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USACE / NAVFAC / AFCEA UFGS-02331 (August 2004)  
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Preparing Activity: USACE (CW) Superseding  
UFGS-02331A (July 2004)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMLR dated 22 December 2004

Latest change indicated by CHG tags

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02331

LEVEE CONSTRUCTION

08/04

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USACE / NAVFAC / AFCESA                                UFGS-02331 (August 2004)
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Preparing Activity:  USACE  (CW)                        Superseding
                                                           UFGS-02331A (July 2004)

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# UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 22 December 2004

Latest change indicated by CHG tags

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02331

## LEVEE CONSTRUCTION 08/04

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NOTE: This guide specification covers the requirements for levee construction.

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.

This Guide Specification includes tailoring options, as listed below, for specific construction requirements. Tailoring tags should be selected based upon project requirements; i.e., if the proposed project requires only embankments for levee construction, select only the tailoring option for embankment (TAI OPT=EMBANK); if the proposed project requires clearing, grubbing, stripping, and excavation for levee construction, select tailoring options for these requirements (TAI OPT=CLEAR-GRUB-STRIP, TAI OPT=EXCAV), etc.

TAI OPT=CLEAR-GRUB-STRIP	CLEARING, GRUBBING, AND STRIPPING
TAI OPT=EXCAVAT	EXCAVATION
TAI OPT=EMBANK	EMBANKMENT

\*\*\*\*\*

PART 1 GENERAL

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NOTE: This guide specification provides for the installation of settlement gages for the determination of increases in quantities of embankment materials resulting from settlement of the embankment foundation during construction and for payment to the Contractor for such increases in quantities. These provisions will be included in a project specification when it is determined that settlement in the range of 5 percent or more of the planned embankment height is anticipated over a considerable portion of the embankment foundation area. They will also be used when gages are needed for engineering control purposes. When settlement gages are to be used the following information will be indicated on the plans:

1. The location of the gages as well as the stations at which zero settlement will be assumed.
2. The detail construction of the foundation settlement gages to be used. Any applicable type of gage may be selected.

The requirements for rock as prescribed herein are intended to be used on embankments involving rock fill sections. Where rock for slope protection is specified, UFGS-02380A STONE, CHANNEL, SHORELINE/COASTAL PROTECTION FOR STRUCTURES should be used.

Approval of testing laboratory is addressed in ER 1110-1-8100, dated 31 Dec 1997, Laboratory Investigations and Testing.

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1.1 REFERENCES

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NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest guide specification. Use of SpecsIntact automated reference checking is recommended for projects based on older guide specifications.

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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 M 43

(1988; R 2003) Sizes of Aggregate for Road  
and Bridge Construction

ASTM INTERNATIONAL (ASTM)

ASTM C 33	(2003) Concrete Aggregates
ASTM D 1556	(2000) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(2002e1) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu.m.))
ASTM D 2167	(1994; R 2001) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D 2216	(1998) Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 2487	(2000) Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 2922	(2004) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 2937	(2000e1) Density of Soil in Place by the Drive-Cylinder Method
ASTM D 3017	(2004) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D 422	(1963; R 2002) Particle-Size Analysis of Soils
ASTM D 4253	(2000) Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
ASTM D 4254	(2000) Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
ASTM D 4318	(2000) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 4643	(2000) Determination of Water (Moisture) Content of Soil by the Microwave Oven Method
ASTM D 5195	(2002) Density of Soil and Rock In-Place at Depths Below the Surface by Nuclear Methods
ASTM D 698	(2000ae1) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.))

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2003) Safety -- Safety and Health
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## Requirements

### 1.2 DEFINITIONS

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**NOTE: Add applicable definitions.**  
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#### 1.2.1 Clearing

Clearing shall consist of the removal and satisfactory disposal of all [above ground and below ground ]trees, downed timber, snags, slash, brush, garbage, trash, debris, fencing, and other items occurring in the designated areas to be cleared.

#### 1.2.2 Grubbing

Grubbing shall consist of the removal and satisfactory disposal of stumps, roots larger than [\_\_\_\_\_] mm inches in diameter, and matted roots from the designated grubbing areas. Grubbing also includes filling of holes from the grubbing operation.

#### 1.2.3 Stripping

Stripping shall consist of the removal and satisfactory disposal of crops, weeds, grass, and other vegetative materials to the ground surface[ and topsoil to a depth of [\_\_\_\_\_] mm inches].

#### 1.2.4 Satisfactory Materials

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**NOTE: Use of CH material should be avoided if possible. As a minimum, constraints should be set governing their use.**  
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Satisfactory materials shall consist of materials classified in accordance with ASTM D 2487 as CL,[ CH,] CL-ML, ML, SC, SP, SW, [\_\_\_\_\_] free from: roots and other organic matter; contamination from hazardous, toxic or radiological substances; trash, debris; and frozen materials. Not all satisfactory materials can be used in levee. Only the satisfactory materials stated above, meeting the additional or modified requirements of paragraph TYPES OF FILL MATERIALS, can be used for levee construction.

#### 1.2.5 Unsatisfactory Materials

Unsatisfactory materials shall not be used in any levee or other required fill. Unsatisfactory materials includes all other materials that are not defined above as satisfactory materials.

#### 1.2.6 Embankment

The terms "levee" or "embankment" as used in these specifications are defined as the earth [and rock ]fill portions of the levee structure or other fills related to the levee structure, including [cut-off trench] and includes all types of earth fill [and filter materials ]for the levee [and cut-off trench,] and all other fills within the limits of the levee [, excepting those stone and filter materials used for slope protection, which are described in paragraph [\_\_\_\_\_] ].

#### 1.2.7 Backfill

Backfill as used in this section is defined as that fill material which cannot be placed around or adjacent to a structure until the structure is completed or until a specified time interval has elapsed after completion.

#### 1.2.8 Excavation

Excavation shall consist of removal of material to the lines and grades shown on the drawings, or as otherwise directed or approved by the Contracting Officer and as described in paragraph [\_\_\_\_\_] EXCAVATION in PART 3 EXECUTION.

#### 1.2.9 Classification of Soils

Materials used to construct the embankments and for backfills shall be classified in accordance with ASTM D 2487 (Unified Soil Classification System). Cohesionless materials shall include materials classified in ASTM D 2487 as GW, GP, SW, and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM will be identified as cohesionless only when the fines are nonplastic.

#### 1.2.10 Degree of Compaction

##### 1.2.10.1 Cohesive Material

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**Note:** If a higher compactive effort than is attainable by ASTM D 698 is desired ASTM D 1557 may be utilized and references to ASTM D 698, relative to compactive effort, should be changed to ASTM D 1557.  
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Degree of compaction shall be expressed as a percentage of the maximum density obtained by the test procedure presented in [ASTM D 698] [ASTM D 1557], abbreviated hereinafter as percent laboratory maximum density.

##### 1.2.10.2 Cohesionless Material

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**Note:** Factors such as (but not limited to) site specific materials, availability of testing equipment and local practice may make it more practical to utilize methods other than ASTM D 4253 and ASTM D 4254 to control the degree of compaction of cohesionless material. If other methods are utilized the appropriate sections of the specifications should be modified to reflect method selected. The other methods used include comparison of in-place density to either the maximum Proctor density or the maximum density obtained by ASTM 4253 (if vibratory table is available).  
\*\*\*\*\*

Degree of compaction shall be expressed as a percentage of the relative density in accordance with ASTM D 4253 and ASTM D 4254.

### 1.3 SUBMITTALS

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NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy projects.

Submittal items not designated with a "G" are considered as being for information only for Army projects and for Contractor Quality Control approval for Navy projects.

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Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for [Contractor Quality Control approval.] [information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

#### SD-02 Shop Drawings

##### Drainage Requirements

Written evidence consisting of an authenticated copy of the [conveyance] [easement] under which the Contractor acquired the property rights and access thereto, prepared and executed in accordance with applicable State and local requirements.

#### SD-03 Product Data

Shoring, Sheeting, and Bracing[; G][; G, [\_\_\_\_]]

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NOTE: Add applicable minimum requirements for the

**shoring, sheeting and bracing plan based upon site  
specific conditions.**

\*\*\*\*\*

Submit a detailed shoring, sheeting and bracing plan [\_\_\_\_\_] days prior to the beginning of any excavation so supported. The plan for shoring, sheeting and bracing shall be prepared and certified by licensed professional engineer. The plan shall include drawings and design computations of the proposed shoring, sheeting, and bracing, and documentation, showing details of the coordination and approval of shoring, sheeting, and bracing by the applicable parties. Approval of the detailed plan shall be obtained from the Contracting Officer prior to starting the work. If necessary, the plan shall be modified as required to meet field conditions, and the modifications shall be approved prior to use.

Excavation[; G][; G, [\_\_\_\_\_] ]

Submit a written excavation plan [\_\_\_\_\_] days prior to the beginning of any excavation. Approval of the detailed plan shall be obtained from the Contracting Officer prior to starting the work. If necessary, the plan shall be modified as required to meet field conditions, and the modifications shall be approved prior to use. As a minimum, the plan shall contain, the following:

- a. Proposed methods for preventing interference with, or damage to, existing underground or overhead utility lines, trees designated to remain and other man-made facilities or natural features designated to remain within or adjacent to the construction rights-of-way.
- b. Provision for coordinating the work with other Contractors working in the construction rights-of-way or on facilities crossing or adjacent to this work.
- c. The proposed methods for controlling surface and ground water in the borrow areas and required excavations.
- d. Stockpiling plan for embankment material before it is transported to the project site showing locations, stockpile heights, slopes, limits, and drainage around the stockpile areas.
- e. A complete listing of equipment used for excavation and to transport the excavated material.
- f. The Contractor's proposed sequence of work for excavating the borrow areas with plan and cross sectional views showing starting and final work locations and clearing, grubbing and stripping limits.
- g. The Contractor's proposals for conserving arable land and for making optimum use of available borrow, including the Contractor's proposed methods for grading the bottom of the borrow areas after completing use of the borrow areas.
- h. The Contractor's proposed road pattern, and plan for implementing dust control measures.

Borrow Areas[; G][; G, [\_\_\_\_\_] ]

Submit a written statement to the Government not later than [\_\_\_\_\_] days after receipt of Notice to Proceed indicating the Contractor's intention to use the specified Government-furnished borrow area(s), Contractor-furnished borrow area(s), dredged borrow areas, or a combination of these borrow areas.

Plan of Operations[; G][; G, [\_\_\_\_\_]]

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**NOTE: Tie this back to Section 01451A CONTRACTOR  
QUALITY CONTROL requirement for inspection and  
validation of CQC laboratories by the government.**

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Thirty (30) days prior to commencement of haul road construction or placing embankment and backfill which ever is earlier, the Contractor shall submit for approval a Plan of Operations for accomplishing all embankment and backfill construction and for the location and construction of haul roads. This plan shall include but not be limited to the Contractor's proposed sequence of construction for embankment and backfill items, and methods and types of equipment to be utilized for all embankment and backfill operations, including transporting, placing, and compaction. This plan shall also include the names and addresses of the [commercial testing labs] [engineering firms] which will perform the soil testing and inspection and describe how all required soils testing will be performed.

[Embankment and Backfill Materials[; G][; G, [\_\_\_\_\_]].

At least [30] [\_\_\_\_\_] days prior to delivery of any Contractor-furnished material to the site of the work, the Contractor shall submit soil classification test results, moisture-density curves, gradation curves, and laboratory results of the required tests of the proposed material.]

[Filter Sand[; G][; G, [\_\_\_\_\_]]

At least [30] [\_\_\_\_\_] days prior to delivery of any Contractor-furnished material to the site of the work, the Contractor shall submit soil classification test results and a gradation curve for each of the proposed filter materials to be used.]

[Nuclear Density[; G][; G, [\_\_\_\_\_]]

Nuclear density testing equipment shall be used in accordance with ASTM D 2922 and ASTM D 3017. In addition, the following condition shall apply:

a. Prior to using the nuclear density testing equipment on the site, the Contractor shall submit to the Contracting Officer a certification that the operator has completed a training course approved by the nuclear density testing equipment manufacturer[, the most recent data sheet from the manufacturer's calibration, and a copy of the most recent statistical check of the standard count precision].

b. The nuclear density testing equipment shall be capable of extending a probe a minimum of 150 mm 6 inches down into a hole.]

#### SD-06 Test Reports

Measurement of Fill Material[; G][; G, [\_\_\_\_]]

Submit a copy of the records of each compliance survey the next work day following the survey.

#### 1.4 [LUMP SUM] [UNIT] PRICES

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NOTE: If Section 01270A MEASUREMENT AND PAYMENT is included in the project specifications, this paragraph title ([LUMP SUM] [UNIT] PRICE) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01270.  
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##### 1.4.1 Clearing, Grubbing, and Stripping

###### 1.4.1.1 Payment

Payment will be made for clearing, grubbing and stripping at the contract [lump sum] [unit price] for clearing, grubbing and stripping. This price shall constitute full compensation for all equipment, labor, materials and incidentals necessary to complete the work specified herein. Payment for refilling of holes resulting from grubbing [and removal or plugging of existing drainage structures] will be included in the contract [lump sum] [unit price] for clearing, grubbing and stripping. No separate or direct payment will be made for stockpiling and disposition of stripped materials.

All costs in connection therewith will be considered as a subsidiary obligation of the Contractor. If regrowth of vegetation or trees occurs after clearing and grubbing and before placement of embankment, and the Contractor is required to clear and grub again prior to embankment construction, no payment will be made for this additional clearing and grubbing.

###### 1.4.1.2 [Measurement]

\*\*\*\*\*  
Note: If clearing, grubbing, and stripping is to be paid for with a unit price bid item include the method of measurement. Delete this paragraph if payment is by lump sum.  
\*\*\*\*\*

[Clearing, grubbing, stripping, stockpiling and the disposition of the materials from these operations[ and plugging or removal of existing drainage structures] will not be measured for payment.] Refilling of grubbing holes will not be measured for payment.]

###### 1.4.1.3 Unit of Measure

Unit of measure: [lump sum] [unit price].

#### 1.4.2 Excavation

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NOTE: If excavation will not be measured or paid for separately, select the following paragraph and delete subparagraphs PAYMENT, MEASUREMENT, and UNIT OF MEASURE. Delete the following paragraph if excavation is to be measured and paid for separately. If significant quantities of rock excavation is anticipated measurement and payment for rock excavation should be addressed separately. A definition of rock excavation should also be included.

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[No separate measurement or payment will be made for Excavation. All costs in connection with excavation will be considered a subsidiary obligation of the Contractor.]

##### 1.4.2.1 [Payment

Payment will be made for Excavation at the contract unit price which includes full compensation for all equipment, labor, materials, and incidentals necessary to complete the work specified. No separate payment will be made for stockpiling.]

##### 1.4.2.2 [Measurement

Excavation will be measured for payment by use of the average end area method. The basis of measurement will be a survey of the area prior to the excavation[ and clearing and grubbing] and a second survey of the same area after the completion of the excavation. For areas where lines and grades are shown on the drawings, measurement will be limited to those lines and grades. Slides caused by fault of the Contractor, over excavation, and excavation performed for the convenience of the Contractor shall not be measured for payment.]

##### 1.4.2.3 [Unit of Measure

Unit of measure: cubic meters yards.]

#### 1.4.3 Fill Material

##### 1.4.3.1 Payment For Embankment Fill

Payment will be made for material placed as required in embankments, backfills and ramps, and including additional material placed by reason of foundation settlement and by reason of soft material in the foundation being forced outward from the section during construction, for [Embankment Material Type [\_\_\_\_],] [Semicompacted Fill] [Uncompacted Fill] [Hydraulic Fill]. Payment shall constitute full compensation for furnishing all plant, labor, equipment and material, [except earth material, ]and performing all operations necessary for foundation preparation and placing and compacting the material [, materials testing,] [and moisture control]. [This payment is in addition to any payment for excavating and transporting of the material as required in paragraph [\_\_\_\_] EXCAVATION.] [ When directed to perform additional rolling for compaction, it will be paid for under the unit price item for additional rolling for compaction.]

