested to comply with MSS SP-81. Valves shall be A-C Valve Fig 76 knife gate valve (metal seat) or approved equal.

2.1.9 Timber Foundation

Timber Foundation for pipes, drainage structure shall be rough cut No. 3 yellow pine, oak, gum, or equal and suitable for the purpose. Timbers shall be treated in accordance with Use Category UC4A as specified by AWWA.

2.1.10 Bedding

Bedding for drainage structures shall be crushed stone from the sources listed in Section 01100, "GENERAL PROVISIONS", paragraph entitled "STONE SOURCES" shall consist of one hundred percent (100%) stone and shall meet the following

requirements when tested in accordance with ASTM C 136 and ASTM C 117, Procedure B:

<u>U.S. Sieve</u>	<u>Percent Passing (by weight)</u>
1 1/2"	100
3/4"	50 – 100
No. 4	35 – 65
No. 40	10 – 32
No. 200	3 – 15

The fraction of material passing the No. 40 sieve shall conform to the following requirements when tested in accordance with ASTM D 4318:

Liquid Limit (Max.)	25
Plasticity Index (Max.)	4

Crushed stone shall show an abrasion loss of not more than forty percent (40%) when tested in accordance with ASTM C 131 and a soundness loss of not more than fifteen percent (15%) when subjected to five (5) cycles of the magnesium sulfate soundness test in accordance with ASTM C 88.

2.1.11 Backfill

All backfill material shall conform to Section 02320, "STRUCTURAL EXCAVATION AND BACKFILL".

2.1.12 Geotextile Fabric

Geotextile fabric shall be as specified in paragraph 02721-2.1.7.

2.1.13 Inline Drains

2.1.13.1 Drains

Inline drains shall be manufactured from PVC pipe stock, utilizing a thermo-molding process to reform the pipe stock to the specified configuration. The drainage pipe connection stubs shall be manufactured from PVC pipe stock and formed to provide a watertight connection with the specified pipe system. This joint tightness shall conform to ASTM D 3212 for joints for drain and sewer plastic pipe using flexible elastomeric seals. The pipe bell spigot shall be joined to the inline drain body by use of a swage mechanical joint. The pipe stock used to manufacture the inline drain body and pipe bell spigot of the surface drainage inlets shall meet the mechanical property requirements for fabricated fittings as described by ASTM D 3034 and ASTM F1336.

2.1.13.2 Grates

The grates furnished for all surface drainage inlets shall be standard fifteen (15) inch ductile iron grates with a fifteen (15) inch cast iron frames and shall be made specifically for each basin so as to provide a round bottom flange that closely matches the diameter of the surface drainage inlet. Grates for inline drains shall be capable of supporting H-25 loading. Fifteen (15) inch grates will be hinged to the frame using pins. Metal used in the manufacture of the castings shall conform to ASTM A 536 grade 70-50-05 for ductile iron. Grates shall be provided painted black.

PART 3 EXECUTION

3.1 INSTALLATION

Bells shall be set into the structure to provide a hinged joint at all pipe entrances. After drain lines are in place, the Contractor shall install all drainage structures to dimensions and grades required. A minimum of twenty-four (24) hours after concrete is poured, forms may be removed and backfilling operations may commence. Castings shall be properly set in mortar to grade.

3.1.1 Trenching

The trench shall be excavated to the depth required to place the required bedding for the drainage structure. The width of the trench shall be sufficient to permit the necessary compacting of the backfill/bedding under and around the structure and shall not be less than the minimum width required. The excavation bottoms shall be cleared of all debris, water, muck, foreign matter, and loose soil and approved by the Contracting Officer prior to placement of the separator geotextile and crushed stone. Areas requiring over excavation shall be backfilled with additional crushed stone. The Contractor shall design a support system to safely and adequately support the trench walls and any adjacent structures or pavement. Trench support system shall be provided and utilized in such a manner that does not allow adjacent material, other than water, to flow into the trench. Sheeting, if used, shall either be left in place or pulled so that adjacent ground or required compaction of bedding/backfill is not adversely affected. The upper part of any sheeting/bracing left in place shall be cut off three (3) feet below finished grade. The Contractor shall be responsible for protection and security of all work and workmen, for damage to existing utilities, fences and various type structures, for stability of trench, and for proper installation and operation of utility pipes, structures and appurtenances.

3.1.2 Separator Fabric

Prior to placing the crushed stone bedding, material separation shall be provided between the natural subgrade and the crushed stone to prevent infiltration of foreign materials. Material separation at the base of the prepared excavation shall be provided by a geotextile fabric specified in paragraph 2.1.12 above.

3.1.3 Bedding

Twelve (12) inches of crushed stone shall be placed over the geotextile to provide a stable working platform for construction and to provide support for the drainage structures. Crushed stone for catch basins and manholes shall extend six (6) inches from the sides of the structure. The crushed stone shall be spread in loose lifts of six (6) to eight (8) inches. Each lift shall be compacted to a minimum ninety-five percent (95%) of its maximum dry density at a moisture content of plus three percent to minus two percent (+3% to -2%) of optimum water content. Compaction of bedding used to replace weak soils below the minimum bedding depth may be reduced to a minimum of ninety-three percent (93%) of the maximum dry density in accordance with ASTM D 698 at a moisture content of plus three percent to minus two percent (+3% to -2%) of optimum water content. The bedding may be compacted using vibratory compactors mounted on or pulled by lightweight low ground pressure vehicles.

3.1.4 Brick Structures

The outside and inside faces of all brick drainage structures shall be plastered. Bricks must be laid in full, close, shove joints or mortar, according to the best work standards.

3.1.5 Headwalls, Manholes and Other Structures

Headwalls and manholes shall be constructed in accordance with the details, dimensions and grades require. All work shall conform to the applicable provisions of LSSRB Sections 702.

3.1.6 Testing

All testing in accordance with Section 02721, "DRAIN LINES" shall be performed before backfill operations begin at the individual structure.

3.1.7 Backfilling

3.1.7.1 General

All drainage structure excavations shall be backfilled with material, as specified in Section 02320, "STRUCTURAL EXCAVATION AND BACKFILL".

3.1.7.2 Backfilling Structure in Trenches

After the structure has been properly bedded, selected material from excavation or borrow, at a moisture content that will facilitate compaction, shall be placed along both sides of pipe or structure in layers not exceeding six (6) inches in compacted depth. The backfill shall be brought up evenly on both sides of pipe or structure for

the full length. 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 twelve (12) inches above the top of the pipe or structure. 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 six (6) inches. Tests for density shall be made as necessary to ensure conformance to the compaction requirements specified below. It may be necessary, in the opinion of the Contracting Officer, that sheeting or portions of bracing used be left in place. There will be no direct payment for this item. Untreated sheeting shall not be left in place beneath structures.

3.1.7.3 Backfilling Structure in Fill Sections

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

3.1.7.4 Movement of Construction Machinery

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

3.1.7.5 Compaction

3.1.7.5.1 General Requirements

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

3.1.7.5.2 Minimum Density

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

- a. Under airfield and heliport pavements, paved roads, streets, parking areas, and similar-use pavements including adjacent shoulder areas, the density shall be not less than ninety percent (90%) of maximum density for cohesive material and ninety-five percent (95%) 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 ninety percent (90%) of maximum density for cohesive material and ninety-five percent (95%) of maximum density for cohesionless material.
- c. Under nontraffic areas, density shall be not less than that of the surrounding material.

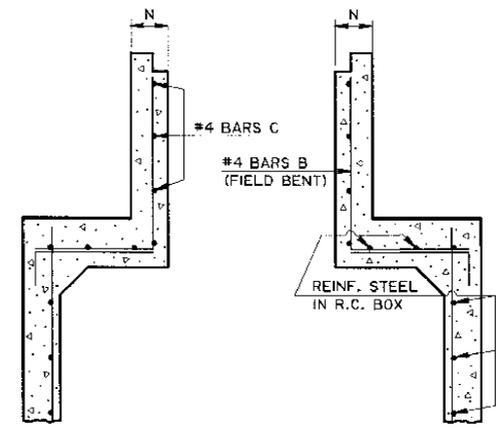
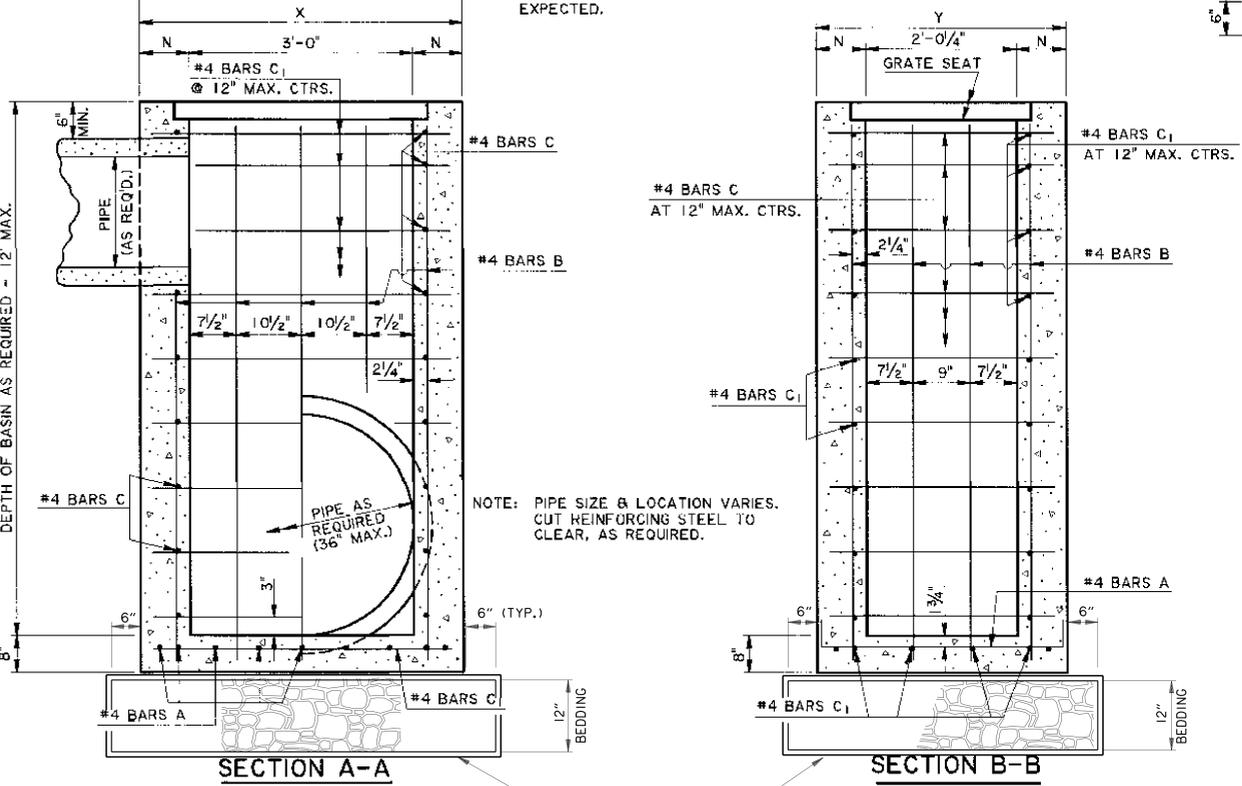
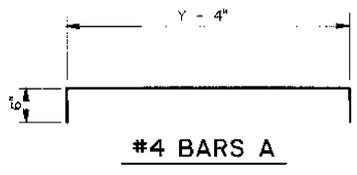
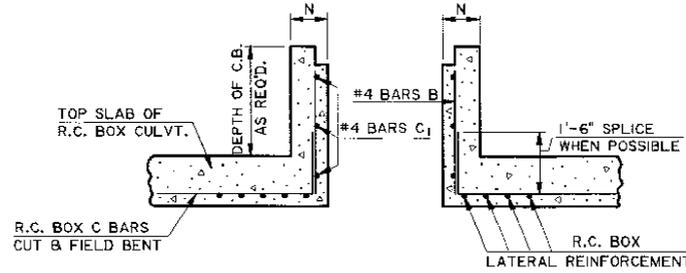
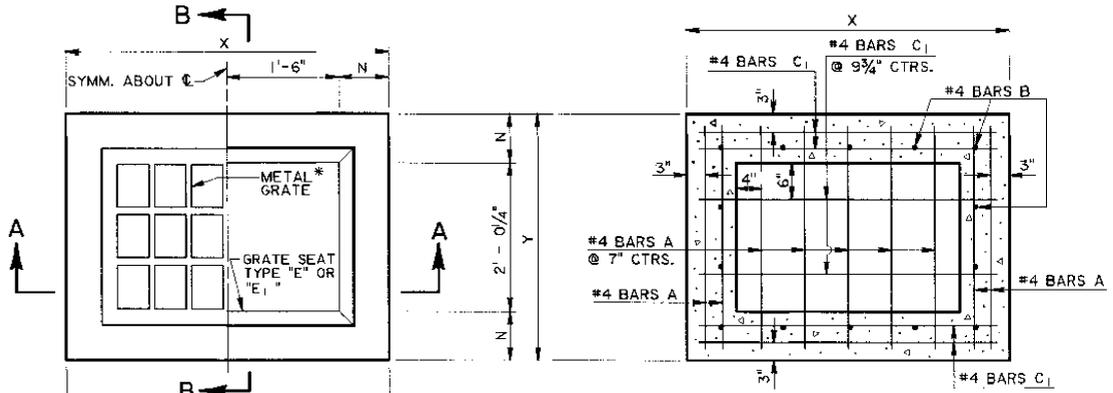
3.1.7.5.3 Determination of Density

Density shall be determined as specified in Section 02320, "STRUCTURAL EXCAVATION AND BACKFILL".

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DIMENSIONS			
DEPTH OF BASIN	N	X	Y
FT.	IN.	FT.-IN.	FT.-IN.
0 - 8	7	4-2	3-2/4
8.1 - 12	8	4-4	3-4/4



GENERAL NOTES:

DIMENSIONS RELATING TO REINFORCING STEEL ARE TO BAR CENTERS.

VERTICAL REINFORCING STEEL MAY BE SPLICED. SPLICE LENGTH IS 35 DIAMETERS.

FOR DETAILS OF GRATE AND SEAT, SEE STD. PLAN MC-01 (TYPE B or C).

SEE PLANS FOR TYPE OF GRATE TO BE USED FOR EACH CATCH BASIN.

CONCRETE OPEN TOP CATCH BASIN
 Max. Pipe: 36" x 24"
 Max. Depth: 12'
 To Be Used in Conjunction With Std. Plan MC-01

DESIGNED BY: K.C.C.
 CHECKED BY: B.A.L.
 DRAWN BY: B.C.L.
 DATE: 8/17/2006

DESIGN FILE NAME: MWS-C42.DGN
 SUBMITTED BY: B.C.L.
 REGION ENGINEER: DACW29-X

REVISIONS:
 1-2-00 Converted Metric CB-01M to English CB-01
 1-3-97

DESIGNED BY: JCM
 CHECKED BY: WMR
 DATE: 1-3-97

APPROVED BY: [Signature]
 PROJECT ENGINEER

DATE: 9-9-06

HYDRAULICS SECTION

U. S. ARMY ENGINEER DISTRICT, NEW ORLEANS
 CORPS OF ENGINEERS
 NEW ORLEANS, LOUISIANA

DESIGNED BY: K.C.C.
 CHECKED BY: B.A.L.
 DRAWN BY: B.C.L.
 DATE: 8/17/2006

DESIGN FILE NAME: MWS-C42.DGN
 SUBMITTED BY: B.C.L.
 REGION ENGINEER: DACW29-X

WBV-1, WESTBANK AND VICINITY, NEW ORLEANS, LOUISIANA
 HYDRAULICS SECTION PROJECT
 PURPOSE: ALIEN CONCRETE
 CONTRACT 1 - SECTOR GATE TO BROOMTOWN CASINO
 EAST OF HARVEY CANAL FLOODWALL
 JEFFERSON PARISH, LOUISIANA
 CB-01 STANDARD
 DETAILS



95% P & S
 DATE: 9-9-06



3500 N. Causeway Blvd., Suite 900
 Metairie, Louisiana 70002
 (504) 837-6326
 PROJECT NO. 10001345.00000

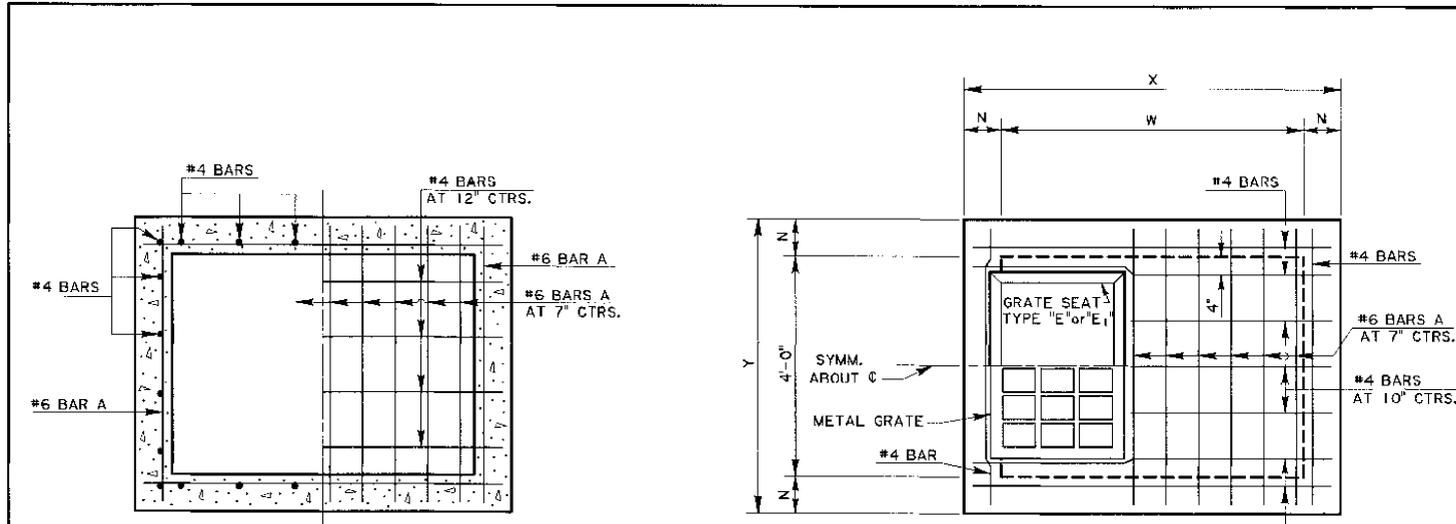
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FILE NUMBER
 H-4-X
 DWG. C-42 OF 142

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US Army Corps of Engineers
New Orleans District



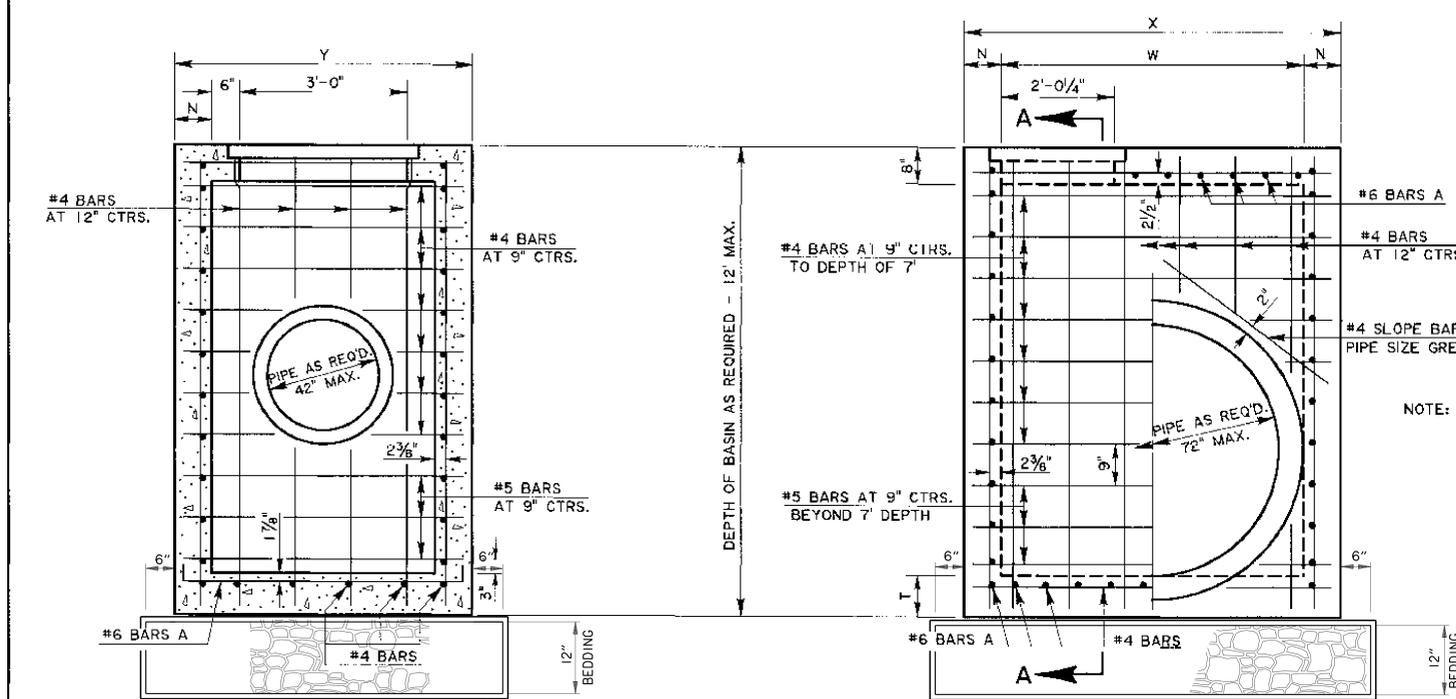
SECTIONAL PLAN
(SHOWING BOTTOM SLAB & WALLS)

NOTE: TYPE "B" GRATE TO BE USED WHERE NO PEDESTRIAN TRAFFIC IS EXPECTED.
TYPE "C" GRATE TO BE USED WHERE PEDESTRIAN TRAFFIC IS EXPECTED.

