W912DQ-08-C-0008

US Army Corps of Engineers
Kansas City District
You Matter – We Care

Blue River Channel Modifications
Brush Creek to 53rd Street

Jackson County, Missouri

Construction Specifications
(Prefinal)

August 2008

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DEPARTMENT OF THE ARMY
Kansas City District, Corps of Engineers
757 Federal Building
Kansas City, Missouri 64106

SPECIFICATIONS FOR CONSTRUCTION OF
Blue River Channel Modifications
Brush Creek to 53rd Street
Jackson County, Missouri

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[2] Section replaced in this submittal.
[3] Section supplemented in this submittal with another Section.
[4] Section included in this submittal for review.
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[5] Section under separate review; not included in this submittal.

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LIST OF DRAWINGS
07/08

PART 1 GENERAL

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STRUCTURAL CONCRETE FORMWORK
07/08

PART 1 GENERAL

1.1 REFERENCES

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

ACI INTERNATIONAL (ACI)

ACI 347 (2004) Guide to Formwork for Concrete

1.2 NOT USED

1.3 DESIGN

Formwork shall be designed in accordance with methodology of ACI 347 for anticipated loads, lateral pressures, and stresses. Forms shall be capable of producing a surface which meets the requirements of the class of finish specified in Section 03 31 00.00 10 CAST-IN-PLACE STRUCTURAL CONCRETE. Forms shall be capable of withstanding the pressures resulting from placement and vibration of concrete.

PART 2 PRODUCTS

2.1 FORM MATERIALS

2.1.1 Forms For Class D Finish

Forms for Class D finished surfaces, except where concrete is placed against earth, shall be wood or steel or other approved concrete form material.

2.1.2 Form Ties

Form ties shall be factory-fabricated metal ties, shall be of the removable or internal disconnecting or snap-off type, and shall be of a design that will not permit form deflection and will not spall concrete upon removal. Solid backing shall be provided for each tie. Except where removable tie rods are used, ties shall not leave holes in the concrete surface less than 1/4 inch nor more than 1 inch deep and not more than 1 inch in diameter. Removable tie rods shall be not more than 1-1/2 inches in diameter.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Formwork

Forms shall be mortar tight, properly aligned and adequately supported to produce concrete surfaces meeting the surface requirements specified in

Section 03 31 00.00 10 CAST-IN-PLACE STRUCTURAL CONCRETE and conforming to construction tolerance given in TABLE 1. Where concrete surfaces are to have a Class A or Class B finish, joints in form panels shall be arranged as approved. Where forms for continuous surfaces are placed in successive units, the forms shall fit over the completed surface to obtain accurate alignment of the surface and to prevent leakage of mortar. Forms shall not be reused if there is any evidence of surface wear and tear or defects which would impair the quality of the surface. Surfaces of forms to be reused shall be cleaned of mortar from previous concreting and of all other foreign material before reuse. Form ties that are to be completely withdrawn shall be coated with a nonstaining bond breaker.

3.2 CHAMFERING

Except as otherwise shown, external corners that will be exposed shall be chamfered, beveled, or rounded by moldings placed in the forms.

3.3 COATING

Forms for Class A and Class B finished surfaces shall be coated with a form releasing agent before the form or reinforcement is placed in final position. The coating shall be used as recommended in the manufacturer's printed or written instructions. Forms for Class C and D finished surfaces may be wet with water in lieu of coating immediately before placing concrete, except that in cold weather with probable freezing temperatures, coating shall be mandatory. Surplus coating on form surfaces and coating on reinforcing steel and construction joints shall be removed before placing concrete.

3.4 REMOVAL OF FORMS

Forms shall be removed preventing injury to the concrete and ensuring the complete safety of the structure. Formwork for columns, walls, side of beams and other parts not supporting the weight of concrete may be removed when the concrete has attained sufficient strength to resist damage from the removal operation but not before at least 24 hours has elapsed since concrete placement.

TABLE 1
TOLERANCES FOR FORMED SURFACES

1. Variations from the plumb:	In any 10 feet of length	1/4 inch
a. In the lines and surfaces of columns, piers, walls and in arises	Maximum for entire length	1 inch
2. Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls	Minus	1/4 inch
	Plus	1/2 inch

-- End of Section --

SECTION 03 15 14.00 10

EXPANSION, CONTRACTION AND CONSTRUCTION JOINTS IN CONCRETE FOR CIVIL WORKS
07/08

PART 1 GENERAL

1.1 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Design Professional approval. Submit the following in accordance with Section 01 33 00, SUBMITTAL PROCEDURES:

SD-03 Product Data

SD-04 Samples

Waterstops; AE

Non-metallic waterstop materials and splice samples shall be submitted for inspection and testing and shall be identified to indicate manufacturer, type of material, size and quantity of material and shipment represented. Each materials sample shall be a piece not less than 12 inches long cut from each 200 feet of finished waterstop furnished, but not less than a total of 4 linear feet of each type and size furnished. For spliced segments of waterstops to be installed in the work, one spliced sample of each size and type for every 50 splices made in the factory and every 10 splices made at the job site shall be furnished for inspection and testing. The spliced samples shall be made using straight run pieces with the splice located at the mid-length of the sample and finished as required for the installed waterstop. The total length of each spliced sample shall be not less than 12 inches long.

SD-06 Test Reports; AE

Certificates of compliance shall be provided for premolded expansion joint filler strips, compression seals and lubricant, and waterstops to verify compliance with applicable specification.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Waterstops

2.1.1.1 Non-Metallic Hydrophilic

The hydrophilic waterstops will be used where specifically indicated on the drawing.

Hydrophilic waterstops shall be dual extension waterstops, thickness by width. Swellable strip type compound of polymer modified chloroprene rubber that swells upon contact with water shall conform to ASTM D 412 as follows: Tensile strength 420 psi minimum; ultimate elongation 600 percent minimum.

Hardness shall be 50 minimum on the type A durometer and the volumetric expansion ratio in distilled water at 70 degrees F shall be 3 to 1 minimum. The waterstop material shall be a combination of chloroprene rubber and chloroprene rubber modified to impart hydrophilic properties. The waterstop shall have a delay coating to inhibit initial expansion due to moisture present in fresh concrete.

2.1.1.2 Hydrophilic Waterstop Accessories

All hydrophilic waterstop accessories and adhesives shall conform to the hydrophilic waterstop manufacturer's recommendations.

PART 3 EXECUTION

3.1 INSTALLATION

Joint locations and details, including materials and methods of installation of joint fillers and waterstops, shall be as specified, as shown, and as directed.

3.1.1 Waterstops

Waterstops shall be carefully and correctly positioned during installation to eliminate faulty installation that may result in joint leakage. All waterstops shall be installed so as to form a continuous watertight diaphragm in each joint. Adequate provision shall be made to support and protect the waterstops during the progress of work. Any waterstop punctured or damaged shall be replaced or repaired at the Contractor's expense. The concrete shall be thoroughly consolidated in the vicinity of the waterstop. Suitable guards shall be provided to protect exposed projecting edges and ends of partially embedded waterstops from damage when concrete placement has been discontinued.

3.1.1.1 Non-Metallic Hydrophilic Waterstop Installation

Install hydrophilic waterstops in accordance with approved manufacturer recommendations.

Ends to be joined shall be miter cut with sharp knife or shears. The ends shall be adhered with cyanacrylate (super glue) adhesive. When joining hydrophilic type waterstop to PVC waterstop, the hydrophilic waterstop shall be positioned as shown on the drawings. A liberal amount of a single component hydrophilic sealant shall be applied to the junction to complete the transition.

3.2 CONSTRUCTION JOINTS

Construction joints are specified in Section 03 31 01.00 10 CAST-IN-PLACE STRUCTURAL CONCRETE FOR CIVIL WORKS except that construction joints coinciding with expansion and contraction joints shall be treated as expansion or contraction joints as applicable.

-- End of Section --

SECTION 03 20 02

STEEL BARS AND WELDED WIRE FABRIC FOR CONCRETE REINFORCEMENT FOR CIVIL WORKS
07/08

PART 1 GENERAL

1.1 REFERENCES

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

ACI INTERNATIONAL (ACI)

ACI 318/318R	(2005; Errata 2005) Building Code Requirements for Structural Concrete and Commentary
ACI SP-66	(2004) ACI Detailing Manual

ASTM INTERNATIONAL (ASTM)

ASTM A 615/A 615M	(2007) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A 706/A 706M	(2006a) Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Design Professional approval. Submit the following in accordance with Section 01 33 00, SUBMITTAL PROCEDURES:

SD-02 Shop Drawings
Fabrication and Placement; AE

Detail drawings showing reinforcing steel placement, schedules, sizes, grades, and splicing and bending details. Drawings shall show support details including types, sizes and spacing. Complete shop drawings shall be submitted. The shop drawings shall be prepared under the direct supervision of a licensed professional engineer. The shop drawings shall contain his/her seal and a statement certifying that they are in compliance with the specifications and contract drawings. The shop drawing shall include details of the bending and placing schedule of the steel reinforcement, together with bar schedules indicating the number, size, dimensions, and total length of various bars required. Bar lists and bending diagrams shall be checked for accuracy and completeness before the bars are fabricated. Details of typical supports for reinforcing steel shall be approved prior to placing

any concrete. Shop drawings shall show reinforcing steel clearances, and the location of all construction joints shown on the drawings or proposed by the contractor. The drawings shall show support details including types, sizes, and spacing. Spacing between vertical reinforcing steel shall be shown on the wall elevations. The minimum scale used in the shop drawings shall be 1:50. Reinforcement bending details shall conform to the requirements of ACI SP-66.

SD-07 Certificates
Reinforcing Steel ; AE

Certified copies of mill reports attesting that the reinforcing steel furnished contains no less than 25 percent recycled scrap steel and meets the requirements specified herein, prior to the installation of reinforcing steel.

PART 2 PRODUCTS

2.1 MATERIALS

Materials shall conform to the following requirements.

2.1.1 Steel Bars

Steel bars shall comply with the requirements of ASTM A 615/A 615M or ASTM A 706/A 706M, deformed, of the grades, sizes and lengths shown.

2.1.2 Accessories

2.1.2.1 Bar Supports

Bar supports shall comply with the requirements of ACI SP-66. Supports for bars in concrete with formed surfaces exposed to view or to be painted shall be plastic-coated wire, stainless steel or precast concrete supports. Precast concrete supports shall be wedged-shaped, not larger than3-1/2 by 3-1/2 inches, of thickness equal to that indicated for concrete cover and have an embedded hooked tie-wire for anchorage.

2.1.2.2 Wire Ties

Wire ties shall be 16 gage or heavier black annealed wire.

PART 3 EXECUTION

3.1 FABRICATION AND PLACEMENT

Reinforcement steel and accessories shall be fabricated and placed as specified and shown and approved shop drawings. Fabrication and placement details of steel and accessories not specified or shown shall be in accordance with ACI SP-66 and ACI 318/318R or as directed. Steel shall be fabricated to shapes and dimensions shown, placed where indicated within specified tolerances and adequately supported during concrete placement. At the time of concrete placement all steel shall be free from loose, flaky rust, scale (except tight mill scale), mud, oil, grease or any other coating that might reduce the bond with the concrete.

3.1.1 Hooks and Bends

Steel bars, except for zinc-coated or epoxy-coated, shall be mill or field-bent. Zinc-Coated and epoxy-coated bars shall be mill-bent prior to coating. All steel shall be bent cold unless authorized. No steel bars shall be bent after being partially embedded in concrete unless indicated or authorized.

3.1.2 Placing Tolerances

3.1.2.1 Spacing

The spacing between adjacent bars and the distance between layers of bars may not vary from the indicated position by more than one bar diameter nor more than 1 inch.

3.1.2.2 Concrete Cover

The minimum concrete cover of main reinforcement steel bars shall be as shown. The allowable variation for minimum cover shall be as follows:

MINIMUM COVER	VARIATION
6 inch	plus 1/2 inch
4 inch	plus 3/8 inch
3 inch	plus 3/8 inch
2 inch	plus 1/4 inch
1-1/2 inch	plus 1/4 inch
1 inch	plus 1/8 inch
3/4 inch	plus 1/8 inch

3.1.3 Splicing

Splices in steel bars shall be made only as required. Bars may be spliced at alternate or additional locations at no additional cost to the Government subject to approval.

3.1.3.1 Lap Splices

Lap splices shall be used only for bars smaller than size 14 and welded wire fabric. Lapped bars may be placed in contact and securely tied or spaced transversely apart to permit the embedment of the entire surface of each bar in concrete. Lapped bars shall not be spaced farther apart than 1/5 the required length of lap or 6 inches.

-- End of Section --

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SECTION 03 31 01.00 10

CAST-IN-PLACE STRUCTURAL CONCRETE FOR CIVIL WORKS
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PART 1 GENERAL

1.1 REFERENCES

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

ACI INTERNATIONAL (ACI)

ACI 117	(2006) Standard Specifications for Tolerances for Concrete Construction and Materials
ACI 211.1	(1991; R 2002) Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 214R	(2002) Recommended Practice for Evaluation of Strength Test Results of Concrete
ACI 305R	(1999; Errata 2006) Hot Weather Concreting
ACI 318/318R	(2005; Errata 2005) Building Code Requirements for Structural Concrete and Commentary

ASTM INTERNATIONAL (ASTM)

ASTM C 1017/C 1017M	(2007) Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C 1059	(1999) Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete
ASTM C 1064/C 1064M	(2005) Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
ASTM C 1077	(2006a) Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
ASTM C 1107/C 1107M	(2007a) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C 1240	(2005) Standard Specification for Silica Fume Used in Cementitious Mixtures
ASTM C 136	(2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

ASTM C 142	(1997; R 2004) Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C 143/C 143M	(2005a) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C 150	(2007) Standard Specification for Portland Cement
ASTM C 171	(2003) Standard Specification for Sheet Materials for Curing Concrete
ASTM C 172	(2004) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C 192/C 192M	(2006) Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C 231	(2004) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 260	(2006) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C 309	(2007) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 31/C 31M	(2006) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C 39/C 39M	(2005e1) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C 42/C 42M	(2004) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C 494/C 494M	(2005a) Standard Specification for Chemical Admixtures for Concrete
ASTM C 566	(1997; R 2004) Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying
ASTM C 597	(2002) Pulse Velocity Through Concrete
ASTM C 803/C 803M	(2003) Penetration Resistance of Hardened Concrete
ASTM C 805	(2002) Rebound Number of Hardened Concrete
ASTM C 881/C 881M	(2002) Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete

ASTM C 94/C 94M	(2007) Standard Specification for Ready-Mixed Concrete
ASTM C 989	(2006) Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
ASTM D 75	(2003) Standard Practice for Sampling Aggregates

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST HB 44	(2007) NIST Handbook 44: Specifications, Tolerances, and other Technical Requirements for Weighing and Measuring Devices

NATIONAL READY MIXED CONCRETE ASSOCIATION (NRMCA)

NRMCA CPMB 100	(2000) Concrete Plant Standards

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 104	(1980) Method of Calculation of the Fineness Modulus of Aggregate
COE CRD-C 318	(1979) Federal Specifications for Cloth, Burlap, Jute (or Kenaf)
COE CRD-C 143	(1962) Specifications for Meters for Automatic Indication of Moisture in Fine Aggregates
COE CRD-C 400	(1963) Requirements for Water for Use in Mixing or Curing Concrete
COE CRD-C 521	(1981) Standard Test Method for Frequency and Amplitude of Vibrators for Concrete
COE CRD-C 94	(1995) Specification for Surface Retarders

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Design Professional approval. Submit the following in accordance with Section 01 33 00, SUBMITTAL PROCEDURES:

SD-03 Product Data

Batch Plant; AE

The Contractor shall submit batch plant data to the Design Professional for review for conformance with applicable specifications.