#### 1.4.3.2 Measurement of Fill Material

\*\*\*\*\*

**NOTE:** The last sentence of the following paragraph (in brackets) should be deleted if surveys are taken "after" clearing and grubbing operations. The last sentence should be included if surveys are taken "prior" to clearing and grubbing operations.

\*\*\*\*\*

a. Fill materials specified for embankment will be measured for payment by the cubic meter yard, and quantities will be determined by the average end area method. The basis for measurement will be cross sections of the areas to be filled taken [prior to] [after] clearing, grubbing, and stripping operations and the [theoretical cross sections] [actual cross sections] of the embankments constructed within the specified tolerance[ plus additional fill placed as the result of displacement or settlement of foundation material as calculated below]. [ Cross sections shall be performed at significant breaks in grade except that the maximum distance between cross sections shall not exceed [\_\_\_\_\_] meters feet.] Embankments not constructed to design grade and section including allowable tolerance as indicated on the Contractor's compliance survey will not be accepted. [ Volumes occupied by drainage structures will not be included in measurement of embankment for payment.] [ Material removed as a result of the clearing, grubbing, and stripping operations will not be included in measurement of embankment for payment.]

b. The basis for measurement of fill placed by reason of soft material in the foundation being forced outward from the section will be a survey of the area taken prior to fill placement and a second survey of the same area after completion of fill placement. The cross sections will extend [\_\_\_\_\_] meters feet beyond the toes of the fills. [ A cross section will be taken at each settlement measurement location.]

\*\*\*\*\*

**NOTE:** The engineer can select one of the two methods of settlement measurement as described below; one based on using settlement gages, and the other based on using core borings. Core borings should only be used when the embankment material and the foundation material are easily distinguishable such that the interface between the embankment and foundation can be easily located.

\*\*\*\*\*

c. Levee Settlement. Measurement of additional fill material placed in each settlement measurement range, shown on the drawings by reason of foundation settlement, will be based on measurements [taken on the respective settlement gage] [obtained from the respective core borings] at the respective settlement measurement locations as specified and will be determined as follows:

(1) The settlement measured at each settlement measurement location will be considered to apply to the foundation area throughout the length of the settlement ranges shown on the drawings.

(2) The foundation settlement under the embankment at each



transverse cross section within a settlement range will be considered to vary uniformly between break points in the cross section.

(3) At each breakpoint, the settlement allowance will be based upon the proportion that the specified fill height at the break point bears to the specified fill height at the settlement measurement locations, in accordance with the following formula.

(4) Symbols used in the formula and the break points are [shown on a typical settlement cross section on the drawing] [included in these specifications].

$S = h \times \frac{sm}{hm}$ , where

$S$  = settlement to be computed at a break point;  
 $h$  = specified gross fill height at  $S$ ;  
 $sm$  = measured or adjusted vertical change at settlement measurement location ;  
 $hm$  = specified gross fill height at settlement measurement location.

d. Forfeiture of Payment for Settlement of Foundation. Failure to utilize settlement gages in strict accordance with the specifications and drawings will result in total forfeiture of any payment which will otherwise be due the Contractor for settlement of the foundation. Payment for settlement of the foundation will be totally forfeited for the reach attributable to the each settlement measurement location in each case for the following reasons: embankment over a settlement measurement location is constructed to a height in excess of the specified construction lines plus the tolerance permitted; settlement plates have been set and cannot be found after completion of the embankment; failure to take the settlement measurement within [\_\_\_\_\_] hours after the final cross sections have been taken over the completed embankment.

#### 1.4.3.3 Unit of Measure

Unit of measure: cubic meters yards.

#### 1.4.4 Mortar and Concrete

##### 1.4.4.1 Payment

Payment will be made for costs associated with mortar and concrete used in foundation and abutment preparation, which includes full compensation for furnishing all labor, equipment, material, and incidentals, and performing all operations necessary for placement of concrete and mortar for foundation and abutment preparation.

##### 1.4.4.2 Measurement

Mortar and concrete used in filling spaces beneath rock overhangs and around protrusions will be measured for payment as the actual volumes of such mortar and concrete in cubic meters yards as determined by field surveys made before and after placement of the mortar and concrete. [ No measurement will be made for the mortar used in filling the open joints and cracks in the rock surface. ] [ Measurement of mortar or concrete used in filling the open joints and cracks in the rock surface will be made by the

square meter yard based on the horizontal projection of the area obtained from a survey performed before application.][ Measurement of mortar or concrete used in filling the open joints and cracks in the rock surface will be the bags of cement used.]

#### 1.4.4.3 Unit of Measure

Unit of measure: cubic meters yards.

#### 1.4.5 [Settlement Gages

No separate payment will be made for furnishing, installing, and maintaining settlement gages during embankment construction as specified herein, if used, including measurements required to be made by the Contractor, and shall be at the expense of the Contractor. No separate payment will be made for compaction of fill around and over the settlement gages or for interference with the Contractor's operations resulting from the settlement gage installations.]

#### 1.4.6 [Core Borings Utilized to Measure Foundation Settlement

No separate payment will be made for core borings performed for measurement of foundation settlement and shall be at the expense of the Contractor.]

### 1.5 SYSTEM DESCRIPTION

The work covered by this section consists of furnishing all equipment, labor, materials, and incidentals, and performing all operations necessary for the clearing, grubbing, and stripping of the areas specified herein or indicated on the drawings, and for the removal and disposal of cleared, grubbed, and stripped materials,[ removal or plugging of existing drainage structures,] and refilling of holes resulting from grubbing; excavation of borrow areas [and existing levees,] and for all other excavations incidental to the construction of levees[, channels] [, ditches] [, structures] [, and ponding areas] as specified and shown; foundation preparation and the construction of levee embankments, including new levee, enlargement of existing levee, backfill of inspection trenches, cutoff trenches, berms, road crossings, backfill at drainage structures, and other incidental earthwork as may be necessary to complete the levee as specified herein and as shown on the drawings. All work under this section shall comply with the requirements of EM 385-1-1.

### 1.6 GENERAL CONDITIONS

#### 1.6.1 Lines and Grades

The embankment and backfill shall be constructed to the lines, grades, and cross sections indicated on the drawings, unless otherwise directed by the Contracting Officer. The Government reserves the right to increase or decrease the foundation widths and embankment slopes or to make such other changes in the embankment or backfill sections as may be deemed necessary to produce a safe structure. Changes in quantities resulting from such revisions will not constitute justification for change in contract unit prices, except as provided for in the Variations in Estimated Quantities Clause. Increases in height of section, made to compensate for settlement or consolidation of the embankment material subsequent to the completion of the embankment, will not exceed [\_\_\_\_\_] percent of the height above the foundation at the levee centerline indicated. The end slopes and side slopes of partial fill sections shall not be steeper than [one vertical on

[\_\_\_\_\_] horizontal] [, unless otherwise shown on the drawings].

#### 1.6.2 Conduct of the Work

The Contractor shall maintain and protect the embankment and backfill in a satisfactory condition at all times until final completion and acceptance of all work under the Contract. [ If, in the opinion of the Contracting Officer, the hauling equipment causes horizontal shear planes or slicken sides, rutting, quaking, heaving, cracking, or excessive deformation of the embankment or backfill, the Contractor shall limit the type, load, or travel speed of the hauling equipment on the embankment or backfill.] The Contractor may be required to remove, at his own expense, any embankment material placed outside of prescribed slope lines. Any approved embankment or backfill material which is lost in transit or rendered unsuitable after being placed in the embankment or backfill and before final acceptance of the work shall be replaced by the Contractor in a satisfactory manner and no additional payment will be made therefor. The Contractor shall excavate and remove from the embankment or backfill any material which is unsatisfactory and shall also dispose of such material and refill the excavated area as directed, all at no cost to the Government.

#### 1.6.3 Embankment and Backfill Materials

\*\*\*\*\*  
**NOTE: All available sources of materials for  
embankment and backfill should be designated.**  
\*\*\*\*\*

Materials for embankment and backfill construction will be obtained from [the borrow sources] [sources provided by the Contractor] [required excavation]. Materials obtained from required excavation which meet or which can be processed to meet the requirements for each embankment material, or any other material required for this project, as specified herein, may be utilized [in the appropriate zone of] [in] the embankment or as backfill. All roots, limbs, and wood fragments shall be removed from embankment materials. Materials containing sod, other organic or perishable material, trash, debris, and frozen materials shall not be used in the embankment. The Contractor shall submit to the Contracting Officer the source or sources from which he intends to obtain materials for embankment construction. If a source is selected other than a commercial quarry or other commercial entity from which earth or rock material will be directly purchased and where the Contractor or his subcontractor will perform the borrow excavation, a written statement will be provided to the Contracting Officer indicating permission to utilize the area. It shall be the responsibility of the Contractor to obtain Federal, State, and local permits which may be required for excavation and reclamation of the borrow area. A copy of the plan and procedures to be utilized for reclamation shall be furnished to the Contracting Officer as required in SECTION [\_\_\_\_], paragraph [\_\_\_\_\_]. The Contracting Officer will require material samples from any proposed borrow source to be submitted as indicated in paragraph Quality Control.

#### 1.6.4 Haul Roads

\*\*\*\*\*  
**NOTE: Haul roads are highly project specific.  
Contractor should be given as much latitude as  
feasible to determine his traffic patterns. Haul  
roads must be safe, not interfere with public**

**traffic, environmentally friendly and generally must  
be restored to preconstruction conditions.**

\*\*\*\*\*

Haul roads shall be located and constructed [as shown on the drawings and] [as] [approved by the Contracting Officer] [within the project boundaries shown on the drawings]. [ Prior to the commencement of construction the contractor shall submit for approval a site plan detailing the location of all haul roads within the project limits.] [ Haul road[s] between the borrow site[s] and the levee embankment shall be located within the limits [shown on the drawings] [approved by the Contracting Officer].] [ The limits of the borrow haul road shall be clearly marked in the field using construction fencing or similar methods approved by the Contracting Officer. Areas on each side of the borrow haul road corridor shall not be disturbed.] Haul roads shall be constructed to maintain the intended traffic, be free draining, and be maintained in good condition throughout the contract period. [ Any haul road which crosses any creek or drainage channel shall be constructed, and maintained by the Contractor so as to not flood either upstream areas by restricting stream flows or flood downstream areas by the release of any stored water in the event that the crossing fails for any cause.] Haul roads constructed during the contract duration shall be removed after work is completed and the impacted area restored to its preconstruction conditions. [ The Contractor shall plow and/or scarify or otherwise loosen all access and haul roads other than existing roads to a minimum of [\_\_\_\_\_] mm inches deep and the surface shall be left in a smooth condition.] All haul roads within the right-of-way that will remain as public thoroughfares after construction shall be cleaned daily and maintained in the preconstruction condition. All costs associated with these haul roads shall be considered as a subsidiary obligation of the Contractor.

#### 1.6.5 Ramps and Crossings

Ramps and crossings shall be constructed at the locations shown on the drawings by placement of a fill as specified in paragraph [\_\_\_\_\_] . Ramps and crossings shall be constructed only by adding material to the levee crown and slopes. Ramps shall have a [\_\_\_\_\_] meter foot crown width, a grade not to exceed [\_\_\_\_\_] percent, and 1V on [\_\_\_\_\_]H side slopes.

#### 1.6.6 Runways

\*\*\*\*\*

**NOTE: Runways are temporary haul roads over a levee.**

\*\*\*\*\*

Where material is hauled over an existing levee for construction, the Contractor at his expense will be permitted to construct temporary runways over the levee by the addition of material to the levee cross section. For the construction of runways, if the Contractor so desires, the existing levee may be cut, [but not to exceed a depth of [\_\_\_\_\_] meters feet below the crown] [not to exceed [\_\_\_\_\_] meters feet below the project flowline] [or 100-year level] [not to excavate below elevation [\_\_\_\_\_] or one half the height of the levee, whichever is less], and provided that the cut is made with side slopes not steeper than 1V on 1H, and with a minimum width of haul road of [\_\_\_\_\_] [7.6] m [\_\_\_\_\_] [25] feet for one-way traffic, and [\_\_\_\_\_] [18.3] m [\_\_\_\_\_] [60] feet for two-way traffic. Cutting into the existing levee at intervals of less than [\_\_\_\_\_] [152] m [\_\_\_\_\_] [500] linear feet for the [\_\_\_\_\_] [7.6]-m [\_\_\_\_\_] [25]-foot bottom widths or less than [\_\_\_\_\_] [304] m [\_\_\_\_\_] [1,000] linear feet for the [\_\_\_\_\_] [18.3]-m

[\_\_\_\_\_] [60]-foot bottom widths will not be allowed, and no more than [\_\_\_\_\_] runways shall be open at one time. The Contractor shall stockpile, as directed by the Contracting Officer, sufficient suitable levee embankment material to construct emergency closure of the cuts.

#### 1.6.7 Closure of Runways

Where runways have been cut through the levee, the Contracting Officer reserves the right to order their closure at no additional cost to the Government at any time that such runways may endanger the security of the levee. Just prior to restoration of the runway, the bottom of any cut made in the levee shall be broken to a depth of [\_\_\_\_\_] [300] mm [\_\_\_\_\_] [6] inches and the side slopes thoroughly scarified. The restoration shall be made with suitable embankment material, placed and compacted as provided in paragraph [\_\_\_\_\_]. Material used in the construction of the approach ramps of the runways shall be removed and may be used for fill, if satisfactory. If not used for fill, the material shall be disposed of by placing it in abandoned portions of the borrow areas or by any other method specified in paragraph disposal of material. [ No section of the levee shall be degraded or weakened to provide runways nor shall existing runways remain open during the nonwork season described in [Section [\_\_\_\_\_]] [GENERAL CONTRACT REQUIREMENTS], [paragraph] [Clause] EXCLUSION OF PERIODS IN COMPUTING COMPLETION SCHEDULES, unless otherwise approved in writing by the Contracting Officer.]

#### 1.6.8 Stockpiling

\*\*\*\*\*  
**NOTE: Cost of stockpiling embankment fill material  
should be included in the price for placing fill in  
the levee embankment.**  
\*\*\*\*\*

Any on-site stockpiling of embankment materials shall be in accordance with paragraph [\_\_\_\_\_] Stockpiles. [ No payment will be made for such stockpiling nor for the reloading and hauling of these materials to their final position.]

#### 1.6.9 Slides and Foundation Failures

When sliding occurs in any part of the embankment and backfills prescribed in this section after they have been placed, but prior to final acceptance of all work under the contract, the Contractor shall repair the slide as directed by the Contracting Officer. When the slide is caused through the fault of the Contractor, the repair shall be made at no cost to the Government. When the slide is not the fault of the Contractor, an equitable adjustment in the contract price shall be made pursuant to the Contract Clause CHANGES to cover the cost of the repairs.

#### 1.6.10 Drainage Requirements

\*\*\*\*\*  
**NOTE: Modify the following paragraph for specific  
job conditions such as fill placed in/under water.**  
\*\*\*\*\*

The Contractor shall not block or restrict the flow in a natural drain, existing culvert, ditch or channel at any time without obtaining prior written approval from the Contracting Officer. This approval shall not

relieve the Contractor from responsibility for any damage caused by his operation. The Contractor shall monitor the [river] [canal] [stream] flow and provide sufficient free discharge areas so that conditions are not worsened upstream or downstream by possible floods during construction. Surface water shall be directed away from excavations and construction sites so as to prevent erosion and undermining of foundations. Diversion ditches, dikes, and grading shall be provided and maintained as necessary during construction. Excavated slopes and backfill surfaces shall be protected to prevent erosion and sloughing. Excavation shall be performed so that the site and the area immediately surrounding the site and affecting operations at the site shall be continually and effectively drained. If private property is to be used for drainage, submit written evidence that the right has been obtained from the property owner for drainage on his property.

#### 1.7 REGULATORY REQUIREMENTS

\*\*\*\*\*  
**NOTE: Include the applicable state highway  
department document title in which an acceptable  
gradation for the concrete aggregate is presented.**  
\*\*\*\*\*

The [state statutory and regulatory requirements] [\_\_\_\_\_] listed below form a part of this specification to the extent referenced.