PLAN
GRATE TO BE TYPE "B" or "C". TYPE "B" SHOWN.

TRUNK PIPE	DEPTH TO 8'					DEPTH 8' TO 12'				
	N	T	W	X	Y	N	T	W	X	Y
42	7	9	4-3	5-5	5-2	8	9	4-3	5-7	5-4
48	7	9	4-10	6-0	5-2	8	9	4-10	6-2	5-4
54	7	9	5-5	6-7	5-2	8	9	5-5	6-9	5-4
60	7	10	6-0	7-2	5-2	8	10	6-0	7-4	5-4
66	7	10	6-7	7-9	5-2	8	10	6-7	7-11	5-4
72	7	10	7-2	8-4	5-2	8	10	7-2	8-6	5-4

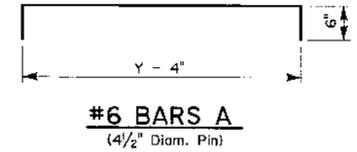
NOTE: X AND W DIMENSIONS MAY BE VARIED FOR SKEWED PIPE, BUT W SHALL NOT EXCEED 7'-2".



SECTION A-A

ELEVATION

NOTE: PIPE SIZE & LOCATION VARIES. CUT REINFORCING STEEL TO CLEAR, AS REQUIRED.



GENERAL NOTES:

DIMENSIONS RELATING TO REINFORCING STEEL ARE TO BAR CENTERS.
VERTICAL REINFORCING STEEL MAY BE SPLICED. SPLICE LENGTH IS 35 DIAMETERS.
FOR DETAILS OF GRATE AND SEAT, SEE STD. PLAN MC-01 (TYPE B or C).
SEE PLANS FOR TYPE OF GRATE TO BE USED FOR EACH CATCH BASIN.

DESIGNED BY: PAA	CHECKED BY: JCM	DATE: 1-31-97
PROJECT: 1-2-00	PROJECT: CB-02	PROJECT: CB-02
REVISION: REVISED	REVISION: REVISED	REVISION: REVISED
APPROVED BY: Original	SIGNED BY: Chief Engineer	DATE:

CONCRETE OPEN TOP CATCH BASIN
Max. Pipes: 72" x 42"
Max. Depth: 12'
To Be Used in Conjunction With Std. Plan MC-01

HYDRAULICS SECTION

U. S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA

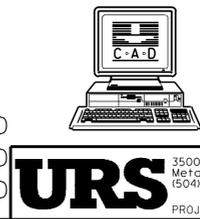
DESIGNED BY: K.C.C.
CHECKED BY: D.A.L.
DRAWN BY: R.C.L.
DATE: 8/3/2006

DESIGN FILE NAME: WFPS-CALBON
SUBMITTED BY: DACW29-X

WBV-1, WESTBANK AND VICINITY, NEW ORLEANS, LOUISIANA
HYDRAULICS SECTION PROJECT
CONTRACT 1 - SECTOR GATE TO BOOMTOWN CASINO
EAST OF HARVEY CANAL FLOODWALL
JEFFERSON PARISH, LOUISIANA
CB-02 - STANDARD
DETAILS



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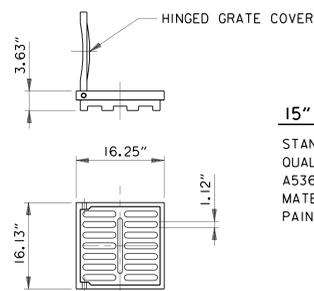


95% P & S
DATE: 9-9-06

3500 N. Causeway Blvd., Suite 900
Metairie, Louisiana 70002
(504) 837-6326
PROJECT No. 10001345.00000

FILE NUMBER
H-4-X
DWG. C-43 OF 142

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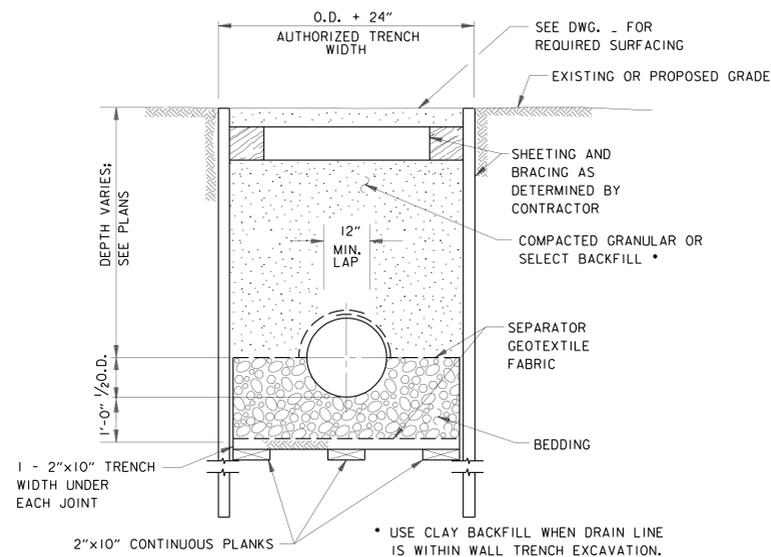


15" GRATES/ COVERS

STANDARD GRATE SHALL BE H-25 HEAVY DUTY RATING
 QUALITY: MATERIALS SHALL CONFORM TO ASTM
 A536 GRADE 70-50-05 AND A48-CLASS 30B
 MATERIAL: DUCTILE IRON GRATE W/ CAST IRON FRAME
 PAINT: CASTINGS SHALL BE PAINTED BLACK.

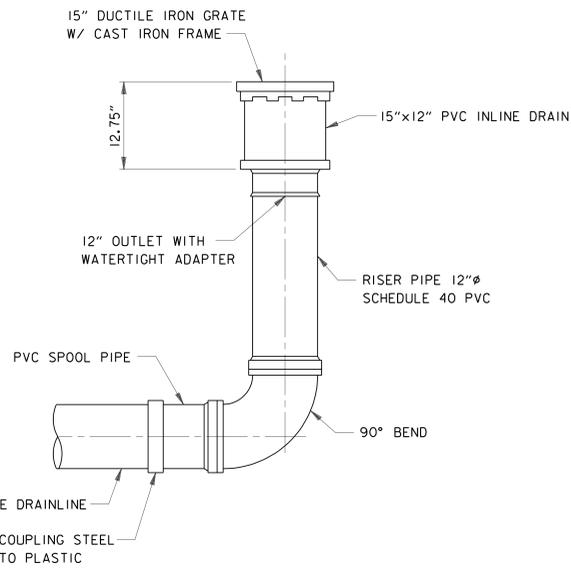
STANDARD

SCALE: N.T.S.
 APPROX. DRAIN AREA = 92.70 SQ. IN.
 APPROX. WEIGHT WITH FRAME = 59.62 LBS.



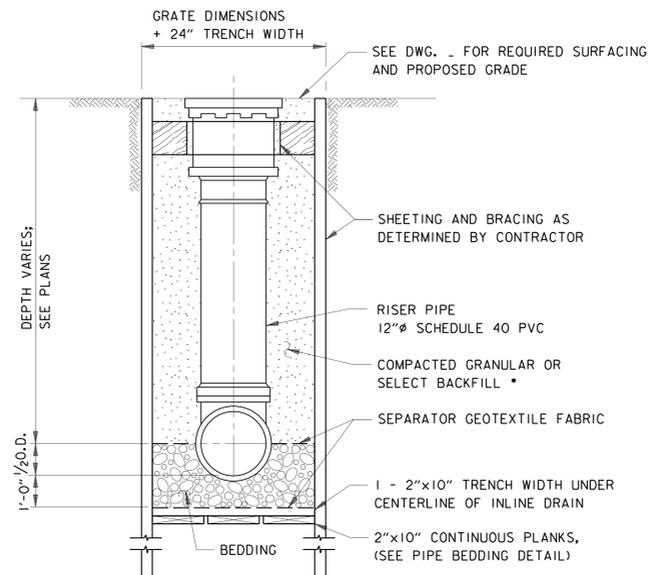
PIPE BEDDING DETAIL

SCALE: N.T.S.



TYPICAL 15"x12" INLINE DRAIN DRAIN STRUCTURE

SCALE: N.T.S.



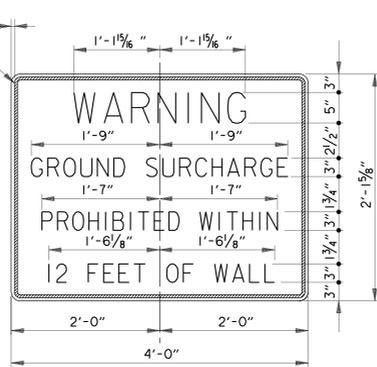
**TYPICAL BEDDING DETAIL FOR
 INLINE DRAIN STRUCTURE**

SCALE: N.T.S.

• USE CLAY BACKFILL WHEN STRUCTURE IS WITHIN WALL TRENCH EXCAVATION.

SIGN No. 1 SPECIFICATIONS

SIGN: ALUMINUM-6061-T6-0.080"
 FACE: No. 2270 SILVER WIDE ANGLE
 FLAT-TOP SCOTCHLITE
 OR APPROVED EQUAL
 LETTERS: SERIES "D" PER "STANDARD
 ALPHABETS FOR HIGHWAY
 SIGNS, LATEST EDITION"
 BORDER: BLACK
 FASTNERS: 1/2 inch GALV. EXP. ANCHORS
 (MOUNT TO FLOODWALL/BULKHEAD
 CAP FACE)
 HOLES: DRILL IN FIELD TO SUIT MOUNTING

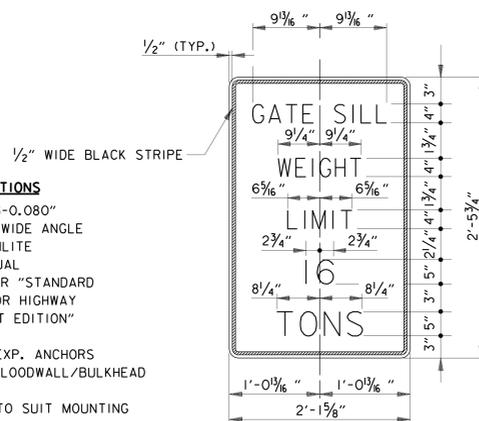


SIGN #1 (1 REQ'D.)

SCALE: N.T.S.

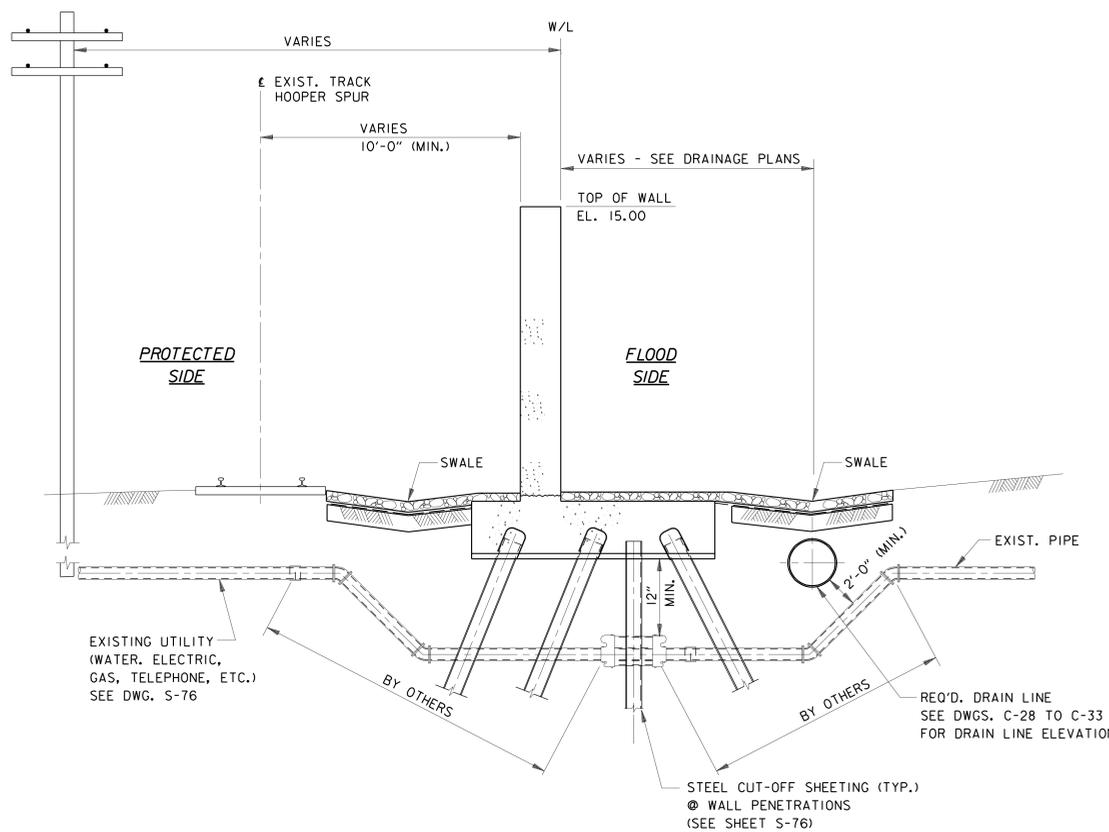
SIGN No. 2 SPECIFICATIONS

SIGN: ALUMINUM-6061-T6-0.080"
 FACE: No. 2270 SILVER WIDE ANGLE
 FLAT-TOP SCOTCHLITE
 OR APPROVED EQUAL
 LETTERS: SERIES "D" PER "STANDARD
 ALPHABETS FOR HIGHWAY
 SIGNS, LATEST EDITION"
 BORDER: BLACK
 FASTNERS: 1/2 inch GALV. EXP. ANCHORS
 (MOUNT TO FLOODWALL/BULKHEAD
 CAP FACE)
 HOLES: DRILL IN FIELD TO SUIT MOUNTING



SIGN #2 (2 REQ'D.)

SCALE: N.T.S.



TYPICAL UTILITY LINE OFFSET

SCALE: N.T.S.

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95% P & S
 DATE: 9-23-06

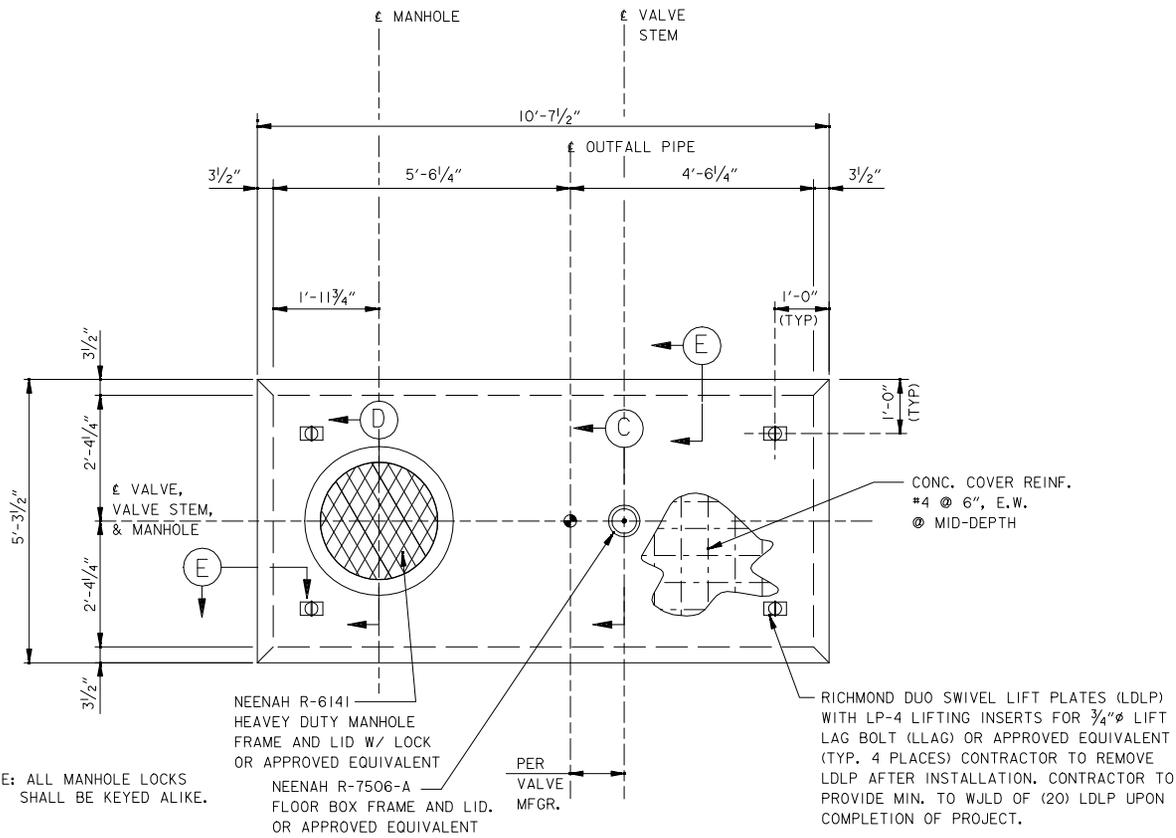


3500 N. Causeway Blvd., Suite 900
 Metairie, Louisiana 70002
 504 837-6326
 PROJECT No. 10001345.00000

U. S. ARMY ENGINEER DISTRICT, NEW ORLEANS
 CORPS OF ENGINEERS
 NEW ORLEANS, LOUISIANA
 DESIGN FILE NAME: EDH-C-4520N
 SOLICITATION NO. DACW29-X
 DESIGNER: B.C.C.
 CHECKED BY: D.C.C.
 DRAWN BY: R.G.L.
 DATE: 8/14/06
 SCALE: 48

WBV-1, WESTBANK AND VICINITY, NEW ORLEANS, LOUISIANA
 FLOODWALL RELOCATION PROJECT
 CONTRACT 1 - SECTOR GATE TO BROOMTOWN CASINO
 EAST OF HARVEY CANAL FLOODWALL
 JEFFERSON PARISH, LOUISIANA
 MISCELLANEOUS DETAILS
 (CONTINUED)

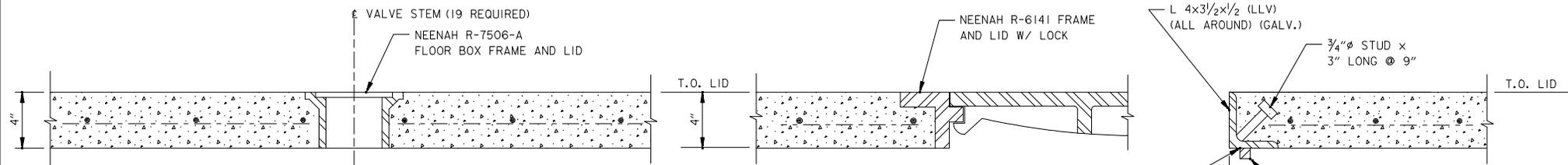
FILE NUMBER
 H-4-45982
 DWG. C-45 OF X



NOTE: ALL MANHOLE LOCKS SHALL BE KEYED ALIKE.