Concrete Mixers; AE
Capacity; AE

The Contractor shall submit concrete mixer data which includes the make, type, and capacity of concrete mixers proposed for mixing concrete.

Conveying Equipment; AE

Data on the conveying equipment and methods for transporting, handling, and depositing the concrete.

Placing Equipment; AE

Data on placing equipment and methods.

Construction Joint Treatment; AE

The method and equipment proposed for joint cleanup and waste disposal shall be submitted for review and approval.

Curing and Protection; AE

The curing medium and methods to be used shall be submitted for review and approval.

Cold-Weather Placing; AE

If concrete is to be placed under cold-weather conditions, the proposed materials, methods, and protection shall be submitted for approval.

Hot-Weather Placing; AE
Finishing; AE

If concrete is to be placed under hot-weather conditions, the proposed materials and methods shall be submitted for review and approval.

SD-04 Samples
Aggregates; AE
Cementitious Materials, Admixtures, and Curing Compound; AE

Samples of materials for government testing and approval.

SD-06 Test Reports
Quality of Aggregates; AE

Aggregate quality tests shall be submitted at least 30 days prior to start of concrete placement.

Mixer Uniformity; AE.

The results of the initial mixer uniformity tests shall be submitted at least 5 days prior to the initiation of placing.

Tests and Inspections; AE

Test results and inspection reports shall be submitted daily and weekly.

SD-07 Certificates
Cementitious Materials; AE

Cementitious Materials, including Cement and Pozzolan, and Ground Granulated Blast-Furnace Slag will be accepted on the basis of the manufacturer's certification of compliance, accompanied by mill test reports that materials meet the requirements of the specification under which they are furnished. Certification and mill test reports shall be from samples taken from the particular lot furnished. No cementitious materials shall be used until notice of acceptance has been given by the Design Professional. 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 Design Professional, 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.

Impervious-Sheet Curing Materials; AE

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

Air-Entraining Admixture; AE

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

Other Chemical Admixtures; AE

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

Membrane-Forming Curing Compound; AE

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

Epoxy Resin; AE
Latex Bonding Compound; AE

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

Nonshrink Grout: AE

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.

1.3 CONTRACTING TESTING AND SAMPLING

The Contractor will sample and test aggregates and concrete to determine compliance with the specifications. The Contractor shall provide facilities and labor as may be necessary for procurement of representative test samples. Samples of aggregates will be obtained at the point of batching in accordance with ASTM D 75. Concrete will be sampled in accordance with ASTM C 172.

1.3.1 Preconstruction Sampling and Testing

1.3.1.1 Aggregates

The Contractor shall be responsible for sampling and testing of sources and materials. There are no pre-approved aggregate sources. All aggregates proposed for use in the work shall be tested for conformance with the specified requirements. The Contractor shall select one source for coarse and one source for fine aggregates. Coarse aggregates proposed for use in the work, shall be produced from Burlington Limestone. Fine aggregate shall be produced from a Kansas (KAW) River source. The aggregate sources proposed for use in the work may be inspected by the Government (EC-GD and EC-GG), and shall be tested by the Contractor's laboratory for compliance with specified requirements prior to use of the aggregates in the work.

The Contractor's aggregate testing and evaluation shall conform to the specified requirements. Material sources shall be tested by an approved independent commercial testing laboratory, and certified copies of laboratory test reports and analysis shall be submitted for approval prior to use of the aggregates in the work.

1.3.2 Construction Testing by the Government

The Government may request additional testing. The Contractor shall be responsible for providing samples of materials for Government testing. Samples shall be collected as directed and in the presence of the Contracting Officer. Testing will be performed by and at the expense of the Government. Government samples shall be taken from the Contractor's materials. The Contractor shall provide assistance and coordination as directed, to support the collection of representative samples.

1.3.2.1 Chemical Admixtures Storage

Chemical admixtures that have been in storage at the project site for longer than 6 months or that have been subjected to freezing shall be retested at the expense of the Contractor and shall be rejected if test results are not satisfactory. Chemical admixtures will be accepted based on compliance with the requirements of paragraph CHEMICAL ADMIXTURES.

1.3.2.2 Concrete Strength

Compressive strength test specimens will be made by the Contractor and cured in accordance with ASTM C 31/C 31M and tested in accordance with ASTM C 39/C 39M. The strength of the concrete will be considered satisfactory so long as the average of all sets of three 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 500 psi. A "test" is defined as the average of two 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.

a. Investigation of Low-Strength Test Results - When any strength test of standard-cured test cylinders falls below the specified strength requirement by more than 500 psi 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/C 803M, or ASTM C 805 may be permitted by the Design Professional 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.

b. 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/C 42M. 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 Design Professional 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 85 percent of the specified strength requirement and if no single core is less than 75 percent of the specified strength requirement.

c. 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 Design Professional 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 Design Professional. All investigations, testing, load tests, and correction of deficiencies will be performed and approved by the Design Professional at the expense of the Contractor.

1.4 DESIGN REQUIREMENTS

1.4.1 Concrete Strength

Specified compressive strength f'c shall be as follows:

COMPRESSIVE STRENGTH (PSI)	STRUCTURE OR PORTION OF STRUCTURE
4,000 @ 28 days	For all CIP work

1.4.2 Maximum Water-Cement (W/C) Ratio

Maximum W/C shall be as follows:

WATER-CEMENT RATIO, BY MASS	STRUCTURE OR PORTION OF STRUCTURE
0.45	For all work

These W/C's may cause higher strengths than that required by paragraph CONCRETE STRENGTH.

1.5 CONSTRUCTION TOLERANCES

Except as specified otherwise, a plus tolerance increases and a minus tolerance decreases the dimension to which it applies. A tolerance without sign means plus or minus. Where only one sign is specified, there is no limit in the other direction. Tolerances are not cumulative. The most restrictive tolerance will control. Tolerances shall not extend the structure beyond legal boundaries.

a. 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.

b. Construction tolerances shall meet the requirements of ACI 117 and any of the following requirements that are applicable.

1.5.1 Formed Concrete Surfaces. Not used.

1.5.2 Floor Finish by the F-Number System. Not used.

1.5.3 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 Design Professional.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Cementitious Materials

Cementitious materials shall be portland cement, 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

Cementitious materials shall be portland cement, portland cement in combination with pozzolan or GGBF slag or silica fume 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.

2.1.1.2 High-Early-Strength Portland Cement

ASTM C 150, Type III, with C3A limited to 8 percent meeting the requirement may be 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 the optional requirements for multiple factor, drying shrinkage, uniformity, and effectiveness in controlling Alkali-Silica reaction requirements in Table 3. The limit on maximum available alakalies shall be 1.5 percent. Loss on ignition shall not exceed 3 percent. Class C fly ash shall not be used when

Aggregate Reactivity testing (ASTM C 1260) indicates the aggregates have a potential for alkali-aggregate reatictivity. Fly Ash, when used to mitigate alkali-aggregate reactivity, shall be Class F.

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 Silica Fume

Silica fume may be furnished as a dry, densified material or as a slurry. Silica fume, unprocessed, or before processing into a slurry or a densified material, shall conform to ASTM C 1240 with Table 2 and the Specific Surface Area and Uniformity Requirements in Table 4 invoked.

The Contractor shall provide at his expense the services of a manufacturer's technical representative, experienced in mixture proportioning, placement procedures, and curing of concrete containing silica fume. The manufacturer's representative shall be available for consultation by both the Contractor and the Design Professional during mixture proportioning, planning, and production of silica-fume concrete and shall be onsite immediately prior to and during at least the first placement of concrete containing silica fume, and at other times if directed.

2.1.1.6 Blended Hydraulic Cement Not used.

2.1.2 Aggregates

2.1.2.1 General

Concrete aggregates may be furnished from any source capable of meeting the quality requirements as stated in paragraph QUALITY.

2.1.2.2 Concrete Aggregate Sources

The Contractor shall designate in writing only one source or combination of sources from which he proposes to furnish aggregates. Fine aggregates shall be obtained from a Kansas River (Kaw River) source. Course aggregate shall be produced from curshed Burlington Limestone. Concrete aggregates shall be produced from sources that are currently approved by MODOT for use in portland cement concrete for State DOT pavements, and shall conform to the requirements specified herein. Crushed aggregate shall be obtained from rock of uniform quality. Coarse aggregate shall be sound, durable, free of objectionable coatings, and dust. Use of chemical treatments, surfactants, or other chemicals introduced to the aggregates for dust control or other purposes shall not be permitted. The Contractor is responsible for all sampling and testing of materials. The proposed aggregates shall not be used in the work, until the Government has inspected the proposed aggregate sources, and certified copies of all specified laboratory testing has been approved. If a source for coarse or fine aggregates designated by the Contractor does not meet the specified requirement, the Contractor shall furnish the coarse or fine aggregate, as the case may be, from another source for testing at no additional cost to the Government.

2.1.2.3 Quality

Fine aggregates shall conform to the aggregate quality requirements of ASTM C 33, except as modified herin. Coarse aggregates shall conform to the aggregate quality requirements of ASTM C 33, Class 5S, except as modified herein. Aggregate particles shall be sound and durable and free from

objectionable coatings. Coarse aggregate shall contain less that 0.2 percent by weight of lightweight chert that has a specific gravity, saturated surface dry, of less than 2.40. Lightweight chert includes the white porous siliceous form of weathered chert (Tripolitic chert) found in nodules and beds within some limestones. Total amount of all types of chert shall be less than 1.5 percent by weight. To keep chert from exceeding these specified maximum limits, it may be necessary to employ selective quarrying to utilize the lesser cherty portions of the limestone deposit and to remove cherty particles by processing, loading, screening, and other processes before and during final processing into finished aggregate sizes.
In addition, aggregates delivered to the mixer shall meet the following requirements:

TEST LIMITS

PROPERTY TEST	FINE AGGREGATE	COARSE AGGREGATE	
Specific Gravity	Greater than 2.60	Greater than 2.58	ASTM C 127 ASTM C 128
Absorption	Less than 1.0	Less than 2.0	ASTM C 127 ASTM C 128
Durability Factor using (Procedure A) (See Note 1)	Greater than 50	Greater than 50	COE CRD-C 114 ASTM C 666
Material Finer than 75-pm (No. 200) Sieve (See Note 2)	ASTM C 33 Limits	ASTM C 33 Limits	ASTM C 117
Organic Impurities	Not darker than No. 3 Not less than 95 percent		ASTM C 40 ASTM C 87
L.A. Abrasion		Less than 37	ASTM C 131 ASTM C 535
Chert, less than 2.40 specific gravity		Less than 0.2	ASTM C 123
Total Chert		Less than 1.5	ASTM C 123
Clay Lumps and Friable Particles	Less than 0.1	Less than 0.25	ASTM C 142
Coal and Lignite, less than 2.00 specific gravity	Less than 0.25	Less than 0.25	ASTM C 123

Petrographic Examination	Presence and types of Chert, Coal, Lignite, Shale, and Alkali-Silica reactive aggregates for coarse and fine aggregates		ASTM C 295

Note 1. Certified laboratory reports from an approved laboratory may be accepted, for Durability Factor tests accomplished in accordance with ASTM C 666 (Procedure A) or COE CRD-C 114. Previous laboratory testing accomplished within ten years prior to use of the materials in the work may be accepted, subject to the Design Professional's approval.

Note 2. Material finer than No. 200 sieve shall not exceed 1.0 percent in accordance with ASTM C 33. Adjustments in the coarse aggregate limit for material finer than number 200 sieve shall conform to ASTM C 33. To control fines and dust on aggregates it may be necessary to thoroughly wash the aggregates in clean water. The water used to wash aggregates shall not contain chemical additives and shall conform to the requirements for water specified herein in paragraph: Water.

2.1.2.4 Particle Shape

The shape of the particles in the fine aggregate and in the coarse aggregate shall be generally spherical or cubical. The quantity of flat and elongated particles in the separated size groups of coarse aggregate, as defined and determined in accordance with COE CRD-C 119 shall not exceed 25 percent in any size group.

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/C 494M, 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/C 494M, 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/C 494M, 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 Design Professional, such approval being contingent upon particular mixture control as described in the Contractor's Quality Control Plan.

2.1.3.4 Other Chemical Admixtures

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

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, except a styrene acrylate or chlorinated rubber compound meeting Class B requirements shall be used for surfaces that are to be painted or are to receive bituminous roofing, or waterproofing, or floors that are to receive adhesive applications of resilient flooring. The curing compound selected shall be compatible with any subsequent paint, roofing, coating, or flooring specified. Nonpigmented compound shall contain a fugitive dye and shall have the reflective requirements in ASTM C 309 waived.

2.1.4.3 Burlap

Burlap used for curing shall conform to COE CRD-C 318

2.1.5 Water

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

2.1.6 Nonshrink Grout

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

2.1.7 Abrasive Aggregates Not used.

2.1.8 Latex Bonding Compound

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

2.1.9 Epoxy Resin

Epoxy resin for use in repairs shall conform to ASTM C 881/C 881M, Type III, Grade I or II.

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/C requirements listed in paragraph DESIGN REQUIREMENTS are met.

2.2.2 Cement Content

The cementitious material content of concrete shall be measured by weight. The total cementitious material content for all concrete shall be at least 564 lb/cubic yard.

2.2.3 Nominal Maximum-Size Coarse Aggregate

Nominal maximum-size coarse aggregate shall be 3/4 inch. Coarse aggregates shall conform to the grading requirements of ASTM C 33 size number 67.

2.2.4 Air Content

All concrete shall be air-entrained with a total air content of 6.5 plus or minus 1.5 percentage points, at the point of placement, as determined by ASTM C 231.

2.2.5 Slump

The slump shall be determined in accordance with ASTM C 143/C 143M and shall be within the range of 1 to 4 inches. Where placement by pump is approved, the slump shall not exceed 6 inches.

2.2.6 Concrete Proportioning

Trial batches and testing requirements for various qualities of concrete specified shall be the responsibility of the Contractor. Samples of 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 the manufacturer's test reports indicating compliance with applicable specified requirements. Trial mixtures having proportions, consistencies, and air content suitable for the work shall be made based on methodology described in ACI 211.1, using at least three different water-cement ratios, which will produce a range of strength encompassing those required for the work. The maximum water-cement ratios required in paragraph MAXIMUM WATER-CEMENT RATIO will be converted to a weight ratio of water to cement plus pozzolan by mass, silica fume, or GGBF slag by mass equivalency as described in ACI 211.1. In the case where GGBF slag is used, the weight of the slag shall be included in the equations for the term P, which is used to denote the mass of pozzolan. If pozzolan is used in the concrete mixture, the minimum pozzolan content shall be 15 percent of the total cementitious material. Trial mixtures shall be proportioned for maximum permitted slump and air content with due consideration to the approved conveying and placement method. The temperature of concrete in each trial batch shall be reported. For each water-cement ratio, at least three test cylinders for each test age shall be made and cured in accordance with ASTM C 192/C 192M. They shall be tested at 7 days and at the design age specified in paragraph DESIGN REQUIREMENTS in accordance with ASTM C 39/C 39M. From these test results, a curve will be plotted showing the relationship between water-cement ratio and strength.