#### 1.8 PERMITS

\*\*\*\*\*  
**NOTE: Reference applicable Federal, State and Local  
permit requirements such as permits for disposal and  
hauling of materials, erosion control, burning, etc.  
The terms and conditions in any permits and  
environmental commitments obtained by the Government  
must be made a part of the contract. The designer  
must include technical requirements necessary to  
comply with these terms and commitments.**  
\*\*\*\*\*

In accordance with Contract Clause PERMITS AND RESPONSIBILITIES, the Contractor shall obtain all necessary permits required for disposal, hauling, erosion control, burning, [\_\_\_\_\_] , and pay all fees associated with permitting and compliance.[ In addition, the Government has obtained permits for storm water discharge[ and [\_\_\_\_\_] ],as specified in Section 01356A STORM WATER POLLUTION PREVENTION MEASURES. The Contractor shall comply with the terms of these permits and with the requirements of Sections 01355A ENVIRONMENTAL PROTECTION, Section 01356A STORM WATER POLLUTION PREVENTION MEASURES, and this section.]

#### 1.9 PROJECT SITE CONDITIONS

##### 1.9.1 Protection of Cultural and Natural Resources

All work and Contractor operations shall comply with the requirements of Section 01355A ENVIRONMENTAL PROTECTION and with the requirements of this section.

### 1.9.2 Protection of Man-Made Facilities and Natural Features

Trees within the clearing area shall be felled in such a manner as to avoid damage to trees left standing and trees outside the clearing area, existing buildings, man-made facilities and natural features, with due regard to the safety of employees and others, and in compliance with EM 385-1-1. Excavation shall follow the same requirements specified above for felling trees and shall be in compliance with EM 385-1-1. Existing utility lines that are shown on the drawings or the locations of which are made known to the Contractor prior to excavation and that are to be retained shall be protected from damage during excavation. When utility lines that are to be removed are encountered within the area of operations, the Contractor shall notify the applicable utility companies in sufficient time for measures to be taken to prevent interruption of the services.

### 1.9.3 Historical, Archeological, and Cultural Resources

Historical, archeological, and cultural resources within the Contractor's work limits [are known to exist] [may exist]. If, during construction activities, the Contractor observes items that may have historical or archeological value, such observations shall be reported immediately to the Contracting Officer so that appropriate authorities may be notified and a determination made as to their significance and what, if any, special disposition of the finds should be made. The Contractor shall cease all activities that may result in the destruction of these resources and shall prevent his employees from trespassing on or otherwise damaging such resources.

### 1.9.4 Subsurface Data

Subsurface soil boring logs are [shown on the drawings] [included in these specifications]. Subsurface investigation reports and samples of materials obtained from subsurface investigations may be examined at the [\_\_\_\_\_] District Office. These data represent subsurface information at the boring locations; however, variations may exist in the subsurface between boring locations. Groundwater levels indicated on the soil boring logs were levels found at the time of exploration. The groundwater table can vary significantly depending on time of year, variation from normal precipitation, and river stage or tide level.

## 1.10 MERCHANTABLE TIMBER

Merchantable timber remaining within the areas to be cleared on or after the date of award of this contract may be disposed of as the Contractor sees fit, as long as such merchantable timber is either removed from the rights-of-way or is satisfactorily disposed of in accordance with the paragraph DISPOSITION OF CLEARED, GRUBBED, AND STRIPPED MATERIAL DISPOSITION OF EXCAVATED MATERIAL and the Contractor complies with all applicable State and local regulations and laws.

## 1.11 SEQUENCE OF WORK

### 1.11.1 Clearing and Grubbing

All clearing and grubbing work shall be completed at least [100] [\_\_\_\_\_] meters [300] [\_\_\_\_\_] feet in advance of embankment construction. [ In locations where work on drainage structures is performed prior to embankment construction, all clearing and grubbing shall be completed for the structure at least [\_\_\_\_\_] meters feet on each side of the structure,

measured along the levee centerline and [\_\_\_\_\_] meters feet perpendicular to the structure.] If regrowth of vegetation or trees occurs after clearing and grubbing and before placement of embankment, the Contractor will be required to clear and grub again prior to embankment construction.

#### 1.11.2 Stripping

After inspection and acceptance of cleared and grubbed areas, stripping may proceed. All stripping work shall be completed not more than [\_\_\_\_\_] meters feet in advance of embankment construction.

### PART 2 PRODUCTS

\*\*\*\*\*  
NOTE: After "PART 2 PRODUCTS" above, insert the following "(NOT APPLICABLE)", if there are no subparagraphs in PART 2. PART 2 material requirements should be added for contracts in which the Contractor is required to supply materials.  
\*\*\*\*\*

#### 2.1 HAUL ROAD MATERIALS

[\_\_\_\_\_].

#### 2.2 TYPES OF FILL MATERIALS

\*\*\*\*\*  
NOTE 1: The types of fill materials used for levee construction usually depend on the availability of materials from required construction excavation and the nearby borrow sources. The material types listed below as satisfactory materials are often used in levee construction.

NOTE 2: Separate paragraphs, such as those below, should be included for each material type that is to be placed under a contract. The plans should clearly show, with labels, the location of the fill types. Embankment fills should include, but not be limited to, the levee, berms, inspection trench, cutoff trenches and any other specified fill. This allows the Designer and Specifications Engineer to use multiple fill types within the same contract and clearly indicate locations of each type. The types of satisfactory materials should be edited for each type of fill. The bid schedule should include a line for each type of fill. Where multiple fills are placed in layers, the measurement, payment and tolerance paragraphs should be edited to specify the interfaces of the multiple fill types.

Omit the following soil types which are not applicable to the specific project.

\*\*\*\*\*

##### 2.2.1 [Select Fill]

Select fill embankment material shall be obtained from [the borrow site



provided by the Government] [sources provided by the Contractor] [required excavation]. The select fill material shall consist of satisfactory materials classified in accordance with ASTM D 2487 as [\_\_\_\_].]

#### 2.2.2 [Impervious Fill]

\*\*\*\*\*

NOTES: Caution should be exercised regarding the use of high plasticity clay and silt (CH, MH) soils with Plasticity Indices greater than about 40 (30 in dry climates and 50 in humid climates). Spreading and compacting CH or MH materials can also present constructability problems due to difficulty maintaining proper moisture content. These soils are susceptible to shrinkage and cracking upon drying. Seasonal cycles of swelling and shrinkage can also result in loss of shear strength, which may ultimately result in slope instability. Chemical treatment, such as lime, has been used to reduce the PI and potential for cracking.

Impervious Fill material shall not be compacted using vibratory rollers.

\*\*\*\*\*

This material shall consist of satisfactory impervious material classified as lean clay (CL), [ fat clay (CH),] low plasticity silt (ML), [ high plasticity silt (MH),] [sand containing more than 30 percent of clay (CL),] and borderline clay and silt (CL-ML) in accordance with ASTM D 2487.]

#### 2.2.3 [Pervious Fill]

\*\*\*\*\*

NOTE: The designer should define the types of material which are acceptable as Random Fill.

\*\*\*\*\*

This material shall consist of satisfactory pervious material classified as well graded sand (SW), poorly graded sand (SP) in accordance with ASTM D 2487.]

#### 2.2.4 [Random Fill]

Random fill shall consist of any satisfactory materials [ other than those classified in ASTM D 2487 as [\_\_\_\_]] [and any silt or sand with a uniformity coefficient (Cu) less than 6]. [ Random fill may consist of select fill, impervious fill, and pervious fill, or a combination of them.]]

#### 2.2.5 Random Rock

\*\*\*\*\*

NOTE: Random rock is sometimes used in levee construction to build up an underwater levee toe foundation or to buttress a slope in a constricted area. Due to its high permeability, random rock or pervious fill should not be used alone as levee fill material. The designer should select the types of acceptable rock material and the maximum allowable percent fines.

\*\*\*\*\*

Random rock shall consist primarily of [\_\_\_\_\_] (shale, siltstone, sandstone, granite or limestone) obtained from a source provided by the Contractor. The random rock shall be free of silt, clay, or other earth material in quantities greater than [\_\_\_\_\_] [5] percent by weight, and shall contain no debris or organic material. Random rock shall be reasonably well-graded and the largest stones shall have a maximum dimension not exceeding [\_\_\_\_\_] [450] mm [\_\_\_\_\_] [18] inches. Rock production at the source shall be controlled such that not more than 20 percent of the material has a maximum dimension between adjacent earth fill shall be choked off with a layer of finer random rock material. Random rock placed within 1 meter 3 feet of any structure shall have a maximum size of 125 mm 5 inches.

#### 2.2.6 [Coarse Drainage Gravel]

Coarse gravel material for the [rectangular and trapezoidal] toe drains shall be obtained from a source provided by the Contractor. Coarse drainage gravel shall be non-calcareous, composed of tough durable particles, and shall not contain any organic material or soft, friable particles in quantities. Blast furnace slag will not be permitted. The gravel material in-place shall meet the requirements of AASHTO M 43, Size No. 57, with the following gradation:

SIEVE SIZE U.S. STANDARD SQUARE MESH	PERCENTAGE BY WEIGHT PASSING INDIVIDUAL SIEVE
[_____] (1-1/2 inches)	[_____] (100)
[_____] (1 - inch )	[_____] (95-100)
[_____] (1/2 - inch)	[_____] (25-60)
[_____] (No. 4)	[_____] (0-10)
[_____] (No. 8)	[_____] (0-5)]

#### 2.2.7 [Fine Drainage Gravel]

\*\*\*\*\*

**NOTE: Identify source of materials.**

\*\*\*\*\*

Fine drainage gravel shall be obtained from a source [provided by the Contractor]. Fine drainage gravel material shall be non-calcareous, composed of tough durable particles, and shall not contain organic material. The fine drainage gravel in-place shall meet the requirements of AASHTO M 43, Size No. 8, with the following gradation:

SIEVE SIZE U.S. STANDARD SQUARE MESH	PERCENTAGE BY WEIGHT PASSING INDIVIDUAL SIEVE
[_____] (1/2-inch)	[_____] (100)
[_____] (3/8-inch)	[_____] (85-100)
[_____] (No. 4)	[_____] (10-30)
[_____] (No. 8)	[_____] (0-10)
[_____] (No. 16)	[_____] (0-5)]

#### 2.2.8 [Filter Sand]

Fine aggregate for the filter sand in-place shall meet the quality requirements of ASTM C 33 grading for fine aggregate with additional limits on the allowable percentage passing the No. 200 sieve as specified below.

SIEVE SIZE U.S. STANDARD SQUARE MESH	PERCENTAGE BY WEIGHT PASSING INDIVIDUAL SIEVE
[ ] (3/8-inch)	[ ] (100)
[ ] (No. 4)	[ ] (95-100)
[ ] (No. 16)	[ ] (50-85)
[ ] (No. 100)	[ ] (2-10)
[ ] (No. 200)	[ ] (0-5)

Additionally, the filter sand shall not contain any organic matter or soft friable particles.]

#### 2.2.9 [Bedding]

Bedding material, placed as a backing layer shall consist of satisfactory pervious fill material satisfying the material requirements presented in [Section 02371 WIRE MESH GABIONS [AND MATTRESSES]] and [Section 02380 STONE, CHANNEL, SHORELINE/COASTAL PROTECTION FOR STRUCTURES].]

#### 2.2.10 [Topsoil]

Topsoil consists of organic soil and shall be placed on the levee slopes as shown on the contract drawings and as specified in Section [02922 SODDING] [ ].]

#### 2.2.11 [Semicompacted Fill]

\*\*\*\*\*  
NOTE: The designer should list the material types  
that are acceptable for semicompacted fill, which  
can be defined in terms of previously defined fill  
types or basic material types.  
\*\*\*\*\*

Material for semicompacted fill shall consist of satisfactory materials classified in accordance with ASTM D 2487 as [ ].]

#### 2.2.12 [Uncompacted Fill]

\*\*\*\*\*  
NOTE: The designer should list the material types  
that are acceptable for uncompacted fill, which can  
be defined in terms of previously defined fill types  
or basic material types.  
\*\*\*\*\*

Material for uncompacted fill shall consist of satisfactory materials classified in accordance with ASTM D 2487 as [ ].]

#### 2.2.13 [Hydraulic Fill for Berms and Depressed Areas]

\*\*\*\*\*

NOTE: Caution should be used when specifying hydraulic fill. Hydraulic fill is to be used only in stability berms, pit fills, and seepage berms. Hydraulic fill will normally not be used in construction for levee embankment. In addition to requiring a large levee footprint, the levee embankment constructed by hydraulic fill is susceptible to soil liquefaction, and excessive seepage. Hydraulic fill also erodes quickly in a situation where a levee is overtopped or where an impervious covering is penetrated. See the appropriate Engineering Manuals for further guidance.

\*\*\*\*\*

Fill shown on the drawings as hydraulic fill shall be placed by hydraulic methods in accordance with the plan of operations approved by the Contracting Officer. The dredged material shall have, as placed, not less than [\_\_\_\_\_] percent by weight passing U.S. Standard Sieve No. [\_\_\_\_\_] and not less than [\_\_\_\_\_] percent by weight passing a U.S. Standard Sieve No. [\_\_\_\_\_] .]

## 2.3 [MANUFACTURED PRODUCTS

\*\*\*\*\*

NOTE: Add applicable requirements.

\*\*\*\*\*

[\_\_\_\_\_] .]

## 2.4 GROUTS AND DENTAL CONCRETE

Grouts and dental concrete shall be as specified in concrete Section [\_\_\_\_\_] , except that the slump shall be [\_\_\_\_\_] mm inches for dental concrete.

## 2.5 [STABILIZERS

\*\*\*\*\*

NOTE: Add applicable requirements.

\*\*\*\*\*

[\_\_\_\_\_] .]

## 2.6 SETTLEMENT GAGES

Settlement gages shall be as shown.

# PART 3 EXECUTION

## 3.1 CLEARING

Clearing shall be accomplished within the limits of existing ground to receive embankment [and structures], together with strips [1.5] [\_\_\_\_\_] meters [5] [\_\_\_\_\_] feet wide, beyond and contiguous thereto, existing levees to be degraded, ponding areas, ditches, structures, traverses, channels, riprap, revetment, borrow areas and ramps. Trees, downed timber, snags, slash, brush, garbage, trash, debris, fencing and other items shall be cleared [[\_\_\_\_\_] mm inches above] [flush with] the existing ground surface. Trees and vegetation designated to be left standing or to remain

shall be protected from damage from construction operations. Clearing of borrow areas shall be limited to the minimum area required for construction operations.

### 3.2 GRUBBING

Grubbing shall be accomplished within the limits of existing ground to receive embankment [and structures], together with strips [1.5] [\_\_\_\_\_] meters [5] [\_\_\_\_\_] feet wide, beyond and contiguous thereto, existing levees to be degraded, ponding areas, ditches, structures, traverses, channels, riprap, revetment, borrow areas and ramps. Grubbing shall be accomplished to a depth of at least [1] [\_\_\_\_\_] m [3] [\_\_\_\_\_] feet below the existing ground surface. All holes caused by grubbing operations and removal of pipes and drains, excluding holes in borrow areas, channels and ditches [above required grade], shall be filled with satisfactory material as specified in paragraph [\_\_\_\_\_] . This material shall be placed in [\_\_\_\_\_] mm inch layers to the elevation of the adjacent ground surface and each layer compacted to a density at least equal to that of the adjoining undisturbed material.

### 3.3 STRIPPING

The entire area within the limits of existing ground to receive embankment and structures, together with strips [1.5] [\_\_\_\_\_] meters [5] [\_\_\_\_\_] feet wide, beyond and contiguous thereto, existing levees to be degraded, ponding areas, and ditches [shown on the drawing shall be stripped to remove crops, weeds, grass, and other vegetative materials to the ground surface [and topsoil to a depth of [\_\_\_\_\_] mm inches]].

### 3.4 DISPOSITION OF CLEARED, GRUBBED, AND STRIPPED MATERIAL

\*\*\*\*\*  
**NOTE: Delete undesirable options for Disposition of  
Cleared, Grubbed, and Stripped Materials.**  
\*\*\*\*\*

Except as otherwise specified or indicated on the drawings, all materials resulting from clearing and grubbing operations shall, at the Contractor's option, be disposed of either by windrowing or stockpiling within construction limits, burying within construction limits, burning, chipping, removal from the site, or a combination thereof. In no case shall any material resulting from clearing and grubbing operations be buried or permanently placed within the levee foundation or any structural foundation. The Contractor shall make a reasonable effort to channel merchantable material into the commercial market and to make beneficial use of the materials resulting from clearing and grubbing. [The topsoil material resulting from the stripping operations shall be temporarily stockpiled within the rights-of-way.]

