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USACE / NAVFAC / AFCESA / NASA | **NASA-02300S (December 2005)**

Preparing Activity: NASA | **MasterFormat™ 2004 - 31 00 00.00 40**

Superseding
NASA-02300 (August 2003)
NASA-02311 (June 2004)
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

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DIVISION 02 - SITE CONSTRUCTION

SECTION 02300S

EARTHWORK

12/05

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SECTION 02300S

EARTHWORK
12/05

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NOTE: This guide specification covers the requirements for earthwork activities for buildings, utilities, roadways, railroads, and airfields.

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.

This guide specification includes tailoring options for topsoil and borrow. Selection or deselection of a tailoring option will include or exclude that option in the section, but editing the resulting section to fit the project is still required.

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

****

PART 1 GENERAL

****

NOTE: Consult with a soils engineer while editing this section to determine specific requirements for each job.

The following information will be indicated on the project drawings:

1. Surface elevations, existing and new;

2. Location of underground obstructions and existing utilities;

3. Location and record of soil borings and test pits. Include ground water observations and topsoil thickness encountered in boring, soil classifications, and properties such as moisture content and Atterberg limit determinations;

4. Location of borrow and disposal area if located on Government property;

5. Clearing stripping and grubbing limits, if different from clearing limits;

6. Areas to be seeded;

7. Hydrological data where available;

8. Shoring and sheeting required (trench protection is specified in Corps of Engineers Manual EM 385-1-1); and

9. Pipe trench excavation details.

10. Location and limits of hard material (rocks);

11. Details of special construction such as under railroad and highways right-of-way requirements for jacking and boring;

12. Details of sewage absorption trenches, absorption pits, and subsurface drains.

****

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

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

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

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

AMERICAN WATER WORKS ASSOCIATION(AWWA)

AWWA C600	(1999) Installation of Ductile-Iron Water Mains and Their Appurtenances

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2004) Structural Welding Code-Steel

AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)

AWPA C2	(2001) Lumber, Timber, Bridge Ties and Mine Ties - Preservative Treatment by Pressure Processes
AWPA P5	(2002) Standard for Waterborne Preservatives

ASTM INTERNATIONAL (ASTM)

ASTM A 139	(2000) Standard Specification for Electric-Fusion (ARC)-Welded Steel Pipe (NPS 4 and over)
ASTM A 252	(1998; R 2002) Welded and Seamless Steel Pipe Piles
ASTM C 136	(2001) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C 33	(2003) Standard Specification for Concrete Aggregates
ASTM D 1140	(2000) Amount of Material in Soils Finer than the No. 200 (75-micrometer) Sieve
ASTM D 1556	(2000) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(2002e1) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)

ASTM D 1883	(1999) CBR (California Bearing Ratio) of Laboratory-Compacted Soils
ASTM D 2167	(1994; R 2001) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D 2434	(1968; R 2000) Permeability of Granular Soils (Constant Head)
ASTM D 2487	(2000) Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 2922	(2001) 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	(2001) 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 4318	(2000) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 698	(2000a) 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 Requirements

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 530/F-93/004	(1993; Rev O; Updates I, II, IIA, IIB, and III) Test Methods for Evaluating Solid Waste (Vol IA, IB, IC, and II) (SW-846)
EPA 600/4-79/020	(1983) Methods for Chemical Analysis of Water and Wastes

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

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

1.2 MEASUREMENT

****

NOTE: These paragraphs will be deleted when lump-sum payment for work under this section is desired and when the work covered by this section is included in one lump-sum contract price for the entire work covered by the Invitation for Bids.

****

1.2.1 Excavation

The unit of measurement for excavation and borrow will be the cubic meter yard, computed by the average end area method from cross sections taken before and after the excavation and borrow operations, including the excavation for ditches, gutters, and channel changes, when the material is acceptably utilized or disposed of as herein specified. The measurements will include authorized excavation of rock (except for piping trenches that is covered below), authorized excavation of unsatisfactory subgrade soil, and the volume of loose, scattered rocks and boulders collected within the limits of the work; allowance will be made on the same basis for selected backfill ordered as replacement. The measurement will not include the volume of subgrade material or other material that is scarified or plowed and reused in-place, and will not include the volume excavated without authorization or the volume of any material used for purposes other than directed. The volume of overburden stripped from borrow pits and the volume of excavation for ditches to drain borrow pits, unless used as borrow material, will not be measured for payment. The measurement will not include the volume of any excavation performed prior to the taking of elevations and measurements of the undisturbed grade.