2.2.7 Required Average Compressive Strength

In meeting the strength requirements specified in paragraph CONCRETE STRENGTH, the selected mixture proportion shall produce a required average compressive strength f'cr exceeding the specified strength f'c by the amount indicated below.

2.2.7.1 Average Compressive Strength from Test Records

Where a concrete production facility has test records, a standard deviation shall be established in accordance with the applicable provisions of ACI 214R. Test records from which a standard deviation is calculated shall represent materials, quality control procedures, and conditions similar to those expected, shall represent concrete produced to meet a specified strength or strengths (f'c) within 1,000 psi of that specified for proposed work, and shall consist of at least 30 consecutive tests. A strength test shall be the average of the strengths of two cylinders made from the same sample of concrete and tested at 28 days or at another test age designated for determination of f'c.

Required average compressive strength f'cr used as the basis for selection of concrete proportions shall be the larger of the equations that follow using the standard deviation as determined above:

$$f'cr = f'c + 1.34S$$
$$f'cr = f'c + 2.33S - 500$$

Where S = standard deviation

Where a concrete production facility does not have test records meeting the requirements above but does have a record based on 15 to 29 consecutive tests, a standard deviation shall be established as the product of the calculated standard deviation and a modification factor from the following table:

NUMBER OF TESTS*	MODIFICATION FACTOR FOR STANDARD DEVIATION Use tabulation in paragraph DETERMINING REQUIRED AVERAGE STRENGTH
less than 15	
15	1.16
20	1.08
25	1.03
30 or more	1.00

*Interpolate for intermediate numbers of tests.

2.2.7.2 Average Compressive Strength without Previous Test Records

When a concrete production facility does not have sufficient field strength test records for calculation of the standard deviation, the required average strength fcr shall be determined as follows:

If the specified compressive strength f'c is less than 3,000 psi,

$$f'cr = f'c + 1,000$$

If the specified compressive strength f'c is 3,000 to 5,000 psi,

f'cr = f'c + 1,200

If the specified compressive strength f'c is over 5,000 psi,

f'cr = f'c + 1,400.

PART 3 EXECUTION

3.1 EQUIPMENT

3.1.1 Capacity

The batching, mixing, conveying, and placing equipment shall have a capacity of at least 75 cubic yards per hour.

3.1.2 Batch Plant

Batch plant shall conform to the requirements of NRMCA CPMB 100and 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 weigh batcher on one 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 0.2 percent 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 TESTS AND INSPECTIONS, and in the presence of a certified scale inspector.

3.1.2.3 Batching Tolerances

a. Weighing Tolerances

MATERIAL	PERCENT OF REQUIRED 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 COE 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/C 94M 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/C 94M. 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 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 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 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 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/C 94M. Nonagitating equipment may be used for transporting plant-mixed concrete over a smooth road when the hauling time is less than 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 Design Professional. 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 36 inches. The belt speed shall be a minimum of 300 feet per minute and a maximum of 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 4 inches. Aluminum pipe shall not be used.

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 INCHES	FREQUENCY VPM	AMPLITUDE 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 COE 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 indicated on the drawings, or 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 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 31 60 00 Foundation Preperation.

3.2.3 Concrete on Rock Foundations

Rock surfaces upon which concrete is to be placed shall be clean, free from oil, standing or running water, ice, mud, drummy rock, coating, debris, and loose, semidetached, or unsound fragments. Joints in rock shall be cleaned to a satisfactory depth, as determined by the Design Professional, and to firm rock on the sides. Immediately before the concrete is placed, all rock surfaces shall be cleaned thoroughly by the use of air-water jets or

sandblasting as described in paragraph CONSTRUCTION JOINT TREATMENT. All rock surfaces shall be kept continuously wet for at least 24 hours immediately prior to placing concrete thereon. All approximately horizontal surfaces shall be covered, immediately before the concrete is placed, with a layer of mortar proportioned similar to that in the concrete mixture. The mortar shall be covered with concrete before the time of initial setting of the mortar.

3.2.4 Construction Joint Treatment

Construction joint treatment shall conform to the following requirements.

3.2.4.1 Joint Preparation

Concrete surfaces to which additional concrete is to be bonded shall be prepared for receiving the next lift or adjacent concrete by cleaning with 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 again as the last operation prior to placing the next lift. There shall be no standing water on the surface upon which concrete is placed.

3.2.4.2 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 90 to 110 psi, and the water pressure shall be just sufficient to bring the water into effective influence of the air pressure. When approved by the Design Professional, a retarder complying with the requirements of COE 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.

3.2.4.3 High-Pressure Water Jet

A stream of water under a pressure of not less than 3,000 psi may be used for cleaning. Its use shall be delayed until the concrete is sufficiently hard so that only the surface skin or mortar is removed and there is no undercutting of coarse-aggregate particles. If the water jet is incapable of a satisfactory cleaning, the surface shall be cleaned by sandblasting.

3.2.4.4 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.

3.2.4.5 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.

3.3 PLACING

3.3.1 Placing Procedures

The surfaces of horizontal construction joints shall be kept continuously wet for the first 12 hours during the 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 Design Professional, 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 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 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 5 feet, except where a properly designed and sized elephant truck with rigid drop chute bottom section is provided to prevent segregation and where specifically authorized. In no case will 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 will not be incorporated into the placement.

3.3.3 Time Interval Between Mixing and Placing

Concrete shall be placed within 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 SUBMITTALS. The ambient temperature of the space adjacent to the concrete placement and surfaces to receive concrete shall be above 32 degrees F. The placing temperature of the concrete having a minimum dimension less than 12 inches shall be between 55 and 75 degrees F when measured in accordance with ASTM C 1064/C 1064M. The placing temperature of the concrete having a minimum dimension greater than 12 inches shall be between 50 and 70 degrees F. 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 SUBMITTALS. The concrete-placing temperature shall not exceed 80 degrees F when measured in accordance with ASTM C 1064/C 1064M. Cooling of the mixing water and aggregates, or both, may be required to obtain an adequate placing temperature. A retarder meeting the requirements of paragraph WATER-REDUCING OR RETARDING ADMIXTURES may be used to facilitate placing and finishing. Steel forms and reinforcement shall be cooled prior to concrete placement when steel temperatures are greater than 120 degrees F. 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 6 inches into the preceding unhardened layer if such exists. It shall be held stationary until the concrete is consolidated and then withdrawn slowly.

3.3.7 Placing Concrete Underwater

Excavations and other placement locations shall be de-watered. Use of underwater concrete placements where de-watering the placement location is determined to be impractical, shall be subject to Design Professional approval. Concrete placements required in water shall be deposited in water by a tremie or concrete pump. The methods and equipment used shall be subject to approval. 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 effected 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 15 feet.

3.4 FINISHING

The ambient temperature of spaces adjacent to surfaces being finished shall be not less than 40 degrees F. 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 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 shown in the drawings. Surfaces to receive additional concrete or backfill shall be brought to the elevation shown on the drawings and left true and regular. Exterior surfaces shall be sloped for drainage unless otherwise shown in the drawing or as 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 deep imprint, 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 unformed surfaces where indicated on drawings. 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.

3.4.2 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 FORMED SURFACE REPAIR. Unless painting of surfaces is required, uniform color of the concrete shall be maintained by use of only one 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, building 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.

3.4.3 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 48 hours after form removal.

3.4.3.1 Class D Finish

Surfaces listed in Section 03 11 13.00 10 STRUCTURAL CONCRETE FORMWORK and as shown to have class D finish shall have surface defects repaired as follows: defective areas, voids, and honeycombs greater than 48 square inches in area or more than 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 an epoxy resin meeting the requirements of paragraph EPOXY RESIN, a latex bonding agent meeting the requirements of paragraph LATEX BONDING COMPOUND, or a neat cement grout after dampening the area with water. The void shall be filled with replacement concrete in accordance with paragraph MATERIAL AND PROCEDURE FOR REPAIRS.

3.4.3.2 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 part cement to two and one-half 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 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 Design Professional. 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 7 days. The temperature of the in situ concrete, adjacent air, and replacement mortar or concrete shall be above 40 degrees F during placement, finishing, and curing. Other methods and materials for repair may be used only when approved in writing by the Design Professional. 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. Curing shall be continuously maintained to ensure that concrete curing is uninterrupted for the entire curing period.

Concrete containing ASTM C 150 Type I or Type III Portland Cement, and Portland Cement Proportioned with silica fume shall be cured for at least 7 days.

Concrete containing Type II Portland cement, or containing 25 percent or less fly ash of GGCF slag shall be cured for at least 14 days.

Concrete containing 25 percent or more fly ash or GGBF slag shall be cured for at least 21 days.

Immediately after placement, concrete shall be protected from premature drying, extremes in temperatures, 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 12 hours and from flowing water for 14 day. 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. If water or curing materials stain or discolor concrete surfaces that are to be permanently exposed, they shall be cleaned as required in paragraph APPEARANCE. Where wooden form sheathing is left in place during curing, the sheathing shall be kept wet at all times. If steel forms are used in hot weather, nonsupporting vertical forms shall be carefully broken loose from the concrete, soon after the concrete hardens, 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 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 12 hours immediately prior to the placing of the following lift. Silica fume concrete, if used, shall be moist-cured. Curing of silica fume concrete shall start immediately after placement.

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 to which a grout-cleaned finish is to be applied or other concrete is to be bonded, on any surface containing protruding steel reinforcement, on an abrasive aggregate finish, or any surface maintained at curing temperature by use of free steam. A styrene acrylate or chlorinated rubber compound may be used for surfaces that are to be painted or are to receive bituminous roofing or waterproofing, or for floors that are to receive adhesive applications of resilient flooring. The curing compound

selected shall be compatible with any subsequent paint, roofing, waterproofing, or flooring specified.

3.5.3.1 Pigmented Curing Compound

A pigmented curing compound meeting the requirements of the above paragraph MEMBRANE-FORMING CURING COMPOUND may be used on surfaces that will not be exposed to view when the project is completed.

3.5.3.2 Nonpigmented Curing Compound

A nonpigmented curing compound containing a fugitive dye may be used on surfaces that will be exposed to view when the project is completed. Concrete cured with nonpigmented curing compound must be shaded from the sun for the first 3 days when the ambient temperature is 90 degrees F or higher.

3.5.3.3 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 75 psi, at a uniform coverage of not more than 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 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

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 12 inches and securely weighted down or shall be lapped not less than 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 F, the temperature of the concrete shall be maintained above 40 degrees F for the first 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 F as determined by observation of ambient and concrete temperatures indicated by suitable temperatures measuring devices furnished by the Contractor as required and installed adjacent to the concrete surface and 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

3.7 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 Design Professional, the concreting operation is out of control, concrete placement shall cease. The laboratory performing the tests shall be on site and 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 Technicians, 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 Transportation Construction Inspector (CTCI) or Concrete Construction Inspector (CCI). The Government may 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 sieve analysis and fineness modulus determination in accordance with ASTM C 136 and COE 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 Design Professional.

c. Moisture Content Testing - When in the opinion of the Design Professional the electric moisture meter is not operating satisfactorily, there shall be at least four tests for moisture content in accordance with ASTM C 566 during each 8-hour period of mixing plant operation. The times for the tests shall be selected randomly within

the 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 0.5 percent 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 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 Design Professional. 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 Design Professional. 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 consecutive readings for smallest size coarse aggregate differ by more than 1.0 percent, frequency of testing shall be increased to that specified above for fine aggregate, until the difference falls below 1.0 percent.

d. Coarse Aggregate Moisture Corrective Action - Whenever the moisture content of any size of coarse aggregate changes by 0.5 percent 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 Quality of Aggregates

a. Frequency of Quality Tests - Thirty days prior to the start of concrete placement the Contractor shall perform all tests for aggregate quality listed below.

PROPERTY	TEST
Specific Gravity	ASTM C 127 ASTM C 128
Absorption	ASTM C 127 ASTM C 128
Clay Lumps and Friable Particles	ASTM C 142
Material Finer than the 75-pm (No. 200) Sieve	ASTM C 117
Impurities	ASTM C 40 ASTM C 87
L.A. Abrasion	ASTM C 131 ASTM C 535
Chert, less than 2.40 specific gravity	ASTM C 123
Coal and Lignite, less than 2.00 gravity	ASTM C 123

b. Corrective Action for Aggregate Quality - If the result of a quality test fails to meet the requirements for quality immediately prior to start of concrete placement, production procedures or materials shall be changed and additional tests shall be performed until the material meets the quality requirements prior to proceeding with either mixture proportioning studies or starting concrete placement. After concrete placement commences, whenever the result of a test for quality fails the requirements, the test shall be rerun immediately. If the second test fails the quality requirement, the fact shall be reported to the Design Professional and immediate steps taken to rectify the situation.

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 for conformance with the applicable requirements of paragraph BATCHING EQUIPMENT. 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, during concrete placement 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 BATCH PLANT 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 cementitious materials, 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 cement used, type and source of pozzolan or slag 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 tests for air content shall be made on randomly selected batches of each separate concrete mixture produced during each 8-hour period of concrete production. Additional tests shall be made when excessive variation in workability is reported by the placing foreman or Design Professional 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 Design Professional. 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 AIR CONTENT. An upper warning limit and a lower warning limit line shall be set 1.0 percentage point above and below the average line. An upper action limit and a lower action limit line shall be set 1.5 percentage points above and below the average line, respectively. The range between each two consecutive tests shall be plotted on a control chart for range where an upper warning limit is set at 2.0 percentage points and up upper action limit is set at 3.0 percentage 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 Design Professional 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 slump tests shall be made on randomly selected batches in accordance with ASTM C 143/C 143M for each separate concrete mixture produced during each 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 Design Professional's quality assurance representative. Test results shall be plotted on control charts which shall at all times be readily available to the Design Professional. 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 SLUMP, 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 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 Design Professional 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/C 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 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/C 1064M. The temperature shall be reported along with the compressive strength data.

f. Compressive-Strength Specimens - At least one 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 Design Professional, 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 Design Professional 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 28-day specified strength per paragraph DESIGN REQUIREMENTS shall consist of four cylinders, two to be tested at 7 days and two at 28 days. A set of test specimens for concrete with a 90-day strength per specified paragraph DESIGN REQUIREMENTS shall consist of six cylinders, two tested at 7 days, two at 28 days, and two at 90 days. Test specimens shall be molded and cured in accordance with ASTM C 31/C 31M and tested in accordance with ASTM C 39/C 39M. All compressive-strength tests shall be reported immediately to the Design Professional. 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 214R.

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 Design Professional 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 COE CRD-C 521prior 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 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 VIBRATORS 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 nonwork 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 nonwork 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 1 day.

3.7.2.13 Mixer Uniformity

a. Stationary Mixers - Prior to the start of concrete placing when concrete is being placed, or once for every 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/C 94M.

b. Truck Mixers - Prior to the start of concrete placing, uniformity of concrete shall be determined in accordance with ASTM C 94/C 94M. 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 Design Professional has the right to examine all test and inspection records.

-- End of Section --

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SECTION 31 00 00

EARTHWORK
07/08

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 180	(2001; R 2004) Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and an 457-mm (18-in) Drop
AASHTO T 224	(2001; R 2004) Correction for Coarse Particles in the Soil Compaction Test

ASTM INTERNATIONAL (ASTM)

ASTM C 136(2006)	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D 1140(2000; R 2006)	Amount of Material in Soils Finer than the No. 200 (75-micrometer) Sieve
ASTM D 1556(2007)	Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557(2007)	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D 2167(1994; R 2001)	Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D 2487(2006)	Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 422(1963; R 2002e1)	Particle-Size Analysis of Soils
ASTM D 4318(2005)	Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 698(2007e1)	Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.))