#### 3.4.1 Windrows

Cleared, grubbed and stripped material shall be placed [as shown on the drawings] in a neat windrow or in piles with tree limbs trimmed sufficiently to make the windrow as small as practicable. No cleared, grubbed or stripped material shall extend beyond the construction limits.

#### 3.4.2 Burning

Subject to applicable Federal, State and local burning restrictions, the

Contractor may burn material within the contract rights-of-way. Burning operations shall be conducted so as to prevent damage to adjacent man-made facilities and natural features. The Contractor shall be responsible for any damage to life and property resulting from fires that are started by the Contractor's employees or as a result of the Contractor's operations. The Contractor shall furnish, at the site of burning operations, adequate fire fighting equipment to properly equip personnel for fighting fires. Fires shall be guarded at all times and shall be under constant surveillance until they have been extinguished. All unburned material (material not reduced to ash) shall be removed from the site or disposed of by [\_\_\_\_].

#### 3.4.3 Burying

Subject to applicable Federal, State and local burying restrictions, the Contractor may bury the cleared and grubbed material in the area(s) as shown on the drawings or in [\_\_\_\_]. No material shall be buried within [\_\_\_\_] meters feet of any standing timber. All material disposed of by burying shall be covered with a minimum of [\_\_\_\_] mm inches of earth.

#### 3.4.4 Chipping

All cut timber, down timber, dead timber, branches, and brush may be chipped. The chips shall be hauled either to stockpiles indicated on the drawings or to other locations approved by the Contracting Officer or removed from site of work. The chips shall be deposited in these areas in either piles or windrows [above] [below] elevation [\_\_\_\_] NGVD.

#### 3.4.5 Removal from Site of Work

The Contractor may elect to remove all or part of the cleared and grubbed materials from the site of the work in accordance with Section 01355A ENVIRONMENTAL PROTECTION. The Contractor shall, at his option, either retain any such materials of value for his own use or dispose of them by sale or otherwise. The Government is not responsible for the protection and safekeeping of any materials retained by the Contractor. Such materials shall be removed from the site of the work before the date of completion of the work.

### 3.5 REMOVAL OR PLUGGING OF ABANDONED PIPE AND CONDUITS

\*\*\*\*\*  
**NOTE: The terms and conditions in any permits and environmental commitments obtained by the Government must be made a part of the contract. The designer must include technical requirements necessary to comply with these terms and commitments.**  
\*\*\*\*\*

Abandoned pipes and conduits shall be removed to the limits shown on the drawings or plugged with concrete a minimum distance of [\_\_\_\_] meters feet from [\_\_\_\_]. Prior to plugging, the Contractor shall clean the interior of the pipe to be plugged and place the concrete in such a manner as to insure a dense, well bonded plug.

### 3.6 SHORING, SHEETING, AND BRACING

Shoring, sheeting, and bracing shall be installed where required for the protection of existing natural features and man-made facilities, for the

safety of workers and the public, in compliance with EM 385-1-1, and to insure the integrity of the embankment. Shoring, sheeting and bracing shall not be used in lieu of the required excavation slopes. Shoring, sheeting, and bracing shall be adequately designed and properly installed to withstand anticipated loads. Shoring, sheeting and bracing shall be planned and designed by a registered professional engineer. The Contractor shall submit a plan for shoring, sheeting, and bracing in accordance with paragraph SUBMITTALS. All shoring, sheeting and bracing shall be removed as embankment and backfill operations progress.

### 3.7 DEWATERING AND DIVERSION

Surface and groundwater control shall be accomplished in coordination with the required excavation and embankment construction. Surface and/or groundwater control may necessitate the use of temporary diversion ditches, cofferdams and/or dewatering by the use of pumping. Methods for care of surface water and for controlling the surface and groundwater levels shall be subject to approval of the Contracting Officer.

### 3.8 EXCAVATION

Excavation shall consist of removal of material in preparing the foundations to the lines and grades shown on the drawings, removal of material from ditches and channels to the lines and grades shown on the drawings, removal of objectionable materials and obtaining required fill materials from the borrow areas.[ Blasting will [not] be permitted.] Over excavation shall be backfilled to grade with similar over excavated material or satisfactory material and compacted to a density of at least that of the surrounding material.

#### 3.8.1 Over Excavation

##### 3.8.1.1 Outside Limits of Levee Foundations or Structures

Over excavation outside the limits of the foundations of levees or structures shall be backfilled to grade with similar over excavated material or satisfactory material and compacted to a density of at least that of the surrounding material.

##### 3.8.1.2 Within Limits of Levee Foundations or Structures

Over excavation within the limits of the foundations of levees or structures shall be backfilled to grade in accordance with paragraph PREPARATION OF FOUNDATION, PARTIAL FILL SURFACES AND ABUTMENTS.

#### 3.8.2 Inspection Trench

An inspection trench shall be excavated and maintained free of standing water to the dimensions and locations shown on the drawings. The trench shall be excavated at least [\_\_\_\_\_] meters feet in advance of but not more than [\_\_\_\_\_] meters feet in advance of construction.

#### 3.8.3 Structures

Excavations for structures shall conform to the dimensions and elevations indicated for each structure and footing, except as specified hereinafter, and shall include trenching for utility and foundation drainage systems to a point [\_\_\_\_\_] meters feet beyond each structure and all work incidental thereto. Excavation shall extend a sufficient distance from walls and

footings to allow for placing and removal of forms. Satisfactory material removed below the depths indicated without specific direction of the Contracting Officer shall be replaced at no additional cost to the Government and filled in accordance with paragraph OVER EXCAVATION above. [ Over excavation below required invert elevations or bottoms of footings shall be backfilled with lean concrete at no additional cost to the Government. No footings shall be constructed on unsatisfactory material as determined by the Contracting Officer.] [ Excessively wet and/or soft material in subgrades resulting from water ponding in footing excavations shall be removed and replaced with [lean concrete] [satisfactory material compacted to the density of the surrounding undisturbed material]].

#### 3.8.4 Channels

Channels shall be excavated at the locations and to the lines and grades shown on the drawings and in accordance with paragraph TOLERANCES.

#### 3.8.5 Ditches

Drainage ditches shall be excavated at the locations and to the lines and grades shown on the drawings and in accordance with paragraph TOLERANCES.

#### 3.8.6 Slopes and Surcharges

Temporary excavation slopes for any channel, structure excavation, or other required excavation shall not be steeper than the specified finished slope or the specified construction slope, as applicable, and subject to the approval of the Contracting Officer. This may be accomplished by benching the temporary slope so that the average slope is not steeper than the specified slope. In addition, no temporary, permanent, or construction slope shall be surcharged with excavated or stockpiled material or with heavy construction equipment which would have the same effect as the surcharge material. The toe of stockpiled material shall be maintained a minimum distance back from the top of the finished excavation equal to the depth of the excavation. The maximum height of such stockpile without causing instability of the excavation slope shall be determined by the Contractor. Any slide or other adverse conditions caused by failure of the Contractor to maintain these conditions shall be considered the responsibility of the Contractor and remedial measures shall be at the Contractor's expense.

#### 3.8.7 Borrow Areas

##### 3.8.7.1 Government-Furnished

Borrow areas shall be excavated to the extent necessary to obtain satisfactory material within the lines and grades as shown on the drawings.

When the material necessary for the construction of the embankment and berms cannot be obtained from adjacent borrow areas, it shall be obtained from other Government-furnished borrow areas. [ The permissible depth(s) in the borrow areas are indicated on the drawings.] Any excavation below the depths and slopes specified herein or shown on the drawings shall be backfilled by the Contractor, at the Contractor's expense, to the specified permissible excavation line, with satisfactory [material(s)] [cohesive material] [or] [other material] as specified by the Contracting Officer to a density of at least that of the surrounding material. Borrow areas shall be drained and kept dry during excavation. Where possible, unsatisfactory materials in borrow areas shall not be removed.



#### 3.8.7.2 Contractor-Furnished

Borrow areas proposed by the Contractor shall be subject to approval by the Contracting Officer. Any borrow sources proposed, accepted and approved by the Contracting Officer shall meet all applicable Federal, State and local requirements. [Proposed sources located within [\_\_\_\_\_] meters feet landward and [\_\_\_\_\_] meters feet riverward of the levee between Stations [\_\_\_\_\_] and [\_\_\_\_\_] will not be permitted.] No payment will be made for Contractor-furnished borrow areas.

#### 3.8.7.3 Dredged

The Contractor has the option of using dredging operations to obtain material for the pervious zones or the random zones subject to the requirements and the conditions specified herein. Dredging operations may be conducted at approved locations in the present stream bed of [\_\_\_\_\_] or as shown on the drawings. Dredging operations will not be permitted within [\_\_\_\_\_] meters feet of the levee centerline and no material shall be obtained within [\_\_\_\_\_] meters feet of any revetment, stabilized channel line, bridge pier and/or abutment.

#### 3.8.8 Cut-Off Trenches

A cutoff trench shall be excavated and maintained free of standing water to the dimensions and locations shown on the drawings. The trench shall be excavated at least [\_\_\_\_\_] meters feet in advance of but not more than [\_\_\_\_\_] meters feet of construction.

#### 3.8.9 Existing Levees and Spoil Banks

Existing levees and spoil banks shall be removed as shown on the drawings. In areas where the existing levee is located within the random or berm zone of the levee, it shall be incorporated into the embankment. Portions of existing embankments which lie within the impervious zone of the levee shall be removed. Existing levees located within the rights-of-way landward of the levee and berms to be constructed, may be utilized as borrow material, but only after equal protection has been provided by construction of the new levee. When excavated for borrow material, the existing levee shall be removed to the adjacent ground surface in a uniform manner, and shaped to maintain drainage in accordance with the adjacent natural drainage pattern. [When lower levels of flood protection would be caused by levee construction the contractor shall provide the Contracting Officer a plan to maintain existing levels of protection during the construction period.]

#### 3.8.10 Toe Drains

Toe drains shall be excavated to the dimensions and the locations indicated on the drawings.

#### 3.8.11 Utilities

Excavations for pipe beds shall be shaped to fit the contour of the pipe over a width of not less than 0.6 of the pipe diameter, or as shown on the drawings.

#### 3.8.12 Rock

Rock and other hard foundation materials shall be cleaned of loose debris

and cut to a firm surface, either level, stepped, or serrated, as shown on the drawings. Loose disintegrated rock and thin strata shall be removed. Rock excavation will not be measured for payment. Rock excavation will not be paid for as a separate bid item.

#### 3.8.13 Riprap and Bedding

Excavations for riprap and bedding shall be performed at the locations and to the lines and grades shown.

#### 3.9 TOLERANCES

A tolerance of [\_\_\_\_\_] mm inches above or below the prescribed grade will be allowed in the excavation for channels, ditches, inspection trenches, cutoff trenches, excavations for riprap and bedding, and mandatory borrow areas. A tolerance of [\_\_\_\_\_] mm inches below the prescribed grade will be allowed in the excavation for all other borrow areas.

All embankments and backfills shall be constructed to the grades, lines, and cross-sections shown on the drawings. At all points a tolerance of [100] [\_\_\_\_\_] mm [4] [\_\_\_\_\_] inches above or below the prescribed grade will be permitted in the final dressing, provided that any excess material is so distributed that the crown of the levee drains and that there are no abrupt humps or depressions in any surfaces. For topsoil, a tolerance of [\_\_\_\_\_] mm inches above the thickness as shown on the drawings will be permitted.

#### 3.10 SLIDES

In case sliding occurs in any part of the excavations prescribed in this section after they have been excavated, but prior to final acceptance of all work under the contract, the Contractor shall repair the slide as directed by the Contracting Officer. In case the slide is caused through the fault of the Contractor, it shall be repaired at no cost to the Government. In case the slide is due to no fault of the Contractor, an equitable adjustment in the contract price will be made for the repairs in accordance with the Contract Clause CHANGES.

#### 3.11 TRAVERSES

Traverses shall be left unexcavated between borrow areas at the locations [and to the cross sections] shown on the drawings. [The traverses shall have minimum top widths of [\_\_\_\_\_] meters feet with side slopes no steeper than 1 on 3 or as shown on the drawings.]

#### 3.12 STOCKPILES

Provisions of paragraph SLOPES AND SURCHARGES are applicable to all stockpiled materials. Upon completion of construction operations, all remaining stockpiled material shall be removed and disposed of by the disposal methods specified in paragraph DISPOSITION OF EXCAVATED MATERIALS.

#### 3.13 SURFACE DRAINAGE OF COMPLETED AREAS

The areas shown on the drawings designated as "GRADE FOR SURFACE DRAINAGE", the borrow areas, and the finished embankment areas shall be graded to the lines and grades shown on the drawings. The surface shall be free from sharp ridges, gullies, potholes, sinkholes, and any other surface irregularities. A tolerance of [\_\_\_\_\_] mm inches above or below the

prescribed grade will be allowed provided that the surface drains in the direction as indicated on the drawings.

### 3.14 MAINTENANCE OF WORK

#### 3.14.1 Debris Removal

The Contractor shall maintain all ditch and channel excavations free from leaves, brush, sticks, trash, and other debris until final acceptance of all work under the contract at no additional cost to the Government.

#### 3.14.2 Sediment Removal

Prior to final acceptance of all work under this contract, the removal of sediments from ditch or channel excavations shall be required to restore design grade and section at no additional cost to the Government.

### 3.15 DISPOSITION OF EXCAVATED MATERIALS

#### 3.15.1 Satisfactory Materials

Satisfactory excavated material shall be incorporated in the appropriate zones of the embankment. Satisfactory material shall consist of material as defined in paragraph DEFINITIONS, subparagraph SATISFACTORY MATERIALS. When direct placement is not practicable, satisfactory material from the excavation [may] [shall] be stockpiled for subsequent use in parts of the work for which it is specified herein and/or as indicated on the drawings. Satisfactory materials in excess of the quantity necessary to construct backfills and embankments shall be disposed of as specified for unsatisfactory materials.

#### 3.15.2 Unsatisfactory Materials

Unsatisfactory materials shall be as defined in paragraph DEFINITIONS, subparagraph UNSATISFACTORY MATERIALS. Unsatisfactory materials from the excavations prescribed in this section shall be permanently disposed of by [removal from the site to a Contractor-furnished disposal area] [placing in the disposal area shown on the drawings] [placing in abandoned portions of the borrow areas]. [ The material shall be shaped so that its surface is free from abrupt changes in grade and shall be sloped to drain.] [ No additional payment will be made for [Contractor-furnished disposal areas] [placing in abandoned portions of the borrow areas].] [ The material shall be shaped so that its surface is free from abrupt changes in grade and shall be sloped to drain.] [ No additional payment will be made for Contractor-furnished disposal areas.]