1.2.2 Piping Trench Excavation

****
NOTE: This paragraph will be coordinated with the payment paragraphs of appropriate contract sections to ensure that there are no dual payments or omission of payment for trench excavation. There should be separate payment items established for trench excavation for each different size of pipe in the contract. Payment for trench excavation for heat-distribution system and for underground electrical-distribution system may be excluded for payment from this paragraph, and included in payment under the appropriate utility section, when the work is of such a nature and extent and so clearly indicated that the excavation quantities involved can be estimated with reasonable accuracy.
****

Measure trench excavation by the number of linear meters feet along the centerline of the trench and excavate to the depths and widths specified for the particular size of pipe. Replace unstable trench bottoms with a selected granular material. Include the additional width at manholes and similar structures, the furnishing, placing and removal of sheeting and bracing, pumping and bailing, and all incidentals necessary to complete the work required by this section.

1.2.3 Rock Excavation for Trenches

****
NOTE: Delete this paragraph when not required in the project.
****

Measure and pay for rock excavation by the number of cubic meters yards of acceptably excavated rock material. Measure the material in place, but

base volume on a maximum 750 mm 30 inch width for pipes 300 mm 12 inch in diameter or less, and a maximum width of 400 mm 16 inch greater than the outside diameter of the pipe for pipes over 300 mm 12 inch in diameter. Provide the measurement to include all authorized overdepth rock excavation as determined by the Contracting Officer. For manholes and other appurtenances, compute volumes of rock excavation on the basis of 300 mm 1 foot outside of the wall lines of the structures.

1.2.4 Topsoil Requirements

Separate excavation, hauling, and spreading or piling of topsoil and related miscellaneous operations will be considered subsidiary obligations of the Contractor, covered under the contract unit price for excavation.

1.2.5 Overhaul Requirements

Allow the unit of measurement for overhaul to be the station-meter station-yard. The overhaul distance will be the distance in stations between the center of volume of the overhaul material in its original position and the center of volume after placing, minus the free-haul distance in stations. The haul distance will be measured along the shortest route determined by the Contracting Officer as feasible and satisfactory. Do not measure or waste unsatisfactory materials for overhaul where the length of haul for borrow is within the free-haul limits.

1.2.6 Select Granular Material

Measure select granular material in place as the actual cubic meters yards replacing wet or unstable material in trench bottoms [within the limits shown] [in authorized overdepth areas]. Provide the unit price to include furnishing and placing the granular material, excavation and disposal of unsatisfactory material, and additional requirements for sheeting and bracing, pumping, bailing, cleaning, and other incidentals necessary to complete the work.

1.3 PAYMENT

****

NOTE: When lump-sum payment for work under this section is desired, these paragraphs will be revised accordingly. These paragraphs will be deleted when the work covered by this section is included in one lump-sum contract price for the entire work covered by the Invitation for Bids. Payment for overhaul will be separate from excavation and borrow.

****

Payment will constitute full compensation for all labor, equipment, tools, supplies, and incidentals necessary to complete the work.

1.3.1 Classified Excavation

Classified excavation will be paid for at the contract unit prices per cubic meter yard for common or rock excavation.

1.3.2 Piping Trench Excavation

Payment for trench excavation shall constitute full payment for excavation and backfilling, [including specified overdepth] except in rock or unstable

trench bottoms.

1.3.3 Rock Excavation for Trenches

****
NOTE: Delete this paragraph when not required in the project.
****

Payment for rock excavation will be made in addition to the price bid for the trench excavation, and will include all necessary drilling and blasting and all incidentals necessary to excavate and dispose of the rock. Select granular material, used as backfill replacing rock excavation, will not be paid for separately, but will be included in the unit price for rock excavation.

1.3.4 Unclassified Excavation

Unclassified excavation will be paid for at the contract unit price per cubic meter yard for unclassified excavation.

1.3.5 Classified Borrow

Classified borrow will be paid for at the contract unit prices per cubic meter yard for common or rock borrow.

1.3.6 Unclassified Borrow

Unclassified borrow will be paid for at the contract unit price per cubic meter yard for unclassified borrow.