STATE OF MISSOURI, CODE OF STATE REGULATIONS (CSR)

10 CSR 80-2 General Provisions

10 CSR 80-8 Scrap Tires

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS A-A-203(Rev C; Notice 2) Paper, Kraft, Untreated

1.2 DEFINITIONS AND CLASSIFICATIONS OF EXCAVATION

1.2.1 Common Excavation

Except where otherwise indicated or specified, all excavation shall be considered Common Excavation.

Any concrete, asphaltic concrete, cinderblocks, and bricks encountered during excavation shall be handled and disposed of as specified for the class of excavation with which it is encountered. Such material shall not be placed within 2 feet of the finish grade at any location. Any concrete or asphaltic concrete used as fill shall not have a dimension greater than 3 feet. For all reinforced concrete used as fill material, reinforcement steel shall be removed to within one inch of the surface of the concrete, and the reinforcing steel shall be disposed of as specified for Solid Waste excavation.

1.2.2 Waste Fill

Waste Fill is uncontaminated soil, rock, sand, gravel, concrete, asphaltic concrete, cinder blocks, brick, minimal amounts of wood and metal and inert solids, for fill, reclamation or other beneficial use as defined under 10 CSR 80-2. "Minimal amounts" is an amount of less than 10 percent based on the total volume of excavated material. Excavated material containing a total volume of less than 10 percent solid waste may be reburied in the same location from where it was excavated.

Roofing shingles, sheet rock, lumber or other construction and demolition wastes are not defined as Waste Fill. When these materials are excavated and comprise 10 percent or greater of the total volume of excavated material they must be properly disposed of as Solid Waste. The upper 2 feet shall be filled with topsoil as defined in paragraph TOPSOIL except in areas covered with riprap or stone, or areas below the normal water surface.

1.2.3 Solid Waste

Solid Waste includes non-hazardous construction and demolition waste as well as garbage and refuse as defined under 10 CSR 80-2. General solid waste must be disposed of at a permitted landfill. It must not be dumped, burned or reburied (except at a permitted landfill) to avoid violating air and solid waste laws and regulations.

1.2.4 Waste Tires

Tires encountered during excavation shall be handled and disposed of in accordance with 10 CSR 80-8.

1.2.5 Topsoil

Material suitable for topsoils obtained from onsite areas and excavations is defined as: Natural, friable soil representative of productive, well-drained soils in the area, free of stumps, rocks larger than three inches in diameter, brush, toxic substances, and other material detrimental to plant growth.

1.2.6 Rock

Solid homogeneous interlocking crystalline material with firmly cemented, laminated, or foliated masses or conglomerate deposits, neither of which can be removed without systematic drilling and blasting, drilling and the use of expansion jacks or feather wedges, or the use of backhoe-mounted pneumatic hole punchers or rock breakers; also large boulders, buried masonry, or concrete other than pavement exceeding 1/2 cubic yard in volume.

1.2.7 Degree of Compaction

Degree of compaction required, except as noted in the second sentence, is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557 abbreviated as a percent of laboratory maximum density. Since ASTM D 1557 applies only to soils that have 30 percent or less by weight of their particles retained on the 3/4 inch sieve, express the degree of compaction for material having more than 30 percent by weight of their particles retained on the 3/4 inch sieve as a percentage of the maximum density in accordance with AASHTO T 180 and corrected with AASHTO T 224. To maintain the same percentage of coarse material, use the "remove and replace" procedure as described in NOTE 8 of Paragraph 7.2 in AASHTO T 180.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Design Professional approval. Submit the following in accordance with Section 01 33 00, SUBMITTAL PROCEDURES:

SD-06 Test Reports
Testing ; AE

Within 24 hours of conclusion of physical tests, 2 copies of test results, including calibration curves and results of calibration tests.

SD-07 Certificates
Testing; AE

Qualifications of the Corps validated commercial testing laboratory or the Contractor's validated testing facilities has been submitted as part of the Contractor's Quality Control Plan.

1.4 SUBSURFACE DATA

Subsurface soil boring logs are shown on the drawings. These data represent the best subsurface information available; however, variations may exist in the subsurface between boring locations.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 GENERAL EXCAVATION

Perform excavation of every type of material encountered within the limits of the project to the lines, grades, and elevations indicated and as

specified. Perform the grading in accordance with the typical sections shown and the tolerances specified in paragraph FINISHING. Transport satisfactory excavated materials and place in fill or embankment within the limits of the work. Excavate unsatisfactory materials encountered within the limits of the work below grade and replace with satisfactory materials as shown on drawings. Include such excavated material and the satisfactory material ordered as replacement in excavation. Dispose surplus satisfactory excavated material not required for fill or embankment in areas approved for surplus material storage or designated waste areas. Dispose unsatisfactory excavated material in designated waste or spoil areas, with the exception that solid waste shall be disposed of in accordance with Section 01 57 20.00 10 ENVIRONMENTAL PROTECTION DESIGN/BUILD. During construction, perform excavation and fill in a manner and sequence that will provide proper drainage at all times. Excavate material required for fill or embankment in excess of that produced by excavation within the grading limits or from other approved areas indicated or selected by the Contractor as specified.

3.1.1 Ditches, Gutters, and Channel Changes

Finish excavation of ditches, gutters, and channel changes by cutting accurately to the cross sections, grades, and elevations shown on Drawing s. Do not excavate ditches and gutters below grades shown. Backfill the excessive open ditch or gutter excavation with satisfactory, thoroughly compacted, material or with suitable stone to grades shown. Dispose of excavated material as shown or as directed, except in no case allow material be deposited a maximum 4 feet from edge of a ditch. Maintain excavations free from detrimental quantities of leaves, brush, sticks, trash, and other debris until final acceptance of the work.

3.1.2 Drainage

Construct storm drainage features at the earliest stages of site development, and throughout construction grade the construction area to provide positive surface water runoff away from the construction activity. It is the responsibility of the Contractor to assess the soil and ground water conditions presented by the plans and specifications and to employ necessary measures to permit construction to proceed.

3.1.3 Dewatering
See Section 35 32 00 SAND DRAINS.

3.2 GROUND SURFACE PREPARATION

3.2.1 General Requirements

Remove and replace unsatisfactory material with satisfactory materials, as specified by the Geotechnical Engineer, in surfaces to receive fill or in excavated areas. Scarify the surface to a depth of 6 inch before the fill is started. Plow, step, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so that the fill material will bond with the existing material.

3.2.2 Frozen Material

Do not place in-channel fill material on surfaces that are frozen or contain frost.

3.3 EMBANKMENTS

3.3.1 In-Channel Fill

Construct in-channel fill from satisfactory materials. Place the material in successive horizontal layers of loose material not more than 12 inch in depth, or 24-inch depth for rubble fill. Spread each layer uniformly on a soil surface that has been moistened or aerated as necessary, and scarified or otherwise broken up so that the fill will bond with the surface on which it is placed. After spreading, plow, disk, or otherwise brake up each layer; moisten or aerate as necessary; thoroughly mix; and compact to at least 90 percent laboratory maximum density for cohesive materials. Compaction requirements for the upper portion of earth embankments forming subgrade for pavements are identical with those requirements specified in this paragraph. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment.

3.4 COMPACTION EQUIPMENT FOR IN-CHANNEL FILLS

3.4.1 General

Suggested compaction equipment are as follows: Tamper-type rollers, power tampers, and crawler-type tractors. Other types of compaction equipment that will obtain results equal to the equipment suggested may be used when approved.

3.4.2 Tamper-Type Rollers

Tamper-type rollers shall consist of heavy-duty, double drum units with a drum diameter not less than 60 nor more than 72 inches. The drums shall be liquid or sand and liquid ballasted. Each drum shall have staggered feet uniformly spaced over the cylindrical surface such as to provide approximately 3 to 9 inches in clear projection from the cylindrical surface of the roller and weight of the roller shall be between 1,000 pounds and 2,000 pounds per linear foot of drum length empty and be capable of being ballasted to at least 3,500 pounds per foot of linear drum length. The design and operation of the tamping roller shall be subject to approval. Rollers shall be self-propelled or drawn by a crawler-type tractor. Self-propelled rollers exceeding the empty weight requirements may be used provided that by the substitution of tamping feet having a face area not exceeding 14 square inches, the nominal foot pressure on the tamping feet of the self-propelled roller can be adjusted to approximate the nominal foot pressure of the towed roller for the particular working condition required for the towed rollers. If the self-propelled rollers cause shearing of the fill or laminations in the fill, the Geotechnical Engineer may direct that the self-propelled rollers be removed from the fill and that the tractor-drawn tamping rollers be used. For self-propelled rollers, in which steering is accomplished through the use of rubber-tired wheels, the tire pressure shall not exceed 40 pounds per square inch. Rollers hall be operated at a speed not to exceed 5 miles per hour.

3.4.3 Crawler-Type Tractors

Crawler-type tractors used for traffic compaction shall weigh not less than 40,000 pounds.

3.4.3.1 Power Tampers

Power tampers shall be approved subject to being capable of obtaining a density of at least 90 percent of maximum when the material is placed in 4-inch lifts (uncompacted thickness), and compacted wet of optimum.

3.4.3.2 Other Types of Compaction

Other types of compaction equipment that the Contractor demonstrates that will obtain results equal to the specified equipment may be used when approved in writing.

3.4.3.3 Sprinkling Equipment

Sprinkling equipment shall consist of pressure distributors designed to apply water in controlled quantities to variable widths of surface. Sprinkling equipment depending solely on gravity flow for dispensing water to the fill will not be permitted.

3.4.3.4 Tamping Rollers

A pass shall consist of complete coverage of the area to be compacted, with each trip of the roller overlapping the adjacent trip not less than 1 foot. One pass shall consist of complete coverage by the tractor, with sufficient overlap of the successive track paths to insure complete coverage. Surfaces to be compacted in confined areas inaccessible for rolling shall be tamped uniformly with approved power tampers.

3.5 NOT USED

3.6 FINISHING

Finish the surface of excavations, embankments, and subgrades to a smooth and compact surface in accordance with the lines, grades, and cross sections or elevations shown. Provide the degree of finish for graded areas within 0.5 foot of the grades and elevations indicated. Finish gutters and ditches in a manner that will result in effective drainage as shown in Drawings. Finish the surface of areas to be seed ed from settlement or washing to a smoothness suitable for the application of seeding materials. Repair graded or backfilled areas prior to acceptance of the work, and re-established grades to the required elevations and slopes.

3.6.1 Crawler tractor

One pass shall consist of complete coverage by the tractor, with sufficient overlap of the successive tread paths to insure complete coverage.

3.7 POWER TAMPERS

Surfaces to be compacted in confined areas inaccessible for rolling shall be tamped uniformly with approved power tampers.

3.8 QUALITY CONTROL IN IN-CHANNEL FILLS

General: Tests, except as otherwise specified herein, shall be performed by the Contractor as part of the quality control program. The Contractor shall obtain representative samples of the materials required for the tests. In addition, and upon request, samples shall be submitted to the Contracting Officer for Government testing. Tests shall be performed in accordance with the following requirements:

3.8.1 Classification shall be determined in accordance with ASTM D2487.

3.8.2 Moisture-density relationship: The maximum density and the optimum moisture content of the fill material and that portion which has the characteristics of material shall be determined in accordance with ASTM D-698. A minimum of three points shall be run for each curve. Additional points shall be added to develop the curve in the range of specified moisture content.

3.8.3 Density tests on compacted materials shall be taken in the field in accordance with ASTM Standard D 1556, or ASTM Standard D 2167.

3.8.4 Tests on In-Place Material

The Contractor shall run sufficient in-place density tests and determine in-place moisture contents when applicable to be sure that the moistures are within the specified limits and that the compaction is satisfactory. Sufficient compaction test specimens shall be run on representative samples from each density test to determine the optimum moisture and density. The location for each test shall be carefully selected to insure that the sample taken is truly representative of the in-place materials in the vicinity. If, in the opinion of the Geotechnical Engineer, the location for a test is not representative of the in-place materials, the Contractor shall change the location of the test as directed. Location, approximate elevation and results of each test shall be recorded. The minimum number of tests shall be as follows:

Type of Test	Material	Required on Per
Density	Fill Material	Fill: one test per 1500 cubic yards placed
One-point Compaction tests	Fill Material	Each density test
Moisture Content	Fill Material	Each compaction test
Sand Cone	Fill Material	Each 10 density tests
Proof Rolling	Soil/ Rubble Fill Mix	Once per lift (25 ton articulating end dump truck)

3.8.5 Additional Tests

Whenever there is a reason to suspect that materials do not meet the specified requirements or that the moisture content or density obtained is not within the specified limits, additional tests shall be performed as directed.

3.8.6 Control Testing

All tests shall be performed as soon as samples are taken and the results checked to determine whether the material meets the specifications requirements. Areas tested shall not be covered before test results are reviewed by the Geotechnical Engineer. Areas that require reworking shall be

so identified and reworked as necessary until the compaction meets the specification requirements. Unsatisfactory material shall be removed and replaced with acceptable material.

Reporting data shall include all pertinent information related to the previously specified tests, material sources, type of equipment used, and other information required by the Geotechnical Engineer. It shall be completed in its entirety and submitted to the Contracting Officer at 30-day intervals.

-- End of Section --

SECTION 31 11 00

CLEARING AND GRUBBING
07/08

PART 1 GENERAL

1.1 DELIVERY, STORAGE, AND HANDLING

Deliver materials to, store at the site, and handle in a manner which will maintain the materials in their original manufactured or fabricated condition until ready for use.

PART 2 NOT USED

PART 3 EXECUTION

3.1 PROTECTION

3.1.1 Roads and Walks

Keep roads and walks free of dirt and debris at all times.

3.1.2 Trees, Shrubs, and Existing Facilities

Trees and vegetation to be left standing shall be protected from damage incident to clearing, grubbing, and construction operations by the erection of barriers or by such other means as the circumstances require.

3.1.3 Utility Lines

Protect existing utility lines that are indicated to remain from damage. Notify the Contracting Officer immediately of damage to or an encounter with an unknown existing utility line. The Contractor shall be responsible for the repairs of damage to existing utility lines that are indicated or made known to the Contractor prior to start of clearing and grubbing operations. When utility lines which are to be removed are encountered within the area of operations, the Contractor shall notify the Contracting Officer in ample time to minimize interruption of the service.

3.2 CLEARING

Clearing shall consist of the felling, trimming, and cutting of trees into sections and the satisfactory disposal of the trees and other vegetation designated for removal, including downed timber, snags, and brush occurring within the areas to be cleared. Clearing shall also include the removal and disposal of structures that obtrude, encroach upon, or otherwise obstruct the work. Trees, stumps, roots, brush, and other vegetation in areas to be cleared shall be cut off flush with or below the original ground surface, except such trees and vegetation as may be indicated or directed to be left standing.

3.3 TREE REMOVAL

Where indicated or directed, trees and stumps that are designated as trees shall be removed from areas outside those areas designated for clearing and grubbing. This work shall include the felling of such trees and the removal of their stumps and roots as specified in paragraph GRUBBING.

3.4 GRUBBING

Grubbing shall consist of the removal and disposal of stumps, roots larger than 3 inches in diameter, and matted roots from the designated grubbing areas. Material to be grubbed, together with logs and other organic or metallic debris not suitable for foundation purposes, shall be removed to a depth of not less than 18 inches below the original surface level of the ground as required to construct embankments as shown in the Drawings. Depressions made by grubbing shall be filled with suitable material and compacted to make the surface conform with the original adjacent surface of the ground.