### 3.16 PREPARATION OF FOUNDATION, PARTIAL FILL SURFACES AND ABUTMENTS

#### 3.16.1 Earth

\*\*\*\*\*  
NOTE: Modify and or add to this paragraph to be  
compatible with the embankment construction  
procedure. If uncompacted or semicompacted fill is  
being utilized major modifications may be required.  
\*\*\*\*\*

After excavation (as described in paragraph EXCAVATION) or stripping (as described in paragraph CLEARING, GRUBBING AND STRIPPING) of the embankment

foundation [and excavation of the cut-off trench] to the extent indicated or otherwise required, the sides of stump holes, test pits, and other similar cavities or depressions shall be broken down so as to flatten out the slopes, and the sides of the cut or hole shall be scarified to provide bond between the foundation material and the fill. [ The slopes and bottom of the cut-off trench shall be scarified, as directed.] Unless otherwise directed, each depression shall be filled with the same material type that is to be placed immediately above the foundation. The fill shall be placed in layers, moistened, and compacted in accordance with the applicable provisions of paragraphs PLACEMENT, MOISTURE CONTROL, and COMPACTION for the specific material type. Materials which cannot be compacted by roller equipment because of inadequate clearances shall be compacted with power tampers in accordance with the paragraph COMPACTION for the specific material type. After filling of depressions [and cut-off trench] and immediately prior to placement of compacted fill in any section of the embankment, the foundation of such section shall be loosened thoroughly by scarifying, plowing, discing or harrowing to a minimum depth of [\_\_\_\_\_] mm inches, and the moisture content shall be adjusted to the amount specified in paragraph MOISTURE CONTROL for the appropriate type of material. [ After removal of roots or other debris turned up in the process of loosening, the entire surface of the embankment foundation area shall be compacted by [\_\_\_\_\_] complete coverages of the compaction equipment as specified for the appropriate type of fill.] Immediately prior to placement of compacted fill on or against the surfaces of any partial fill section, all soft or loose material, all material containing cracks or gullies, and all material that does not conform with the specified zoning of the embankment shall be removed. The remaining surface of the partial fill shall be loosened by scarifying, plowing, discing or harrowing to a minimum depth of [\_\_\_\_\_] [150] mm [\_\_\_\_\_] [6] inches, and the moisture content shall be adjusted as specified in paragraph MOISTURE CONTROL for the appropriate type of material. The surface of the partial fill section upon which fill is to be placed shall then be compacted as hereinafter specified for the appropriate type of fill. No separate payment will be made for loosening and rolling the foundation area, the abutment area, or the surfaces of partial fill sections, but the entire cost thereof shall be included in the applicable contract price for fill.

### 3.16.2 Rock Foundation

All rock surfaces upon which or against which embankment materials are to be placed shall be excavated (as described in paragraph EXCAVATION) or stripped (as described in paragraph CLEARING, GRUBBING AND STRIPPING). Prior to the placement of embankment material upon or against a rock surface, all open joints and cracks in that surface shall be filled with mortar to the depths cleaned. Those portions of such rock surfaces where, in the opinion of the Contracting Officer, the compaction of the embankment materials cannot be accomplished satisfactorily with power tampers or other specified compaction equipment, shall be filled with mortar or concrete as directed to the extent necessary to permit satisfactory use of the compaction equipment. In no case shall a thin coat of mortar be left on smooth, intact rock surfaces. Large rock overhangs and protrusions shall be removed and rock surfaces shall be laid back to a slope no steeper than 4V on 1H by the use of pre-splitting or line drilling techniques in such a manner as to minimize damage to the underlying rock, or the spaces beneath overhangs and around protrusions shall be filled with tamped concrete so that satisfactory compaction of embankment materials can be accomplished. Rock surfaces shall not be more than 0.67 m 2 feet in height, and benches of sufficient width shall be provided as necessary so that the average slope of any rock face is not steeper than [\_\_\_\_\_]V on [\_\_\_\_\_]H. Mortar

and concrete, including forming as necessary, shall conform with the applicable provisions of Section [03307 CONCRETE FOR MINOR STRUCTURES] [\_\_\_\_].

### 3.16.3 [Benching]

Benching into existing levee embankment and abutments is required in order to place and compact the material in horizontal layers. The vertical face cut into the existing embankment or abutment resulting from the benching operation shall be a minimum of [\_\_\_\_] mm inches in height but shall not exceed [\_\_\_\_] mm inches in height.]

### 3.16.4 [Preloading]

\*\*\*\*\*  
**NOTE: Insert applicable language for preloading as required. Identify the extent of the area over which preloading will be required by designating the stationing along the centerline of the levee. Indicate the length of time the preload will be left in place or define the settlement conditions which must occur before construction in the preloaded area can proceed. Address whether or not the preload embankment will become part of the permanent levee.**  
\*\*\*\*\*

Preloading of the levee foundation will be required between Station [\_\_\_\_] and Station [\_\_\_\_]. The preload embankment will be constructed to the cross section shown on the drawings for the applicable location. After completion of the construction of the preload embankment no additional construction shall take place in the preloaded areas [for [\_\_\_\_] days] [until the required settlement has occurred]].

### 3.16.5 [Settlement of Foundation]

\*\*\*\*\*  
**NOTE: Modify the following to the method of determining foundation settlement, which may be achieved by installing settlement gages or performing core borings**  
\*\*\*\*\*

The Contractor [shall] [may elect to] [furnish and install settlement gages] [perform core borings], at the settlement measurement locations shown on the plans, for determination of settlement of the foundation during construction within the settlement measurement ranges shown on the drawings. [ Each settlement measurement location shall be located on the prepared foundation at a point directly under the crown of the planned levee section prior to placing of fill material. The gages shall be maintained and extended, if necessary, during the construction. The type and arrangement of the gages shall be as shown on the drawings. The Contractor shall make such measurements and determine such elevations on the gages prior to the placing of fill material and again within [72] [\_\_\_\_] hours after final cross sections have been taken over the completed embankment at the locations of the gages.] [ The Contractor shall perform a cross section at the settlement measurement location prior to the placing of fill material to establish the elevation of the foundation/embankment interface. Within [72] [\_\_\_\_] hours after final cross sections have been taken over the completed embankment at the settlement measurement location

the contractor shall perform the core boring to determine foundation settlement.] Settlement measurements will be [verified] [subject to verification] by the Contracting Officer.]

### 3.17 [TEST FILL STRIPS]

\*\*\*\*\*

**NOTE:** Test strips are needed when the volume of the project is large, the compaction requirement will be obtained by specifying the type of compaction equipment and the number of passes on each lift (i.e. a method or procedure specification is being utilized) and there is not sufficient information on the compaction characteristics of the proposed fill materials and equipment to be used for the project. On projects where the levees are small (greater than 5 meters (15 feet) high) and on levee raising projects where fill placement zones are narrow (3.3 meters (10 feet), some of the larger compaction equipment specified herein (such as 50-ton rubber tired roller and some tamping rollers) are not appropriate. Consistently contractors propose using smaller equipment with shorter tamping feet. Test fills, therefore, may also be an appropriate means of evaluating performance and setting placement and compaction criteria to assure satisfactory result.

\*\*\*\*\*

#### 3.17.1 [General]

Before beginning embankment construction, the Contractor shall construct test strip(s) for [\_\_\_\_\_] fill materials to demonstrate that the equipment and compaction procedure will achieve the moisture-dry density relationship as specified. The test strips may be incorporated as part of the final embankment, if the fills meet the requirements of the specifications. The test strips shall be constructed using materials from the borrow sources which have been approved by the Contracting Officer. A test strip shall be performed for each of the following type of fill materials [\_\_\_\_\_] . Each test strip shall be of sufficient size to allow compaction equipment to achieve normal operating speed over a [\_\_\_\_\_] [17] meter [\_\_\_\_\_] [50] foot length. The test strip shall be a minimum of two (2) times wider than the compaction equipment. Each test strip shall be constructed with a minimum of 4 lifts. Prior to the construction of the test strips, the foundation (subgrade) shall be proof rolled as specified in paragraph [\_\_\_\_\_] and an 200 mm 8 inch thick subbase layer installed. The subbase layer shall consist of the same material to be used in the test strip and shall be spread and compacted to the same requirements. The test strips shall be constructed in accordance with the applicable provisions of paragraphs PLACEMENT, MOISTURE CONTROL, and COMPACTION for the specific material type.

The fill material shall be placed and spread in layers in accordance with the applicable provisions of paragraphs PLACEMENT for the specific material type. Each layer of the fill shall be compacted with a minimum of four (4) complete coverages using the specified compaction equipment, and as many additional coverages as may be required to achieve the specified density. Even if the results from the test strips show that the required densities can be obtained with less than four coverages by the compaction equipment, the Contractor shall still be required to compact the impervious and random fills with a minimum of (4) complete coverages. If the use of the proposed compaction equipment causes shearing of the fill, laminations in the fill,

or results in inadequate compaction, the Contracting Officer may direct that such roller be removed from the fill and that another appropriate tamping roller be used.]

### 3.17.2 [Testing and Reporting Requirements for Test Strips

Prior to construction of the test strips, the Contractor shall perform one laboratory compaction test for each type of material used in test strips. The compaction tests shall be performed in accordance with the requirements specified in paragraph MATERIALS TESTING. Test results shall be submitted to the Contracting Officer before construction of the test strips. After placement and spreading of the fill in the test strip, but prior to compaction, five samples shall be obtained from each lift for moisture content determination in accordance with ASTM D 2216. After compaction of the fill, a minimum of [\_\_\_\_\_] [5] in-place nuclear density and moisture content tests (in accordance with ASTM D 2922 and ASTM D 3017, respectively) and one (1) sand cone density test (in accordance with ASTM D 1556) shall be performed on each lift. One sample shall be obtained from each test strip for classification testing as specified in paragraph MATERIALS TESTING. All testing and sampling locations shall be determined by the Contracting Officer. The Contractor's QC personnel shall monitor and document construction and testing of the test strips. Documentation shall include weather conditions, soil type, spreading and compaction equipment type, lift thickness, number of coverages, moisture content, dry density, and a plan showing approximate location of sampling and testing. Documentation of the test strip construction procedures and results of all testing shall be provided to the Contracting Officer. Full scale embankment construction shall not commence until the equipment and placement methods are approved by the Contracting Officer.]

### 3.18 PLACEMENT AND SPREADING

#### 3.18.1 General

[Prior to beginning embankment placement on the levee foundation the Contractor shall notify the Government that the foundation is ready to receive fill.] [No fill shall be placed on any part of the embankment foundation until such areas have been inspected and given final approval by the Contracting Officer.]

##### 3.18.1.1 Gradation and Distribution

The gradation and distribution of materials throughout each zone of the levee shall be such that the embankment will be free from lenses, pockets, streaks, and layers of material differing substantially in texture or gradation from surrounding material of the same class. If lenses, pockets, or layers of materials differing substantially in texture or gradation from surrounding material occur in the spread material, the layer shall be mixed by harrowing or any other approved method to blend the materials. During the placing and spreading process, the Contractor shall maintain at all times a force of workers adequate to remove all roots, debris, and oversize stone from all embankment materials. All stones and rock fragments larger than [2/3 of the placement lift thickness measured by the greatest dimension] [75 mm 3 inches in any dimension] shall be removed [at the source prior to hauling to] [from] the fill. No fill shall be placed upon a frozen surface, nor shall snow, ice, or frozen earth be incorporated in the embankment.

#### 3.18.1.2 Foundations and Partial Embankment Fills

The foundations and all partial embankment receiving fills shall be kept thoroughly drained. Placing operations will be such as to avoid mixing of materials from adjacent sections as much as practicable.

#### 3.18.1.3 Equipment Traffic

Equipment traffic on any embankment zone shall be routed to distribute the compactive effort as much as practicable. Ruts formed in the surface of any layer of spread material will be filled before that material is compacted. If, in the opinion of the Contracting officer, the compacted surface of any layer of material is too smooth to bond properly with the succeeding layer, the surface shall be loosened by scarifying or other approved methods before material from the succeeding layer is placed.

#### 3.18.2 Placement on Surfaces Containing Frozen Materials

Embankment shall not be placed on a foundation which contains frozen material, [or which has been subjected to freeze-thaw action]. This prohibition encompasses all foundation types, including the natural ground, all prepared subgrades (whether in an excavation or on an embankment, and all layers of previously placed and compacted earth fill which become the foundations for successive layers of earth fill. All material that freezes or has been subjected to freeze-thaw action during the construction work, or during periods of temporary shutdowns, such as, but not limited to nights, holidays, weekends, or winter shutdowns of earthwork operations, shall be removed to a depth that is acceptable to the Contracting Officer and replaced with new material. Alternatively, the material shall be thawed, dried, reworked and recompact to the specified criteria before additional material is placed. The Contracting Officer will determine when placement of fill shall cease due to cold weather. The Contracting Officer may elect to use average daily air temperatures, and/or physical observation of the soils for the determination. Levee embankment material shall not contain frozen clumps of soil, snow or ice.

#### 3.18.3 Placement of Embankment and Backfill Against Rock

All rock surfaces upon which or against which embankment materials are to be placed shall be cleaned in accordance with Section 02330 EMBANKMENT FOR EARTH DAMS [and shall be prepared in accordance with paragraph PREPARATION OF FOUNDATION, PARTIAL FILL SURFACES AND ABUTMENTS, subparagraph ROCK]. In restricted areas where material can not be placed in large lifts with normal spreading and compaction equipment material shall be spread in lifts not exceeding [\_\_\_\_\_] mm inches and compacted with mechanical hand tampers, vibrating plates, or other approved methods and equipment.

#### 3.18.4 Placement of Embankment and Backfill Against Structures

No embankment or backfill shall be placed on or against concrete less than 7 days after placement or 70 percent of the design strength, without prior approval of the Contracting Officer. Crawler-type tractors, vibratory equipment and other similar compaction equipment shall not be used within [\_\_\_\_\_] [1] meter [\_\_\_\_\_] [4] feet of any completed or partially completed structure. Compaction within [\_\_\_\_\_] [1] meter [\_\_\_\_\_] [4] feet of completed or partially completed structures shall be accomplished by the use of mechanical hand tampers, vibrating plates, or other approved methods and equipment. The Contractor shall ensure that compaction operations do not damage any existing utilities. Any damage caused by the Contractor's



operation shall be repaired at the Contractor's expense.

### 3.18.5 Select Fill

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**NOTE:** If it is desired that the first layer of fill over the foundation be of a different thickness than subsequent layers, then the last bracketed sentence should be selected and the following should be substituted into the appropriate paragraphs below.  
[The materials for [\_\_\_\_\_] fill shall be placed or spread in layers, the first layer not more than [\_\_\_\_\_] [mm] [\_\_\_\_\_] inches in thickness and the succeeding layers not more than [\_\_\_\_\_] mm [\_\_\_\_\_] inches in thickness prior to compaction.]

\*\*\*\*\*

Select fill material shall be placed and spread in layers not more than 200 mm 8 inches in uncompacted thickness, except that within [\_\_\_\_\_] [1] m [\_\_\_\_\_] [4] feet of [\_\_\_\_\_] structures, the uncompacted layer thickness shall be reduced to [150] [\_\_\_\_\_] mm [6] [\_\_\_\_\_] inches. [Layers should be started full out to the slope stakes and shall be carried substantially horizontal and parallel to the levee centerline with sufficient crown or slope to provide satisfactory drainage during construction.] [The materials for [\_\_\_\_\_] fill shall be placed or spread in layers, the first layer not more than [\_\_\_\_\_] mm [\_\_\_\_\_] inches in thickness and the succeeding layers not more than [\_\_\_\_\_] mm [\_\_\_\_\_] inches in thickness prior to compaction.]

### 3.18.6 Coarse Drainage Gravel and Filter Sand

Coarse drainage gravel and filter sand shall be placed and spread in layers not more than [\_\_\_\_\_] [300] mm [\_\_\_\_\_] [12] inches in uncompacted thickness, except that within [\_\_\_\_\_] [1] m [\_\_\_\_\_] [4] feet of the [\_\_\_\_\_] structures, the uncompacted layer thickness shall be reduced to [\_\_\_\_\_] [150] mm [\_\_\_\_\_] [6] inches. The method of placement of all gravel and sand material shall be controlled to minimize segregation of particle sizes and contamination with other embankment materials.

### 3.18.7 Impervious Fill

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**NOTE:** If it is desired that the first layer of fill over the foundation be of a different thickness than subsequent layers, then the last bracketed sentence should be selected.

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The impervious fill material shall be placed and spread in layers not more than [\_\_\_\_\_] [200] mm [\_\_\_\_\_] [8] inches in uncompacted thickness, except that within [\_\_\_\_\_] [1] m [\_\_\_\_\_] [4] feet of [\_\_\_\_\_] structures, the uncompacted layer thickness shall be reduced to [\_\_\_\_\_] [100] mm [\_\_\_\_\_] [4] inches. [Layers should be started full out to the slope stakes and shall be carried substantially horizontal and parallel to the levee centerline with sufficient crown or slope to provide satisfactory drainage during construction.] [The materials for [\_\_\_\_\_] fill shall be placed or spread in layers, the first layer not more than [\_\_\_\_\_] mm [\_\_\_\_\_] inches in thickness and the succeeding layers not more than [\_\_\_\_\_] mm [\_\_\_\_\_] inches in thickness prior to compaction.]