1.3.7 Authorized Overhaul

The number of station-meters station-yards of overhaul to be paid for will be the product of number of cubic meters yards of overhaul material measured in the original position, multiplied by the overhaul distance measured in stations of 100 meters feet and will be paid for at the contract unit price per station-meter station-yard for overhaul in excess of the free-haul limit as designated in paragraph DEFINITIONS.

1.3.8 Sheeting and Bracing

****
NOTE: Delete subparagraphs or items not required in the project.
****

Sheeting and bracing, when shown or authorized by the Contracting Officer to be left in place, will be paid for as follows: [_____].

1.3.8.1 Timber Sheeting

Timber sheeting will be paid for as the number of board feet of lumber below finish grade measured in place prior to backfilling. Include in the measurement sheeting wasted when cut off between the finished grade and 300 mm 1 foot below the finished grade.

1.3.8.2 Steel Sheeting and Soldier Piles

****
NOTE: The blank will be filled with an appropriate number not greater than 1 meter (3 feet). However, if the quantities of sheeting involved are anticipated to be substantial, and since the cut off steel can be sold by the Contractor as scrap, the whole part in brackets can be deleted and no payment provided for wasted cut off ends.
****

Steel sheeting, soldier piles, and steel bracing will be paid for according to the number of pounds of steel calculated. Calculate the steel by multiplying the measured in-place length in meters feet below finish grade by the unit weight of the section in kg per meter pounds per foot. Obtain Unit weight of rolled steel sections from recognized steel manuals. [Sheeting wasted when cut off between the finished grade and a distance of up to [_____] meters feet below the finished grade shall be included in the measurement.]

1.4 DEFINITIONS

****
NOTE: Delete definitions that will not be used in the specification text for a specific project.
****

1.4.1 Satisfactory Materials

****
NOTE: Satisfactory material will be defined in accordance with locally available materials, design slopes, etc., and suitable classes, based on the geotechnical report, will be listed in the project specification in accordance with the Unified Soil Classification System, ASTM D 2487. Maximum rock size will be determined based on how thick the fill is and how it is going to be accomplished. As a rule of thumb, it should be no larger than 1/2 the allowable lift thickness. Clay material should be checked for expansive characteristics and this section should be edited accordingly.
****

Compromise any satisfactory materials classified by ASTM D 2487 as GW, GP, GM, GP-GM, GW-GM, GC, GP-GC, GM-GC, SW, SP, [SM,] [SW-SM,] [SC,] [SW-SC,] [SP-SM,] [SP-SC,] [CL,] [ML,] [CL-ML,] [CH,] [MH]. Comprise satisfactory materials for grading of stones less than 200 mm 8 inch, except for fill material for pavements and railroads which of stones less than 75 mm 3 inch in any dimension.

1.4.2 Unsatisfactory Materials

****
NOTE: Unsatisfactory material will be defined in accordance with locally available materials, design slopes, etc., and unsuitable classes will be listed in the project specifications in accordance with

ASTM D 2487. This paragraph should be edited to delete inapplicable materials.

****

Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Unsatisfactory materials also include man-made fills; trash; refuse; backfills from previous construction; and material classified as satisfactory which contains root and other organic matter or frozen material. Notify the Contracting Officer of any contaminated materials.

1.4.3 Cohesionless and Cohesive Materials

****

NOTE: When classification will be necessary during construction, determination of grain size for classification will be specified to be made in conformance with ASTM C 117, ASTM C 136, and ASTM D 422.

****

Cohesionless materials 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. Conform testing required for classifying materials in accordance with ASTM D 4318, ASTM C 136, ASTM D 422, and ASTM D 1140.

1.4.4 Degree of Compaction

****

NOTE: ASTM D 1557 will be used for maximum density determinations, unless soil borings indicate a gradation that may include coarse material where more than 30 percent is retained on the 19 mm (3/4") sieve; in that case, the Contractor will be required to use AASHTO T 180, Method D and corrected with AASHTO T 224 for the maximum density determinations. The designer should determine if AASHTO T 180 is appropriate for the existing soil gradation. If maximum density cannot be determined by either method, the specification may need to require a test section and the COR to determine the number of compaction coverages and equipment type.