-- End of Section --

SECTION 31 32 39

BIOENGINEERING PRACTICES FOR STREAM HABITAT AND STORMWATER RUNOFF
07/08

PART 1 GENERAL

1.1 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Design Professional approval. Submit the following in accordance with Section 01 33 00, SUBMITTAL PROCEDURES:

SD-02 Record Data

1.2 DESCRIPTION OF WORK

The work shall consist of the Contractor furnishing and installing bioengineered features and structures to enhance stream habitat and control stormwater runoff. This work shall include all necessary evaluation, design, materials, labor, supervision, and equipment for installation in accordance with contract documents. This section shall be coordinated with the requirements of Section 31 11 00 CLEARING AND GRUBBING, 31 00 00 EARTHWORK, 35 31 19 CHANNEL PROTECTION, and 32 92 19 ENHANCEMENT SEEDING and all other specifications or requirements as necessary."

1.3 QUALITY ASSURANCE

The Contractor shall be responsible for all quality control measures. All Contractor records, documents, and work may be inspected by the Design Professional or designated representative at any time. Items not meeting quality requirements shall be replaced or repaired immediately by the Contractor at no cost to the Government.

1.4 DELIVERIES, INSPECTION, STORAGE, AND HANDLING

Materials shall be stored in designated areas as recommended by the manufacturer and that are protected from direct exposure to the elements, moisture, and any potential damage. Containers shall not be dropped from trucks. Material shall be free of defects that would void required performance or warranty. Manufactured items shall be delivered in the manufacturer's original sealed containers and stored in a secure area.

a. Vegetation cuttings, herbaceous plants, and clump plantings shall be inspected for species, size, health, and preparation. Diseased, improperly sized, and incorrect species shall be rejected. Specific requirements for storage and handling are provided below.

b. Stone and rock shall meet design specifications.

1.5 SUBSTITUTIONS

Substitutions may be submitted for approval by the Design Professional.

PART 2 PRODUCTS

2.1 PERMANENT VEGETATION SPECIES AND MIXTURES

Refer to Section 32 92 19 ENHANCEMENT SEEDING for swale plantings and plan sheets for wetland deep cell plugging and live pole staking, species, and material type.

All live pole stakings shall be capable of growth and rooting and free of disease or defects at the time of installation.

2.2 CRUSHED ROCK, STONE, RIPRAP, AND BACKFILL

The quality of rock, gravel, sand, stone, riprap, and backfill shall be in accordance with requirements in Section 31 00 00 EARTHWORK and Section 35 31 19 CHANNEL PROTECTION. Materials not meeting specified requirements shall be rejected and immediately replaced by suitable material at no cost to the Government.

2.3 WATER

Water source for soaking of pole live staking and dust control shall be provided by City of Kansas City, Missouri.

PART 3 EXECUTION

3.1 HARVESTING OF VEGETATION

3.1.1 Harvesting of Woody Plants

Stakes and poles shall be harvested from local sources of selected species. With prior approval, the Contractor may obtain material from approved City of Kansas City, Missouri properties. Stakes and poles shall be cut from healthy plants and shall be as straight as possible. All cuts shall be clean and free of splits or excessive peeling of bark. All branches emanating from the stake pole shall be trimmed as close as possible to the surface of the stake without damage to the bark. The bottom end of the stake pole may be cut at an angle of approximately 60 degrees to the horizontal to facilitate insertion. The top of the stake pole shall be cut normal to its length.

3.2 TRANSPORTATION OF HARVESTED VEGETATION

a. All freshly harvested and prepared live woody vegetation shall be submerged in water and shall not be allowed to dry out prior to installation. If site conditions prohibit direct access to storage bins filled with water, then the freshly cut live vegetation shall be wrapped in cloth, which is thoroughly saturated with water, and shall be transported to a storage bin filled with water.

b. Cut vegetation shall not be left uninstalled at the work site and exposed to air or heat or excessive cold for any reason.

3.3 SOAKING OF LIVE HARVESTED VEGETATION

a. All harvested live vegetation shall be soaked in clean water before installation into the ground. The live vegetation shall be placed in clean, leak proof, large storage containers. Reused drums used for the containment of hazardous wastes or chemicals shall not be used.

b. The water levels in the containers shall be checked as necessary and water shall be added as needed to ensure the containers are filled with sufficient water to completely cover the contained vegetation. W eights, clean cobbles, or boulders may be used to weight down the vegetation and retain it under the water surface. These weights shall not crush or damage the vegetation.

3.4 BIOENGINEERED STRUCTURES

3.4.1 Common Structures

3.4.1.1 Live Pole Staking

Live pole stakes shall be driven or placed into the ground as shown on plans.

3.4.1.2 Pole Planting

The driving tip may be shaped to a point to aid in installation. Branches shall not be stripped from the pole where exposed above grade after installation. The top of each pole shall be cut normal to its length.

3.4.1.3 Locked Log

The submerged portion of each log shall be approximately 1 to 2 feet above channel invert elevation measured to bottom of log. If necessary, contractor may provide fastening system (e.g. cabling, anchor, rock) for use during installation to temporarily or permanently secure logs prior to placement of soil and rock fills.

3.4.1.4 Lunker Logs

Contractor to provide new, used, or recycled 24 to 36 inch diameter RCP free of hazardous substances. Length of logs can vary, but should generally extend approximately full length of RCP. Upstream end of logs must consist of rootwad base or crown remnants from recycled trees and the diameter of rootwad or crown must be a minimum 1.5 times the diameter of RCP installed in to prevent log from being forced through RCP by water current. Average diameter of individual roots from rootwad or branches from crown remnant must be thick enough to prevent breakage from water current. Lunker logs to be placed at the intersection of the low 1:3 slope and the channel invert elevation. Contractor shall secure lunker log RCP with rock riprap as shown on plans.

3.4.1.5 Root Wad

Upstream end of logs must consist of intact (un-pruned) rootwad base. A minimum of 1/3 the vertical height of the installed root wad must be submerged during normal base flow conditions.

-- End of Section --

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SECTION 31 41 16

METAL SHEET PILING
07/08

PART 1 GENERAL

1.1 REFERENCES

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

ASTM INTERNATIONAL (ASTM)

ASTM A 6/A 6M	(2007) Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Design Professional approval. Submit the following in accordance with Section 01 33 00, SUBMITTAL PROCEDURES:

SD-02 Shop Drawings
Metal Sheet Piling; AE

Detail drawings for sheet piling shall be provided.

SD-03 Product Data
Pile Driving Equipment; AE

Complete descriptions of sheet piling driving equipment prior to commencement of work.

SD-06 Test Reports
Materials Tests; AE

Certified materials test reports. Reports showing that sheet piling and appurtenant metal materials meet the specified requirements shall be submitted for each shipment and identified with specific lots prior to installing materials. Material test reports shall meet the requirements of ASTM A 6/A 6M.

SD-11 Closeout Submittals
Pile Driving Record; AE

Record for each sheet pile driven, as specified. These records shall show the top and bottom elevations of installed piling.

1.3 DELIVERY, STORAGE AND HANDLING

Materials delivered to the site shall be new and undamaged and shall be accompanied by certified test reports. The manufacturer's logo and mill identification mark shall be provided on the sheet piling as required by the referenced specifications. Sheet piling shall be stored and handled in the

manner recommended by the manufacturer to prevent permanent deflection, distortion or damage to the interlocks; as a minimum, support on level blocks or racks spaced not more than 10 feet apart and not more than 2 feet from the ends. Storage of sheet piling should also facilitate required inspection activities and prevent damage to coatings and corrosion prior to installation.

1.4 QUALITY ASSURANCE

1.4.1 Material Certificates

For each shipment, submit mill certificates identified with specific lots prior to installing piling. Identification data should include piling type, dimensions, chemical composition, mechanical properties, section properties, heat number, and mill identification mark.

PART 2 PRODUCTS

2.1 METAL SHEET PILING

Metal sheet piling shall be hot-rolled steel sections conforming to ASTM A 328/A 328M, interlocked joint strength in tension as shown. The sheet pile shall have a minimum thickness of 0.335 inches, with a minimum section modules of 21.7 CuIn/Ft. Cold-formed steel sections shall be formed from hot-rolled steel meeting the chemical and mechanical requirements of ASTM A 328/A 328M. The interlocks of sheet piling shall be free-sliding, provide a swing angle suitable for the intended installation but not less than 5 degrees when interlocked, and maintain continuous interlocking when installed. Sheet piling shall be full-length sections of the dimensions shown. Fabricated sections shall conform to the requirement and the piling manufacturer's recommendations for fabricated sections. Sheet piling shall be provided with standard pulling holes.

2.2 GENERAL REQUIREMENTS

Sheet piling shall be full-length sections of the dimensions shown. Sheet piling shall be provided with standard pulling holes.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Pile Driving Equipment

Pile driving equipment shall conform to the following requirements.

3.1.1.1 Driving Hammers

Hammers shall be steam, air, or diesel drop, single-acting, double-acting, differential-acting, or vibratory type. The driving energy of the hammers shall be as recommended by the manufacturer for the piling weights and subsurface materials to be encountered. Repair damage to piling caused by use of a pile hammer with excess delivered force or energy.

3.1.1.2 Jetting Equipment

Jetting will not be permitted.

3.1.2 Placing and Driving

3.1.2.1 Placing

Any excavation required within the area where sheet pilings are to be installed shall be completed prior to placing sheet pilings. Pilings properly placed and driven shall be interlocked throughout their length with adjacent pilings to form a continuous diaphragm throughout the length or run of piling wall.

a. Pilings shall be carefully located as shown. Pilings shall be placed plumb with out-of-plumbness not exceeding 1/4 inch per foot of length and true to line. Place the pile so the face will not be more than 6 inches from vertical alignment at any point. Top of pile at elevation of cut-off shall be within 1/2 inch horizontally and 2 inches vertically of the location indicated. Manipulation of piles to force them into position will not be permitted. Check all piles for heave. Redrive all heaved piles to the required tip elevation.

3.1.2.2 Driving

Pilings shall be driven with the proper size hammer and by approved methods so as not to subject the pilings to damage and to ensure proper interlocking throughout their lengths.

a. Driving hammers shall be maintained in proper alignment during driving operations by use of leads or guides attached to the hammer. Caution shall be taken in the sustained use of vibratory hammers when a hard driving condition is encountered to avoid interlock-melt or damages. The use of vibratory hammers should be re-evaluated by the Geotechnical Engineer when the penetration rate due to vibratory loading is one foot or less per minute.

b. Pilings damaged during driving or driven out of interlock shall be removed and replaced at the Contractor's expense.

c. Pilings shall be driven without the aid of a water jet.

d. Adequate precautions shall be taken to insure that pilings are driven plumb. Where possible, drive Z-pile with the ball end leading. If an open socket is leading, a bolt or similar object placed in the bottom of the interlock will minimize packing material into it and ease driving for the next sheet. If at any time the forward or leading edge of the piling wall is found to be out-of-plumb in the plane of the wall the piling being driven shall be driven to the required depth and tapered pilings shall be provided and driven to interlock with the out-of-plumb leading edge or other approved corrective measures shall be taken to insure the plumbness of succeeding pilings. The maximum permissible taper for any tapered piling shall be 1/8 inch per foot of length.

e. Pilings in each run or continuous length of piling wall shall be driven alternately in increments of depth to the required depth or elevation. No piling shall be driven to a lower elevation than those behind it in the same run except when the pilings behind it cannot be driven deeper. Incrementally sequence driving of individual piles such that the tip of any sheet pile shall not be more than 4 feet below that of any adjacent sheet pile.

f. If obstructions restrict driving a piling to the specified penetration the obstructions shall be removed or penetrated with a chisel beam. If the Contractor demonstrates that removal or penetration is impractical the Contractor shall make changes in the design alignment of the piling structure as directed to insure the adequacy and stability of the structure. Pilings shall be driven to depths shown and shall extend up to the elevation indicated for the top of pilings. A tolerance of 3 inches above the indicated top elevation will be permitted. Pilings shall not be driven within 100 feet of concrete less than 7 days old.

3.1.3 Cutting-Off and Splicing

Pilings driven to refusal or to the point where additional penetration cannot be attained and are extending above the required top elevation in excess of the specified tolerance shall be cut off to the required elevation.

a. The tops of pilings excessively battered during driving shall be trimmed when directed, at no cost to the Government. Piling cut-offs shall become the property of the Contractor and shall be removed from the site.

3.1.4 Inspection of Driven Piling

Perform continuous inspection during pile driving. Inspect all piles for compliance with tolerance requirements. Bring any unusual problems which may occur to the attention of the Geotechnical Engineer. The Contractor shall inspect the interlocked joints of driven pilings extending above ground. Pilings found to be out of interlock shall be removed and replaced at the Contractor's expense.

3.2 REMOVAL

The removal of sheet pilings shall consist of pulling, sorting, cleaning the interlocks, inventorying and storing previously installed sheet pilings as shown and directed.

3.2.1 Pulling

The method of pulling piling must be approved. Pulling holes shall be provided in pilings as required. Extractors shall be of suitable type and size. Care shall be exercised during pulling of pilings to avoid damaging piling interlocks and adjacent construction. If the Geotechnical Engineer determines that adjacent permanent construction has been damaged during pulling, the Contractor will be required to repair this construction at no cost to the Government. Pilings shall be pulled one sheet at a time. Pilings fused together shall be separated prior to pulling unless the Contractor demonstrates, to the satisfaction of the Geotechnical Engineer, that the pilings cannot be separated. The Contractor will not be paid for the removal of pilings damaged beyond structural use due to proper care not being exercised during pulling.

3.2.2 Sorting, Cleaning, Inventorying and Storing

Pulled pilings shall be sorted, cleaned, inventoried and stored by type into groups as:

a. Piling usable without reconditioning.

b. Piling requiring reconditioning.

c. Piling damaged beyond structural use.

-- End of Section --

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SECTION 32 92 19

ENHANCEMENT SEEDING
07/08

PART 1 GENERAL

1.1 REFERENCES

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

U.S. DEPARTMENT OF AGRICULTURE (USDA)

AMS Seed Act (1940; R 1988; R 1998) Federal Seed Act

1.2 DEFINITIONS

1.2.1 Stand of Native Grasses and Forbs

70 percent seedling ground cover with no bare areas larger than 10 square feet of the established species, after one full growing season.

1.3 RELATED REQUIREMENTS

Section 31 00 00 EARTHWORK and Section 32 93 00 EXTERIOR PLANTS apply to this section for pesticide use and plant establishment requirements, with additions and modifications herein.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Design Professional approval. Submit the following in accordance with Section 01 33 00, SUBMITTAL PROCEDURES:

SD-03 Product Data
Erosion Control Materials

SD-07 Certificates
State certification for seed

SD-08 Manufacturer's Instructions
Erosion Control Materials

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery

1.5.1.1 Seed Protection

Protect from drying out and from contamination during delivery, on-site storage, and handling.

1.5.2 Storage

1.5.2.1 Handling

Do not drop or dump materials from vehicles.

1.6 TIME RESTRICTIONS AND PLANTING CONDITIONS
1.6.1 Restrictions

Do not plant when the ground is muddy.

1.7 TIME LIMITATIONS

1.7.1 Seed

Apply seed within twenty four hours after seed bed preparation.