### 3.18.8 Pervious Fill

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**NOTE: If it is desired that the first layer of fill over the foundation be of a different thickness than subsequent layers, then the last bracketed sentence should be selected.**

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The pervious fill material shall be placed and spread in layers not more than [\_\_\_\_\_] [200] mm [\_\_\_\_\_] [8] inches in uncompacted thickness, except that within [\_\_\_\_\_] [1] m [\_\_\_\_\_] [4] feet of [\_\_\_\_\_] structures, the uncompacted layer thickness shall be reduced to [\_\_\_\_\_] [150] mm [\_\_\_\_\_] [6] inches. [Layers should be started full out to the slope stakes and shall be carried substantially horizontal and parallel to the levee centerline with sufficient crown or slope to provide satisfactory drainage during construction.] [The materials for [\_\_\_\_\_] fill shall be placed or spread in layers, the first layer not more than [\_\_\_\_\_] mm [\_\_\_\_\_] inches in thickness and the succeeding layers not more than [\_\_\_\_\_] mm [\_\_\_\_\_] inches in thickness prior to compaction.]

### 3.18.9 Random Fill

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**NOTE: If it is desired that the first layer of fill over the foundation be of a different thickness than subsequent layers, then the last bracketed sentence should be selected.**

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Random fill material shall be placed and spread in layers not more than [\_\_\_\_\_] [200] mm [\_\_\_\_\_] [8] inches in uncompacted thickness, except that within [\_\_\_\_\_] [1] m [\_\_\_\_\_] [4] feet of [\_\_\_\_\_] structures, the uncompacted layer thickness shall be reduced to [\_\_\_\_\_] [150] mm [\_\_\_\_\_] [6] inches. [Layers should be started full out to the slope stakes and shall be carried substantially horizontal and parallel to the levee centerline with sufficient crown or slope to provide satisfactory drainage during construction.] [The materials for [\_\_\_\_\_] fill shall be placed or spread in layers, the first layer not more than [\_\_\_\_\_] mm inches in thickness and the succeeding layers not more than [\_\_\_\_\_] mm inches in thickness prior to compaction.]

### 3.18.10 [Random Rock

Random rock shall be placed within the limits indicated on the drawings in such a manner as to produce a reasonably well graded mass of stone with a minimum percentage of voids. The random rock shall be placed in layers that will will produce a compacted [\_\_\_\_\_] [600] mm [\_\_\_\_\_] [24] inch thick layer as shown on the drawings. [ Dewatering of the foundation beneath the random rock zone shall be sufficient to allow the random rock material to be placed and compacted as specified herein to produce a firm, dense surface upon which to place select earth fill.] The outside slope of the random rock zone shall be graded to produce a reasonably even surface, within a tolerance of plus or minus [\_\_\_\_\_] [300] mm [\_\_\_\_\_] [12] inches measured [vertical] [normal] to the slope from the lines indicated on the he drawings, upon which slope protection layers can be placed.]

### 3.18.11 [Fine Drainage Gravel Placed Around Structures

Fine drainage gravel placed for drainage around [\_\_\_\_\_] structures shall be placed in horizontal layers not exceeding [\_\_\_\_\_] mm [\_\_\_\_\_] inches in loose lift thickness, or within [\_\_\_\_\_] [1] m [\_\_\_\_\_] [4] feet when hand operated compactors are used. After placing, each layer shall be uniformly spread, moistened or aerated as necessary to obtain the specified moisture content, thoroughly mixed and compacted as specified. Backfilling shall not begin until construction below finish grade has been approved, forms removed, and the excavation cleaned of trash and debris. Power driven hand operated compactors shall be used along the closure structure for compaction within [\_\_\_\_\_] [0.7] m [\_\_\_\_\_] [2] feet of concrete structures. Backfill shall not be placed against concrete prior to 7 days after placement. As far as practicable, backfill shall be brought up evenly on each side of the structure and sloped to drain away from the structure.]

### 3.18.12 [Semicompacted Fill

\*\*\*\*\*  
**NOTE: If it is desired that the first layer of fill over the foundation be of a different thickness than subsequent layers, then the last bracketed sentence should be selected.**  
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The location and extent of the semicompacted fill shall be as shown on the drawings. Semicompacted fill shall not be placed in water. Semicompacted fill material shall be placed and spread in layers not more than [\_\_\_\_\_] [300] mm [\_\_\_\_\_] [12] inches in uncompacted thickness, [except that within [\_\_\_\_\_] [1] m [\_\_\_\_\_] [4] feet of [\_\_\_\_\_] structures, the uncompacted layer thickness shall be reduced to [\_\_\_\_\_] [150] mm [\_\_\_\_\_] [6] inches]. [ Layers shall be started full out to the slope stakes and shall be carried substantially horizontal and parallel to the levee centerline with sufficient crown or slope to provide satisfactory drainage during construction.] [ The materials for [\_\_\_\_\_] fill shall be placed or spread in layers, the first layer not more than [\_\_\_\_\_] mm [\_\_\_\_\_] inches in thickness and the succeeding layers not more than [\_\_\_\_\_] mm [\_\_\_\_\_] inches in thickness prior to compaction.]]

### 3.18.13 [Uncompacted Fill

\*\*\*\*\*  
**NOTE: If it is desired that the first layer of fill over the foundation be of a different thickness than subsequent layers, then the second bracketed sentence should be selected.**  
\*\*\*\*\*

Uncompacted fill shall be placed in approximately horizontal layers not exceeding [\_\_\_\_\_] mm [\_\_\_\_\_] inches in thickness. The layers shall be uniformly spread, distributed, and otherwise manipulated during placement to such an extent that individual loads of material deposited on the fill will not remain intact, and large, open voids in the fill will be eliminated. Lifts shall not be placed in a manner which causes shrinkage cracks and open voids from developing in previously placed lifts. [ Layers shall be started full out to the slope stakes and shall be carried in lifts approximately horizontal and parallel to the centerline with sufficient crown or slope to provide satisfactory drainage during construction.] [ The materials for [\_\_\_\_\_] fill shall be placed or spread in layers, the first

layer not more than [\_\_\_\_\_] mm [\_\_\_\_\_] inches in thickness and the succeeding layers not more than [\_\_\_\_\_] mm [\_\_\_\_\_] inches in thickness prior to compaction.][ Compaction other than that obtained by the controlled movement of the hauling and spreading equipment over the area will not be required.][ Where material must be placed in water, it shall be dumped therein until it reaches an elevation [\_\_\_\_\_] mm [\_\_\_\_\_] foot above the water surface, or until a stable fill surface is obtained before layer construction will be required. The material deposited under water shall be placed in such a manner to ensure that any soft material will be forced progressively outward from the section and not be trapped within the base of the embankment.][ Material containing more than [\_\_\_\_\_] [15] percent fines passing the No. 200 sieve shall not be placed below the water surface.]]

#### 3.18.14 Hydraulic Fill

##### 3.18.14.1 Discharge Pipe

At all times when the dredge discharge pipe is being washed out or when the discharge consists of a high percentage of water with only a minimum amount of solid material being pumped, all control plates at the bottom openings along the spill-pipe sections of the discharge pipe lines shall be closed immediately and shall remain in a closed position until the pumping operation produces a minimum of [10] [\_\_\_\_\_] percent solid materials in the discharge.

##### 3.18.14.2 Discharge Pipe Outlets

During placement operations of the fill, free outlets to conduct discharge water away from the embankment shall be provided at intervals of not more than [610] [\_\_\_\_\_] m [2,000] [\_\_\_\_\_] feet, for 300-mm 12-inch dredges or smaller; [915] [\_\_\_\_\_] m [3,000] [\_\_\_\_\_] feet, for 325 to 400 mm 13- to 16-inch dredges; and [1219] [\_\_\_\_\_] m [4,000] [\_\_\_\_\_] feet, for dredges over 400 mm 16 inches. The size of dredges are determined by the minimum inside diameter of the discharge pipe. No obstruction to free flow will be permitted in these outlets or at any point in the fill area, between the end of the discharge pipe and the outlet. A retaining dike, transverse to the fill area center line, shall be constructed immediately beyond each outlet and shall not be breached until the end of the discharge pipe has approached the retaining dike to within 76 m 250 feet, in the case of 300 mm 12-inch dredges or smaller; 114 m 375 feet, in case of 325 to 400 mm 13- to 16-inch dredges; or 152 m 500 feet, in the case of dredges over 400 mm 16 inches.

##### 3.18.14.3 Control of Materials in Hydraulic Construction

In general, the materials in the fill shall be distributed in such a way as to produce a section of relatively uniform permeability. In order to maintain uniform permeability of the fill, the Contractor shall not place strata and large pockets of gravel, not containing sufficient fines. Whenever they occur they shall be promptly blended with finer materials. The Contractor shall take necessary precautions to prevent damage from discharge water or other causes.

##### 3.18.14.4 Rehandling Hydraulic Material

Rehandling of hydraulic material to bring the fill area to required grade and cross section shall conform to paragraph [\_\_\_\_\_]. If, in the opinion of the Contracting Officer, the rehandled material is too dry to permit its

placement by compacted fill method, then the soil placement shall conform to paragraph [\_\_\_\_].

### 3.19 MOISTURE CONTROL

#### 3.19.1 General

The materials in each layer of the fill shall contain the amount of moisture, within the limits specified below or as directed by the Contracting Officer, necessary to obtain the required compaction. Material that is not within the specified moisture content limits after compaction shall be reworked to obtain the specified moisture content, regardless of density.

##### 3.19.1.1 Insufficient Moisture for Suitable Bond

If the top or contact surfaces of a partial fill section become too dry to permit suitable bond between these surfaces and the additional fill to be placed thereon, the Contractor shall loosen the dried materials by scarifying or discing to such depths as may be directed by the Contracting Officer, shall dampen the loosened material to an acceptable moisture content, and shall compact this layer in accordance with the applicable requirements of paragraph COMPACTION.

##### 3.19.1.2 Excessive Moisture for Suitable Bond

If the top or contact surfaces of a partial fill section become too wet to permit suitable bond between these surfaces and the additional fill to be placed thereon, the wet material shall be scarified and permitted to dry, assisted by discing or harrowing, if necessary, to such depths as may be directed by the contracting officer. The material shall be dried to an acceptable moisture content, and shall be compacted in accordance with the applicable requirements of paragraph COMPACTION.

##### 3.19.1.3 Drying Wet Material

Material that is too wet shall [be spread on the embankment and permitted to dry,] [be dried in the borrow area prior to bringing to the levee embankment] be assisted by discing or harrowing, if necessary, until the moisture content is reduced to an amount within the specified limits.

##### 3.19.1.4 Increasing Moisture in Dry Material

The moisture content of material that is too dry, [will be adjusted on the levee embankment] [will be adjusted in the borrow area prior to bringing to the levee embankment]. The Contractor will add water to the fill material and by harrowing, or other approved methods, work the moisture into the material until a uniform distribution of moisture within the specified limits is obtained. Water applied on a layer of fill on the levee embankment shall be accurately controlled in amount so that free water will not appear on the surface during or subsequent to rolling. Should too much water be added to any part of the embankment, the rolling on that section of the embankment shall be delayed until the moisture content of the materials is reduced to an amount within the specified limits. If it is impracticable to obtain the specified moisture content by wetting or drying the material on the fill, the Contractor may be required to pre-wet or dry back the material at the source of excavation or in the borrow area.

### 3.19.2 Select Fill

The moisture content after compaction shall be within the limits of [\_\_\_\_\_] percentage points above optimum to [\_\_\_\_\_] percentage point below optimum moisture content as determined by ASTM D 698.

### 3.19.3 Impervious Fill

The moisture content after compaction shall be within the limits of [2] [\_\_\_\_\_] percentage points above optimum to [2] [\_\_\_\_\_] percentage point below optimum moisture content as determined by ASTM D 698.

### 3.19.4 Pervious Fill

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**NOTE: Saturation of the pervious fill may not be appropriate if the fill is placed in a zone or area (trenches, etc.) which can not readily drain.**  
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Each layer of material shall be placed, worked, and compacted in a saturated condition.

### 3.19.5 Random Fill

\*\*\*\*\*  
**NOTE: The moisture control of random earth shall be conformed to the requirements of the material type it most closely approximates in behavior.**  
\*\*\*\*\*

[The moisture content after compaction shall be within the limits of [\_\_\_\_\_] percentage points above optimum to [\_\_\_\_\_] percentage point below optimum moisture content as determined by ASTM D 698.] [The moisture content shall be that which will facilitate obtaining the specified compaction.]

### 3.19.6 Coarse Drainage Gravel and Filter Sand

The moisture content shall be controlled such that hauling, spreading, and compacting equipment can operate with normal procedure without excessive rutting of the fill. If the material is too wet or too dry to facilitate proper compaction, the coarse drainage gravel or filter sand shall be wetted or dried as required by the procedures specified in paragraph [\_\_\_\_\_].

### 3.19.7 Fine Drainage Gravel

Fine drainage gravel shall be placed, worked, and compacted in a saturated condition. The moisture content after compaction shall be as uniform as practicable throughout any one layer of fine drainage gravel.

### 3.19.8 Semicompacted Fill

[Semicompacted fill shall be placed within plus or minus [\_\_\_\_\_] percent of optimum moisture content.] [Semicompacted fill will be placed at their in situ moisture content.] [The moisture content of semicompacted fill shall be controlled such that hauling, spreading, and compacting equipment can operate with normal procedure without excessive rutting of the fill.] [The

moisture content shall be that which will facilitate obtaining the specified compaction.]

#### 3.19.9 Uncompacted Fill

Uncompacted fill will be placed at their in situ water content.[ The moisture content shall be controlled such that hauling, spreading, and compacting equipment can operate with normal procedure without excessive rutting of the fill.]

#### 3.19.10 Hydraulic Fill

No moisture control is required for Hydraulic Fill.

### 3.20 COMPACTION

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NOTE: The designer should edit the following paragraphs to account for the use of either an end product specification (i.e., the Contractor is required to obtain a specified degree of compaction) or a method specification (i.e., when the Contractor is required to compact the embankment by a specified number of coverages of a specified/approved roller and is not responsible for the obtained degree of compaction). If the method specification is used and the required degree of compaction is not achieved, the contractor should be paid for additional rolling for compaction under a separate bid item as specified in paragraph ADDITIONAL ROLLING FOR COMPACTION.

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#### 3.20.1 Compaction Equipment

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NOTE: With reference to the use of compaction equipment in this paragraph, the following precautions should be noted:

1. Specifications should be written to insure that the type of compaction equipment will be used which, is best suited to obtain the desired compaction of the material being utilized. When the size of the contract can justify the costs a requirement should be included in the specifications for the performance evaluation of each type of compaction equipment conforming with the specifications and intended for use by the Contractor at an early stage of embankment construction. This equipment evaluation should be accomplished through analysis of test fill areas that are carefully constructed under representative working conditions with materials and moisture contents as specified. Test fill areas may either be separate or part of the permanent work, and for clarity to prospective bidders, payment under a separate item is recommended to equitably cover costs of required variations in equipment coverages, possible changes

in equipment loading or foot sizes, as well as intensified field soils testing.

2. For tamping rollers that are either towed or self-propelled, with drums capable of being ballasted with fluid, the provision for a pressure relief valve and safety head is optional, and should be included at the discretion of the designer based on local experience and practice. Over-pressurization of fluid ballasted compaction drums to the level of a safety hazard has been rare, but has occurred on several occasions at locations of high elevation and temperature.

3. In compacting materials consisting of shales, sandstones, weathered rock and similar random materials, consideration should be given to specifying sheepfoot-type tamping equipment that has been modified by replacing the standard feet with "chisel" point tamper feet generally referred to as "shale breakers". The end areas of these modified tamper feet range from 650 to 1000 square mm (1 to 1-1/2 square inches) and tend to break up weathered rock to prevent the bridging effect sometimes created by large rock particles.