VALVE BOX LID PLAN

NOTE:
1. f'c = 4000 psi
2. fy = 60 KSI



SECTION C
SCALE: 3" = 1'-0"

SECTION D
SCALE: 3" = 1'-0"

SECTION E
SCALE: 3" = 1'-0"

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SECTION 03301 - CAST-IN-PLACE STRUCTURAL CONCRETE

PART 1 GENERAL

1.1 SCOPE

The work covered by this section consists of furnishing all plant, labor, materials, and performing all operation in connection with furnishing and placing cast-in-place concrete for stabilization slabs, floodwalls, reinforced concrete pavement for curb and gutter, headwalls, and concrete lined ditches as specified herein.

1.2 DEFINITIONS

1.2.1 Reinforced Concrete Floodwall

Reinforced concrete floodwall concrete is reinforced concrete that will be used in either T-Walls, I-Walls, or L-Walls.

1.2.2 Architectural Textured Finish

An architectural textured finish is a texture that is produced by the addition of form liners inside the formwork to create the specified appearance for the walls. Such finishes include trapezoidal rib, fractured fin, stone, or brick.

1.3 REFERENCES

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

ACI INTERNATIONAL (ACI)

117/117R	(1990(2002)) Tolerances for Concrete Construction and Materials
211.1	(1991(2002)) Selecting Proportions for Normal, Heavyweight, and Mass Concrete
214	(2002) Evaluation of Strength Test Results of Concrete
305R	(1999) Hot Weather Concreting
318/318R	(2005) Building Code Requirements for Structural Reinforced Concrete

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

C 29	(1997(2003)) Bulk Density (Unit Weight) and Voids in Aggregate
C 31	(2003a) Making and Curing Concrete Test Specimens in the Field
C 33	(2003) Concrete Aggregates
C 39	(2005) Compressive Strength of Cylindrical Concrete Specimens
C 42	(2004) Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
C 94	(2005) Ready-Mixed Concrete
C 127	(2004) Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
C 128	(2004a) Density, Relative Density (Specific Gravity) and Absorption of Fine Aggregate
C 136	(2006) Sieve Analysis of Fine and Coarse Aggregates
C 143	(2005a) Slump of Hydraulic Cement Concrete
C 150	(2005) Portland Cement
C 171	(2003) Sheet Materials for Curing Concrete
C 172	(2004) Sampling Freshly Mixed Concrete
C 192	(2006) Making and Curing Concrete Test Specimens in the Laboratory
C 231	(2004) Air Content of Freshly Mixed Concrete by the Pressure Method
C 260	(2001) Air-Entraining Admixtures for Concrete
C 309	(2006) Liquid Membrane-Forming Compounds for Curing Concrete
C 494	(2005a) Chemical Admixtures for Concrete

C 566	(1997(2004)) Total Evaporable Moisture Content of Aggregate by Drying
C 595	(2005) Blended Hydraulic Cements
C 597	(2002) Pulse Velocity Through Concrete
C 618	(2005) Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
C 803	(2003) Penetration Resistance of Hardened Concrete
C 805	(2002) Rebound Number of Hardened Concrete
C 989	(2005) Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
C 1017	(2003) Chemical Admixtures for Use in Producing Flowing Concrete
C 1059	(1999) Latex Agents for Bonding Fresh to Hardened Concrete
C 1064	(2005) Temperature of Freshly Mixed Hydraulic-Cement Concrete
C 1077	(2005be1) Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
C 1107	(2005) Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
D 75	(2003) Sampling Aggregates

CORPS OF ENGINEERS (CE)

CRD-C 61	(1989A) Determining the Resistance of Freshly Mixed Concrete to Washing Out in Water
CRD-C 94	(1995) Surface Retarders
CRD-C 100	(1975) Sampling Concrete Aggregate and Aggregate Sources, and Selection of Material for Testing

CRD-C 104	(1980) Calculation of the Fineness Modulus of Aggregate
CRD-C 143	(1962) Meters for Automatic Indication of Moisture in Fine Aggregates
CRD-C 400	(1963) Water for Use in Mixing or Curing Concrete
CRD-C 521	(1981) Frequency and Amplitude of Vibrators for Concrete

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CCC-C-467C	(Feb 8, 1972) Cloth, Burlap, Jute (or Kenaf)
------------	--

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

HB 44	(2006) Specifications, Tolerances, and other Technical Requirements for Weighing and Measuring Devices
-------	--

NATIONAL READY-MIXED CONCRETE ASSOCIATION (NRMCA)

CPMB 100	(2000) Concrete Plant Standards
----------	---------------------------------

LOUISIANA STANDARD SPECIFICATIONS FOR ROADS AND BRIDGES (LSSRB) 2000 EDITION, STATE OF LOUISIANA, DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT (LDOTD)

1003.02*	Aggregates for Portland Cement Concrete and Mortar
----------	--

*Including Supplemental Specifications dated November 2005

1.4 BIDDING SCHEDULE LINE ITEMS

1.4.1 Reinforced Concrete Floodwall

Bidding Schedule Line Items for "Reinforced Concrete Floodwall Stem", "Reinforced Concrete Floodwall Base" or "Reinforced Concrete Floodwall/Bulkhead Cap" shall include the cost of all labor, materials, and the use of all equipment and tools required to complete the concrete work. Reinforced concrete monoliths consist of base slabs, walls, reinforcing steel, formwork, waterstops, expansion joint filler, and other components incidental thereto. Reinforced concrete floodwall/bulkhead cap consists of underwater concrete base, concrete waler, reinforcing steel, form work placed in the wet and over the water, construction joint preparation, waterstops, expansion joint filler, and other components incidental thereto. Float, trowel or broom finishes for the concrete are also included.

1.4.2 Dolphin Pile Unreinforced Concrete

Bidding Schedule Line Item for “Dolphin Pile Unreinforced Concrete Fill” shall constitute full compensation for furnishing all labor, equipment and tools to complete the dolphin pile concrete work as specified herein. Float, trowel or broom finishes for the concrete are also included.

1.4.3 Pipe Guard Concrete

Concrete for the pipe guard concrete shall be included in the Bidding Schedule Line Item for " Pipe Guard (10” Steel Pipe, Concrete Filled)".

1.4.4 Reinforced Concrete Pavement

Reinforced concrete pavement, sidewalks and gutters shall be included in the applicable Bidding Schedule Line Items for “8 Inch Thick Reinforced Concrete Pavement”, “4 Inch Thick Reinforced Concrete Pavement”, or “Concrete Curb and Gutter Bottom”.

1.4.5 Concrete Slope Paving

Bidding Schedule Line Item for “Concrete Slope Paving” shall constitute full compensation for furnishing all labor, materials, equipment and tools required to complete the concrete work and all other work incidental thereto. Concrete slope paving consists of concrete paving, and welded wire fabric and reinforcing steel. Float, trowel or broom finishes for the concrete are also included.

1.4.6 Gate Monoliths

Bidding Schedule Line Items for "Gate Monolith Base" and “Gate Monolith Column or Pilaster” shall include the cost of all labor, materials, and the use of all equipment and tools required to complete the concrete work. Reinforced concrete bases and columns or pilasters consist of reinforcing steel, formwork, waterstops, expansion joint filler, and other components incidental thereto. Float, trowel or broom finishes for the concrete are also included.

1.4.7 Underwater Concrete

Bidding Schedule Line Item for “Underwater Concrete” shall constitute full compensation for furnishing all labor, materials, equipment and tools required to complete the concrete work as required.

1.4.8 Stabilization Slab Concrete

Bidding Schedule Line Item for "Stabilization Slab Concrete" shall constitute full compensation for furnishing all labor, materials, equipment and tools required to complete the concrete work as required.

1.4.9 Special Finishes for Walls

Bidding Schedule Line Items for "Architectural Textured Finish" or "Grout-Cleaned Finish" shall include the cost of all labor, materials, and the use of all equipment and tools required to complete the finish as specified. Special dyes, coloring or painting of finish is not included.

1.4.10 Miscellaneous Metals

Furnishing, fabricating, installing, painting miscellaneous metals will be included in the Bidding Schedule Line Items specified in Section 05500, "MISCELLANEOUS METALWORK".

1.4.11 Reinforced Pile Cap Concrete

Bidding Schedule Line Item for "Reinforced Pile Cap Concrete" shall constitute full compensation for furnishing all labor, equipment and tools to complete the dolphin cap and the drainage pipe support cap concrete work as specified herein. Float, trowel or broom finishes for the concrete are also included.

1.4.12 Miscellaneous Concrete

Bidding Schedule Line Item for "Miscellaneous Concrete" shall include the cost of all labor, materials, and the use of all equipment and tools required for concrete not included in the Bidding Schedule Line Items above.

1.5 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "SUBMITTAL PROCEDURES".

1.5.1 Concrete Mixture Proportioning

Concrete mixture proportions shall be determined by the Contractor, in accordance with the requirements in paragraph 2.2, and submitted for approval. The concrete mixture quantities of all ingredients per cubic yard and nominal maximum coarse aggregate size that will be used in the manufacture of each quality of concrete shall be stated. Proportions shall indicate the mass of cement, pozzolan and ground granulated blast-furnace (GGBF) slag when used, and water; the mass of aggregates in a saturated surface-dry condition; and the quantities of admixtures. The

submission shall be accompanied by test reports from a laboratory complying with ASTM C 1077, which show that proportions thus selected will produce concrete of the qualities indicated. The submission shall provide information specified in paragraph 2.2.8, and if applicable, paragraph 2.2.6. Mix proportions, slump and air content shall be reported, for all cylinders used to develop the mix design. For concrete that is to be deposited underwater, the exact amount of washout determined for each trial mixture, including the submitted mixture proportions, shall also be reported. No substitution shall be made in the source or type of materials used in the work without additional tests to show that the quality of the new materials and concrete are satisfactory.

1.5.2 Batch Plant

The Contractor shall submit batch plant data to the Contracting Officer for review for conformance with paragraphs 3.1.1 and 3.1.2.

1.5.3 Concrete Mixers

The Contractor shall submit concrete mixer data, which includes the make, type, and capacity of concrete mixers for review of conformance with paragraphs 3.1.1 and 3.1.3.

1.5.4 Conveying Equipment and Methods

The conveying equipment and methods for transporting, handling, and depositing the concrete shall be submitted for review for conformance with paragraphs 3.1.1 and 3.1.4.

1.5.5 Placing Equipment and Methods

All placing equipment and methods shall be submitted for review for conformance with paragraphs 3.1.1 and 3.3.

1.5.6 Testing Technicians, Concrete Construction Inspector

The Contractor shall submit statements that the concrete testing technicians and the concrete inspectors meet the requirements of paragraph 3.7.

1.5.7 Construction Joint Treatment

The method and equipment proposed for construction joint preparation and waste disposal shall be submitted for review for conformance with paragraph 3.2.3.

1.5.8 Curing and Protection

The curing medium and methods to be used shall be submitted for review for conformance with paragraph 3.5.

1.5.9 Cold-Weather Placing

If concrete is to be placed under cold-weather conditions, the proposed materials, methods, and protection meeting the requirements of paragraph 3.3.4 shall be submitted for review.

1.5.10 Hot-Weather Placing

If concrete is to be placed under hot-weather conditions, the proposed materials and methods, meeting the requirements of paragraph 3.3.5 and paragraph 3.5, shall be submitted for review.

1.5.11 Aggregate

Information identifying the aggregate source to be used along with gradation tests for fine and coarse aggregates shall be submitted for approval. The gradation test for fine aggregate shall include the No. 8 and No. 30 sieve sizes. Specific gravity and absorption of fine and coarse aggregates determined by ASTM C 128 and ASTM C 127, respectively shall also be submitted. Samples of materials for Government testing and approval shall be submitted as required in paragraph 1.6.1.

1.5.12 Uniformity of Concrete Mixing

The results of the initial mixer uniformity tests as required in paragraph 3.7.2.13 shall be submitted at least five (5) days prior to the initiation of placing. The initial test results submitted shall not be more than three (3) months old. Additional tests shall be conducted and submitted within six (6) months of the previous tests. Uniformity testing shall continue until all concrete is placed.

1.5.13 Tests and Inspections

Test results and inspection reports shall be submitted daily and weekly as required in paragraph 3.7.3.

1.5.14 Cementitious Materials

Cementitious materials will be accepted on the basis of the manufacturer's certification of compliance, accompanied by mill test reports stating that materials meet the requirements of the specification under which they are furnished. Certification and mill test reports shall be from samples taken from current production and be representative of the particular lot furnished. No cementitious materials shall

be used until notice of acceptance has been given by the Contracting Officer. Cementitious materials will be subject to check testing from samples obtained at the source, at transfer points, or at the project site, as scheduled by the Contracting Officer, and such sampling will be by or under the supervision of the Government at its expense. Material not meeting specifications shall be promptly removed from the site of work.

1.5.15 Impervious-Sheet Curing Materials

Impervious-Sheet Curing Materials shall be certified for compliance with all specification requirements.

1.5.16 Air-Entraining Admixture

Air-Entraining Admixture shall be certified for compliance with all specification requirements.

1.5.17 Other Chemical Admixtures

Other Chemical Admixtures shall be certified for compliance with all specification requirements.

1.5.18 Membrane-Forming Curing Compound

Membrane-Forming Curing Compound shall be certified for compliance with all specification requirements.

1.5.19 Latex Bonding Compound

Latex Bonding Compound shall be certified for compliance with all specification requirements.

1.5.20 Nonshrink Grout

Descriptive literature of the Nonshrink Grout proposed for use shall be furnished together with a certificate from the manufacturer stating that it is suitable for the application or exposure for which it is being considered.

1.5.21 Underwater Concrete Plan

A concrete plan shall be submitted to the Contracting Officer for comment and approval at least ninety (90) days prior to start of placement of any underwater concrete. The plan shall describe the equipment and methods proposed for each area of placement. The timing and sequence of the various steps shall also be described. The plan shall be of sufficient detail to demonstrate that equipment and

methods are appropriate for the specific type of concrete and that the work conforms to all specification requirements.

1.5.22 Anti-Washout Admixture

Manufacturer's written literature showing compliance with all specification requirements shall be submitted for approval.

1.6 GOVERNMENT TESTING AND SAMPLING

The Contractor shall provide facilities and labor as may be necessary for procurement of representative test samples of aggregates and concrete. Concrete and aggregate requirements in this paragraph and its subparagraphs do not relieve the Contractor of the requirements outlined in paragraph 3.7.

1.6.1 Aggregates

The aggregate sources listed in "AGGREGATE SOURCES" of Section 01100, "GENERAL PROVISIONS" have been tested and at the time testing was performed, and these sources were capable of producing materials of a quality acceptable for this project provided suitable processing was performed. If the Contractor proposes to furnish aggregates from a source not listed in "AGGREGATE SOURCES" of Section 01100, "GENERAL PROVISIONS" samples consisting of not less than five hundred (500) pounds of each size coarse aggregate and three hundred (300) pounds of fine aggregate taken under the supervision of the Contracting Officer in accordance with CRD-C 100 shall be delivered to the U.S. Army Engineer Research and Development Center, Structures Lab (3909 Halls Ferry Road) in Vicksburg, MS within fifteen (15) days after notice to proceed. Sampling and shipment of samples shall be at the Contractor's expense. The cost of testing one (1) source for each size aggregate will be borne by the Government. If the Contractor selects more than one source for each aggregate size or selects a substitute source for any size aggregate after the original source was tested, the cost of that additional testing will be borne by the Contractor. From ninety (90) to one hundred twenty (120) days will be required to complete evaluation of the aggregates. Testing will be in accordance with applicable CRD or ASTM test methods. Tests to which aggregate may be subjected are specific gravity, absorption, cycles of freezing and thawing in concrete, alkali-aggregate reaction, organic impurities, and any other test necessary to demonstrate that the aggregate is of a quality that is at least equivalent to those sources listed in Section 01100, "AGGREGATE SOURCES".

1.6.2 Concrete

The Government will determine when concrete shall be sampled. The Contractor shall cast, protect and deliver concrete cylinders and determine slump and air content. The person conducting the tests shall meet the Concrete Field Testing Technician requirements contained in paragraph 3.7.1. Concrete shall be sampled in

accordance with ASTM C 172. When cylinders are molded, slump and air content shall be determined in accordance with ASTM C143 and ASTM C 231, respectively. Test samples for each class of concrete shall be taken at least once every eight (8) hour shift or for every one hundred fifty (150) cubic yards placed, whichever requires more samples. From each sample, three 6-inch by 12-inch compression test specimens shall be made in accordance with ASTM C 31. Compression test specimens shall be cured while in the field in accordance with paragraphs 10.1 and 10.1.1, 10.1.2, and 10.1.3 of ASTM C 31. If cylinders are not delivered to the testing laboratory within twenty-four (24) to forty-eight (48) hours after molding, they shall be submerged in a water tank provided by the Contractor, where the surrounding water temperature is maintained by the Contractor at 73.4 plus or minus 3 degrees Fahrenheit. Cylinders shall be transported in accordance with ASTM C 31 (with cushioning material) and unloaded in the Government designated location. Compression testing will be performed by the Government in accordance with ASTM C 39. One (1) cylinder will be tested at seven (7) days for information and two (2) cylinders will be tested at twenty-eight (28) days (90 if pozzolan or GGBF slag is used) for acceptance.

1.6.3 Concrete Strength

Compressive strength test specimens required in paragraph 1.6.2 will be used to determine compliance. The strength of the concrete will be considered satisfactory so long as the average of all sets of three (3) consecutive test results equals or exceeds the specified compressive strength f'_c and no individual test result falls below the specified strength f'_c by more than five hundred (500) pounds per square inch. A "test" is defined as the average of two (2) companion cylinders, or if only one cylinder is tested, the results of the single cylinder test. Additional analysis or testing, including nondestructive testing, taking cores and/or load tests may be required at the Contractor's expense when the strength of the concrete in the structure is considered potentially deficient.

1.6.3.1 Investigation of Low-Strength Test Results

When any strength test of standard-cured test cylinders falls below the specified strength requirement by more than five hundred (500) pounds per square inch or if tests of field-cured cylinders indicate deficiencies in protection and curing, steps shall be taken to assure that the load-carrying capacity of the structure is not jeopardized. Nondestructive testing in accordance with ASTM C 597, ASTM C 803 or ASTM C 805 may be permitted by the Contracting Officer to estimate the relative strengths at various locations in the structure as an aid in evaluating concrete strength in place or for selecting areas to be cored. Such tests shall not be used as a basis for acceptance or rejection.

1.6.3.2 Testing of Cores

When the strength of concrete in place is considered potentially deficient, cores shall be obtained and tested in accordance with ASTM C 42. At least three representative cores shall be taken from each member or area of concrete in place that is considered potentially deficient. The location of cores will be determined by the Contracting Officer to least impair the performance of the structure. Concrete in the area represented by the core testing will be considered adequate if the average strength of the cores is equal to at least eighty-five percent (85%) of the specified strength requirement and if no single core is less than seventy-five percent (75%) of the specified strength requirement.