PART 2 PRODUCTS

2.1 SEED
2.1.1 Classification

Provide seed of the latest season's crop delivered in original sealed packages, bearing producer's guaranteed analysis for percentages of mixtures, purity, germination, weedseed content, and inert material. Label in conformance with AMS Seed Act and applicable state seed laws. Wet, moldy, or otherwise damaged seed will be rejected.

2.1.2 Planting Dates

Planting Season	Planting Date
Season 1	Nov 15 - June 30
Temporary Seeding	Jan 1 - Dec 31

2.1.3 Seeding Outside Planting Season

At the option, risk, and full responsibility of the Contractor, seeding may be performed at times outside of the seeding dates specified herein. If such seeding fails to produce the required stand of vegetation, the seeding shall be repeated until the required stand of vegetation is achieved.

Exception to completion time: in case the Design Professional determines that seeding is not feasible during the completion time for the contract, the Contractor shall accomplish such seeding in the first planting period following the contract completion time.

2.1.4 Seed Purity

Botanical Name	Common Name	Percent Pure Seed	Percent Weed
Panicum virgatum	switchgrass	85%	1%
Andropogon gerardii	big blue stem	85%	1%
Sorgastrum nutans	indian grass	85%	1%
Rudbeckia hirta	black-eyed susan	85%	1%
Liatris aspera	rough blazing star	85%	1%
Symphyotrichum ericodes	heath aster	85%	1%
Solidago rigida	stiff goldenrod	85%	1%
Dalea purpurea	purple prairie clover	85%	1%
Erngium yuccifolium	rattlesnake master	85%	1%

Botanical Name	Common Name	Percent Pure Seed	Percent Weed
Ratibida columnifera	prairie cone flower	85%	1%
Helianthus hirsuta	hairy sunflower	85%	1%
Elymus virginicus	virginia wildrye	85%	1%
Spartina pectinata	prairie cordgrass	85%	1%
Eupatorium perfoliatum	boneset	85%	1%
Asclepias incarnata	marsh milkweed	85%	1%
Boltonia asteroides	false aster	85%	1%
Monarda fistulosa	Wild Bergamot	85%	1%
Silphium perfoliatum	cup plant	85%	1%
Aster novae-angliae	new england aster	85%	1%
Spartina pectinata	prairie cordgrass	85%	1%
Calamagrotis canadensis	bluejoint	85%	1%
Penstemon digitalis	Foxglove Beardtongue	85%	1%
Asclepias syriaca	Common Milkweed	85%	1%
Echinacea purpurea	purple coneflower	85%	1%
Liastris pycnostachya	Prairie blazing star	85%	1%
Heliopsis helianthoides	Oxeye sunflower	85%	1%
Pycanthemum tenuifolium	Slender mountain mint	85%	1%
Scirpus atrovirens	green bulrush	85%	1%
Carex hyalinolepis	shoreline sedge	85%	1%
Carex molesta	troublesome sedge	85%	1%
Rudbeckia laninata	cutleaf coneflower	85%	1%
Asclepias incarnata	marsh milkweed	85%	1%
Physostegia viriniana	obedient plant	85%	1%
Acorus calamus	sweetflag	85%	1%
Pycnanthemum virginianum	virginia mountain mint	85%	1%
Elymus canadensis	canada wildrye	85%	1%
Schizachryum scoparium	little blue stem	85%	1%

2.1.5 Seed Mixture by Weight

Planting Areas	Seed Mixture	Percent (by Weight)
Hydrophytic	Grasses (3 spp. Minimum)	80%
	Elymus virginicus	
	Andropogon gerardii	
	Panicum virgatum	
	Spartina pectinata	
	Forbs (4 spp. Minimum)	20%
	Eupatorium perfoliatum	
	Asclepias incarnata	
	Boltonia asteroides	
	Monarda fistulosa	
	Silphium perfoliatum	
	Aster novae-angliae	
Upland	Grasses (3 spp. Minimum)	80%
	Elymus canadensis	
	Schizachyrum scoparium	
	Panicum virgatum	
	Andropogon gerardii	

Planting Areas	Seed Mixture	Percent (by Weight)
	Sorgastrum nutans	
	Forbs (3 spp. Minimum)	20%
	Rudbeckia hirta	
	Liatris aspera	
	Symphyotrichum ericoides	
	Solidago rigida	
	Dalea purpurea	
	Erngium yuccifolium	
	Ratibida columnifera	
	Helianthus hirsuta	
	Pycnanthemum virginianum	
Swale	Grasses (3 spp. Minimum)	80%
	Spartina pectinata	
	Panicum virgatum	
	Elymus virginicus	
	Calamagrotis canadensis	
	Forbs (3 spp. Minimum)	20%
	Boltonia asteroides	
	Rudbeckia laninata	
	Asclepias incarnata	
	Physostegia viriniana	
	Acorus calamus	
	Pycnanthemum virginianum	

Proportion seed mixtures by weight and minimum number of species. Temporary seeding must later be replaced by Season 1 plantings for a permanent stand of grass and forbs.

At the option, risk, and full responsibility of the Contractor, seeding may be performed at times outside of the seeding dates specified herein. If such seeding fails to produce the required stand of vegetation, the seeding shall be repeated until the required stand of vegetation is achieved.

Exception to completion time: in case the Design Professional determines that seeding is not feasible during the completion time for the contract, the Contractor shall accomplish such seeding in the first planting period following the contract completion time.

Permanent seeding for other disturbed non-enhancement areas shall follow Section 01 23 00.00 23 requirements.

2.2 TOPSOIL

2.2.1 On-Site Topsoil

See Section 31 00 00 EARTHWORK.

2.3 SOIL CONDITION

All topsoil to be free of heavy compaction.

2.4 MULCH

See Section 01 23 00.00 23 paragraph 2.2.

2.5 EROSION CONTROL MATERIALS
Erosion control material shall conform to the following:

2.5.1 Erosion Control Blanket

70 percent agricultural straw/30 percent coconut fiber matrix stitched with a degradable nettings, or other approved product, designed to degrade within 12 months to 18 months. The Contractor has the option to use permanent three-dimensional open structure erosion protection mats mad of monofilaments fused together, or UV stabilized high denier polypropylene netting erosion control blanket turf reinforcement matting.

2.5.2 Erosion Control Material Anchors

Erosion control anchors shall be as recommended by the manufacturer.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 EXTENT OF WORK

Provide soil preparation (see Section 01 23 00.00 23, paragraph 3.1.4), seeding and mulching of all newly graded finished earth surfaces, unless indicated otherwise, and at all areas inside or outside the limits of construction that are disturbed by the Contractor's operations.

3.2 SEEDING

3.2.1 Seed Application Seasons and Conditions
Immediately before seeding, restore top soil to proper grade. Do not seed when ground is muddy or in an unsatisfactory condition for seeding. If special conditions exist that may warrant a variance in the above seeding dates or conditions, submit a written request to the Design Professional stating the special conditions and proposed variance. Apply seed within twenty four hours after seedbed preparation.

3.2.2 Seed Application Method

3.2.2.1 Broadcast or Drop Seeding

Seed shall be uniformly broadcast at the rate of 16 pounds pure live seed per acre. Use broadcast or drop seeders only in areas not reachable by drill seeder. Cover seed uniformly to a maximum depth of 1/4 inch in clay soils and 1/2 inch in sandy soils by means of spike-tooth harrow, cultipacker, raking or other approved devices.

3.2.2.2 Drill Seeding
Seed shall be drilled at the rate of 16 pounds pure live seed per acre. Use cultipacker seeders or grass seed drills. Drill seed uniformly to average depth of 1/4-1/2 inch.

3.2.3 Mulching

3.2.3.1 Mulch

Mulch shall be spread uniformly at the rate of 1-2 tons per acre. Mulch shall be spread by hand, blower-type mulch spreader, or other approved method. Mulching shall be started on the windward side of relatively flat areas or on the upper part of steep slopes, and continued uniformly until the area is covered. The mulch shall not be bunched or clumped. Sunlight shall not be completely excluded from penetrating to the ground surface. All areas installed with seed shall be mulched on the same day as the seeding. Mulch shall be anchored immediately following spreading.

3.2.3.2 Mechanical Anchor

Mechanical anchor shall be a V-type-wheel land packer; a scalloped-disk land packer designed to force mulch into the soil surface; or other suitable equipment.

3.2.4 Erosion Control Material

Install in accordance with manufacturer's instructions, where indicated or as directed by the Design Professional.

3.3 PROTECTION OF NATIVE GRASSES AND FORBS

Immediately after seeding, protect area against traffic and other use.

3.4 ESTABLISHMENT OF NATIVE GRASS AND FORB AREAS

Establishment period will cease on the date that the inspection by the Design Professional shows that the stand of native grasses and forbs furnished under this contract have been met.

3.4.1 Mowing

Refer to section 01 23 00.00 23, paragraph 3.5 for details.

3.5 REPAIRING AND RESEEDING

The Contractor shall be fully responsible for any damage or lack of cover caused by elements under his or her control. The Contracting Officer may direct that areas that do not attain the required cover or areas that become damaged be repaired and reseeded to specification requirements. If such lack of cover is determined to be caused by no fault of the Contractor, equitable adjustment will be made in the contract price for additional work directed and performed.

3.6 RESTORATION

Restore to original condition existing native grass and forb areas (and all installed vegetation) areas which have been damaged during installation operations at the Contractor's expense.

-- End of Section --

SECTION 32 93 00

EXTERIOR PLANTS
07/08

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

Section 31 00 00 EARTHWORK and Section 32 92 10 SEEDING applies to this section for plant establishment requirements, with additions and modifications herein.

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Design Professional approval. Submit the following in accordance with Section 01 33 00, SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals
Time Restrictions and Planting Conditions; AE

Indicate anticipated dates and locations for each type of planting.

SD-03 Product Data
Local/Regional Materials; AE

Submit documentation indicating distance between production facility and the project site. Indicate distance of raw material origin from the project site.

Mulch; AE
Weed control fabric; AE
Erosion control materials; AE

SD-07 Certificates
Nursery certifications; AE

Indicate names of plants including type, quality, and size.

1.3 QUALITY ASSURANCE

1.3.1 Nursery Certifications

a. Indicate on nursery letterhead the name of plants, including botanical common names, quality, and size.

b. Inspection certificate.

c. Mycorrhizal fungi inoculum for plant material treated

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Delivery

1.4.1.1 Branched Plant Delivery

Deliver with branches tied and exposed branches covered with material which allows air circulation. Prevent damage to branches, trunks, root systems, and root balls and desiccation of leaves.

1.4.1.2 Plant Labels

Deliver plants with durable waterproof labels in weather-resistant ink. Provide labels stating the correct botanical and common plant name and variety as applicable and size as specified in the list of required plants. Attach to plants, bundles, and containers of plants. Groups of plants may be labeled by tagging one plant. Labels shall be legible for a minimum of 60 days after delivery to the planting site.

1.4.2 Storage

1.4.2.1 Plant Storage and Protection

Store and protect plants not planted on the day of arrival at the site as follows:

a. Shade and protect plants in outside storage areas from the wind and direct sunlight until planted.

b. Heel-in bare root plants.

c. Not used.

d. Keep plants in a moist condition until planted by watering with a fine mist spray.

e. Do not store plant material directly on concrete or bituminous surfaces.

1.4.2.2 Mulch Storage

Store in dry locations away from contaminants.

1.4.3 Handling

Do not drop or dump plants from vehicles. Avoid damaging plants being moved from nursery or storage area to planting site. Handle boxed bare-root balled and potted processed balled in-ground fabric bag grown container plants carefully to avoid damaging or breaking the earth ball or root structure. Do not handle plants by the trunk or stem. Puddle bare-root plants after removal from the heeling-in bed to protect roots from drying out. Remove damaged plants from the site.

1.4.4 TIME LIMITATION

Except for container-grown plant material, the time limitation from digging to installing plant material shall be a maximum of 90 days. The time limitation between installing the plant material and placing the mulch shall be a maximum of 24 hours.

1.5 TIME RESTRICTIONS AND PLANTING CONDITIONS

Coordinate installation of planting materials during optimal planting seasons for each type of plant material required.

1.5.1 Restrictions

Do not plant when ground is frozen or muddy.

1.6 LOCAL/REGIONAL MATERIALS

1.6.1 Local/Regional Materials

Use materials or products extracted, harvested, or recovered, as well as manufactured, within a 200 mile radius from the project site.

PART 2 PRODUCTS

2.1 PLANTS

2.1.1 Regulations and Varieties

Furnish nursery stock in accordance with project plans. Plants of the same specified size shall be of uniform size and character of growth. All plants shall comply with all Federal and State Laws requiring inspection for plant diseases and infestation.

2.1.2 Shape and Condition

Well-branched, well-formed, sound, vigorous, healthy planting stock free from disease, sunscald, windburn, abrasion, and harmful insects or insect eggs and having a healthy, normal, and undamaged root system.

2.1.2.1 Deciduous Trees and Shrubs

Symmetrically developed and of uniform habit of growth, with straight boles or stems, and free from objectionable disfigurements.

2.1.3 Plant Size

Plants larger in size than specified may be provided with approval of the Design Professional. When larger plants are provided, increase the ball of earth or spread of roots.

2.1.4 Root Ball Size

All wrappings and ties shall be biodegradable. Root growth in container grown plants shall be sufficient to hold earth intact when removed from containers. Root bound plants will not be accepted.

2.1.4.1 Mycorrhizal fungi inoculum

Before shipment, or after installation, root systems shall be inoculated with Mycorrhizal fungi inoculum, as recommended by manufacturer or installation contractor.

2.1.5 Growth of Trunk and Crown

2.1.5.1 Deciduous Trees

Height of branching shall bear a relationship to the size and species of tree specified and with the crown in good balance with the trunk. The trees shall not be "poled" or the leader removed.

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

b. Multi-stem: All countable stems, in aggregate, shall average the size specified. To be considered a stem, there shall be no division of the trunk which branches more than 6 inches from ground level.

2.1.5.2 Deciduous Shrubs

Acceptable plant material shall be well shaped, with sufficient well-spaced side branches, and recognized by the trade as typical for the species grown in the region of the project.

2.2 TOPSOIL

See Section 31 00 00 EARTHWORK.

2.3 WEED CONTROL FABRIC

2.3.1 Roll Type Polypropylene or Polyester Mats

Fabric shall be woven, needle punched or non-woven and treated for protection against deterioration due to ultraviolet radiation. Fabric shall be minimum 99 percent opaque to prevent photosynthesis and seed germination from occurring, yet allowing air, water and nutrients to pass thru to the roots. Minimum weight shall be 5 ounces per square yard with a minimum thickness of 20 mils.

2.4 MULCH

Free from mold, pesticides, or other deleterious materials.

2.5 MARKING MATERIAL

Surveyor's plastic tape, approximately 12 inches long, fastened to plant (except deep cell plugs).

2.6 WATER

Source of water to be City of Kansas City, Missouri provided tap water.

2.7 MYCORRHIZAL FUNGI INOCULUM

Mycorrhizal fungi inoculum shall be composed of multiple-fungus inoculum as recommended by the manufacturer for the plant material specified.

2.8 SOURCE QUALITY CONTROL

The Design Professional will inspect plant materials at the project site and approve them.

PART 3 EXECUTION

3.1 EXTENT OF WORK

Provide tree, shrub, and deep cell plug plantings, weed control fabric and mulch topdressing for tree and shrub plantings.

3.2 PREPARATION

3.2.1 Protection

Plan equipment and vehicle access to minimize and confine soil disturbance and compaction.