****

Degree of compaction required, except as noted in the second sentence, is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557 abbreviated as a percent of laboratory maximum density. Since ASTM D 1557 applies only to soils that have 30 percent or less by weight of their particles retained on the 9.0 mm 3/4 inch sieve, the degree of compaction for material having more than 30 percent by weight of their particles retained on the 9.0 mm 3/4 inch sieve expressing as a percentage of the maximum density in accordance with AASHTO T 180 and corrected with AASHTO T 224. To maintain the same percentage of coarse material, use the "remove and replace" procedure as described in the NOTE 8 in Paragraph 7.2 of AASHTO T 180.

1.4.5 Overhaul

****
NOTE: This paragraph is to be deleted when the earthwork is to be paid for under a lump sum contract. The blank will be filled with the appropriate number of stations.
****

Overhaul is the authorized transportation of satisfactory excavation or borrow materials in excess of the free-haul limit of [_____] stations. Overhaul is the product of the quantity of materials hauled beyond the free-haul limit, and the distance such materials are hauled beyond the free-haul limit, expressed in station meters yards.

1.4.6 Topsoil

****
NOTE: Additional requirements such as pH value and necessary soil conditioning, according to applicable provisions of Sections 02921A through 02923A, should be inserted in this paragraph. The depth of the topsoil should be given in the text of the specification, preferably in this paragraph.
****

Material suitable for topsoils obtained from [offsite areas] [excavations] [areas indicated on the drawings] is defined as: Natural, friable soil representative of productive, well-drained soils in the area, free of subsoil, stumps, rocks larger than 25 mm one inch diameter, brush, weeds, toxic substances, and other material detrimental to plant growth. Amend topsoil pH range to obtain a pH of 5.5 to 7.

1.4.7 Hard/Unyielding Materials

****
NOTE: Stones should generally not exceed 75 mm 3 inch in diameter. However, pipe manufacturer's criteria, if any, should be used.
****

Weathered rock, dense consolidated deposits, or conglomerate materials which are not included in the definition of "rock" with stones greater than [_____] mm inch in any dimension or as defined by the pipe manufacturer, whichever is smaller. These materials usually require the use of heavy excavation equipment, ripper teeth, or jack hammers for removal.

1.4.8 Rock

Solid homogeneous interlocking crystalline material with firmly cemented, laminated, or foliated masses or conglomerate deposits, neither of which can be removed without systematic drilling and blasting, drilling and the use of expansion jacks or feather wedges, or the use of backhoe-mounted pneumatic hole punchers or rock breakers; also large boulders, buried masonry, or concrete other than pavement exceeding [0.375] [_____] cubic meter [1/2] [_____] cubic yard in volume. Removal of hard material will not be considered rock excavation because of intermittent drilling and blasting that is performed merely to increase production.

1.4.9 Unstable Material

Unstable material are too wet to properly support the utility pipe, conduit, or appurtenant structure.

1.4.10 Select Granular Material

****

NOTE: It is important to specify select material under footings and slabs to minimize settlement and to ensure stability of a structure. Consideration should be made of the sensitivity of the structure to total and/or differential settlements related to the structural design. This is particularly true of add-on structures and structures to be founded partly on fill and partly on natural ground. For crib retaining wall, not more than 10 percent by weight of the fill material should be finer than 75 micrometers (No. 200) sieve. Also, specify coefficient of permeability within the range of 0.01 to 1.0 mm per second 0.002 to 0.20 feet per minute and soil classification GW, GP, SW and SP. Indicate with cross sections or section details on the contract drawings the limits or extents of any controlled fills or backfills. Specify class of material that is acceptable in the fill or backfill giving preference to any types available at or near the site. Select appropriate values for Atterberg limits and percentage of fines and specify maximum thickness of lifts for compaction.

For piping bedding the maximum size of aggregate should be not more than 8 mm per 100 mm 1 inch per foot of pipe diameter, or 75 mm 3 inch maximum. Refer to pipe manufacturer's criteria for more stringent requirements, if any, on aggregate size and gradation.

If suitable materials for this project are limited to materials classified as GW, GP, SW, or SP, delete the bracketed sentences of this paragraph. Coordinate requirements with a geotechnical engineer. Select fill used for structures should extend a minimum of 1.5 m 5 feet outside the building foundation lines or other building elements gaining support from the fill.