1.6.3.3 Load Tests

If the core tests are inconclusive or impractical to obtain or if structural analysis does not confirm the safety of the structure, load tests may be directed by the Contracting Officer in accordance with the requirements of ACI 318/318R. Concrete work evaluated by structural analysis or by results of a load test shall be corrected in a manner satisfactory to the Contracting Officer. All investigations, testing, load tests, and correction of deficiencies will be performed and approved by the Contracting Officer at the expense of the Contractor, except that if all concrete is in compliance with the specifications, the cost of investigations, testing, and load tests will be at the expense of the Government.

1.7 DESIGN REQUIREMENTS

1.7.1 Concrete Strength

Specified compressive strength f'c shall be as follows:

Compressive Strength (PSI)	Structure Or Portion Of Structure
2,500 @ 28 * days	Stabilization Slab
3,000 @ 28 * days	Dolphin pile concrete fill, bollard (pipe guard) concrete fill, concrete slope paving
4,000 @ 28 * days	All other features

* 90 days if pozzolan or GGBF slag is used.

1.7.2 Maximum Water-Cementitious Materials (W/CM) Ratio

Maximum W/CM shall be as follows:

W/CM, By Mass	Structure Or Portion Of	Structure
0.60		Stabilization Slab
0.50		4,000 psi concrete
0.55		3,000 psi concrete
0.45		Concrete Placed Underwater

1.8 CONSTRUCTION TOLERANCES

1.8.1 General

The definitions of the terms used in the following tables shall be as defined in ACI 117/117R Commentary. Level and grade tolerance measurements of slabs shall be made as soon as possible after finishing. When forms or shoring are used, the measurements shall be made prior to removal. Tolerances are not cumulative. The most restrictive tolerance controls. Tolerances shall not extend the structure beyond legal boundaries. Except as specified otherwise, plus tolerance increases the amount or dimension to which it applies, or raises a level alignment, and minus tolerance decreases the amount or dimension to which it applied, or lowers a level alignment. A tolerance without sign means plus or minus. Where only one signed tolerance is specified, there is no limit in the other direction.

TOLERANCES FOR FOUNDATIONS

(1) Lateral alignment

Eccentricity measured from the center of gravity of footing as cast to the center of gravity as specified; 0.02 times width of footing in direction of misplacement but not more than	2 inch
Supporting masonry construction	1/2 inch

(2) Level alignment

Top of footings supporting masonry	1/2 inch
Top of other footings	+ 1/2 inch
.....	- 2 inch

(3) Cross-sectional dimension

Horizontal dimension of formed member +2 inch
..... -1/2 inch

Horizontal dimensions of unformed
members cast against soil 2 foot or less.....+3 inch
..... -1/2 inch

Greater than 2 foot but less than 6 foot +6 inch
..... -1/2 inch

Over 6 foot+12 inch
..... -1/2 inch

Vertical dimension (thickness)-5 percent

(4) Relative alignment

Slope of footing side and top
Surfaces with respect to
the specified plane 1 inch maximum per 10 foot

TOLERANCES FOR CAST-IN-PLACE REINFORCED CONCRETE STRUCTURES

(1) Vertical alignment

For heights 100 foot or less
Lines, surfaces, and arises1 inch

Outside corner of exposed corner
columns and control joint grooves in
concrete exposed to view1/2 inch

For heights greater than 100 foot
Lines, surfaces, and arises,
1/1,000 times the height
at any point but not more than 6 inch

Outside corner of exposed
corner columns and control
joint grooves in concrete,
1/2,000 times the height at any
point but not more than 3 inch

(2) Lateral alignment

Members	1 inch
In slabs, centerline location of openings 12 inch or smaller and edge location of larger openings	1/2 inch
Sawcuts, joints, and weakened plane embedment in slabs	3/4 inch

(3) Level alignment

Top of slabs

Elevation of slabs-on-grade	3/4 inch
Elevation of top surfaces of formed slabs before removal of supporting shores	3/4 inch
Elevation of formed surfaces before removal of shores	3/4 inch
Lintels, sills, parapets, horizontal grooves, and other lines lines exposed to view	1/2 inch

(4) Cross-sectional dimensions

Members, such as columns,
beams, piers, walls (thickness
only), and slabs (thickness only)

2-inch dimension or less	+ 3/8 inch
.....	-1/4 inch
More than 12 inch but not over 3-foot dimension	+1/2 inch
.....	-3/8 inch
Over 3-foot dimension	+1 inch
.....	-3/4 in.

(5) Relative alignment

Stairs

Different in height
between adjacent risers 1/8 inch

Different in width
between adjacent treads 1/4 inch

Grooves

Specified width 2 inch or less 1/8 inch

Specified width more than
2 inch but not more than 12 inch 1/4 inch

Sawcuts, joints, and weakened plane on slab

Lateral, gradual 3/4 inch maximum in 10 foot

Lateral, abrupt 0 inch

(6) Openings through members

Cross-sectional size of opening -1/4 inch
..... +1 inch

Location of centerline of opening 1/2 inch

TOLERANCE FOR FINISHED FORMED CONCRETE SURFACES

(1) Formed surfaces slope with respect to the specified plane

Vertical alignment of outside
corner of exposed corner
columns and control joint
grooves in concrete exposed
to view 1/4 inch maximum in 10 foot

All other conditions 3/8 inch maximum in 10 foot

(2) Abrupt variation

The offset between concrete surfaces for the following classes of surface:

Class A 1/8 inch

Class D 1 inch

(3) Gradual variation

Surface finish tolerances as measured by placing a freestanding (unleveled), 5-foot straightedge for plane surface or curved template for curved surface anywhere on the surface and allowing it to rest upon two high spots within 72 hours after concrete placement. The gap at any point between the straightedge or template and the surface shall not exceed:

Class A 1/8 inch

Class D 1 inch

1.8.2 Appearance

Permanently exposed surfaces shall be cleaned, if stained or otherwise discolored, by a method that does not harm the concrete and that is approved by the Contracting Officer.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Cementitious Materials

Cementitious materials shall be portland cement, portland-pozzolan cement, portland blast-furnace slag cement, or portland cement in combination with pozzolan or GGBF slag and shall conform to appropriate specifications listed below. Use of cementitious materials in architectural concrete shall be restricted to one color, one source, and one type.

2.1.1.1 Portland Cement

ASTM C 150, Type I or II, low alkali, except that the maximum amount of C₃A in Type I cement shall be fifteen percent (15%) and cement with a Blaine Fineness of four hundred (400) square meters per kilogram or greater shall be considered Type III cement.

2.1.1.2 High-Early-Strength Portland Cement

ASTM C 150, Type III, low alkali, used only when specifically approved in writing.

2.1.1.3 Pozzolan, Other than Silica Fume

Pozzolan shall conform to ASTM C 618, Class C or F, with Multiple Factor and the Effectiveness in Controlling Alkali-Silica Reaction requirements of Table 3.

2.1.1.4 Ground Granulated Blast-Furnace Slag

Ground Granulated Blast-Furnace Slag shall conform to ASTM C 989, Grade 100 or 120.

2.1.1.5 Reserved

2.1.1.6 Blended Hydraulic Cement

Portland blast-furnace slag cement shall conform to ASTM C 595, Type IS. Portland-pozzolan cement shall conform to ASTM C 595, Type IP. Blended hydraulic cement shall meet the mortar expansion limits found in Table 2 of ASTM C 595.

2.1.2 Aggregates

Concrete aggregate shall be produced from the sources in Section 01100, "AGGREGATE SOURCES". Fine and coarse aggregates shall conform to the grading requirements of ASTM C 33 or LSSRB 1003.02. The quality of all aggregates shall conform to ASTM C 33. The nominal maximum size shall be as listed in paragraph 2.2.2.

2.1.3 Chemical Admixtures

Chemical admixtures to be used, when required or permitted, shall conform to the appropriate specification listed.

2.1.3.1 Air-Entraining Admixture

The air-entraining admixture shall conform to ASTM C 260 and shall consistently cause the concrete to have an air content in the specified ranges under field conditions.

2.1.3.2 Accelerating Admixture

Accelerators shall meet the requirements of ASTM C 494, Type C or E, except that calcium chloride or admixtures containing calcium chloride shall not be used.

2.1.3.3 Water-Reducing or Retarding Admixture

- a. Water-Reducing or Retarding Admixtures: ASTM C 494, Type A, B, or D, except that the 6-month and 1-year compressive strength tests are waived.
- b. High-Range Water Reducing Admixture: ASTM C 494, Type F or G, except that the 6-month and 1-year strength requirements shall be waived. The admixture may be used only when approved by the Contracting Officer, such

approval being contingent upon particular mixture control as described in the Contractor's Quality Control Plan. High-Range Water Reducing Admixtures shall not be used as a retarder for underwater concrete.

2.1.3.4 Anti-Washout Admixture

Anti-washout admixture shall be RHEOMAC UW 450 by Master Builders, Inc.; EUCON AWA by Euclid Chemical Company; Sikament 100 as manufactured by Sika Corporation; or an approved equal.

2.1.3.5 Other Chemical Admixtures

Other chemical admixtures for use in producing flowing concrete shall comply with ASTM C 1017, Type 1 or 2. These admixtures shall be used only for concrete listed in paragraph 2.2.4.

2.1.4 Curing Materials

2.1.4.1 Impervious-Sheet Curing Materials

Impervious-sheet curing materials shall conform to ASTM C 171, type optional, except polyethylene film shall not be used.

2.1.4.2 Membrane-Forming Curing Compound

The membrane-forming curing compound shall conform to ASTM C 309, Type 1-D or 2, Class B.

2.1.4.3 Burlap

Burlap used for curing shall conform to GSA CCC-C-467C.

2.1.5 Water

Water for mixing and curing shall be fresh, clean, potable, and free of injurious amounts of oil, acid, salt, sugar, or alkali, except that nonpotable water may be used if it meets the requirements of CE CRD-C 400.

2.1.6 Nonshrink Grout

Nonshrink grout shall conform to ASTM C 1107 and shall be a commercial formulation suitable for the application proposed.

2.1.7 Latex Bonding Compound

Latex bonding compound agents for bonding fresh to hardened concrete shall conform to ASTM C 1059.

2.2 CONCRETE MIXTURE PROPORTIONING

2.2.1 Quality of Mixture

For each portion of the structure, mixture proportions shall be selected so that the strength and W/CM requirements listed in paragraph 1.7 are met.

2.2.2 Nominal Maximum-Size Coarse Aggregate

Nominal maximum-size coarse aggregate shall be 1-1/2 inches or 1 inch except 3/4 inch nominal maximum-size coarse aggregate shall be used when any of the following conditions exist: the narrowest dimension between sides of forms is less than 7-1/2 inches; the depth of the slab is less than four (4) inches; the minimum clear spacing between reinforcing and sheet piling is less than 2-1/4 inches; or the minimum clear spacing between reinforcing is less than 2-1/4 inches. Maximum aggregate size for concrete placed underwater for floodwall/bulkhead cap shall be one (1) inch.

2.2.3 Air Content

Air content as delivered to the forms and as determined by ASTM C 231 shall be between four and seven percent (4% and 7%) except that when the nominal maximum-size coarse aggregate is 3/4 inch, it shall be between four and one-half and seven and one-half percent (4 1/2% and 7 1/2%).

2.2.4 Slump

The slump shall be determined in accordance with ASTM C 143 and shall range of one (1) to four (4) inches. Where placement by pump is approved, the slump shall range from three (3) to six (6) inches. Concrete may contain a chemical admixture meeting ASTM C 1017 for use in producing flowing concrete. Before the addition of flowing concrete admixture, the slump shall not exceed four (4) inches and afterwards in no case shall the slump exceed eight (8) inches. The slump of concrete to be placed underwater for the floodwall/bulkhead cap shall range from six (6) to nine (9) inches.

2.2.5 Pozzolan Content

If pozzolan is used, it shall range from fifteen to thirty-five percent (15% to 35%) by weight of the total cementitious materials, except underwater concrete mixes for the

floodwall/bulkhead cap must contain fifteen to thirty-five percent (15% to 35%) pozzolan by weight of the total cementitious materials.

2.2.6 Determining Standard Deviation

Where a concrete production facility has test records, a standard deviation shall be established in accordance with the applicable provisions of ACI 214. Test records from which a standard deviation is calculated shall:

- 1). Represent materials, quality control procedures, and conditions similar to those expected at the proposed work;
- 2). Not be from a project where the allowable changes in materials and/or proportions were more restricted than for the proposed work;
- 3). Represent concrete produced to meet a specified strength or strengths, f'_c , within one thousand (1,000) pounds per square inch of that specified for the proposed work;
- 4). Be from consecutive tests;
- 5). Be from different batches;
- 6). Be the average of strengths from two (2) cylinders made from the same sample of concrete and tested at the age indicated in paragraph 1.7.1; and
- 7). Be from concrete that was produced within one (1) year of the time when concrete placement is expected to begin for the proposed work.

2.2.6.1 For 30 or More Test Records

Use an unmodified standard deviation and calculate f'_{cr} as specified in paragraph 2.2.7.1.

2.2.6.2 For 15 to 29 Test Records

Where a concrete production facility does not have thirty (30) test records, but does have a record based on fifteen (15) to twenty-nine (29) consecutive tests, a modified standard deviation may be established as the product of the standard deviation based on fifteen (15) to twenty-nine (29) tests and modification factor from the following table. Calculate f'_{cr} as specified in paragraph 2.2.7.1.

<u>Number of Records *</u>	<u>Modification Factor for Standard Deviation</u>
15	1.16

20	1.08
25	1.03
30 or more	1.00

*Interpolate for intermediate numbers of records.

2.2.6.3 For Less Than 15 Test Records

No standard deviation is needed. Calculation of f'_{cr} shall be as specified in paragraph 2.2.7.2.

2.2.7 Required Average Compressive Strength, f'_{cr} .

In meeting the strength requirements specified in paragraph 1.7.1, the selected mixture shall have proportions so as to produce an f'_{cr} exceeding f'_c as indicated in paragraph 2.2.7.1 or 2.2.7.2.

2.2.7.1 For 15 or More Test Records

If a standard deviation is calculated as specified in paragraph 2.2.6, f'_{cr} shall be determined based on the value of f'_c and the standard deviation, S, as follows:

<u>Standard Deviation, S</u>	<u>Required Average Compressive Strength, f'_{cr} (psi)</u>
Less than or equal to 505	$f'_c + 1.34 S$
Greater than 505	$f'_c + 2.33 S - 500$

2.2.7.2 For less than 15 Test Records

When a concrete production facility does not have field strength test records for calculation of standard deviation, f'_{cr} shall be determined based on the value of f'_c as follows:

<u>Specified Compressive Strength, f'_c (psi)</u>	<u>Required Average Compressive Strength, f'_{cr} (psi)</u>
Less than 3000	$f'_c + 1000$
3000-5000	$f'_c + 1200$
Greater than 5000	$f'_c + 1400$

2.2.8 Documenting Average Strength

Documentation that proposed concrete proportions produce the required average strength, f'_{cr} , determined in paragraph 2.2.7 shall be based on previous field

experience (paragraph 2.2.8.1) or laboratory trial batches (paragraph 2.2.8.2). Documentation shall include compression, slump and air content tests performed on concrete produced using the proposed mixture proportions.

2.2.8.1 Field Experience

Required average strength can be documented by field experience if compressive strength test records consisting of not less than ten (10) consecutive tests and encompassing a period of not less than sixty (60) days are used. Test records shall represent similar materials to those proposed and similar conditions to those expected. Changes in materials, conditions, and proportions within the test record shall not have been more closely restricted than those for the proposed work.

2.2.8.2 Laboratory Trial Batches

The laboratory used to develop information required by this section shall comply with ASTM C 1077.

2.2.8.2.1 Delivery of Samples

Representative samples for all concrete materials proposed for this project and a copy of this Section entitled "CAST-IN-PLACE STRUCTURAL CONCRETE" shall be delivered to the laboratory that performs the concrete proportioning at least sixty (60) days (120 when pozzolan or GGBF slag is used) before concrete placement is expected to begin. Samples of approved aggregates shall be obtained in accordance with the requirements of ASTM D 75. Samples of materials other than aggregate shall be representative of those proposed for the project and shall be accompanied by manufacturer's test reports indicating compliance with applicable specification requirements. When all of these materials have been delivered, the name, address, and phone number of this laboratory and a list of the sources and types of all concrete materials shall be submitted to the Contracting Officer.

2.2.8.2.2 Trial Mixtures

Trial mixtures having proportions, consistencies, maximum slump, washout and maximum air content suitable for the work shall be made based on ACI 211.1, using at least three different water-cementitious materials ratios which will produce a range of strengths encompassing those required for the work. The trial mixtures shall have a slump and air content within plus or minus 3/4 inch and plus or minus one-half percent (0.5%), respectively, of the maximum permitted. The target water-cementitious materials ratios required in paragraph 1.7.2 include the total weight of cement plus pozzolan and GGBF slag, converted from absolute volume as described in ACI 211.1. Trial mixtures shall be designed in accordance with the procedure in ACI 211.1, Chapter 6, using the absolute volume basis for determining the required amount of fine aggregate. The dry rodded weight per cubic foot of the coarse aggregate determined according to ASTM C 29; the fineness modulus of the

fine aggregate determined according to CRD-C 104; and the yield, slump, washout and air content shall be reported. For each water-cementitious materials ratio at least three test cylinders for each test age shall be made and cured in accordance with ASTM C 192. They shall be tested in accordance with ASTM C 39 at seven (7) and twenty-eight (28) days (also 90 if pozzolan or GGBF slag is used). From these test results a curve shall be plotted and submitted showing the relationship between water-cementitious materials ratio and strength at design age. Trial mixtures shall be tested for washout in accordance with CRD-C 61.

2.2.9 Anti-Washout Admixture

Concrete to be placed underwater shall contain anti-washout admixture at the manufacturer's recommended dosage rate.

2.2.10 Washout

The maximum allowable washout determined in accordance with CRD-C 61 for the underwater concrete placed for the floodwall/bulkhead cap shall be eight percent (8%).

2.2.11 Cementitious Materials Content

For the floodwall/bulkhead cap's underwater concrete, the cementitious materials content shall be at least six hundred (600) pounds per cubic yard of concrete.

2.2.12 Fine Aggregate Content

For the floodwall/bulkhead cap's underwater concrete, fine aggregate shall comprise approximately forty-five to fifty-five percent (45% to 55%) by volume, of the total aggregate.

PART 3 EXECUTION

3.1 EQUIPMENT

3.1.1 Capacity

The batching, mixing, conveying, and placing equipment shall have a capacity of at least thirty (30) cubic yards per hour.

3.1.2 Batch Plant

Batch plant shall conform to the requirements of NRMCA CPMB 100 and as specified; however, rating plates attached to batch plant equipment are not required.

3.1.2.1 Batching Equipment

The batching controls shall be semiautomatic, or automatic. The semiautomatic batching system shall be provided with interlocks such that the discharge device cannot be actuated until the indicated material is within the applicable tolerance. The batching system shall be equipped with an accurate recorder or recorders that meet the requirements of NRMCA CPMB 100. Separate bins or compartments shall be provided for each size group of aggregate and cement, pozzolan, and GGBF slag. Aggregates shall be weighed either in separate weigh batchers with individual scales or cumulatively in one (1) weigh batcher on one (1) scale. Aggregate shall not be weighed in the same batcher with cement, pozzolan, or GGBF slag. If both cement and pozzolan or GGBF slag are used, they may be batched cumulatively provided that the portland cement is batched first. If measured by mass, the mass of the water shall not be weighed cumulatively with another ingredient. Water batcher filling and discharging valves shall be so interlocked that the discharge valve cannot be opened before the filling valve is fully closed. An accurate mechanical device for measuring and dispensing each admixture shall be provided. Each dispenser shall be interlocked with the batching and discharging operation of the water so that each admixture is separately batched and discharged automatically in a manner to obtain uniform distribution throughout the batch in the specified mixing period. Admixtures shall not be combined prior to introduction in water. The plant shall be arranged so as to facilitate the inspection of all operations at all times. Suitable facilities shall be provided for obtaining representative samples of aggregates from each bin or compartment. All filling ports for cementitious materials bins or silos shall be clearly marked with a permanent sign stating the contents.