3.2.2 Layout

Stake out approved plant material locations on the project site before digging plant pits. The Design Professional reserves the right to adjust plant material locations to meet field conditions. Do not plant closer than36 inches to a pavement edge, fence or wall edge and other similar structures.

3.3 PLANT PIT PREPARATION

Verify location of underground utilities prior to excavation. Measure depth of plant pits from finished grade. Depth of plant pit excavation shall be as indicated and provide proper relation between top of root ball and finished grade. Install plant material as specified in paragraph entitled "Plant Installation." Do not install trees within 10 feet of any utility lines or building walls.

3.4 PLANT INSTALLATION

3.4.1 Individual Plant Pit Excavation

Excavate pits at least twice as large in diameter as the size of ball or container to depth shown.

3.4.2 Handling and Setting

Move plant materials only by supporting the container. Set plants on hand compacted layer of prepared backfill soil mixture. Set plants on native soil and hold plumb in the center of the pit until soil has been tamped firmly around root ball. Set plant materials, in relation to surrounding finish grade, one to 2 inches above depth at which they were grown in the nursery, collecting field or container. Replace plant material whose root balls are cracked or damaged either before or during the planting process.

Plant material shall be set in plant beds according to the drawings. Backfill soil mixture shall be placed on previously scarified subsoil to completely surround the root balls, and shall be brought to a smooth and even surface, blending to existing areas.

3.4.2.1 Container Grown Stock

Remove from container and prevent damage to plant or root system.

3.4.3 Earth Mounded Watering Basin for Individual Plant Pits

Form with topsoil around each plant by placing a mound of topsoil around the edge of each plant pit. Watering basins shall be 6 inches deep for trees and

4 inches deep for shrubs. Construct watering basin in a 4 1/2 foot diameter circle around specimen (not planted in a close group) trees and shrubs.

3.4.4 Weed Control Fabric Installation

Weed control fabric to be used for tree and shrub plantings only. Remove grass and weed vegetation, including roots, from within an approximate 4 1/2-foot diameter circle around specimen. Completely cover areas with specified 4 1/2 feet diameter weed control fabric prior to placing mulch layer.

3.4.5 Placement of Mulch Topdressing

Place specified mulch topdressing on top of weed control fabric covering total area. Place mulch topdressing to a depth of 3 inches.

3.4.6 Watering

Thoroughly water newly installed exterior plants at installation only.

3.4.7 Marking

3.4.7.1 Flags

Securely fasten flags on each tree/shrub approximately two-thirds of the distance up from ground level.

3.4.8 Pruning

Prune in accordance with applicable safety requirements.

3.4.8.1 Trees and Shrubs

Remove dead and broken branches as required at installation only. Prune to correct structural defects only. Retain typical growth shape of individual plants with as much height and spread as practical. Do not cut central leader on trees. Make cuts with sharp instruments. Do not flush cut with trunk or adjacent branches. Collars shall remain in place. Pruning shall be accomplished by trained and experienced personnel.

-- End of Section --

SECTION 33 40 00

STORM DRAINAGE UTILITIES
07/08

PART 1 GENERAL

1.1 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Design Professional approval. Submit the following in accordance with Section 01 33 00, SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals
Flapgate Design; AE.

The complete design of the flap gates shall be submitted for approval prior to installation.

Lists of Materials; AE.

The Contractor shall furnish three copies of all purchase and mill orders, shop orders and work orders. The Contractor shall furnish a list designating the material to be used for each item at the time of submittal of shop drawings. Where mill tests are required, purchase orders shall contain the test site address and the name of the testing agency. The Contractor shall also furnish a shipping bill or memorandum of each shipment of finished pieces or members to the memorandum of each shipment of finished pieces or members to the project site giving the designation mark and weight of each piece, the number of pieces, the total weight and the car initial and number.

SD-02 Shop Drawings
Shop Drawings; AE

Complete shop drawings and erection drawings for the flap gates and appurtenant items shall be submitted for approval prior to fabrication of any gate.

Drawings shall include catalog cuts, templates, fabrication, erection and assembly details, and grade and class of materials. Elements of fabricated items inadvertently omitted from contract drawings shall be indicated on the submittals.

SD-03 Product Data
Placing Pipe; AE

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

SD-06 Test Reports
Commercial Equipment (Flap Gates); AE

Three copies of records and tests, as well as records of corrective action taken, shall be furnished when work under this section is being performed.

SD-07 Certificates
Pipeline Testing; AE

Certified copies of test reports demonstrating conformance to applicable pipe specifications, before pipe is installed.

1.2 DELIVERY, STORAGE, AND HANDLING

1.2.1 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, plastic pipe and fittings shall be protected from any environment that would result in damage or deterioration to the material. Keep a copy of the manufacturer's instructions available at the construction site at all times and follow these instructions unless directed otherwise by the Design Professional. Solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install plastic pipe 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.

1.2.2 Handling

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

PART 2 PRODUCTS

2.1 PIPE FOR CULVERTS AND STORM DRAINS

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

2.1.1 Concrete Pipe

Concrete pipe shall conform to ASTM C 76, Class III, Wall B.

2.2 DRAINAGE STRUCTURES

2.2.1 Flared End Sections

Sections shall be of a standard design precast concrete.

2.3 MISCELLANEOUS MATERIALS

2.3.1 Concrete

Unless otherwise specified, concrete and reinforced concrete shall conform to the requirements for 4000 psi concrete under Section C:\DOCUMENTS AND

SETTINGS\TKIMES\MY DOCUMENTS\PROJECTS\SPECSINTACT\JOBS\BRCM\prntdata\3.doc03 31 00 01.00 10 CAST-IN-PLACE CONCRETE FOR CIVIL WORKS. The concrete mixture shall have air content by volume of concrete, based on measurements made immediately after discharge from the mixer, of 5 to 7 percent when maximum size of coarse aggregate exceeds 1-1/2 inches. Air content shall be determined in accordance with ASTM C 231. The concrete covering over steel reinforcing shall not be less than 1 inch thick for covers and not less than 1-1/2 inches thick for walls and flooring. Concrete covering deposited directly against the ground shall have a thickness of at least 3 inches between steel and ground.

2.3.2 Flap Gates

2.3.2.1 Design

The flap gate leaf and frame shall be of cast-iron construction with ribbed reinforcing designed to withstand the seating head specified. The gate shall be of double-hinged type with bronze seat rings and bronze disc rings constructed to seat properly when the pipe axis is inclined 3 degrees. The design of the gate shall be such that the flap cannot be opened to the extent that it will not close by its own weight, and such that the flap cannot become lodged in the opening of the frame. The hinge pins for the upper and lower pivot points shall be in double shear, and the hinge link arms provided with bossed bearing areas. The upper pivot point shall be adjustable and the contracting machined surface between flap and frame shall form a mating low leakage closure, which at no point shall exceed a 0.004 inch gap. Provision shall be made for adequate lubrication of the hinge pins, either by means of permanently-lubricated bearings or by means of suitable bronze bushings equipped with lubrication fittings. The complete design of flap gate shall be submitted to the Design Professional for approval.

The flap gates shall be of the sizes and types specified below. All components shall be adequate to withstand, without breakage or deleterious deformation, all stressed encountered during installation or operations under the conditions specified. All components shall be manufactured under the principal of interchangeability. Where a flat frame is furnished, it shall be connected to a cast-iron wall thimble designed for connection to the gate frame. The design seating heads are measured from the horizontal center line of the gate opening to the top of the flood protection systems.

Flap Gate Location	Thimble Type	Pipe Size (ft)	Design Seating Head (ft)	Frame Type
Sta. 107 + 00 LB	Type E round	1.5	20.0	Flat Back

2.3.2.2 Materials

Flap gate leaf and frame shall be cast iron, conforming to ASTM A126, Class B.

Hinge pins shall be silicon bronze conforming to ASTM B98, Alloy 655, or stainless steel conforming to ASTM A276, Type 304. Hinge arms shall be

high-tensile bronze, ASTM B584, Alloy 865. Fasteners, including anchor bolts, shall be stainless steel conforming to ASTM F593, Type 304. Nuts shall be silicon bronze meeting ASTM B98, Alloy 655.

2.3.2.3 Painting

All cast iron and steel parts (except stainless steel and galvanized steel) shall be painted with a corrosion resisting paint. Color shall be subject to the approval of the Design Professional.

2.3.2.4 Storage

Upon delivery to the work site, storage may be outdoors provided such storage is on wood blocking not less than 8 inches above a base of washed gravel or crushed stone not less than 2 inches thick.

2.3.2.5 Field Installation

Installation shall be as indicated on the drawings and in accordance with instructions of the manufacturer, and shall include the flap gate structure, new RCP, and all appurtences related to the installation of the flap gate.

The gate shall be operated to the satisfaction of the Design Professional, to determine that the gate has been properly manufactured, assembled, and installed and meets the requirements of the specifications. The Contractor shall notify the Design Professional at least 5 days prior to installation. Any malfunction or discrepancy will be remedied by the Contractor at no expense to the Government.

Equipment furnished under this specification shall be guaranteed for a period of one year from the date of final acceptance thereof against defective materials, design and workmanship. Upon receipt of notice from the Government of failure of any part of the guaranteed equipment during the guarantee period, a new replacement PART OR PARTS SHALL BE FURNISHED AND INSTALLED PROMPTLY BY THE Contractor at no additional cost to the Government.

PART 3 EXECUTION

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

Excavation of trenches and for appurtenances and backfilling for culverts and storm drains, shall be in accordance with the applicable portions of Section 31 00 00 EARTHWORK and the requirements specified below.

3.1.1 Trenching

The width of trenches at any point below the top of the pipe shall be not greater than the outside diameter of the pipe plus 12 inches to permit satisfactory jointing and thorough tamping of the bedding material under and around the pipe. Sheeting and bracing, where required, shall be placed within the trench width as specified, without any overexcavation. Where trench widths are exceeded, redesign with a resultant increase in cost of stronger pipe or special installation procedures will be necessary. Cost of this redesign and increased cost of pipe or installation shall be borne by the Contractor without additional cost to the Government.

3.1.2 Removal of Rock

Rock in either ledge or boulder formation shall be replaced with suitable materials to provide a compacted earth cushion having a thickness between unremoved rock and the pipe of at least 8 inches or 1/2 inch for each foot of fill over the top of the pipe, whichever is greater, but not more than three-fourths the nominal diameter of the pipe. Where bell-and-spigot pipe is used, the cushion shall be maintained under the bell as well as under the straight portion of the pipe. Rock excavation shall be as specified and defined in Section 31 00 00 EARTHWORK.

3.1.3 Removal of Unstable Material

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

3.2 BEDDING

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

3.2.1 Concrete Pipe Requirements

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

3.3 PLACING PIPE

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

3.4 BACKFILLING

3.4.1 Backfilling Pipe in Trenches

For purposes of backfilling pipe in trenches, riprap bedding, as defined in Section 31 00 00 Earthwork, may be used as select material. After the pipe has been properly bedded, selected material from excavation or borrow, at a moisture content that will facilitate compaction, shall be placed along both

sides of pipe in layers not exceeding 6 inches in compacted depth. The backfill shall be brought up evenly on both sides of pipe for the full length of pipe. The fill shall be thoroughly compacted under the haunches of the pipe. Each layer shall be thoroughly compacted with mechanical tampers or rammers. This method of filling and compacting shall continue until the fill has reached an elevation of at least 12 inches bove the top of the pipe. The remainder of the trench shall be backfilled and compacted by spreading and rolling or compacted by mechanical rammers or tampers in layers not exceeding 8 inches. Tests for density shall be made 1 per lift per 150 lineal feet to ensure conformance to the compaction requirements specified below. Where it is necessary, in the opinion of the Design Professional, that sheeting or portions of bracing used be left in place, the contract will be adjusted accordingly. Untreated sheeting shall not be left in place beneath structures or pavements.

3.4.2 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, not exceeding 6 inches in compacted depth, and shall be compacted by rolling parallel with pipe or by mechanical tamping or ramming. Prior to commencing normal filling operations, the crown width of the fill at a height of 12 inches above the top of the pipe shall extend a distance of not less than twice the outside pipe diameter on each side of the pipe or 12 feet, whichever is less. After the backfill has reached at least 12 inches above the top of the pipe, the remainder of the fill shall be placed and thoroughly compacted in layers not exceeding 8 inches.

3.4.3 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.

3.4.4 Compaction

3.4.4.1 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.

-- End of Section --

SECTION 35 31 19

CHANNEL PROTECTION
07/08

PART 1 GENERAL
1.1 REFERENCES

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

ASTM INTERNATIONAL (ASTM)

ASTM C 136	(2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C 33	(2003) Standard Specification for Concrete Aggregates
ASTM D 4791	(2005e1) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 1110-2-1601	(1994; Change 1) Hydraulic Design of Flood Control Channels

1.2 DEFINITIONS

1.2.1 Bank Stabilization

This paragraph explains certain terminology which is common to construction of bank stabilization work on the channel and which may not be self explanatory in the subsequent applicable provisions of the technical specifications and on the drawings.

1.2.1.1 Newbury-Type Structures

The term "Newbury Structure" applies to the types of stabilization structures that are constructed across the river at an angle to the current. Newbury Structures are constructed of riprap.

1.2.2 Riprap

Riprap is defined as a material having a gradation band similar to those specified in EM 1110-2-1601, Chapter 3, uniform graded material. Riprap is normally produced by mechanical methods.

1.2.3 Rockfill

The term "rockfill" refers to crushed or broken rock that may include pieces up to 1000 pounds. Rockfill may be developed from material produced during the crushing and gradation activities of other rock materials. The gradation of rockfill is generally more flexible than that of other stone materials.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Design Professional approval. Submit the following in accordance with Section 01 33 00, SUBMITTAL PROCEDURES:

SD-03 Product Data

Riprap; AE
Bedding Material; AE
Rockfill; AE

The source for materials used in riprap, bedding, and rockfill.

SD-06 Test Reports

Gradation Test; AE

The gradation tests using the GRADATION TEST DATA SHEET enclosed at end of this section for riprap or stone.

SD-07 Certificates

Weigh Scale Certification; AE

A copy of the certification from the regulation agency attesting to the scale's accuracy.

Certified Weight Scale Tickets; AE

A copy of each certified weight scale ticket 10 working day(s) after weighing.

1.4 QUALITY ASSURANCE

1.4.1 Stone

Stone shall be from a preapproved source as listed in Section 0800, SPECIAL CONTRACT REQUIREMENTS.

1.5 CONSTRUCTION TOLERANCES

The finished surface and stone layer thickness shall not deviate from the lines and grades shown by more than the tolerances listed below. Tolerances are measured perpendicular to the indicated neatlines. Extreme limits of the tolerances given shall not be continuous in any direction for more than five (5) times the nominal stone dimension nor for an area greater than 1000 square feet of the structure surface.

	NEATLINE TOLERANCES	
MATERIAL	ABOVE NEATLINE (feet)	BELOW NEATLINE (feet)
Bedding	0.2	0.1
Rockfill	0.3	0.2
Riprap	0.3	0.2

The intention is that the work shall be built generally to the required elevations, slope and grade and that the outer surfaces shall be even and

present a neat appearance. Placed material not meeting these limits shall be removed or reworked as directed by the Design Professional.

PART 2 PRODUCTS

2.1 BEDDING MATERIAL

2.1.1 General

Bedding material shall consist of crushed stone.