4. For compaction of sand and gravel fills or filter and drainage layers, equipment characteristics for both a large and small vibratory roller have been provided for optional selection by the designer, depending upon location, selected lift thickness, gradation, grain shape, and durability properties of the materials. The smaller roller, which utilizes an upper limit of 40 kN/m (9000 lbs. per foot) of drum length applied force, should be specified for materials which exhibit degradation under compaction. Other options, based on construction experience may also be exercised. For example, it has been found that improved trafficability can often be achieved when compacting clean, fine grained, uniform sands by specifying a drum driven self-propelled vibratory roller.

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Compaction equipment shall conform to the following requirements and shall be used as prescribed in subsequent paragraphs.

#### 3.20.1.1 Tamping Rollers

Tamping rollers shall be as follows:

a. Towed -Tamping rollers shall consist of a heavy duty double drum unit, with a drum diameter not less than 1.5 m 60 inches, and an individual drum length of not less than 1.5 m 60 inches. The drums shall be capable of being ballasted with water or a combination of sand and water. Each drum shall have staggered feet uniformly spaced over the cylindrical surface such as to provide approximately three tamping feet for each 0.19 square meter 2 square feet of drum surface. The tamping feet shall be 175 to 225 mm 7 to 9 inches in clear projection



from the cylindrical surface of the roller and shall have a face area of not less than 3226 square mm 5 square inches nor more than 4516 square mm 7 square inches. The roller shall be equipped with cleaning fingers, so designed and attached as to prevent the accumulation of material between the tamping feet, and these cleaning fingers shall be maintained at their full length throughout the periods of use of the roller. The weight of the roller shall not be less than 5200 kg/m 3500 psf of linear drum length weighted, and shall not be more than 2975 kg/m 2000 psf of drum length empty. The two drums comprising one roller unit shall be yoked such that they will oscillate when traversing uneven surfaces. The design and operation of the tamping roller shall be subject to the approval of the Contracting Officer who shall have the right at any time during the prosecution of the work to direct such repairs to the tamping feet, minor alterations in the roller and variations in the weight as may be found necessary to secure optimum compaction of the earth fill materials. The Contractor may be required to add ballast to the roller to the maximum capacity specified by the manufacturer of the roller. The roller shall be drawn by a crawler-type or a rubber-tired tractor at a speed not to exceed 5.6 km 3.5 miles per hour. The use of the rubber-tired tractor shall be discontinued if the tires leave ruts that prevent uniform compaction by the tamping roller. If tamping rollers are used in tandem, not more than two rollers in tandem will be permitted and in such case, one trip of the tandem rollers over any surface will be considered as two passes. When tamping rollers are used in tandem, the tamper foot spacing shall be offset so that the circumferential rows on the rear drums are in line with the mid-point of the circumferential rows on the forward drums.

b. Self-propelled - [Conditioned upon satisfactory performance, self-propelled tamping rollers may be used in lieu of tractor-drawn tamping rollers. Self-propelled rollers exceeding the empty weight requirement may be used provided that by the substitution of tamping feet, having a face area not exceeding [\_\_\_\_\_] [9030 square mm 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. The tamping feet shall be 175 to 225 mm 7 to 9 inches in clear projection from the cylindrical surface of the roller. For self-propelled rollers, in which steering is accomplished through use of rubber-tired wheels, the tire pressure shall not exceed [\_\_\_\_\_] [276 kPa 40 psi]. Self-propelled rollers shall be operated at a speed not to exceed 5.6 km 3.5 miles per hour.] [Self-propelled tamping rollers may be used in lieu of tractor drawn tamping rollers provided the foot pressure on the tamping feet of the self-propelled roller are approximately the same as the foot pressure on the towed roller. For self-propelled rollers steered with rubber-tired wheels, the tire pressure shall not exceed [\_\_\_\_\_] [276 kPa 40 psi]. Self-propelled rollers shall be operated at speeds not exceeding 5.6 km 3.5 miles per hour. The Contracting Officer has the authority to limit or eliminate the use of self-propelled rollers if they are found to cause shearing or laminations of the compacted fill.]

#### 3.20.1.2 Vibratory Rollers

Vibratory rollers for compacting rock fills, pervious sand and gravel fills, or filter and transition drainage layers shall be equipped with a smooth steel compaction drum and shall be operated at a frequency of vibration during compaction operations between 1100 and 1500 vpm.

Vibratory rollers may be either towed or self-propelled and shall have an unsprung drum weight that is a minimum of 60 percent of the rollers' static weight. Towed rollers shall have at least 90 percent of their weight transmitted to the ground through the compaction drum when the roller is standing in a level position hitched to the towing vehicle. Rollers for compacting rockfill, [sand and gravel fills, or filter and drainage layers] shall have a minimum static weight of 90 kN 20,000 pounds, a minimum dynamic force of 180 kN 40,000 pounds when operating at 1400 vpm, and an applied force not less than 130 kN/m 9,000 pounds per foot of compaction drum length. [ Rollers for compacting sand and gravel fills or filter and drainage layers shall have a minimum static weight of 36 kN 8,000 pounds, a minimum dynamic force of 71kN 16,000 pounds when operating at 1400 vpm, and an applied force not less than 22 kN 5,000 pounds nor greater than 130 kN/m 9,000 pounds per foot of compaction drum length.] The level of amplitude and vibration frequency during compaction will be maintained uniform throughout the embankment zone within which it is operating. Rollers shall be operated at speeds not to exceed 2.4 km/h 1.5 mph. The equipment manufacturer shall furnish sufficient data, drawings, and computation for verification of the above specifications, and the character and efficiency of this equipment shall be subject to approval.

#### 3.20.1.3 Rubber-tired Rollers

Rubber-tired rollers shall have a minimum of four wheels equipped with pneumatic tires. The tires shall be of such size and ply as to be capable of being operated at tire pressures between 550 and 690 kPa 80 and 100 psi at an 11,340 kg 25,000 pound wheel load. The roller wheels shall be located abreast and so designed that each wheel will carry approximately equal load in traversing uneven ground. The spacing of the wheels shall be such that the distance between the nearest edges of adjacent tires will not be greater than 50 percent of the rated tire width of a single tire at the operating pressure for an 11,340 kg 25,000 pound wheel load. The roller shall be provided with a body suitable for ballast loading such that the load per wheel may be varied, as directed by the Contracting Officer, from 8,165 to 11,340 kg 18,000 to 25,000 pounds. The roller shall be towed at a speed not to exceed 8 km 5 miles per hour. The character and efficiency of this equipment shall be subject to the approval of the Contracting Officer.

#### 3.20.1.4 Hand Operated Compactors

Compaction of material, in areas where it is impracticable to use a roller or tractor compaction shall be performed by the use of approved hand operated power compactors.

a. Power Tampers: Power tampers shall be hand operated equipment capable of compacting material in confined areas. The compactors shall be either an internal combustion or pneumatic activated tamper. Tampers shall have sufficient weight and striking power to produce the specified compaction. The character and efficiency of this equipment shall be subject to the approval of the Contracting Officer.

b. Vibratory Plate Compactor: Vibratory compactors operated by hand in confined areas shall utilize the oscillating cam principal and shall deliver an impact of not less than 9 kN 2000 lbf at a rate of approximately 2000 impulses per minute. The character and efficiency of this equipment shall be subject to the approval of the Contracting Officer.

### 3.20.1.5 Crawler-type Tractors

Crawler-type tractors used for spreading or compaction shall weigh not less than [\_\_\_\_\_] [9,070] kg [\_\_\_\_\_] [20,000] pounds, shall exert a unit tread pressure of not less than [\_\_\_\_\_] [41.4] kPa [\_\_\_\_\_] [6] psi, and shall be operated at a speed not to exceed [\_\_\_\_\_] [5.6] km [\_\_\_\_\_] [3.5] miles per hour.

### 3.20.1.6 Sprinkling Equipment

Sprinkling equipment shall consist of tank trucks, pressure distributors or other equipment designed to apply water uniformly and in controlled quantities to variable width of surface.

### 3.20.1.7 Miscellaneous Equipment

Scarifiers, disks, spring-tooth or spike-tooth harrows, spreaders, and other equipment shall be suitable for use in embankment construction and approved by the Contracting Officer. Equipment used for blending fill material shall be capable of penetrating the full loose lift thickness of the specific material type.

### 3.20.2 Compaction of Select Fill

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NOTE: Experience indicates that by the time the surface lift has been laid down, sufficient compactive effort has occurred due to hauling and spreading equipment such that one, two, or even three passes of a heavy disk plow is not sufficient for penetrating the full depth of lift. A harrow equipped with closely spaced spikes (teeth) has been found to effectively penetrate the semi-compacted surface lift in one pass, but this type of device has minimal ability to blend and mix the fill material. It was found that a suitably designed spiked-tooth harrow working in combination with a heavy disk plow can reliably produce the desired result. This note applies to all types of fill placement for which moisture and blending are required.

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After a layer of material has been dumped and spread, it shall be harrowed to break up and blend the fill materials and to obtain uniform moisture distribution. Harrowing shall be performed with a heavy disk plow, or other approved harrow, to the full depth of the layer. If one pass of the harrow does not accomplish the breaking up and blending of the materials, additional passes of the harrow shall be required, but in no case will more than [\_\_\_\_\_] [three] passes of the harrow on any one layer be required for this purpose. When the moisture content and the condition of the layer are satisfactory, the lift shall be compacted [to a minimum of [95] [\_\_\_\_\_] percent of the maximum dry density as determined by the Contractor in accordance with ASTM D 698] [with not less than [six] [\_\_\_\_\_] complete coverages of an approved tamping roller or [four] [\_\_\_\_\_] complete coverages of an approved 45 metric ton 50-ton rubber-tired roller traversing in a direction parallel to the axis of the levee]. In areas which are not accessible by roller, the fill shall be placed in layers not more than 100 mm 4 inches in uncompacted depth and compacted with an

approved hand operated compactor to a density equal to that obtained in other areas which are accessible to rollers. Dumping, spreading, sprinkling, and compacting may be performed at the same time at different points along a section when there is sufficient area to permit these operations to proceed simultaneously. Compaction equipment shall be operated such that the strip being traversed by the roller shall overlap the rolled adjacent strip by not less than [\_\_\_\_\_] [1] m [\_\_\_\_\_] [3] feet.

### 3.20.3 Compaction of Random Fill

\*\*\*\*\*  
**NOTE: Random fill shall be compacted in accordance  
with the requirements of the material type it most  
closely approximates in behavior.**  
\*\*\*\*\*

After a layer of material has been dumped and spread, it shall be harrowed to break up and blend the fill materials and to obtain uniform moisture distribution. Harrowing shall be performed with a heavy disk plow, or other approved harrow, to the full depth of the layer. If one pass of the harrow does not accomplish the breaking up and blending of the materials, additional passes of the harrow shall be required, but in no case will more than [\_\_\_\_\_] [three] passes of the harrow on any one layer be required for this purpose. When the moisture content and the condition of the layer are satisfactory, the lift shall be compacted [to a minimum of [95] [\_\_\_\_\_] percent of the maximum dry density as determined by the Contractor in accordance with ASTM D 698] [with not less than [six] [\_\_\_\_\_] complete coverages of an approved tamping roller or [four] [\_\_\_\_\_] complete coverages of an approved 45 metric ton 50-ton rubber-tired roller traversing in a direction parallel to the axis of the levee]. In areas which are not accessible by roller, the fill shall be placed in layers not more than 100 mm 4 inches in uncompacted depth and compacted with an approved hand operated compactor to a density equal to that obtained in other areas which are accessible to rollers. Dumping, spreading, sprinkling, and compacting may be performed at the same time at different points along a section when there is sufficient area to permit these operations to proceed simultaneously. Compaction equipment shall be operated such that the strip being traversed by the roller shall overlap the rolled adjacent strip by not less than [\_\_\_\_\_] [1] m [\_\_\_\_\_] [3] feet.

### 3.20.4 Compaction of Impervious Fill

After a layer of material has been dumped and spread, it shall be harrowed to break up and blend the fill materials and to obtain uniform moisture distribution. Harrowing shall be performed with a heavy disk plow, or other approved harrow, to the full depth of the layer. If one pass of the harrow does not accomplish the breaking up and blending of the materials, additional passes of the harrow shall be required, but in no case will more than [\_\_\_\_\_] [three] passes of the harrow on any one layer be required for this purpose. When the moisture content and the condition of the layer are satisfactory, the lift shall be compacted with not less than [six] [\_\_\_\_\_] complete coverages of an approved tamping roller traversing in a direction parallel to the axis of the levee. If the desired compaction to a minimum of [95] [\_\_\_\_\_] percent of the maximum dry density as determined by the Contractor in accordance with ASTM D 698 is not achieved, additional rolling will be required. In areas which are not accessible by roller, the fill shall be placed in layers not more than 4 inches in uncompacted depth and compacted with an approved hand operated compactor to a density equal to that obtained in other areas which are accessible to rollers. Dumping,

spreading, sprinkling, and compacting may be performed at the same time at different points along a section when there is sufficient area to permit these operations to proceed simultaneously. Compaction equipment shall be operated such that the strip being traversed by the roller shall overlap the rolled adjacent strip by not less than [\_\_\_\_\_] [1] meter [\_\_\_\_\_] [3] feet.

#### 3.20.5 Compaction of Pervious Fill

After a layer of material has been dumped and spread it shall be harrowed as required to break up and blend the fill materials and to obtain uniform moisture distribution. Harrowing shall be performed with a heavy disk plow, or other approved harrow, to the full depth of the layer. If one pass of the harrow does not accomplish the breaking up and blending of the materials, additional passes of the harrow shall be required, but in no case will more than [\_\_\_\_\_] [three] passes of the harrow on any one layer be required for this purpose. When the moisture content and the condition of the layer are satisfactory, the lift shall be compacted to a [minimum [80] [\_\_\_\_\_] percent relative density in accordance with ASTM D 4253 and ASTM D 4254] [with not less than [six] [\_\_\_\_\_] complete coverages of an approved vibratory roller]. In areas which are not accessible by roller, the fill shall be placed in layers not more than 100 mm 4 inches in uncompacted depth and compacted with an approved hand operated compactor to a density equal to that obtained in other areas which are accessible to rollers. Dumping, spreading, sprinkling, and compacting may be performed at the same time at different points along a section when there is sufficient area to permit these operations to proceed simultaneously. Compaction equipment shall be operated such that the strip being traversed by the roller shall overlap the rolled adjacent strip by not less than [\_\_\_\_\_] [1] m [\_\_\_\_\_] [3] feet.

#### 3.20.6 [Compaction of Random Rock]

After the random rock has been placed and spread to the thickness specified herein, and oversized rock has been removed or broken down, compaction shall be accomplished by not less than [\_\_\_\_\_] [3-6] complete coverages of the specified [crawler tractor] [vibratory roller]. [ Each coverage of the tractor shall consist of sufficient trips to provide complete coverage of the area by the treads of the tractor. The tractor coverages specified shall be in addition to spreading operations.] [ The vibratory roller shall be operated such that the strip being traversed by the roller shall overlap the rolled adjacent strip by not less than [\_\_\_\_\_] [1] m [\_\_\_\_\_] [3] feet.]

#### 3.20.7 Compaction of Semicompacted Fill

[After a layer of material has been dumped and spread it shall be harrowed as required to break up and blend the fill materials and to obtain uniform moisture distribution. Harrowing shall be performed with a heavy disk plow, or other approved harrow, to the full depth of the layer. If one pass of the harrow does not accomplish the breaking up and blending of the materials, additional passes of the harrow shall be required, but in no case will more than [\_\_\_\_\_] [three] passes of the harrow on any one layer be required for this purpose.] [ When the moisture content and the condition of the layer are satisfactory, the lift shall be compacted by not less than [four] [\_\_\_\_\_] complete coverages of a tamper-type roller, or by not less than [three] [\_\_\_\_\_] complete coverages of a crawler-type tractor, or by not less than [two] [\_\_\_\_\_] complete coverages of a rubber-tired roller, all conforming to the requirements of paragraph EQUIPMENT.] [In areas which are not accessible by roller, the fill shall be placed in layers not more than 100 mm 4 inches in uncompacted depth and compacted

with an approved hand operated compactor to a density equal to that obtained in other areas which are accessible to rollers.] [After preparation of the previous compacted layer to receive the new layer of fill the new layer shall be compacted by the controlled movement of the hauling equipment over the area of the fill.] Equipment shall be routed so as to prevent excessive rutting of the fill surface. Dumping, spreading, sprinkling, and compacting may be performed at the same time at different points along a section when there is sufficient area to permit these operations to proceed simultaneously.