3.1.2.2 Scales

The equipment for batching by mass shall conform to the applicable requirements of NIST HB 44, except that the accuracy shall be plus or minus two-tenths percent ($\pm 0.2\%$) of scale capacity. The Contractor shall provide standard test weights and any other auxiliary equipment required for checking the operating performance of each scale or other measuring devices. Tests shall be made at the frequency required in paragraph 3.7, and in the presence of a government inspector.

3.1.2.3 Batching Tolerances

The batching tolerances are as follows:

a). Weighing Tolerance	PERCENT OF REQUIRED MATERIAL MASS
Cementitious materials	0 to plus 2
Aggregate	plus or minus 2
Water	plus or minus 1
Chemical admixture	0 to plus 6

b). Volumetric Tolerances - For volumetric batching equipment, the following tolerances shall apply to the required volume of material being batched:

Water:Plus or minus 1 percent.
Chemical admixtures: Zero to plus 6 percent.

3.1.2.4 Moisture Control

The plant shall be capable of ready adjustment to compensate for the varying moisture content of the aggregates and to change the masses of the materials being batched. An electric moisture meter complying with the provisions of CRD-C 143 shall be provided for measuring moisture in the fine aggregate. The sensing element shall be arranged so that the measurement is made near the batcher charging gate of the sand bin or in the sand batcher.

3.1.3 Concrete Mixers

The concrete mixers shall not be charged in excess of the capacity recommended by the manufacturer. The mixers shall be operated at the drum or mixing blade speed designated by the manufacturer. The mixers shall be maintained in satisfactory operating condition, and the mixer drums shall be kept free of hardened concrete. Should any mixer at any time produce unsatisfactory results, its use shall be promptly discontinued until it is repaired.

3.1.3.1 Stationary Mixers

Concrete plant mixers shall be tilting, nontilting, horizontal-shaft, vertical-shaft, or pugmill and shall be provided with an acceptable device to lock the discharge mechanism until the required mixing time has elapsed. The mixing time and uniformity shall conform to all the requirements in ASTM C 94 applicable to central-mixed concrete.

3.1.3.2 Truck Mixers

Truck mixers, the mixing of concrete therein, and concrete uniformity shall conform to the requirements of ASTM C 94. A truck mixer may be used either for complete mixing (transit-mixed) or to finish the partial mixing done in a stationary mixer (shrink-mixed). Each truck shall be equipped with two (2) counters from which it will be possible to determine the number of revolutions at mixing speed and the number of revolutions at agitating speed.

3.1.4 Conveying Equipment

The conveying equipment shall conform to the following requirements.

3.1.4.1 Buckets

The interior hopper slope shall be not less than 58 degrees from the horizontal, the minimum dimension of the clear gate opening shall be at least five times the nominal maximum-size aggregate, and the area of the gate opening shall not be less than two (2) square feet. The maximum dimension of the gate opening shall not be greater than twice the minimum dimension. The bucket gates shall be essentially grout tight when closed and may be manually, pneumatically, or hydraulically operated except that buckets larger than two (2) cubic yards shall not be manually operated. The design of the bucket shall provide means for positive regulation of the amount and rate of deposit of concrete in each dumping position.

3.1.4.2 Transfer Hoppers

Concrete may be charged into nonagitating hoppers for transfer to other conveying devices. Transfer hoppers shall be capable of receiving concrete directly from delivery vehicles and have conical-shaped discharge features. The transfer hopper shall be equipped with a hydraulically operated gate and with a means of external vibration to effect complete discharge. Concrete shall not be held in nonagitating transfer hoppers more than thirty (30) minutes.

3.1.4.3 Trucks

Truck mixers operating at agitating speed or truck agitators used for transporting plant-mixed concrete shall conform to the requirements of ASTM C 94. Nonagitating equipment may be used for transporting plant-mixed concrete over a smooth road when the hauling time is less than fifteen (15) minutes. Bodies of nonagitating equipment shall be smooth, watertight, metal containers specifically designed to transport concrete, shaped with rounded corners to minimize segregation, and equipped with gates that will permit positive control of the discharge of the concrete.

3.1.4.4 Chutes

When concrete can be placed directly from a truck mixer, agitator, or nonagitating equipment, the chutes attached to this equipment by the manufacturer may be used. A discharge deflector shall be used when required by the Contracting Officer. Separate chutes and other similar equipment will not be permitted for conveying concrete.

3.1.4.5 Belt Conveyors

Belt conveyors shall be designed and operated to assure a uniform flow of concrete from mixer to final place of deposit without segregation of ingredients or loss of mortar and shall be provided with positive means for preventing segregation of the concrete at the transfer points and the point of placing. Belt conveyors shall be constructed such that the idler spacing shall not exceed thirty-six (36) inches. The belt speed shall be a minimum of three hundred (300) feet per minute and a maximum of seven hundred fifty (750) feet per minute. If concrete is to be placed through installed horizontal or sloping reinforcing bars, the conveyor shall discharge concrete into a pipe or elephant trunk that is long enough to extend through the reinforcing bars.

3.1.4.6 Concrete Pumps

Concrete may be conveyed by positive displacement pump when approved. The pumping equipment shall be piston or squeeze pressure. The pipeline shall be rigid steel pipe or heavy-duty flexible hose. The inside diameter of the pipe shall be at least three times the nominal maximum-size coarse aggregate in the concrete mixture to be pumped but not less than four (4) inches. Aluminum pipe shall not be used.

3.1.4.7 Tremie Equipment

Funnel-shaped hoppers of sufficient volume shall be required at the top of all tremie pipes, but shall not be less than two (2) cubic yards. Aluminum pipe or equipment shall not be used for placing concrete. The tremie pipe for underwater concrete shall have a diameter of eight (8) to twelve (12) inches to permit a free flow of concrete. Tremie pipes shall be made of steel and have watertight joints. Hoisting equipment for raising and lowering tremie pipes as the concrete is placed and tools for connecting the pipe sections shall be continuously available and on hand. Each section of tremie pipe shall be suitably secured together and a gasket used at each joint to prevent leakage. The tremie pipe shall be marked to allow quick determination of the distance from the surface of the water to the mouth of the tremie.

A stable platform shall be provided to the tremie pipe during placements. The platform shall be capable of supporting the tremie while sections are being removed from the upper end of the tremie. A dry pipe with a plate and gasket wired to the bottom to prevent contact of the concrete and the water in the pipe shall be required to start each placement. Go-devils or similar devices are not permitted.

3.1.5 Vibrators

Vibrators of the proper size, frequency, and amplitude shall be used for the type of work being performed in conformance with the following requirements:

Application	Head Diameter	Frequency	Amplitude
	Inches	VPM	Inches
Thin walls, beams, etc.	1-1/4 to 2-1/2	9,000 to 13,500	0.02 to 0.04
General construction	2 to 3-1/2	8,000 to 12,000	0.025 to 0.05

The frequency and amplitude shall be determined in accordance with CRD-C 521.

3.2 PREPARATION FOR PLACING

3.2.1 Embedded Items

Before placement of concrete, care shall be taken to determine that all embedded items are firmly and securely fastened in place as required. Embedded items shall be free of oil and other foreign matter such as loose coatings or rust, paint, and scale. The embedding of wood in concrete will be permitted only when specifically authorized or directed. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable materials to prevent the entry of concrete into voids. Welding, including tack welding, will not be permitted on embedded metals within two (2) feet of the surface of the concrete.

3.2.2 Concrete on Earth Foundations

Earth surfaces upon which concrete is to be placed shall be clean, damp, and free from debris, frost, ice, and standing or running water. Prior to placement of concrete, the earth foundation shall have been satisfactorily compacted in accordance with Section 02200, "EARTHWORK" or Section 02320, "STRUCTURAL EXCAVATION AND BACKFILL" as applicable.

3.2.3 Construction Joint Treatment

Construction joint treatment shall conform to the following requirements.

3.2.3.1 Joint Preparation

Concrete surfaces to which additional concrete is to be bonded shall be prepared for receiving the next lift or adjacent concrete by ensuring that the surface is roughened to an amplitude of one-quarter ($\frac{1}{4}$) inch by either air-water cutting, sandblasting, high-pressure water jet, or other approved method. Air-water cutting will not be permitted on formed surfaces or surfaces congested with reinforcing steel. Regardless of the

method used, the resulting surfaces shall be free from all laitance and inferior concrete so that clean, well bonded coarse aggregate is exposed uniformly throughout the lift surface. The edges of the coarse aggregate shall not be undercut. The surface shall be washed clean as the last operation prior to placing the next lift. There shall be no standing water on the surface upon which concrete is placed.

3.2.3.2 Air-Water Cutting

Air-water cutting of a construction joint shall be performed at the proper time and only on horizontal construction joints. The air pressure used in the jet shall be ninety (90) to one hundred ten (110) pounds per square inch, and the water pressure shall be just sufficient to bring the water into effective influence of the air pressure. When approved by the Contracting Officer, a retarder complying with the requirements of CRD-C 94 may be applied to the surface of the lift to prolong the period of time during which air-water cutting is effective. Prior to receiving approval, the Contractor shall furnish samples of the material to be used and shall demonstrate the method to be used in applications. After cutting, the surface shall be washed and rinsed as long as there is any trace of cloudiness of the wash water. Where necessary to remove accumulated laitance, coatings, stains, debris, and other foreign material, high-pressure water jet or sandblasting will be required as the last operation before placing the next lift.

3.2.3.3 High-Pressure Water Jet

A stream of water under a pressure of not less than three thousand (3,000) pounds per square inch may be used for construction joint preparation. Its use shall be delayed until the concrete is sufficiently hard so that only the surface skin of mortar is removed and there is no undercutting of coarse-aggregate particles. If the water jet is incapable of uniformly exposing coarse aggregate, the surface shall be prepared by sandblasting.

3.2.3.4 Wet Sandblasting

This method may be used when the concrete has reached sufficient strength to prevent undercutting of the coarse aggregate particles. The surface of the concrete shall then be washed thoroughly to remove all loose materials.

3.2.3.5 Waste Disposal

The method used in disposing of waste water employed in cutting, washing, and rinsing of concrete surfaces shall be such that the waste water does not stain, discolor, or affect exposed surfaces of the structures, or damage the environment of the project area. The method of disposal shall be subject to approval.

3.2.3.6 Joint Preparation for Bonding to Existing Concrete

Concrete surfaces where additional concrete is to be bonded to existing concrete shall be prepared for receiving the next lift or adjacent concrete by use of a chipping hammer, bush hammer, pneumatic scabbler or other engineer approved mechanical means. The resulting surfaces shall be free from all laitance and inferior concrete so that clean, sound, well-bonded coarse aggregate is exposed uniformly throughout the lift surface. The work required to achieve this condition regardless of the amount of inferior concrete that must be removed is considered incidental to the work included in the applicable unit cost for the concrete. No additional compensation for this work will be provided to the Contractor.

3.2.4 Underwater Concrete Placement

All platforms, tremie pipes, ramps and walkways, as required, shall be completed prior to any placements to allow safe and expeditious access for concrete and workmen. Snow, ice, flowing water, loose particles, debris and foreign matter shall have been removed. Reinforcement shall be secured in place; anchors and other embedded items shall have been positioned and anchored. The entire preparation shall be accepted by the Contracting Officer prior to placing. Underwater concrete placements shall commence immediately after final inspection of the area of placement, reinforcing steel and embedded items.

3.3 PLACING

3.3.1 Placing Procedures

The surfaces of horizontal construction joints shall be kept continuously wet for the first twelve (12) hours during the twenty-four (24) hour period prior to placing concrete. Surfaces may be dampened immediately before placement if necessary. Concrete placement will not be permitted when, in the opinion of the Contracting Officer, weather conditions prevent proper placement and consolidation. Concrete shall be deposited as close as possible to its final position in the forms and, in so depositing, there shall be no vertical drop greater than five (5) feet except where suitable equipment is provided to prevent segregation and where specifically authorized. Depositing of the concrete shall be so regulated that it may be effectively consolidated in horizontal layers two (2.0) feet or less in thickness with a minimum of lateral movement. The amount deposited in each location shall be that which can be readily and thoroughly consolidated. Sufficient placing capacity shall be provided so that concrete placement can be kept plastic and free of cold joints while concrete is being placed. Concrete shall be placed by methods that will prevent segregation or loss of ingredients. Any concrete transferred from one conveying device to another shall be passed through a hopper that is conical in shape. The concrete shall not be dropped vertically more than five (5) feet, except where a properly designed and sized elephant trunk with rigid drop chute bottom section is provided to prevent segregation and where specifically authorized. In no case shall concrete be discharged to free-fall through reinforcing bars.

3.3.2 Placement by Pump

When concrete is to be placed by pump, the nominal maximum-size coarse aggregate shall not be reduced to accommodate the pumps. The distance to be pumped shall not exceed limits recommended by the pump manufacturer. The concrete shall be supplied to the concrete pump continuously. When pumping is completed, concrete remaining in the pipeline shall be ejected without contamination of concrete in place. After each operation, equipment shall be thoroughly cleaned, and flushing water shall be wasted outside of the forms. Grout used to lubricate the pumping equipment at the beginning of the placement shall not be incorporated into the placement.

3.3.3 Time Interval Between Mixing and Placing

Concrete shall be placed within thirty (30) minutes after discharge into nonagitating equipment. When concrete is truck-mixed or when a truck mixer or agitator is used for transporting concrete mixed by a concrete plant mixer, the concrete shall be delivered to the site of the work, and discharge shall be completed within 1-1/2 hours after introduction of the cement to the aggregates. When the length of haul makes it impossible to deliver truck-mixed concrete within these time limits, batching of cement and a portion of the mixing water shall be delayed until the truck mixer is at or near the construction site.

3.3.4 Cold-Weather Placing

When cold-weather placing of concrete is likely to be subjected to freezing temperatures before the expiration of the curing period, it shall be placed in accordance with procedures previously submitted in accordance with paragraph 1.5. The ambient temperature of the space adjacent to the concrete placement and surfaces to receive concrete shall be above 32 degrees Fahrenheit. The placing temperature of the concrete having a minimum dimension less than twelve (12) inches shall be between 55 and 75 degrees Fahrenheit when measured in accordance with ASTM C 1064. The placing temperature of the concrete having a minimum dimension greater than twelve (12) inches shall be between 50 and 70 degrees Fahrenheit. Heating of the mixing water or aggregates will be required to regulate the concrete-placing temperatures. Materials entering the mixer shall be free from ice, snow, or frozen lumps. Salt, chemicals, or other materials shall not be mixed with the concrete to prevent freezing.

3.3.5 Hot-Weather Placing

Concrete shall be properly placed and finished with procedures previously submitted in accordance with paragraph 1.5. The concrete-placing temperature shall not exceed 90 degrees Fahrenheit when measured in accordance with ASTM C 1064. Cooling of the mixing water and aggregates, or both, may be required to obtain an adequate placing temperature. A retarder shall be used to facilitate placing and

finishing when concrete temperatures exceed 85 degrees Fahrenheit. Steel forms and reinforcement shall be cooled prior to concrete placement when steel temperatures are greater than 120 degrees Fahrenheit. Conveying and placing equipment shall be cooled if necessary to maintain proper concrete-placing temperature.

3.3.6 Consolidation

Immediately after placement, each layer of concrete, including flowing concrete, shall be consolidated by internal vibrating equipment. Vibrators shall not be used to transport concrete within the forms. Hand spading may be required, if necessary, with internal vibrating along formed surfaces permanently exposed to view. Form or surface vibrators shall not be used unless specifically approved. The vibrator shall be inserted vertically at uniform spacing over the entire area of placement. The distance between insertions shall be approximately 1-1/2 times the radius of action of the vibrator. The vibrator shall penetrate rapidly to the bottom of the layer and at least six (6) inches into the preceding unhardened layer if such exists. It shall be held stationary until there is a general cessation in escape of large bubbles of entrapped air at the surface of the concrete (generally five (5) to fifteen (15) seconds) then withdrawn slowly at about three (3) inches per second.

3.3.7 Placement Underwater

Underwater concrete shall be deposited in water by a tremie or concrete pump. Concrete buckets will not be permitted for underwater placement of concrete except to deliver concrete to the tremie. The tremie shall be watertight and sufficiently large to permit a free flow of concrete. The discharge end of the pump line or tremie shaft shall be kept continuously submerged in the concrete. The underwater seal shall be affected in a manner that will not produce undue turbulence in the water. The tremie shaft shall be kept full of concrete to a point well above the water surface. Placement shall proceed without interruption until the concrete has been brought to the required height. The tremie shall not be moved horizontally during a placing operation, and a sufficient number of tremies shall be provided so that the maximum horizontal flow will be limited to fifteen (15) feet.

3.4 FINISHING

The ambient temperature of spaces adjacent to surfaces being finished shall be not less than 40 degrees Fahrenheit. In hot weather when the rate of evaporation of surface moisture, as determined by use of Figure 2.1.5 of ACI 305R, may reasonably be expected to exceed two-tenths (0.2) pounds per square foot per hour, provisions for windbreaks, shading, fog spraying, or wet covering with a light-colored material shall be made in advance of placement, and such protective measures shall be taken as quickly as finishing operations will allow. All unformed surfaces that are not to be covered by additional concrete or backfill shall have a float finish. Additional finishing shall be as specified below and shall be true to the elevation required. Surfaces to

receive additional concrete or backfill shall be brought to the elevation required and left true and regular. Exterior surfaces shall be sloped for drainage unless otherwise directed. Joints shall be carefully made with a jointing or edging tool. The finished surfaces shall be protected from stains or abrasions. Grate tampers or jitterbugs shall not be used.

3.4.1 Unformed Surfaces

3.4.1.1 Float Finish

Surfaces shall be screeded and darbied or bullfloated to bring the surface to the required finish level with no coarse aggregate visible. No water, cement, or mortar shall be added to the surface during the finishing operation. The concrete, while still green but sufficiently hardened to bear a man's weight without more than about a ¼ inch indentation, shall be floated to a true and even plane. Floating may be performed by use of suitable hand floats or power-driven equipment. Hand floats shall be made of magnesium or aluminum.

3.4.1.2 Trowel Finish

A trowel finish shall be applied to the top surfaces of all floodwalls. Concrete surfaces shall be finished with a float finish, and after surface moisture has disappeared, the surface shall be troweled to a smooth, even, dense finish free from blemishes including trowel marks.

3.4.1.3 Broom Finish

A broom finish shall be applied to all gate structure roadway openings. The concrete surface shall be finished with a float finish. The floated surface shall be broomed with a fiber-bristle brush in a direction transverse to that of the main traffic.

3.4.2 Formed Surfaces

Unless another finish is specified, surfaces shall be left with the texture imparted by the forms except that defective surfaces shall be repaired as described in paragraph 3.4.3. Other finishes shall be applied to the following structures or portions of structures.

TYPES OF FINISH	STRUCTURE OR PORTION OF STRUCTURE
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**** To be added for each Task Order.**

Unless painting of surfaces is required, uniform color of the concrete shall be maintained by use of only one (1) mixture without changes in materials or proportions for any structure or portion of structure that is exposed to view or on which a special finish is required. The form panels used to produce the finish shall be orderly in arrangement, with joints between panels planned in approved relation to openings, corners, and other architectural features. Forms shall not be reused if there is any evidence of surface wear or defects that would impair the quality of the surface.