2.1.2 Material

Bedding material shall be composed of tough, durable particles, adequately free from thin, flat and elongated pieces, and shall contain no organic matter nor soft, friable particles in quantities considered objectionable by the Design Professional. The aggregates shall meet the quality requirements of ASTM C 33. Gradation shall conform to the following requirements:

Bedding and Crushed Stone

US Standard Sieve	Permissible Limits Percent by Weight, Passing
6 in	100
3 in	75-95
1 in	40-60
1/4 in	5-25

Provide bedding material well-graded between the limits shown. Perform at least one test on each 3000 tons placed for each specified gradation in accordance with ASTM C 136. All points on individual grading curves obtained from representative samples of bedding material shall lie between the boundary limits as defined by smooth curves drawn through the tabulated gradation limits plotted on ENG FORM 2087 or similar form. The individual gradation curves within these limits shall not exhibit abrupt changes in slope denoting either gap grading or scalping of certain sizes or other irregularities which would be detrimental to the proper functioning of the bedding layers.

2.2 STONE

2.2.1 General

2.2.1.1 Quarry Operations

Conduct quarry operations in a manner to produce stone conforming to the requirements specified, this may involve selective quarrying, handling, processing, blending, and loading as necessary. Control blasting and handling of rock to produce rock of the size ranges and quality specified. Techniques such as the use of proper hole diameter, hole depth, hole angle, burden and spacing distances, types and distribution of explosives. delay intervals and sequence, removal of muck piles between each shot, and special handling techniques are required as necessary to produce the specified materials. All aspects of blasting operations shall be specifically designed so that the end product is not damaged from the blasting technique and that the stone is suitable for the intended purpose.

2.2.1.2 Gradation Test

Perform a gradation test or tests on the riprap, stone, bedding or rockfill at the quarry in accordance with paragraph Standard Test Method for Gradation of Riprap. Take the sample in the presence of the Design Professional. Notify the Design Professional not less than 3 days in advance of each test. In the event of unavailability of the Contracting Office, perform the tests and certify to the Design Professional that the riprap, stone, bedding, or rockfill shipped complies with the specifications. At least one gradation test(s) shall be performed per 15,000 tons of each size of riprap or rockfill placed, but not less than one test shall be performed. The gradation tests shall be reported using the forms, GRADATION TEST DATA SHEET and ENG FORM 4794-R, attached at end of this section.

2.2.1.3 Proportional Dimension Limitations

The maximum aspect ratio (greatest dimension: least dimension) of any piece of stone for size ranges shall be not greater than 3:1 when measured across mutually perpendicular axis. A maximum of 5 percent flat and elongated pieces by weight will be acceptable. A flat and elongated piece of riprap is defined as having a ratio of width to thickness or length to width greater than 3:1. ASTM D 4791 shall be used as a guide to perform the test.

2.2.2 Riprap

Only quarried stone shall be used. Stone shall be well graded and shall conform to the tables below and to the Drawings.

TABLE 2.4.2.1 "36-Inch"
(FOR RIPRAP "R2200")

PERCENT LIGHTER BY WEIGHT (SSD)	LIMITS OF STONE WEIGHT, LB.
100	2200
85-95	1700
30-50	550
0-15	75

2.2.3 Rockfill

Stone for rockfill shall be sound, durable, limestone, free from cracks, seams, partings, and overburden spoil. Stone shall be approximately rectangular in cross sections, free from thin slabby pieces having an elongation ratio more than four, and the quantity of stone having an elongation ratio more than three shall not exceed 20 percent of weight. Deleterious substances which include soft friable particles, objectionable material, and other foreign matter, shall not exceed 10 percent by weight.

The stone shall be graded from coarse to fine. The material shall have a maximum size of 1000 pounds, with not more than 50 percent of the material smaller than 100 pounds. The material may contain up to a maximum of 25 percent fines (by weight) except that the outer 3 feet of the rock shell section shall not contain more than 15 percent fines (by weight). Fines are defined as material smaller than 3 inches in size.

PART 3 EXECUTION

3.1 BASE PREPARATION

Areas on which bedding material and riprap are to be placed shall be graded and/or dressed to conform to cross sections shown on the contract drawings within an allowable tolerance of plus 2 inches and minus 4 inches from the theoretical slope lines and grades. Where such areas are below the allowable minus tolerance limit they shall be brought to grade by fill with earth similar to the adjacent material and then compacted to a density equal to the adjacent in place material. Subaqueous areas on which bedding material (rockfill) and riprap are to be placed shall be graded and/or dressed to conform to cross sections shown on the contract drawings within an allowable tolerance of plus 1 foot and minus 2 feet from the specified slope line and grades. Where such areas are below the allowable minus tolerance limit they shall be filled with sand fill. As an alternative, these areas may be filled with rockfill. Immediately prior to placing the bedding layers, the prepared base will be inspected by the Design Professional and no material shall be placed thereon until that area has been approved.

3.2 PLACEMENT OF BEDDING LAYERS

3.2.1 General

A bedding layer, consisting of a 6-inch layer of crushed stone, shall be placed on the prepared base as described below, in accordance with the details shown on the contract drawings, and within the limits shown on the contract drawings or staked in the field. A tolerance of plus 2 inches and minus 1 inch from the slope lines and grades shown on the contract drawings will be allowed in the finished surface of the bedding, except that the extreme of this tolerance shall not be continuous over an area greater than 200 square feet.

3.2.2 Placement of Bedding Material on Prepared Base

Bedding material shall be spread uniformly on the prepared base to the slopelines and grades as indicated on the contract drawings and in such manner as to avoid damage to the prepared base. Placing of crushed stone by methods which tend to segregate the particle sizes within the bedding layer will not be permitted. Placement shall begin at the bottom of the area to be covered and continue up slope. Subsequent loads of material shall be placed against previously placed material in such a manner as to ensure a relatively homogenous mass. Any damage to the surface of the prepared base during placing of the material shall be repaired before proceeding with the work. Compaction of material placed on the prepared base will not be required, but the material surface shall be finished to present an adequately even surface, free from mounds or windrows.

3.3 PLACEMENT OF RIPRAP

3.3.1 General

Riprap above water shall be placed on the bedding layers. Riprap placed underwater shall be placed on rockfill layers.

3.3.2 Placement

3.3.2.1 Above Water

Riprap shall be placed to full layer thickness measured normal to the slope, in one operation in a manner that will minimize segregation and avoid displacing the underlying material and in a manner that will produce a stable mass of rock that corresponds to the lines, grades, and minimum thickness shown on the drawings. Stone shall be placed by any method that will avoid segregation. Suggested equipment for placement are cradle, skip box, or clam bucket. Placement shall begin at the bottom or toe of the slope in a continuous manner. When required, hand placing shall be done to the extent necessary to secure the results specified herein. Excavation to subgrade shall not proceed more than 500 feet ahead of finished riprap lines.

3.4 NEWBURY STRUCTURE

3.4.1 Newbury Stone Placement

Newbury structures shall be constructed to the elevations, cross sections, side slopes, and minimum thicknesses and within the limits shown on the contract drawings. The structures shall be constructed of riprap as specified in paragraph RIPRAP. Stone shall be placed in the structures in such a manner as to produce a well-graded mass of stone with the minimum practicable percentage of voids. A tolerance of 1 foot will be allowed in the specified elevation, and 1 foot under and 2 feet over in the specified thicknesses provided these variations are gradual over the length of these structures.

3.5 TESTS AND INSPECTIONS

3.5.1 Placement Control

3.5.1.1 Quality Control Measures

Establish and maintain quality control for all work performed at the job site under this section to assure compliance with contract requirements. Maintain records of the quality control tests, inspections and corrective actions. Quality control measures shall cover all construction operations including, but not limited to, the placement of all materials to the slope and grade lines shown and in accordance with this section.

3.5.1.2 Check Surveys

Surveys made by the Contractor are required on each material placed for determining that the materials are acceptably placed in the work. Make checks as the work progresses to verify lines, grades and thicknesses established for completed work. At least one (1) check survey as specified below shall be made for each 50 foot section as shown as practicable after completion. Following placement of each type of material, the cross section of each step of the work shall be approved by the Design Professional before proceeding with the next step of the work. Approval of cross sections based upon check surveys shall not constitute final acceptance of the work. Cross sections shall be taken on lines 50 feet apart, measured along the structure reference line, with readings at 25-foot intervals and at breaks along the lines. However, other cross section spacing and reading intervals may be used if determined appropriate by the Design Professional. Additional elevations shall be taken as the Design Professional may deem necessary or advisable. The surveys shall be conducted in the presence of an authorized

representative of the Design Professional, unless this requirement is waived by the Design Professional.

a. Above Water: The elevation of stone above the water surface shall be determined by the use of a total station or GPS. If approved by the Design Professional other means may also be used.

b. Below Water: For portions of the work that are under water, sounding surveys shall be performed by means of a sounding pole.

3.5.2 Gradation Tests for Stone

3.5.2.1 Standard Test Method for Gradation of Riprap

a. Select a representative sample (See Note No. 1), weigh and dump on hard stand.

b. Select specific sizes (see example) on which to run "individual weight larger than" test. (See Note No. 2). Procedure is similar to the standard aggregate gradation test for "individual weight retained".

c. Determine the largest size stone in the sample. (100 percent size)

d. Separate by "size larger than" the selected weights, starting with the larger sizes. Use reference stones, with identified weights, for visual comparison in separating the obviously "larger than" stones. Stones that appear close to the specific weight must be individually weighed to determine size grouping. Weigh each size group, either individually or cumulatively.

e. Paragraph d above will result in "individual weight retained" figures. Calculate individual percent retained (heavier than), cumulative percent retained, and cumulative percent passing (lighter than). Plot percent passing, along with the specification curve on ENG Form 4794-R.

NOTE NO. 1: Sample Selection: The most important part of the test and the least precise is the selection of a representative sample. No "standard" can be devised; larger quarry run stone is best sampled at the shot or stockpile by given direction to the loader; small graded stone is best sampled by random selection from the transporting vehicles. If possible, all parties should take part in the sample selection and agree before the sample is run that the sample is representative.

NOTE NO. 2: Selection of Size for Separation: It is quite possible and accurate to run a gradation using any convenient sizes for the separation, without reference to the specifications. After the test is plotted on a curve, then the gradation limits may be plotted. Overlapping gradations with this method are no problem. However, it is usually more convenient to select points from the gradation limits, such as the minimum 50 percent size, the minimum 15 percent size, and one or two others, as separation points. For these types of stone gradations the separation points need to be selected as

the smallest size stone at each break in the gradation specified.

F O R
E X A M P L E
O N L Y

EXAMPLE GRADATION
SPECIFICATIONS

PERCENT LIGHTER BY WEIGHT	STONE WEIGHT IN LBS.
100	400 - 160
50	160 - 80
15	80 - 30

EXAMPLE WORKSHEET

STONE SIZE LBS.	INDIVIDUAL WT. RETAINED	INDIVIDUAL PERCENT RETAINED	CUMULATIVE RETAINED	PERCENT PASSING
400	0	0	0	100
160	9,600	30	30	70
80	11,200	35	65	35
30	8,000	25	90	10
<30	3,200	10	100	-
TOTAL	32,000 pounds			

NOTE: Largest stone 251 pounds

G R A D A T I O N T E S T D A T A S H E E T

Quarry _____ Type of Stone Tested _____

Date of Test _____ Testing Rate _____

T E S T R E P R E S E N T S

Contract No.	District	Tons
	TOTAL	

G R A D A T I O N

Stone Size (lbs)	Weight Retained	Individual % Retained	Cumulative % Ret.	Cumulative % Pass	Specification % Finer by wt
Total Weight					

Max Size Stone = _____

Remarks:

_____

I certify that the above stone sample is representative of the total tonnage covered by this test report.

Contractor Representative _____

Government Representative _____]

-- End of Section --

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SECTION 35 32 00

SAND DRAINS
07/08

PART 1 GENERAL

1.1 SUMMARY

The work covered by this Section includes furnishing necessary labor, equipment and material as required to construct bank sand drains as shown on the Contract Drawings and as specified herein. This section is to be used in conjunction with all other requirements contained contract drawings and elsewhere in the specifications.

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for approval of the Geotechnical Engineer. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Data
Sand Drain Installation Plan; AE
The sand drain installation plan shall conform to the requirements described in Paragraph 3.5: Sand Drain Installation Plan.
SD-09 Reports
Drain Sand; AE
Certified test reports and analysis certifying that the drain sand proposed for use conforms to the specified requirements.

PART 2 PRODUCTS

2.1 DRAIN SAND

Drain sand shall consist of sand classified in ASTM D 2487 as SP or SW as determined by ASTM D 422. Drain sand shall contain not more than 2 percent by weight passing the No. 200 mesh sieve and not less than 100 percent by weight passing the U.S. No. 4 sieve.

PART 3 EXECUTION

3.1 DRAIN LOCATIONS

Based on conditions encountered during construction, the Geotechnical Engineer shall direct the Contractor to install sand drains at specific locations and directed spacing.

3.2 TRENCH EXCAVATION

3.2.1 General

All trenches shall be excavated so as to allow placement of drain sand to the lines, grades and cross-sections as indicated on the Contract Drawings.

The trenches shall have essentially vertical walls, a minimum width of 24 inches, and shall extend to the depths indicated.

The Contractor may construct the sand drain systems in open trenches providing caving of the trench walls does not occur prior to back filling with drain sand material. If the Contractor cannot construct the systems in open trenches, supported excavations utilizing conventional trench boxes, one-pass continuous trenchers or other approved means shall be utilized.

The Geotechnical Engineer will be notified if loss of material occurs on the outside of the trench box and full depth of the trench cannot be completed.

The Contractor shall take care to minimize surcharge loads from equipment, or stockpiled materials adjacent to the trench, which may lead to trench instability.

Excavated materials shall be handled as specified elsewhere in the Contract Specifications for the class of materials encountered.

3.3 BACKFILL

Drain sand shall be placed to the limits indicated on the plans and by the Geotechnical Engineer along the entire length of trench. Prior to placing backfill, the Contractor shall make measurements every 10 feet along the trench or as directed by the Geotechnical Engineer using a weighted tape, cable or other approved device to monitor the bottom of the excavation and ensure drain sand material will be placed to the required limits.

Contractor shall ensure there is no intermixing of the sand with the soil material. Contaminated sand shall be removed and replaced with clean sand as directed at no cost to the Government. Any caved or sloughed materials shall be removed from the trench before proceeding further with backfill. If the contractor utilizes a progressive excavation/backfill procedure, a minimum 10-foot separation between the toe of the slope of the sand and the toe of the slope of the excavation shall be maintained.

The backfilled drain sand is not subject to any maximum lift thickness. Compaction of the sand backfill is not required.

The drains shall be capped with rockfill and excavated soil as depicted on the Contract Drawings. The final configuration of the drains shall conform to the shape of the design channel cross-sections as depicted on the Contract Drawings.

3.4 SEQUENCE

Drains shall commence within 48 hours of direction by Geotechnical Engineer. Drain installation may proceed ahead of the bank preparation operations, however installation procedures shall be adjusted as appropriate to ensure drains are installed to the required vertical and horizontal limits relative to the design slope.

3.5 SAND DRAIN INSTALLATION PLAN

Within 45 days before intended construction, the Contractor shall submit a Sand Drain Installation Plan.

The Sand Drain Installation Plan shall outline proposed procedures, materials, equipment and methods for getting materials to the drain locations, excavating trenches, methods to prevent sand contamination, maintaining trench stability, and placing drain sand to the required limits. Procedures to be followed for installation of drains on both prepared banks and on banks not yet cut to the design cross-section shall be identified.

-- End of Section --