#### 3.20.8 Compaction of Uncompacted Fill

No compaction other than that obtained by the controlled movement of the hauling equipment over the area of the fill is required. Equipment shall be routed so as to prevent excessive rutting of the fill surface.

#### 3.20.9 Compaction of Hydraulic Fill

Hydraulic fill shall be compacted as uncompacted fill. If the rehandled hydraulic fill is too dry to permit its placement by uncompacted full method, then the fill material shall be compacted using the method specified in paragraph [\_\_\_\_\_] [COMPACTION OF SEMICOMPACTED FILL].

#### 3.20.10 [Compaction of Random Fill Within the MSE Walls

Random earth fill within the limits of the Mechanically Stabilized Earth (MSE) walls shall be placed and compacted in accordance with [the vendor's requirements, subject to the approval of the Contracting Officer] [requirements specified in Section [\_\_\_\_\_] ].]

#### 3.20.11 Compaction of Coarse Drainage Gravel and Filter Sand

Coarse drainage gravel placed in the drains shall be placed in maximum [\_\_\_\_\_] [300] mm [\_\_\_\_\_] [12] inch loose lifts and compacted by not less than four (4) complete coverages with a [static] [vibratory] roller. Each lift of gravel within confined spaces which is not accessible to rollers shall be compacted by at least [\_\_\_\_\_] [3] complete coverages with a vibratory plate compactor [and as many additional coverages as necessary to achieve the same density obtained with full-size compaction equipment]. Filter sand placed along the existing rock fill shall be compacted in accordance with the requirements for the adjacent select earth fill material.

#### 3.20.12 Compaction of Fine Drainage Gravel

Fine drainage gravel placed in the drains shall be placed in maximum [\_\_\_\_\_] [300] mm [\_\_\_\_\_] [12] inch loose lifts and compacted by not less than four (4) complete coverages with a [static] [vibratory] roller. Each lift of gravel within confined spaces which is not accessible to rollers shall be compacted by at least three [\_\_\_\_\_] [3] complete coverages with a vibratory plate compactor [and as many additional coverages as necessary to achieve the same density obtained with full-size compaction equipment].

#### 3.20.13 Compaction Adjacent to Structures and Utilities

Heavy equipment for spreading and compacting fill shall not be operated within [\_\_\_\_\_] [1] m [\_\_\_\_\_] [4] feet of structures or utilities, except as otherwise specified herein. Material within [\_\_\_\_\_] [1] m [\_\_\_\_\_] [4] feet shall be compacted using appropriate hand operated compactors specified

herein.

#### 3.20.14 [Additional Rolling for Compaction

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NOTE: Use the following paragraph only when a method specification is utilized. A bid item for "Additional Rolling for Compaction" should be included in the bid form so that payment can be made. Measurement and payment information should also be added to paragraph [UNIT] [LUMP SUM] PRICES or Section 01270A MEASUREMENT AND PAYMENT as applicable.

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If the Contracting Officer determines that the desired compaction of any portion of the embankment is not achieved by the number of coverages specified, additional complete coverages shall be made over the surface area as directed by the Contracting Officer. Payment for additional rolling directed by the Contracting officer shall be made in accordance with Bid Item No. [\_\_\_\_\_] ADDITIONAL ROLLING FOR COMPACTION; however, no payment will be made for additional rolling not specifically directed by the Contracting Officer.]

#### 3.20.15 [Topsoil

Topsoil shall be placed on the embankment surfaces as shown on the contract drawings and as specified in SECTION [02922 SODDING] [\_\_\_\_\_] ].

#### 3.21 FIELD QUALITY CONTROL

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NOTE: FAR Part 46.312 establishes a requirement for Contractor Quality Control (CQC) in construction contracts and ER 1180-1-6 requires that a CQC section based on UFGS-01451A CONTRACTOR QUALITY CONTROL be included in contracts of \$1,000,000 or more. Use of UFGS-01451A for contracts of less than \$1,000,000 is discretionary. This part of the specifications must be consistent with the CQC section.

Use caution when applying nuclear gages for in-place density measurement of cohesive and cohesionless soils. Soils consisting of mica, halloysite, some other chemical composition, or oversize rocks and large voids would affect the measurement accuracy of wet density. The chemical composition and "non-free" water of the sample may also dramatically (sometimes over 10 percent) affect the measurement of moisture content (see the paragraph entitled "Interferences" in ASTM D2922 and D3017. Also see paragraph 5-10.d.(2).(b). entitled "Nuclear Method" in EM 1110-2-1911). When water content can not be accurately measured using nuclear method, a computer controlled microwave oven system for water content measurement combined with nuclear method for wet density has been successfully used by some districts. Sand Cone or similar field density tests

should be performed periodically at the same  
location as Nuclear Tests to assure nuclear testing  
is providing accurate information.

\*\*\*\*\*

### 3.21.1 Clearing, Grubbing, and Stripping

The Contractor shall establish and maintain quality control for clearing, grubbing, and stripping operations to assure compliance with contract requirements, and maintain records of the quality control for all construction operations including but not limited to the items indicated below. These records, as well as the records of corrective actions taken, shall be furnished to the Government in accordance with Section 01451A CONTRACTOR QUALITY CONTROL.

#### 3.21.1.1 Clearing

Station to station limits, transverse clearing limits from applicable centerline; percentage of area complete; types of materials cleared.

#### 3.21.1.2 Grubbing

Station to station limits, transverse grubbing limits from applicable centerline; percentage of area complete; type of material; filling of grubbed holes.

#### 3.21.1.3 Stripping

Station to station limits, transverse stripping limits from applicable centerline; percentage of area complete; type of material; depth of stripping.

### 3.21.2 Excavation

The Contractor shall establish and maintain quality control for excavation operations to assure compliance with contract requirements, and maintain records of the Contractor's quality control for all construction operations including but not limited to the following:

- a. Lines, grades and tolerances,
- b. Segregation of materials,
- c. Disposal and/or stockpiling of materials,
- d. Unsatisfactory materials,
- e. Conditions that may induce seepage or weaken the foundation or embankment,
- f. Stability of excavations.

Records of inspections and tests, as well as the records of corrective actions taken, shall be furnished to the Government in accordance with Section 01451A CONTRACTOR QUALITY CONTROL.



### 3.21.3 Embankment

#### 3.21.3.1 General

[As a part of the Contractor Quality Control (CQC) system required by SECTION 01451A CONTRACTOR QUALITY CONTROL, the] [The] Contractor shall establish and maintain field quality control for foundation preparation, embankment and backfill operations to assure compliance with contract requirements and maintain detailed records of field quality control for all operations including but not limited to the following:

##### a. Earthwork Equipment

Type, size, number of units and suitability for construction of the prescribed work.

##### b. Foundation Preparation

Methods of preparing the foundations in advance of embankment and backfill construction and methods for providing drainage of the foundation and partially completed fills.

#### 3.21.3.2 Materials Testing

\*\*\*\*\*  
NOTE: Types of tests and frequency of testing should be detailed below. Types of tests and frequency of testing will be dependent upon the types of materials utilized, configuration of foundation and embankment, placement and compaction procedures required, moisture control requirements etc. Testing requirements are material type specific rather than embankment fill type specific.  
\*\*\*\*\*

The contractor shall perform sufficient testing to insure that the fill is being constructed as specified. The testing program specified below shall be considered the minimum acceptable frequency of testing. This does not relieve the Contractor from the responsibility of performing additional testing, if required to ensure compliance with these specifications.

##### [a. Soil Classification Tests

Soil classification tests shall be performed in accordance with ASTM D 2487. One initial classification test shall be required for each different classification of material to be utilized as embankment fill or backfill. As prescribed in ASTM D 2487, grain size analyses in accordance with ASTM D 422 and Atterberg limits in accordance with ASTM D 4318 shall be performed on each different classification. The Contractor shall submit additional tests for every [\_\_\_\_\_] cubic m cubic yards of embankment or backfill material. Soil classification tests shall be performed on foundation material as required to determine the acceptability of the in-situ soils. Additional tests will be required if noticeable changes in the material occur.]

##### b. Cohesive Material Testing

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NOTE: Edit the following to comply with the method selected to determine the optimum properties (i.e., density and moisture content).

\*\*\*\*\*

(1) Moisture Density Relationships. The moisture-density relations for each different classification of cohesive material utilized shall be determined in accordance with [\_\_\_\_\_] [ASTM D 698], [Method A] [Method B] [Method C]. [ Prior to placing any fill material containing cohesive material, a minimum of [\_\_\_\_\_] (5) five-point [\_\_\_\_\_] compaction test shall be performed on representative samples of the material to be used as fill.] During fill placement a minimum of one additional moisture-density test shall be performed for every [\_\_\_\_\_] cubic m cubic yard placed. Additional tests will be required each time a new material is encountered. [ The moisture-density curves will be compiled to form a family of curves which will be utilized to estimate optimum properties (maximum dry density and optimum moisture content) to be used with field density test.]

(2) Water (Moisture) Content Tests. Determination of water content shall be performed in accordance with ASTM D 2216. [ ASTM D 4643 may be used when rapid moisture content results are needed. All rapid results obtained by ASTM D 4643 shall be confirmed by a test on a duplicate sample performed in accordance with ASTM D 2216. In the event of disagreement between the results, ASTM D 2216 shall govern.] One water content test will be performed for each [\_\_\_\_\_] cubic m cubic yards of material placed [or each lift of material whichever is less]. [ These test will be in addition to the water content tests performed in conjunction with in-place density tests.] Backfill and fills not meeting the required specifications for water content shall be retested after corrective measures have been applied.

\*\*\*\*\*

NOTES: The designer should pick the method or methods of In-place density which are acceptable. If uncompacted fill is specified density control may not be required.

Use caution when applying nuclear gages for in-place density measurement of cohesive and cohesionless soils. Soils consisting of certain chemical composition, or oversize rocks and large voids would affect the measurement accuracy of wet density. The chemical composition and "non-free" water of the sample may also dramatically (sometimes over 10 percent) affect the measurement of moisture content (see the paragraph entitled "Interferences" in ASTM D2922 and D3017. Also see paragraph 5-10.d.(2).(b). entitled "Nuclear Method" in EM 1110-2-1911). When water content can not be accurately measured using nuclear method, a computer controlled microwave oven system for water content measurement combined with nuclear method for wet density has been successfully used by some districts.

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(3) In-place Density Testing for Cohesive Materials. The

in-place density of the cohesive materials shall be determined in accordance with [ASTM D 1556] [, ASTM D 2167] [, ASTM D 2922] [, ASTM D 2937] [, or ] [ASTM D 5195]. At least one (1) in-place density test shall be performed on [each lift of material or] every [\_\_\_\_\_] cubic m cubic yards of completed fill whichever is more frequent with the horizontal locations randomly staggered in the fill.[ At each field density test location, soil samples shall be obtained and one [one-point] [two-point] compaction test, one moisture content, [one grain size analysis,] [ and one Atterberg limits test,] [if applicable,] shall be performed on the sample.] [ The results of the [one-point] [two-point] compaction test and the moisture content test will be utilized to obtain the optimum properties to compare to the results of the in-place density test.] [ For use with the family of curves to determine the optimum properties of the material a [one-point] [two-point] compaction tests shall be performed in conjunction with each in-place density. A portion of the soil from the in-place field density test and soil obtained immediately adjacent to the field density test location shall be used for a [one-point] [two-point] compaction test. The minus 19 mm 3/4-inch portion of the soil shall be subjected to [\_\_\_\_\_] compactive effort using a 150 mm 6-inch compaction mold in accordance with the procedures presented in ASTM D [\_\_\_\_\_] [ASTM D 698] [ASTM D 1557]]. Fill not meeting the required specifications for in-place density shall be retested after additional compaction has been completed.[ When nuclear method is used for in-place density testing according to ASTM D 2922 and ASTM D 3017, the first test and every tenth test thereafter for each material type shall include a sand cone correlation test in accordance with ASTM D 1556. The sand cone test shall be performed adjacent to the location of the nuclear test, shall include a nominal 150 mm 6 inch diameter sand cone, and shall include a minimum wet soil weight of 2.7 kg 6 pounds extracted from the hole. Nuclear density testing equipment shall not be used during rain. The density correlations shall be submitted with test results. Each transmittal including density test data shall include a summary of all density correlations for the job neatly prepared on a summary sheet including at a minimum:

- (i) Meter serial number and operators initials.
- (ii) Standard count for each test.
- (iii) Material type.
- (iv) Probe depth.
- (v) Moisture content by each test method and the deviation.
- (vi) Wet density by each test method and the deviation.]

[c. Cohesionless Material Testing

(1) Compaction Tests. The Contractor shall run not less than one relative density test for every [3,000] [\_\_\_\_\_] cubic m 3,900 [\_\_\_\_\_] cubic yards of cohesionless fill in accordance with ASTM D 4253 and ASTM D 4254.

(2) In-Place Density Tests. The in-place density of the cohesionless materials shall be determined in accordance with [ ASTM D 1556] [, ASTM D 2167] [, ASTM D 2922] [, ASTM D 2937] [, or] [ASTM D 5195]. The Contractor shall run not less than one (1) field in-place density test on [each lift of material or] every [\_\_\_\_\_] cubic m cubic yards of completed embankment fill or backfill whichever is less. Horizontal locations shall be

randomly staggered in the fill.[ When nuclear method is used for in-place density testing according to ASTM D 2922 and ASTM D 3017, the first test and every tenth test thereafter for each material type shall include a sand cone correlation test in accordance with ASTM D 1556. The sand cone test shall be performed adjacent to the location of the nuclear test, and shall include a nominal 150 mm 6 inch diameter sand cone, and shall include a minimum wet soil weight of 2.7 kg 6 pounds extracted from the hole. The density correlations shall be submitted with test results. Each transmittal including density test data shall include a summary of all density correlations for the job neatly prepared on a summary sheet including at a minimum:

- (i) Meter serial number and operators initials.
- (ii) Standard count for each test.
- (iii) Material type.
- (iv) Probe depth.
- (v) Moisture content by each test method and the deviation.
- (vi) Wet density by each test method and the deviation.]

[(3) Water (Moisture) Content Tests. Determination of water content shall be performed in accordance with ASTM D 2216.[ ASTM D 4643 may be used when rapid moisture content results are needed.

All rapid results obtained by ASTM D 4643 shall be confirmed by a test on a duplicate sample performed in accordance with ASTM D 2216.

In the event of disagreement between the results, ASTM D 2216 shall govern.] One water content test will be performed for each [\_\_\_\_\_] cubic m cubic yards of material placed [or each lift of material whichever is less].[ These test will be in addition to the water content tests performed in conjunction with in-place density tests.] Backfill and fills not meeting the required specifications for water content shall be retested after corrective measures have been applied.]]

#### d. Additional Testing

The Contracting Officer may request additional tests if there is reason to doubt the adequacy of the compaction, or special compaction procedures are being used, or materials change or if the Contracting Officer determines that the Contractor's testing is inadequate or the Contractor is concentrating backfill and fill operations in a relatively small area.

#### 3.21.3.3 Materials

Suitability of materials for use in embankment and backfill.

#### 3.21.3.4 Fill Placement

Layout, maintaining existing drainage, moisture control, thickness of layers, removal of oversized material, spreading and compaction for embankment and backfill.

#### 3.21.3.5 Grade and Cross Section

Surveys to verify that the dimensions, slopes, lines and grades conform to those shown on the drawings.[ Surveys to monitor settlement gages to measure foundation settlement.] [ Surveys to locate core boring locations and elevations to determine foundation settlement.]

#### 3.21.3.6 Testing by the Government

During the life of this contract, the Government [or its contractors] will perform quality assurance tests. The Contractor shall make available to the government [or its contractors] the equipment to perform these test.

#### 3.21.3.7 Reporting

[On a daily basis, the] [The] Contractor shall furnish the inspection records and all material testing results, [the quantity of fill placed,] as well as the records of corrective action taken, in accordance with Section 01451A CONTRACTOR QUALITY CONTROL.

-- End of Section --