3.4.2.1 Grout-Cleaned Finish

The flood side and protected side surfaces of gate monoliths and floodwalls not textured finished shall be given a grout-cleaned finish as described, as approved by the Contracting Officer and after all required curing, cleaning, and repairs have been completed. Surfaces to be grout-cleaned shall be moist cured for the required period of time before application of the grout-cleaned finish. Grout cleaning shall be delayed until near the end of construction on all surfaces not to be painted in order to achieve uniformity of appearance and reduce the chance of discoloring caused by subsequent construction operations. The temperature of the air adjacent to the surface shall be not less than 40 degrees Fahrenheit for twenty-four (24) hours prior to and 72 hours following the application of the finish. The finish for any area shall be completed in the same day, and the limits of a finished area shall be made at natural breaks in the finished surface. The surface to receive grout-cleaned finish shall be thoroughly wetted to prevent absorption of water from the grout but shall have no free water present. The surface shall then be coated with grout. The grout shall be applied as soon as the surface of the concrete approaches surface dryness and shall be vigorously and thoroughly rubbed over the area with clean burlap pads, cork floats or stones, so as to fill all voids. The grout shall be composed of one part portland cement as used on the project, to two parts by volume of well-graded sand passing a No. 30 sieve mixed with water to the consistency of thick paint. White portland cement shall be used for all or part of the cement as approved by the Contracting Officer to give the desired finish color. The applied coating shall be uniform, completely filling all pits, air bubbles, and surface voids. While the grout is still plastic, remove all excess grout by working the surface with a rubber float, burlap pad, or other means. Then, after the surface whitens from drying (about thirty (30) minutes at normal temperature) rub vigorously with clean burlap pads. Immediately after rubbing is completed, the finished surface shall be continuously moist cured for seventy-two (72) hours. Burlap pads used for this operation shall be burlap stretched tightly around a board to prevent dishing the mortar in the voids.

3.4.2.2 Textured Finish

This type of finish shall be applied where specified to conform to details required by use of approved textured form liners. Liner panels shall be secured in the forms by methods recommended by the manufacturer but not by methods that will permit impressions of nail heads, screw heads, washers, or the like to be imparted to the surface of the concrete. Edges of textured panels shall be sealed to each other to prevent grout leakage. The sealant used shall be non-staining to the surface. The finish shall be similar to and shall closely match the finish on the sample panel.

3.4.3 Formed Surface Repair

After removal of forms, all ridges, lips, and bulges on surfaces permanently exposed shall be removed. All repairs shall be completed within forty-eight (48) hours after form removal.

3.4.3.1 Class A Finish

Surfaces listed in Section 03101, "FORMWORK FOR CONCRETE" and as shown to have class A finish shall have surface defects repaired as follows: defective areas, voids, and honeycombs smaller than sixteen (16) square inches in area and less than 1/2 inch deep and bug holes exceeding 1/2 inch in diameter shall be chipped and filled with dry-packed mortar. Holes left by removal of tie rods shall be reamed and filled with dry-packed mortar as specified in paragraph 3.4.3.3. Defective and unsound concrete areas larger than described shall be defined by 1/2 inch deep dovetailed saw cuts in a rectangular pattern with lines parallel to the formwork, the defective concrete removed by chipping, and the void repaired with replacement concrete. The prepared area shall be brush-coated with a latex bonding agent meeting the requirements of paragraph 2.1.7, or a neat cement grout after dampening the area with water. The void shall be filled with replacement concrete in accordance with paragraph 3.4.3.3.

3.4.3.2 Class D Finish

Surfaces listed in Section 03101, "FORMWORK FOR CONCRETE" and as shown to have class D finish shall have surface defects repaired as follows: defective areas, voids, and honeycombs greater than forty-eight (48) square inches in area or more than two (2) inches deep shall be defined by 1/2 inch deep dovetailed saw cuts in a rectangular pattern, the defective concrete removed by chipping and the void repaired with replacement concrete. The prepared area shall be brush-coated with a latex bonding agent meeting the requirements of paragraph 2.1.7, or a neat cement grout after dampening the area with water. The void shall be filled with replacement concrete in accordance with paragraph 3.4.3.3.

3.4.3.3 Material and Procedure for Repairs

The cement used in the dry-packed mortar or replacement concrete shall be a blend of the cement used for production of project concrete and white portland cement properly proportioned so that the final color of the mortar or concrete will match adjacent concrete. Trial batches shall be used to determine the proportions required to match colors. Dry-packed mortar shall consist of one (1) part cement to two and one-half (2-1/2) parts fine aggregate. The fine aggregate shall be that used for production of project concrete. The mortar shall be remixed over a period of at least thirty (30) minutes without addition of water until it obtains the stiffest consistency that will permit placing. Mortar shall be thoroughly compacted into the prepared void by tamping, rodding, ramming, etc. and struck off to match adjacent concrete. Replacement concrete shall be produced using project materials and shall be proportioned by the Contracting Officer. It shall be thoroughly compacted into the prepared void by internal vibration, tamping, rodding, ramming, etc. and shall be struck off and finished to match adjacent concrete. Forms shall be used to confine the concrete. If an expanding agent is used in the repair concrete, the repair shall be thoroughly confined on all sides including the top surface. Metal tools shall not be used to finish permanently exposed surfaces. The repaired areas shall be cured for seven (7) days. The temperature of the in situ concrete, adjacent air, and replacement mortar or concrete shall be above 40 degrees Fahrenheit during placement, finishing, and curing. Other methods and materials for repair may be used only when approved in writing by the Contracting Officer. Repairs of the so called "plaster-type" will not be permitted.

3.5 CURING AND PROTECTION

3.5.1 Duration

The length of the curing period shall be determined by the type of cementitious material, as specified below. Concrete shall be cured by an approved method.

Type III portland cement _____	3 days
Portland cement when accelerator is used to achieve high early strength, except when pozzolan or GGBF slag is used _____	3 days
Type I portland cement _____	7 days
Type IS or Type IP portland cement _____	7 days
Type II portland cement _____	14 days
Portland cement blended with 25 percent or less pozzolan or GGBF slag _____	14 days

Portland cement blended with more than

25 percent pozzolan or GGBF slag _____ 21 days

Immediately after placement, concrete shall be protected from premature drying, extremes in temperature, rapid temperature change, and mechanical damage. All materials and equipment needed for adequate curing and protection shall be available and at the placement site prior to the start of concrete placement. Concrete shall be protected from the damaging effects of rain for twelve (12) hours and from flowing water for fourteen (14) days, seven (7) days with Type III cement. No fire or excessive heat including welding shall be permitted near or in direct contact with concrete or concrete embedments at any time.

3.5.2 Moist Curing

Moist-cured concrete shall be maintained continuously, not periodically, wet for the entire curing period. Vertical surfaces shall be cured using soaker hoses, fog sprayers or sprinklers. Burlap may be used to assist moist curing provided that the wall and burlap are kept continuously saturated, including nights and weekends, and the burlap is kept in contact with the concrete being cured. If water or curing materials stain or discolor concrete surfaces that are to be permanently exposed, they shall be cleaned as required in paragraph 1.8.2. Where wooden form sheathing is left in place during curing, the sheathing shall be kept wet at all times. Where steel forms are left in place during curing, the forms shall be carefully broken loose from the hardened concrete and curing water continuously applied into the void so as to continuously saturate the entire concrete surface. Horizontal surfaces may be moist cured by ponding, by covering with a minimum uniform thickness of two (2) inches of continuously saturated sand, or by covering with saturated nonstaining burlap or cotton mats. Horizontal construction joints may be allowed to dry for twelve (12) hours immediately prior to the placing of the following lift.

3.5.3 Membrane-Forming Curing Compound

Concrete may be cured with an approved membrane-forming curing compound in lieu of moist curing except that membrane curing will not be permitted on any surface that is to receive any subsequent treatment dependent upon adhesion or bonding to the concrete, on any surface containing protruding steel reinforcement, or any surface maintained at curing temperature by use of free steam. A pigmented-type curing compound shall not be used on surfaces that will be exposed to view when the project is complete. Concrete cured with nonpigmented curing compound must be shaded from the sun for the first three (3) days when the ambient temperature is 90 degrees Fahrenheit or higher.

3.5.3.1 Application

The curing compound shall be applied to formed surfaces immediately after the forms are removed and prior to any patching or other surface treatment except the cleaning of loose sand, mortar, and debris from the surface. The surfaces shall be thoroughly moistened with water, and the curing compound applied as soon as free water disappears. The curing compound shall be applied to unformed surfaces as soon as free water has disappeared and bleeding has stopped. The curing compound shall be applied in a two-coat continuous operation by approved motorized power-spraying equipment operating at a minimum pressure of seventy-five (75) pounds per square inch, at a uniform coverage of not more than four hundred (400) square feet per gallon for each coat, and the second coat shall be applied perpendicular to the first coat. Concrete surfaces that have been subjected to rainfall within three (3) hours after curing compound has been applied shall be resprayed by the method and at the coverage specified. All concrete surfaces on which the curing compound has been applied shall be adequately protected for the duration of the entire curing period from pedestrian and vehicular traffic and from any other cause that will disrupt the continuity of the curing membrane.

3.5.4 Evaporation Retardant

The following concrete surfaces may be cured using sheet material:

Horizontal surfaces only:

Sheet curing shall not be used on vertical or near-vertical surfaces. All surfaces shall be thoroughly wetted and be completely covered with waterproof paper or polyethylene-coated burlap having the burlap thoroughly water-saturated before placing. Covering shall be laid with light-colored side up. Covering shall be lapped not less than twelve (12) inches and securely weighted down or shall be lapped not less than four (4) inches and taped to form a continuous cover with completely closed joints. The sheet shall be weighted to prevent displacement so that it remains in contact with the concrete during the specified length of curing. Coverings shall be folded down over exposed edges of slabs and secured by approved means. Sheets shall be immediately repaired or replaced if tears or holes appear during the curing period.

3.5.5 Cold-Weather Curing and Protection

When the daily outdoor low temperature is less than 32 degrees Fahrenheit, the temperature of the concrete shall be maintained above 40 degrees Fahrenheit for the first seven (7) days after placing. In addition, during the period of protection removal, the air temperature adjacent to the concrete surfaces shall be controlled so that concrete near the surface will not be subjected to a temperature differential of more than 25 degrees Fahrenheit as determined by observation of ambient and concrete temperatures indicated by suitable temperature measuring devices furnished by the Government as required and installed adjacent to the concrete surface and two (2)

inches inside the surface of the concrete. The installation of the thermometers shall be made by the Contractor at such locations as may be directed.

3.6 SETTING OF BASE PLATES AND BEARING PLATES

3.6.1 Setting of Plates

After being plumbed and properly positioned, column base plates, bearing plates for beams and similar structural members, and machinery and equipment base plates shall be provided with full bearing with nonshrink grout except where noted otherwise.

The space between the top of concrete or masonry-bearing surface and the bottom of the plate shall be approximately 1/24 of the width of the plate, but not less than 1/2 inch for plates less than twelve (12) inches wide. Concrete surfaces shall be rough, clean, and free of oil, grease, and laitance, and they shall be damp. Metal surfaces shall be clean and free of oil, grease, and rust.

3.6.2 Nonshrink Grout Application

Nonshrink grout shall conform to the requirements of paragraph 2.1.6. Water content shall be the minimum that will provide a flowable mixture and fill the space to be grouted without segregation, bleeding, or reduction of strength.

3.6.2.1 Mixing and Placing of Nonshrink Grout

Mixing and placing shall be in conformance with the material manufacturer's instructions and as specified. Ingredients shall be thoroughly dry-mixed before adding water. After adding water, the batch shall be mixed for three (3) minutes. Batches shall be of size to allow continuous placement of freshly mixed grout. Grout not used within thirty (30) minutes after mixing shall be discarded. The space between the top of the concrete or masonry-bearing surface and the plate shall be filled solid with the grout. Forms shall be of wood or other equally suitable material for retaining the grout and shall be removed after the grout has set. If grade "A" grout as specified in ASTM C 1107 is used, all surfaces shall be formed to provide restraint. The placed grout shall be worked to eliminate voids; however, overworking and breakdown of the initial set shall be avoided. Grout shall not be retempered or subjected to vibration from any source. Where clearances are unusually small, placement shall be under pressure with a grout pump. Temperature of the grout, and of surfaces receiving the grout, shall be maintained at 65 to 85 degrees Fahrenheit until after setting.

3.6.2.2 Treatment of Exposed Surfaces

After the grout has set, those types containing metallic aggregate shall have the exposed surfaces cut back one (1) inch and immediately covered with a parge coat of mortar proportioned by mass of one (1) part portland cement, two (2) parts sand, and sufficient water to make the mixture placeable. The parge coat shall have a smooth,

dense finish. The exposed surface of other types of nonshrink grout shall have a smooth, dense finish.

3.6.2.3 Curing

Grout and parge coats shall be cured in conformance with paragraph 3.5.

3.7 TESTS AND INSPECTIONS

Tests and inspections shall conform to the following requirements.

3.7.1 General

The Contractor shall perform the inspections and tests described below, and, based upon the results of these inspections and tests, he shall take the action required and submit reports as required. When, in the opinion of the Contracting Officer, the concreting operation is out of control, concrete placement shall cease. The laboratory performing the tests shall conform with ASTM C 1077. The individuals who sample and test concrete or the constituents of concrete 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 Technician, Grade I. The individuals who perform the inspection of concrete construction shall have demonstrated a knowledge and ability equivalent to the ACI minimum guidelines for certification of Concrete Construction Inspector. The Government will inspect the laboratory, equipment, and test procedures prior to start of concreting operations and at least once per year thereafter for conformance with ASTM C 1077.

3.7.2 Testing and Inspection Requirements

3.7.2.1 Fine Aggregate

a). Grading - At least once during each shift when the concrete plant is operating, there shall be one (1) sieve analysis and fineness modulus determination in accordance with ASTM C 136 and CRD-C 104 for the fine aggregate or for each size range of fine aggregate if it is batched in more than one size or classification. The location at which samples are taken may be selected by the Contractor as the most advantageous for control. However, the Contractor is responsible for delivering fine aggregate to the mixer within specification limits.

b). Corrective Action for Fine Aggregate Grading - When the amount passing on any sieve is outside the specification limits, the fine aggregate shall be immediately resampled and retested. If there is another failure on any sieve, the fact shall immediately be reported to the Contracting Officer.

c). Moisture Content Testing - When in the opinion of the Contracting Officer the electric moisture meter is not operating satisfactorily, there shall be at least four (4) tests for moisture content in accordance with ASTM C 566 during each eight (8) hour period of mixing plant operation. The times for the tests shall be selected randomly within the eight (8) hour period. An additional test shall be made whenever the slump is shown to be out of control or excessive variation in workability is reported by the placing foreman. When the electric moisture meter is operating satisfactorily, at least two direct measurements of moisture content shall be made per week to check the calibration of the meter. The results of tests for moisture content shall be used to adjust the added water in the control of the batch plant.

d). Moisture Content Corrective Action - Whenever the moisture content of the fine aggregate changes by one-half percent (0.5%) or more, the scale settings for the fine-aggregate batcher and water batcher shall be adjusted (directly or by means of a moisture compensation device) if necessary to maintain the specified slump.

3.7.2.2 Coarse Aggregate

a). Grading - At least once during each shift in which the concrete plant is operating, there shall be a sieve analysis in accordance with ASTM C 136 for each size of coarse aggregate. The location at which samples are taken may be selected by the Contractor as the most advantageous for production control. However, the Contractor shall be responsible for delivering the aggregate to the mixer within specification limits. A test record of samples of aggregate taken at the same locations shall show the results of the current test as well as the average results of the five (5) most recent tests including the current test. The Contractor may adopt limits for control which are coarser than the specification limits for samples taken at locations other than as delivered to the mixer to allow for degradation during handling.

b). Corrective Action for Grading - When the amount passing any sieve is outside the specification limits, the coarse aggregate shall be immediately resampled and retested. If the second sample fails on any sieve, that fact shall be reported to the Contracting Officer. Where two consecutive averages of five tests are outside specification limits, the operation shall be considered out of control and shall be reported to the Contracting Officer. Concreting shall be stopped and immediate steps shall be taken to correct the grading.

c). Coarse Aggregate Moisture Content - A test for moisture content of each size group of coarse aggregate shall be made at least twice per week. When two (2) consecutive readings for smallest size coarse aggregate differ by more than one percent (1.0%), frequency of testing shall be increased to that specified above for fine aggregate, until the difference falls below one percent (1.0%).

d). Coarse Aggregate Moisture Corrective Action - Whenever the moisture content of any size of coarse aggregate changes by one-half percent (0.5%) or more, the scale setting for the coarse aggregate batcher and the water batcher shall be adjusted if necessary to maintain the specified slump.

3.7.2.3 Deleterious Substances

a). When in the opinion of the Contracting Officer a problem exists in connection with deleterious substances in fine or coarse aggregates, test shall be made in accordance with ASTM C 33 at a frequency not less than one (1) per week.

b). When the results for a deleterious substance are outside the specification limit, the aggregate shall be resampled and retested for the deleterious substances that failed. If the second sample fails, that fact shall be immediately reported to the Contracting Officer. When material finer than No. 200 sieve for coarse aggregate exceeds the specification limit, immediate steps, such as washing or other corrective actions, shall be initiated.

3.7.2.4 Scales

a). Weighing Accuracy - The accuracy of the scales shall be checked by test weights prior to start of concrete operations and at least once every three (3) months for conformance with the applicable requirements of paragraph 3.1.2.2. Such tests shall also be made as directed whenever there are variations in properties of the fresh concrete that could result from batching errors.

b). Batching and Recording Accuracy - Once a week the accuracy of each batching and recording device shall be checked during a weighing operation by noting and recording the required weight, recorded weight, and the actual weight batched. The Contractor shall confirm that the calibration devices described in paragraph 3.1.2.2 for checking the accuracy of dispensed admixtures are operating properly.

c). Scales Corrective Action - When either the weighing accuracy or batching accuracy does not comply with specification requirements, the plant shall not be operated until necessary adjustments or repairs have been made. Discrepancies in recording accuracies shall be corrected immediately.

3.7.2.5 Batch-Plant Control

The measurement of all constituent materials including each cementitious material, each size of aggregate, water, and admixtures shall be continuously controlled. The aggregate weights and amount of added water shall be adjusted as necessary to compensate for free moisture in the aggregates. The amount of air-entraining agent shall be adjusted to control air content within specified limits. A report shall be prepared indicating type and source of each cementitious materials used, amount and

source of admixtures used, aggregate source, the required aggregate and water weights per cubic yard, amount of water as free moisture in each size of aggregate, and the batch aggregate and water weights per cubic yard for each class of concrete batched during plant operation.

3.7.2.6 Concrete Mixture

a). Air Content Testing - Air content tests shall be made when test specimens are fabricated. In addition, at least two (2) tests for air content shall be made on randomly selected batches of each separate concrete mixture produced during each eight (8) hour period of concrete production. Additional tests shall be made when excessive variation in workability is reported by the placing foreman or Government quality assurance representative. Tests shall be made in accordance with ASTM C 231. Test results shall be plotted on control charts, which shall at all times be readily available to the Government. Copies of the current control charts shall be kept in the field by the Contractor's quality control representatives and results plotted as tests are made. When a single test result reaches either the upper or lower action limit a second test shall immediately be made. The results of the two tests shall be averaged and this average used as the air content of the batch to plot on both the control chart for air content and the control chart for range, and for determining the need for any remedial action. The result of each test, or average as noted in the previous sentence, shall be plotted on a separate chart for each mixture on which an "average line" is set at the midpoint of the specified air content range from paragraph 2.2.3. An upper warning limit and a lower warning limit line shall be set one percentage (1.0%) point above and below the average line. An upper action limit and a lower action limit line shall be set one and one-half percentage (1.5%) points above and below the average line, respectively. The range between each two (2) consecutive tests shall be plotted on a control chart for range where an upper warning limit is set at two percentage (2.0%) points and an upper action limit is set at three percentage (3.0%) points. Samples for air content may be taken at the mixer, however, the Contractor is responsible for delivering the concrete to the placement site at the stipulated air content. If the Contractor's materials or transportation methods cause air content loss between the mixer and the placement, correlation samples shall be taken at the placement site as required by the Contracting Officer and the air content at the mixer controlled as directed.

b). Air Content Corrective Action - Whenever points on the control chart for percent air reach either warning limit, an adjustment shall immediately be made in the amount of air-entraining admixture batched. As soon as is practical after each adjustment, another test shall be made to verify the result of the adjustment. Whenever a point on the control chart range reaches the warning limit, the admixture dispenser shall be recalibrated to ensure that it is operating accurately and with good reproducibility. Whenever a point on either control chart reaches an action limit line, the air content shall be considered out of control and the concreting operation shall immediately be halted until the air

content is under control. Additional air content tests shall be made when concreting is restarted. All this shall be at no extra cost to the Government.

c). Slump Testing - In addition to slump tests which shall be made when test specimens are fabricated, at least four (4) slump tests shall be made on randomly selected batches in accordance with ASTM C 143 for each separate concrete mixture produced during each eight (8) hour or less period of concrete production each day. Also, additional tests shall be made when excessive variation in workability is reported by the placing foreman or Government's quality assurance representative. Test results shall be plotted on control charts which shall at all times be readily available to the Government. Copies of the current control charts shall be kept in the field by the Contractor's quality control representatives and results plotted as tests are made. When a single slump test reaches or goes beyond either the upper or lower action limit, a second test shall immediately be made on the same batch of concrete. The results of the two tests shall be averaged and this average used as the slump of the batch to plot on both the control chart for percent air and the chart for range, and for determining the need for any remedial action. An upper warning limit shall be set at 1/2 inch below the maximum allowable slump on separate control charts for percent air used for each type of mixture as specified in paragraph 2.2.4, and an upper action limit line and lower action limit line shall be set at the maximum and minimum allowable slumps, respectively, as specified in the same paragraph. The range between each consecutive slump test for each type of mixture shall be plotted on a single control chart for range on which an upper action limit is set at two (2) inches. Samples for slump shall be taken at the mixer, however, the Contractor is responsible for delivering the concrete to the placement site at the stipulated slump. If the Contractor's materials or transportation methods cause slump loss between mixer and the placement, correlation samples shall be taken at the placement site as required by the Contracting Officer and the slump at the mixer controlled as directed.

d). Slump Corrective Action - Whenever points on the control chart for slump reach the upper warning limit, an adjustment shall be immediately made in the batch weights of water and fine aggregate. The adjustments are to be made so that the total water content does not exceed that amount allowed by the maximum W/CM specified, based upon aggregates which are in a saturated surface-dry condition. When a single slump reaches the upper or lower action limit, no further concrete shall be delivered to the placing site until proper adjustments have been made. Immediately after each adjustment, another test shall be made to verify the correctness of the adjustment. Whenever two (2) consecutive slump tests, made during a period when there was no adjustment of batch weights, produce a point on the control chart for range at or above the upper action limit, the concreting operation shall immediately be halted and the Contractor shall take appropriate steps to bring the slump under control. Also, additional slump tests shall be made as directed. All this shall be at no additional cost to the Government.

e). Temperature - The temperature of the concrete shall be measured when compressive strength specimens are fabricated. Measurement shall be in accordance with ASTM C 1064. The temperature shall be reported along with the compressive strength data.

f). Compressive-Strength Specimens - At least one (1) set of test specimens shall be made each day on each different concrete mixture placed during the day. Additional sets of test cylinders shall be made, as directed by the Contracting Officer, when the mixture proportions are changed or when low strengths have been detected. A random sampling plan shall be developed by the Contractor and approved by the Contracting Officer prior to the start of construction. The plan shall assure that sampling is done in a completely random and unbiased manner. A set of test specimens for concrete with a twenty-eight (28) day specified strength per paragraph 1.7 shall consist of four (4) cylinders, two (2) to be tested at seven (7) days and two (2) at twenty-eight (28) days. A set of test specimens for concrete with a ninety (90) day strength per specified paragraph 1.7 shall consist of six (6) cylinders, two (2) tested at seven (7) days, two (2) at twenty-eight (28) days, and two (2) at ninety (90) days. Test specimens shall be molded and cured in accordance with ASTM C 31 and tested in accordance with ASTM C 39. All compressive-strength tests shall be reported immediately to the Contracting Officer. Quality control charts shall be kept for individual strength tests, moving average for strength, and moving average for range for each mixture. The charts shall be similar to those found in ACI 214.

3.7.2.7 Inspection Before Placing

Foundation or construction joints, forms, and embedded items shall be inspected for quality by the Contractor in sufficient time prior to each concrete placement to certify to the Contracting Officer that they are ready to receive concrete. The results of each inspection shall be reported in writing.

3.7.2.8 Placing

a). Placing Inspection - The placing foreman shall supervise all placing operations, shall determine that the correct quality of concrete or grout is placed in each location as directed and shall be responsible for measuring and recording concrete temperatures and ambient temperature hourly during placing operations, weather conditions, time of placement, yardage placed, and method of placement.

b). Placing Corrective Action - The placing foreman shall not permit batching and placing to begin until he has verified that an adequate number of vibrators in working order and with competent operators are available. Placing shall not be continued if any pile of concrete is inadequately consolidated. If any batch of

concrete fails to meet the temperature requirements, immediate steps shall be taken to improve temperature controls.

3.7.2.9 Vibrators

a). Vibrator Testing and Use - The frequency and amplitude of each vibrator shall be determined in accordance with CRD-C 521 prior to initial use and at least once a month when concrete is being placed. Additional tests shall be made as directed when a vibrator does not appear to be adequately consolidating the concrete. The frequency shall be determined at the same time the vibrator is operating in concrete with the tachometer held against the upper end of the vibrator head while almost submerged and just before the vibrator is withdrawn from the concrete. The amplitude shall be determined with the head vibrating in air. Two (2) measurements shall be taken, one near the tip and another near the upper end of the vibrator head and these results averaged. The make, model, type, and size of the vibrator and frequency and amplitude results shall be reported in writing.

b). Vibrator Corrective Action - Any vibrator not meeting the requirements of paragraph 3.1.5 shall be immediately removed from service and repaired or replaced.

3.7.2.10 Curing

a). Moist-Curing Inspections - At least once each shift, and once per day on non-work days an inspection shall be made of all areas subject to moist curing. The surface moisture condition shall be noted and recorded.

b). Moist-Curing Corrective Action - When a daily inspection report lists an area of inadequate curing, immediate corrective action shall be taken, and the required curing period for such areas shall be extended by one (1) day.

c). Membrane-Curing Inspection - No curing compound shall be applied until the Contractor's authorized representative has verified that the compound is properly mixed and ready for spraying. At the end of each operation, he shall estimate the quantity of compound used by measurement of the container and the area of concrete surface covered and compute the rate of coverage in square feet per gallon. He shall note whether or not coverage is uniform.

d). Membrane-Curing Corrective Action - When the coverage rate of the curing compound is less than that specified or when the coverage is not uniform, the entire surface shall be sprayed again.

e). Sheet-Curing Inspection - At least once each shift and once per day on nonwork days, an inspection shall be made of all areas being cured using

material sheets. The condition of the covering and the tightness of the laps and tapes shall be noted and recorded.

f). Sheet-Curing Corrective Action - When a daily inspection report lists any tears, holes, or laps or joints that are not completely closed, the tears and holes shall promptly be repaired or the sheets replaced, the joints closed, and the required curing period for those areas shall be extended by one (1) day.

3.7.2.11 Cold-Weather Protection and Sealed Insulation Curing

At least once each shift and once per day on non-work days, an inspection shall be made of all areas subject to cold-weather protection. The protection system shall be inspected for holes, tears, unsealed joints, or other deficiencies that could result in damage to the concrete. Special attention shall be taken at edges, corners, and thin sections. Any deficiencies shall be noted, corrected, and reported.

3.7.2.12 Cold-Weather Protection Corrective Action

When a daily inspection report lists any holes, tears, unsealed joints, or other deficiencies, the deficiency shall be corrected immediately and the period of protection extended one (1) day.

3.7.2.13 Mixer Uniformity

a). Stationary Mixers - Prior to the start of concrete placing and once every six (6) months when concrete is being placed, or once for every seventy-five thousand (75,000) cubic yards of concrete placed, whichever results in the longest time interval, uniformity of concrete mixing shall be determined in accordance with ASTM C 94.

b). Truck Mixers - Prior to the start of concrete placing and at least once every six (6) months, uniformity of concrete shall be determined in accordance with ASTM C 94. The truck mixers shall be selected randomly for testing. When satisfactory performance is found in one truck mixer, the performance of mixers of substantially the same design and condition of the blades may be regarded as satisfactory.

3.7.2.14 Mixer Uniformity Corrective Action

When a mixer fails to meet mixer uniformity requirements, either the mixer shall be removed from service on the work, the mixing time shall be increased, batching sequence changed, batch size reduced, or adjustments shall be made to the mixer until compliance is achieved.

3.7.3 Reports

All results of tests or inspections conducted shall be reported informally as they are completed and in writing daily. A weekly report shall be prepared for the updating of control charts covering the entire period from the start of the construction season through the current week. During periods of cold-weather protection, reports of pertinent temperatures shall be made daily. These requirements do not relieve the Contractor of the obligation to report certain failures immediately as required in preceding paragraphs. Such reports of failures and the action taken shall be confirmed in writing in the routine reports. The Contracting Officer has the right to examine all test and inspection records.

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SECTION 05500 - MISCELLANEOUS METALWORK

PART 1 GENERAL

1.1 SCOPE

The work covered by this Section consists of furnishing all plant, labor, materials and equipment, and furnishing and installing the miscellaneous metalwork as specified herein and shall include, but is not limited to, the following items:

1.1.1 Corrosion Resistant Steel (C.R.S.)

Settlement reference bolts

Identification tag for reference bolts

Gate seal plates (except welded anchors) and track plates

Seal retaining bars

Latching devices including handles, latching pad eyebolt, plate washers, double end stud, eye hooks, turnbuckles, and anchor rods

1.2 FABRICATED STEEL

Galvanized floodwall ladders

Galvanized corner protection angles with welded stud anchors

Slip joint T-wall

Steel Dolphin pipe braces, padeyes, and mooring bits

1.3 FABRICATED ALUMINUM

Aluminum Stop Logs

1.4 MANUFACTURED PRODUCTS

Flexible bonding jumpers for bonding of piling as specified in Section 16640, "CATHODIC PROTECTION".

Galvanized 18 gage steel sheet metal.

Padlocks, bicycle locks, eye hooks, turnbuckles, clevises, plastic sealant, grout, screw jacks, chains, wire rope clip and thimble, and anchors as specified herein.

1.5 FORGED AND MACHINED STEEL

Welded anchors for gate seal plates, including anchor bolts, leveling nuts and steel beams.

1.6 HINGES AND BEARING

Hinges for the swing gate include set screws, bolts, nuts, washers, shims, grease seals and fittings, bronze bushings, upper hinge shaft, thrust washers, struts, bearing plate, and bearing pedestal.

1.7 REFERENCES

The following publications of the issues listed below but referred to thereafter by basic designation only form a part of this specification to the extent indicated by the references thereto or as required.

ALUMINUM ASSOCIATION (AA)

AA DAF-45 (1997) Designation System for Aluminum Finishes

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

Manual of Steel Construction

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A14.3 (2002) Ladders - Fixed - Safety Requirements

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

A 36 (2005) Carbon Structural Steel

A53 (2006) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

A 123 (2002) Zinc (Hot Dip-Galvanized) Coatings on Iron and Steel Products

A 276 (2006) Stainless Steel Bars and Shapes

A 413 (2001) Carbon Steel Chain

A 489	(2004) Carbon Steel Lifting Eyes
A 500	(2003a) Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
A 513	(2006) Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing
A 572	(2006) High-Strength Low-Alloy Columbium-Vanadium Structural Steel
A 603	(1998(2003)) Zinc-Coated Steel Structural Wire Rope
A 615	(2006a) Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
A 653	(2006) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
A 924	(2004) General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
A 992	(2006) Structural Steel Shapes
B 22	(2002) Bronze Castings for Bridges and Turntables
B 26	(2005) Aluminum-Alloy Sand Castings
B 209	(2004) Aluminum and Aluminum Alloy Sheet and Plate
B 221	(2005b) Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
B 308	(2002) Aluminum Alloy 6061-T6 Standard Structural Profiles
D 395	(2003) Rubber Property—Compression Set
D 412	(98a(2002)e1) Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers-Tension
D 471	(1998e2) Rubber Property-Effect of Liquids
D 572	(2004) Rubber Deterioration by Heat and Oxygen

D 2000 (2006) Standard Classification System for Rubber Products in Automotive Applications
D 2240 (2005) Rubber Property-Durometer Hardness
F 467 (2006) Nonferrous Nuts for General Use

AMERICAN WELDING SOCIETY (AWS)

D1.1/D1.1M (2006) Structural Welding Code - Steel

FEDERAL SPECIFICATIONS (FED. SPEC.)

FF-C-450D(1) (14 May 1974) Clamp, Wire Rope
FF-N-836E (14 Sep 1994) Nut: Square, Hexagon, Cap Slotted, Castle, Knurled, Welding and Single Ball Seat
FF-P-386D(1) (16 Dec 1971) Pins, Cotter (Split)
FF-T-276B(1) (31 Mar 1989) Thimbles, Rope
FF-W-92B(1) (9 May 1974) Washers, Flat (Plain)
SS-S-210A(1) (31 Oct 1987) Sealing Compound, Preformed Plastic, for Expansion Joints and Pipe Joints

COMMERCIAL ITEM DESCRIPTION (CID)

A-A-1923(A) (18 July 1995) Shield Expansion (Lag, Machine and Externally Threaded Wedge Bolt Anchors)

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

MBG 531 (2000) Metal Bar Grating Manual
MBG 532 (1994) Heavy Duty Metal Bar Grating Manual

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-344(B) (15 Aug 1996) Lacquer, Clear Gloss, Exterior, Interior

1.8 QUALITY CONTROL

1.8.1 General

The Contractor shall establish and maintain quality control for proper fabrication and installation of all work covered in this Section to assure compliance with the requirements of this Section and maintain records of his quality control for all construction operations including but not limited to the following:

- 1). Fabrication.
- 2). Protective coating.
- 3). Placement and protection.
- 4). Material compliance with plans and specifications.

1.8.2 Reporting

The original and two (2) copies of these records and tests, as well as the records of corrective action taken, shall be furnished to the Government daily. Format of the report shall be as prescribed in Section 01451, "CONTRACTOR QUALITY CONTROL".

1.9 SUBMITTALS

1.9.1 Shop Drawings

The Contractor shall prepare and submit for approval, complete shop drawings and descriptive literature showing details of all auxiliary items required as indicated herein. Shop drawings shall indicate computed weights of structural steel and approval of shop drawings will constitute acceptance of the computed weights shown on these drawings.

1.9.2 Manufacturer's Certification

The galvanizing compound shall be certified for compliance with all specification requirements.

1.10 BIDDING SCHEDULE LINE ITEM

1.10.1 Miscellaneous Metalwork – Carbon Steel

Bidding Schedule Line Item for "Miscellaneous Metalwork – Carbon Steel" shall constitute full compensation for material, fabrication, painting and installation of the

miscellaneous metalwork including all required fasteners, support brackets, and all other work incidental thereto.

1.10.2 Miscellaneous Metalwork – Galvanized Carbon Steel

Bidding Schedule Line Item for "Miscellaneous Metalwork – Galvanized Carbon Steel" shall constitute full compensation for material, fabrication, galvanizing and installation of the miscellaneous metalwork including all required fasteners, support brackets, and all other work incidental thereto.

1.10.3 Miscellaneous Metalwork – Stainless Steel

Bidding Schedule Line Item for "Miscellaneous Metalwork – Stainless Steel" shall constitute full compensation for material, fabrication, and installation of the miscellaneous metalwork including all required fasteners, support brackets, and all other work incidental thereto.

1.10.4 Miscellaneous Metalwork – Aluminum

Bidding Schedule Line Item for "Miscellaneous Metalwork – Aluminum" shall constitute full compensation for material, fabrication, and installation of the miscellaneous metalwork including all required fasteners, support brackets, and all other work incidental thereto.

1.10.5 Steel Handrail

Bidding Schedule Line Item for "Steel Handrail" shall constitute full compensation for fabrication and installation of the steel handrails including all required fasteners, inserts, painting and all other work incidental thereto.

1.10.6 Aluminum Handrail

Bidding Schedule Line Item for "Aluminum Handrail" shall constitute full compensation for fabrication and installation of the aluminum handrails including all required fasteners, support brackets, and all other work incidental thereto.

1.10.7 Grating

Bidding Schedule Line Items for "Steel Grating" or "Aluminum Grating" shall constitute full compensation for material, fabrication, and installation of the grating including all required fasteners, support brackets, and all other work incidental thereto.

1.10.8 Gate Miscellaneous Hardware

Bidding Schedule Line Items for "Gate Miscellaneous Hardware – Swing Gate", "Gate Miscellaneous Hardware – Roller Gate", and "Gate Miscellaneous Hardware – Railroad Gate" shall constitute full compensation for material, fabrication, and installation of the gate miscellaneous hardware including all required fasteners.

1.10.9 Grout

Bidding Schedule Line Item for "Grout" shall constitute full compensation for material and installation of the grout including any grout dams or other means of keeping the grout in place until it is set.

1.10.10 Other Miscellaneous Hardware

Bidding Schedule Line Item for "Miscellaneous Hardware" shall include all miscellaneous items not included in any of the Line Items specified herein.

1.10.11 Miscellaneous Metalwork – Gray Iron Castings

Bidding Schedule Line Item for "Miscellaneous Metalwork – Castings" shall constitute full compensation for material, fabrication, and installation of the miscellaneous metalwork castings.

1.11 GENERAL REQUIREMENTS

The Contractor shall verify all measurements and shall take all field measurements necessary before fabrication. Welding to or on structural steel shall be in accordance with AWS D1.1/D1.1M. Items specified to be galvanized, when practicable and not indicated otherwise, shall be hot-dip galvanized after fabrication. Galvanizing shall be in accordance with ASTM A 123, ASTM A 653, or ASTM A 924, as applicable. Exposed fastenings shall be compatible materials, shall generally match in color and finish, and shall harmonize with the material to which fastenings are applied. Materials and parts necessary to complete each item, even though such work is not definitely shown or specified, shall be included. Poor matching of holes for fasteners shall be cause for rejection. Fastenings shall be concealed where practicable. Thickness of metal and details of assembly and supports shall provide strength and stiffness. Joints exposed to the weather shall be formed to exclude water.

1.12 DISSIMILAR MATERIALS

Where dissimilar metals are in contact, or where aluminum is in contact with concrete, or absorptive materials subject to wetting, the surfaces shall be protected with a coat of bituminous paint or asphalt varnish.

1.13 WORKMANSHIP

Miscellaneous metalwork shall be well formed to shape and size, with sharp lines and angles and true curves. Drilling and punching shall produce clean true lines and surfaces. Welding shall be continuous along the entire area of contact except where tack welding is permitted. Exposed connections of work in place shall not be tack welded. Exposed welds shall be ground smooth. Exposed surfaces of work in place shall have a smooth finish. Where tight fits are required, joints shall be milled. Corner joints shall be coped or mitered, well formed, and in true alignment. Work shall be accurately set to established lines and elevations and securely fastened in place. Installation shall be in accordance with manufacturer's installation instructions and approved drawings, cuts, and details.

1.14 ANCHORAGE

Anchorage shall be provided where necessary for fastening miscellaneous metal items securely in place. Anchorage not otherwise specified or indicated shall include slotted inserts made to engage with the anchors, expansion shields, and power-driven fasteners when approved for concrete; toggle bolts and through bolts for masonry; machine and carriage bolts for steel.

1.15 ALUMINUM FINISHES

Unless otherwise specified, aluminum items shall have standard mill finish. The thickness of the coating shall be not less than that specified for protective type finishes for items used in exterior locations in AA DAF-45. Aluminum surfaces to be in contact with plaster or concrete during construction shall be protected with a field coat conforming to CID A-A-344.

1.16 SHOP PAINTING

Surfaces of ferrous metal except galvanized surfaces, shall be cleaned and shop coated with the manufacturer's standard protective coating unless otherwise specified. Surfaces of items to be embedded in concrete shall not be painted. Items to be finish painted shall be prepared according to manufacturer's recommendations or as specified.

PART 2 PRODUCTS

2.1 FABRICATED AND MANUFACTURED CARBON STEEL ITEMS

Fabrication and placement of all fabricated items shall conform to the applicable provisions of Section 05501, "METALWORK FABRICATION, MACHINE WORK, AND MISCELLANEOUS PROVISIONS".

2.1.1 Metal Straps for Pipe Supports

Metal straps for pipe supports shall conform to ASTM A 36.

2.1.2 Structure Walkway Supports

Tubular members shall be fabricated of steel conforming to ASTM A 36, and shall be galvanized after fabrication as specified in Section 05501, "METALWORK FABRICATION, MACHINE WORK, AND MISCELLANEOUS PROVISIONS".

2.1.3 Discharge Bell Support

All support plates and stiffeners shall be of painted ASTM A 36 steel plates of the sizes indicated.

2.1.4 Miscellaneous Plates and Shapes

Miscellaneous plates, pipe, structural tubing, and shapes for items that do not form a part of the structural steel framework shall be provided to complete the work. Corner guards shall be fabricated of steel conforming to ASTM A 36, ASTM A 53 (Grade B), ASTM A 500 (Grade B), ASTM A 572 (Grade 50), or ASTM A992 and painted in accordance with Section 09940, "PAINTING", unless specified otherwise, after fabrication.

2.1.5 Fasteners

Fasteners for carbon steel shall meet the requirements of paragraph 05501- 2.1.2, unless specified otherwise.

2.2 FABRICATED AND MANUFACTURED GALVANIZED STEEL ITEMS

2.2.1 Ladders

Ladders shall be fixed-rail metal ladders conforming to the requirements of ANSI A14.3. Ladders shall be fabricated of steel conforming to ASTM A 36, and shall be galvanized after fabrication as specified in Section 05501, "METALWORK FABRICATION, MACHINE WORK, AND MISCELLANEOUS PROVISIONS". Fabrication of ladders shall consist of solid-section rod rungs fitted into holes in bar side rails and welded. Splices in side rails shall be made using full penetration welds and shall be a smooth transition between connecting ends without sharp or extensive projections. All welds shall be ground smooth. Ladders shall be anchored to supporting structures with either expansion or epoxy anchors as specified in paragraphs 2.14.2 or 2.14.3.

2.2.2 Corner Guards

Corner guards and sills of openings and edges of abutment shall be steel shapes anchored in concrete with end weld stud anchors. Corner guards shall be fabricated of steel conforming to ASTM A 36 or ASTM A 572 and galvanized after fabrication.

2.2.3 Pipe Sleeves

Pipe sleeves shall be ASTM A 53, Schedule 40 galvanized pipe. Galvanized bolting shall be used to attach pipe sleeve to discharge bell.

2.2.4 Miscellaneous Plates and Shapes

Miscellaneous plates, pipe, structural tubing, and shapes for items that are not included in the paragraphs above, but are required complete the work shall be fabricated of steel conforming to ASTM A 36, ASTM A 53 (Grade B), ASTM A 500 (Grade B), ASTM A 572 (Grade 50), or ASTM A992 and galvanized after fabrication.

2.2.5 Fasteners

Fasteners for galvanized carbon steel shall meet the requirements of paragraph 05501- 2.1.2, unless specified otherwise.

2.3 FABRICATED AND MANUFACTURED STAINLESS STEEL ITEMS

Fabrication and placement of all fabricated items shall conform to the applicable provisions of Section 05501, "METALWORK FABRICATION, MACHINE WORK, AND MISCELLANEOUS PROVISIONS".

2.3.1 Corrosion Resistant Steel

Corrosion resistant steel shall conform to ASTM A 276, Type 304. High strength corrosion resistant steel shall conform to ASTM A 276, Type 431.

2.3.2 Seal Plates

Seal plates shall be solid corrosion-resistant steel of the sizes and dimensions required. Corrosion resistant steel shall conform to ASTM 276, Type 304. Seal plates may be spliced at the Contractor's convenience and at no cost to the Government. The Contractor shall not commence work on any seal plate splice until the procedure has been approved by the Contracting Officer.

2.3.3 Fasteners

Fasteners for stainless steel shall meet the requirements of paragraph 05501- 2.1.3, unless specified otherwise.

2.4 FABRICATED AND MANUFACTURED ALUMINUM ITEMS

Fabrication and placement of all fabricated items shall conform to the applicable provisions of Section 05501, "METALWORK FABRICATION, MACHINE WORK, AND MISCELLANEOUS PROVISIONS".

2.4.1 Aluminum

Aluminum structural shapes shall conform to ASTM B 308. Plates and bars shall conform to ASTM B 209.

2.5 HANDRAILS

2.5.1 Steel Handrail

Rails and posts shall consist of 1-1/2" nominal size schedule 40 steel pipe conforming to ASTM A 53 Grade B. Posts shall not be spaced more than five (5) feet on center and shall be located at all corners and changes in direction. All steel handrail shall be hot dipped galvanized after fabrication as specified herein and in Section 05501, "METALWORK FABRICATION, MACHINE WORK, AND MISCELLANEOUS PROVISIONS".

2.5.2 Aluminum Handrail

Handrails shall consist of 1-3/4 inch square aluminum semi-hollow tube with rounded corners ASTM B 221. Railings and pipe collars shall be mill finish. All fasteners shall be Type 300 stainless steel. Jointing shall be by one of the following methods:

- 1). Flush type rail fittings, welded and ground smooth with splice locks secured with 3/8 inch recessed head setscrews.
- 2). Mitered and welded joints, made by fitting post to top rail and intermediate rail to post and corners, shall be groove welded and ground smooth. Splices, where allowed by the Contracting Officer, shall be butted and reinforced by a tight fitting dowel or sleeve not less than six (6) inches in length. Dowel or sleeve shall be connected to one side of the splice by tack welding or by using epoxy cement.
- 3). Railings shall be assembled using slip-on aluminum-magnesium alloy fittings for joints. Fittings shall be fastened to pipe or tube with 1/4 inch or 3/8 inch stainless steel recessed head setscrews. Assembled railings shall be provided with fittings only at vertical supports or at rail terminations attached to walls.

Expansion joints shall be at the midpoint of panels. A setscrew shall be provided in only one side of the slip-on sleeve. Alloy fittings shall conform to ASTM B 26.

4). Removable sections, toe-boards and brackets shall be provided where indicated, using flange castings as appropriate.

2.6 GRATING

Grating shall be fabricated to span the openings required and shall support a uniform design load of one hundred (100) pounds per square foot. Grating shall be designed in accordance with NAAMM MBG 531 and/or NAAMM MBG 532 to meet the indicated load requirements. Edges shall be banded with bars 1/4 inch less in height than bearing bars for grating sizes above 3/4 inch. Banding bars shall be flush with the top of bearing grating. Grating bars shall be connected together by cross bars that are swaged on either side of the bearing bars. Grating bars shall have a serrated surface for foot traffic and shall have a minimum of one and a quarter (1 1/4) inches deep by one eighth (3/16) inch wide and spaced at maximum one and three-sixteenths (1 3/16) inch centers. At maximum span, the grating shall have a safe uniform load capacity of at least one hundred (100) pounds per square foot, with a mid-span deflection of one quarter (1/4) inch or less. All grating shall be secured on twenty (20) inch on center spacing with Type 316 stainless steel saddle type clips and fastened to the support frame.

2.6.1 Steel Grating

Grating shall be fabricated from either ASTM A 36 or A 572 steel and shall be galvanized after fabrication in accordance with Section 05501, "METALWORK FABRICATION, MACHINE WORK, AND MISCELLANEOUS PROVISIONS".

2.6.2 Aluminum Grating

Grating shall be serrated and shall be made from aluminum meeting the requirements of ASTM B 221, Alloy 6063 or Alloy 6061, Temper T6. Grating shall be pressure locked close mesh rectangular design. Main bars and cross bars to be slotted at their intersections so as not to remove excessive material from the load-sustaining members. Main bars shall be "dovetail" slotted and have their slots solidly filled by cross bars. Finish shall be mill finish.

2.7 GATE MISCELLANEOUS HARDWARE

2.7.1 Turnbuckles, Clevises and Fitted Bolts

Turnbuckles and clevises for gates shall be furnished in the sizes and to the dimensions required. Turnbuckles and clevises shall be forged, zinc coated steel with U.N.C. threads and shall conform to dimensions and working loads as indicated in the AISC "Manual of Steel Construction".

2.7.2 Fitted Bolts

Fitted or turned bolts shall be as specified in paragraph 05501-2.1.3.7. Cotter pins for fitted bolts shall conform to the provisions of Fed Spec. FF-P-386D(1), Type C, Size 3/8 by 2-1/2 inch. Nuts shall conform to ASTM F 467, Alloy CU 464 and washers to Fed. Spec. FF-W-92B(1), as indicated in 05501-2.1.3.7.

2.7.3 Latching Devices

2.7.3.1 Bicycle Locks

Bicycle locks shall be No. 8029A21 Long Shackle Laminated Brass Padlock, keyed alike, as shown in McMaster-Carr Supply Co., Catalog 91, or an approved equal for use at swing gates.

2.7.3.2 Padlocks

Padlocks for gates shall be Master Lock, Co. No. 517KA or an approved equal. All padlocks of each type shall be keyed alike.

2.7.3.3 Eye Hook

Eye hooks for latching devices shall be 1-1/2 ton (safe working load) as manufactured by Crosby- Laughlin, catalog No. 950-5, Item No. 320A (Alloy Steel), or equal. Eye hooks shall be hot-dip galvanized.

2.7.3.4 Standard Turnbuckles

Standard turnbuckles for latching devices shall be 3/4-inch by 6-inch C.R.S., Item No. M- 10-St, manufactured by Holloway Louisiana, or an approved equal.

2.7.4 Hinges

2.7.4.1 Hinge and Bearing for Swing Gate

Hinges for the swing gate include set screws, bolts, nuts, washers, shims, grease seals and fittings, mechanical tubing, bronze bushings, upper hinge shaft, thrust washers, struts, bearing plate, and bearing pedestal.

2.7.4.1.1 Bearing Pedestal

The bearing pedestal shall consist of a stainless steel shaft conforming to ASTM A 276, Type 431, with a stainless steel bottom plate conforming to ASTM A 276, Type 304.

2.7.4.1.2 Lubrication Fittings

Lubrication fittings for bearing shall be pressure type with thread or surface check and 1/8-inch NPT threads, Alemite, or an approved equal. Grease seals shall be Garlock Std., Closure No. 2176 and 2753, or an approved equal.

2.7.4.1.3 Bushings, Thrust Washers, and Upper Hinge Shaft

Bushings, thrust washers, and upper hinge shaft shall conform to the applicable provisions of ASTM B 22, Copper Alloy No. 937. The upper hinge shaft shall be high-strength, corrosion-resistant steel conforming to ASTM A 276, Type 431.

2.7.4.1.4 Mechanical Tubing

The mechanical tubing for hinges shall consist of cold-rolled, electric-resistant, welded carbon material conforming to the applicable provisions of ASTM A 513, Type 6.

2.7.5 Screw Jacks

Screw jacks for the swing gate shall have a twelve (12) ton rated capacity with a 1-1/2 by 8-inch malleable base, bell bottom, ball-bearing screw jack as manufactured by Simplex Model No. 03090, or an approved equal.

2.7.6 Steel Casters

Steel casters for bottom roller gate shall be heavy duty, rigid type, roller bearing with metal wheels and lubrication fitting with removable axle, similar to the Service Caster Co., Part No. R-MD-84 FVH 8" V-groove rigid caster or equal.

2.7.7 Gate Seals

Gate seals for the gate shall be made to the shapes, sizes and dimensions shown for Buckhorn No. 2514 and shall be made from rubber.

2.7.7.1 Rubber Seals

The rubber seals shall be molded only and the material shall be compounded of natural rubber or a copolymer of butadiene and styrene, or a blend of both and shall contain reinforcing carbon black, zinc oxide, accelerators, antioxidants, vulcanizing agents and plasticizers. Physical characteristics shall meet the following requirements:

PHYSICAL TEST	TEST VALUE	TEST METHOD SPECIFICATION
Tensile Strength	3000 psi (min)	ASTM D 412
Elongation at Break	450% (min)	ASTM D 412

PHYSICAL TEST	TEST VALUE	TEST METHOD SPECIFICATION
300% Modulus	900 psi (min)	ASTM D 2412
Durometer Hardness Shore Type A	60 to 70	ASTM D 2240
Water Absorption	5% by weight (max)	ASTM D 471
Compression Set	30% (max)	ASTM D 395
Tensile Strength After Oxygen Bombing Agent	80% (min) of tensile strength	ASTM D 572

2.7.7.2 Spliced

All joints in seals shall be spliced as specified for non-metallic waterstops in paragraph 03150-3.1.2.1. All holes in the gate seals shall be drilled as per manufacturer's recommendations.

2.8 GROUT

The non-shrink grout shall be EMBECO or an approved equal.

2.9 TIE-BACK RODS

Tie-Back rods shall be DYWIDAG Reinforcing Steel THREADBARS conforming to ASTM A 615, Grade 60, as manufactured by DYWIDAG Systems International or approved equal. All tie rods and accessory hardware shall be coated with coal-tar epoxy paint as specified in Section 09940, "PAINTING".

2.10 WIRE ROPE

2.10.1 Wire Rope

ASTM A 603, 3/8-inch nominal diameter guy or seizing strand, 1 X 7, prestretched, steel, galvanized.

2.10.2 Wire Rope Clips

Fed. Spec. FF-C-450D, Single Grip, single Malleable iron saddle, with U-Bolts and Nuts, Type I, Class 2, 3/8-inch nominal size, hot-dip galvanized.

2.10.3 Wire Rope Thimbles

Fed. Spec. FF-T-276B, 3/8-inch nominal size, split oval light, Type II, carbon steel, hot-dip galvanized.

2.11 CHAIN

2.11.1 Chain

Chain shall meet the requirements of ASTM A 413, Grade 30 (Proof Coil Chain) and shall be 3/8-inch nominal size, welded link hot-dipped galvanized steel.

2.11.2 Eyebolts

Eyebolts shall meet the requirements of ASTM A 489, Type 2 (Shoulder Pattern) and shall be hot-dipped galvanized steel, minimum 3/8-inch nominal size.

2.11.3 Miscellaneous Hardware

Links, shackles, snap hooks and other hardware shall be sized to fit chain and eyebolts. Hardware shall be either chrome or zinc plated or hot-dipped galvanized.

2.12 SHEET METAL

Sheet metal shall meet the requirements of ASTM A 653, hot-dip galvanized steel, commercial quality, G-90 Coating, 14 Gage (0.0747-inches), 16 Gage (0.0598-inches), 18 Gage (0.0478-inches), 20 Gage (0.0359-inches), or 22 Gage (0.0299-inches).

2.13 NEOPRENE SHEETING

Neoprene sheeting shall meet the requirements of ASTM D 2000 Type BC.

2.14 OTHER MISCELLANEOUS HARDWARE

2.14.1 Plastic Sealant

Sealant shall conform to the applicable provisions of Fed. Spec. SS-S-00210.

2.14.2 Expansion Anchors

Expansion anchors shall meet the requirements of Fed. Spec. A-A-1923, Class 1. Nail driven types will not be acceptable. Anchors shall be galvanized unless otherwise indicated.

2.14.3 Epoxy Anchors

Epoxy anchors, if required, shall be HVA Adhesive System as manufactured by Hilti Corporation or approved equal. System shall consist of HVU adhesive capsules and stainless steel HAS rods with stainless steel washers and nylon-insert locknuts as specified in Section 05501, "METALWORK FABRICATION, MACHINE WORK, AND MISCELLANEOUS PROVISIONS".

2.14.4 Seals

Miscellaneous seals shall be as specified in paragraph 2.7.7 above and shall be made to the shapes, sizes and dimensions similar to Buckhorn No. 3545.

2.15 GRAY IRON CASTINGS

Casting shall be true to pattern in form and dimensions and free from pouring faults, sponginess, cracks, blowholes and other defects in positions affecting their strength and value for service intended. Casting shall be boldly filleted at angles and rises shall be sharp and perfect. Casting shall be sandblasted or otherwise effectively cleaned of scale and sanded to a smooth, clean and uniform surface. Gray iron casting shall comply with ASTM A 48/A 48M, Class 30.

2.16 GALVANIZING

Hot-dip galvanizing or zinc coating applied on products fabricated from rolled, pressed, or forged steel shapes, plates, bars, and strips shall comply with ASTM A 123. Hot-dip galvanizing or zinc coatings on assembled steel products shall comply with ASTM A 123. Weight of coatings shall be as designated in Table 1 of the ASTM specification for class and thickness of material to be coated, but in no case shall it be less than 1.25 oz. per square foot.

PART 3 EXECUTON

3.1 WORKMANSHIP

All metalwork fabrication and machine work shall comply with the applicable provisions of Section 05501, "METALWORK FABRICATION, MACHINE WORK, AND MISCELLANEOUS PROVISIONS". All parts shall be properly fabricated, assembled and installed to conform to the shapes, sizes and dimensions indicated on the approved shop drawings.

3.1.1 Settlement Reference Bolts

Upon installation of the settlement reference bolts the Contractor shall determine elevations of each bolt and submit his results to the Contracting Officer.

3.1.2 Transition from Floodwall/Bulkhead to T-Wall

The steel sheet piling slip joint shall be surrounded by 18 gage steel sheet metal. The space between the sheet metal and the steel sheet piling shall be filled with a plastic sealant, as specified in paragraph 2.1.9.

3.1.3 Corner Protection Angles

Gate column corner protection angles shall be fabricated from steel conforming to ASTM A 36, except that minimum yield strength shall be thirty-three thousand (33,000) pounds per square inch, the maximum tensile strength shall be waived, and the maximum allowable manganese content shall be 1.40 percent. The continuous edges of the exposed face shall not have a vertical or horizontal distortion from a straight line greater than 0.025-inch per foot of length. Distortion for any single section shall not exceed 1/4-inch. When there is a warp in the installed angles greater than 1/16-inch, an extra anchor shall be installed at the proper location to draw the section into position. Joints between abutting sections shall be square and the butting ends shall be sawed or otherwise made smooth and regular.

3.1.4 Seal Plates

Seal plates shall be solid corrosion-resistant steel. Anchors attached to the seal plate shall be welded to the base metal. Seal plates may be spliced at the Contractor's convenience at no cost to the Government. The Contractor shall not commence work on any seal plate splice until this procedure has been approved by the Contracting Officer.

3.1.5 Hinge and Bearing Assemblies

The gate hinges and bearings shall be fabricated, assembled, and installed in accordance with the details and materials required. Lubrication fittings shall be pressure type with throat or surface check. Lubrication fittings and grease seals shall be of commercial grade. Bearings shall be greased before operating them, in accordance with the requirements of section 05501, "METALWORK FABRICATION, MACHINE WORK, AND MISCELLANEOUS PROVISIONS".

3.1.6 Gate Latching Device

The gate latching devices shall be fabricated, assembled, and installed in accordance with the details and the materials required. Bicycle type locks, with all locks keyed alike, shall be included. Threads shall be lubricated as specified in section 05501, "METALWORK FABRICATION, MACHINE WORK, AND MISCELLANEOUS PROVISIONS".

3.1.7 Screw Jacks for Gates

The screw jacks shall be fabricated, assembled, and installed in accordance with the details and the materials required. Screw jacks shall be lubricated as specified in section 05501, "METALWORK FABRICATION, MACHINE WORK, AND MISCELLANEOUS PROVISIONS".

3.1.8 Handrail

All handrails shall be plumb, straight and in proper alignment after erection. Railings shall be protected until completion of the construction against strain, discoloration or other surface injuries. Railing posts anchored to concrete surfaces parallel to the posts shall have the sides of posts continuously welded to base plates. Ends of rails anchored to concrete or masonry shall be rigidly secured to flange fittings anchored to concrete or masonry with epoxy anchors. Installation of fittings and provisions for epoxy anchors shall be in accordance with the manufacturer's recommendation. Handrail in contact with concrete, it shall be protected from corrosion by either two (2) coats of bituminous paint or ¼" neoprene sheeting.

3.1.9 Shop Painting

Corrosion-resistant and galvanized steel items shall not be painted. Corrosion-resistant steel shall be cleaned as specified in section 05501, "METALWORK FABRICATION, MACHINE WORK, AND MISCELLANEOUS PROVISIONS". Anchors to be bedded in concrete shall not be painted. All other ferrous metal shall be cleaned and shop painted before delivery to the project site. Requirements governing cleaning and painting are as specified in Section 09940, "PAINTING".