****

1.4.10.1 General Requirements

Select granular material shall consist of materials classified as [GW,] [GP,] [SW,] [SP,] or [_____] by ASTM D 2487 where indicated. [Do not exceed the liquid limit of such material of [35] [_____] percent when tested in accordance with ASTM D 4318. Do not exceed the plasticity index of [12] [_____] percent when tested in accordance with ASTM D 4318, and maximum [35] [_____] percent by weight that is finer than 75 micrometers No. 200 sieve when tested in accordance with ASTM D 1140.] [Provide a minimum coefficient of permeability of [0.01] [_____] mm per second [0.002] [_____] feet per minute when tested in accordance with ASTM D 2434.]

1.4.10.2 California Bearing Ratio Values

****
NOTE: Where California Bearing Ratio values are needed include the following paragraph:
****

[Bearing Ratio: At 2.5 mm 0.1 inch penetration, provide a [_____] percent the bearing ratio at 95 percent ASTM D 1557 maximum density as determined in accordance with ASTM D 1883 for a laboratory soaking period of not less than 4 days. [Provide [_____] percent maximum expansion.] [Conform to the following sieve analysis for combined material:]]

Sieve Size	Percent Passing by Weight
63 mm	100
4.75 mm	40 - 85
2.00 mm	20 - 80
425 micrometers	10 - 60
75 micrometers	5 - 25

Sieve Size	Percent Passing by Weight
2-1/2 inch	100
No. 4	40 - 85
No. 10	20 - 80
No. 40	10 - 60
No. 200	5 - 25

1.4.11 Initial Backfill Material

Consist initial backfill of select granular material or satisfactory materials free from rocks [_____] mm inch or larger in any dimension or free from rocks of such size as recommended by the pipe manufacturer, whichever is smaller. When the pipe is coated or wrapped for corrosion protection, free the initial backfill material of stones larger than [_____] mm inch in any dimension or as recommended by the pipe manufacturer, whichever is smaller.

1.4.12 Expansive Soils

****
NOTE: Additional laboratory testing and analysis might be needed to better define site specific expansive soils. If expansive soils are anticipated at the construction site, this specification should be edited to ensure proper construction techniques are undertaken per TM 5-818-7.
****

Expansive soils are defined as soils that have a plasticity index equal to or greater than [_____] when tested in accordance with ASTM D 4318.

1.4.13 Nonfrost Susceptible (NFS) Material

****
NOTE: Contract specifications for nonfrost-susceptible fill and backfill will follow

the gradation requirements recommended in TM 5-822-5. For fill under critical structures, materials with ML, MH, and CH classification will be specified as unsatisfactory (if at all feasible from an economic or material-availability standpoint). If such materials must be used, the specification will point out the critical nature of the materials and the control difficulties to be anticipated. Organic materials and topsoil having OL, OH, and Pt classification will not be used in fill or backfill.

****

Provide a uniformly graded washed sand of nonfrost susceptible material with a maximum particle size of [_____] mm inch and less than 5 percent passing the 0.075 mm No. 200 size sieve, and with not more than 3 percent by weight finer than 0.02 mm grain size.

1.4.14 Pile Supported Structure

As used herein, a structure where both the foundation and floor slab are pile supported.

1.5 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01330 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control.

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, Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

****

Government approval is required for submittals with a "G" designation;

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

SD-01 Preconstruction Submittals

[Shoring[; G][; G, [_____]]]

[Dewatering Work Plan[; G][; G, [_____]]]

[Blasting[; G][; G, [_____]]]

Submit 15 days prior to starting work.

SD-03 Product Data

Utilization of Excavated Materials[; G][; G, [_____]]
Rock Excavation
Opening of any Excavation or Borrow Pit
Shoulder Construction

Procedure and location for disposal of unused satisfactory material. Proposed source of borrow material. Notification of encountering rock in the project. Advance notice on the opening of excavation or borrow areas. Advance notice on shoulder construction for rigid pavements.

SD-06 Test Reports

Testing
Borrow Site Testing

Within 24 hours of conclusion of physical tests, [_____] copies of test results, including calibration curves and results of calibration tests. Results of testing at the borrow site.

SD-07 Certificates

Testing

Qualifications of the commercial testing laboratory or Contractor's testing facilities.

1.6 SUBSURFACE DATA

Subsurface soil boring logs are [shown on the drawings] [appended to the SPECIAL CONTRACT REQUIREMENTS]. The subsoil investigation report and samples of materials taken from subsurface investigations may be examined at [_____]. These data represent the best subsurface information available; however, variations may exist in the subsurface between boring locations.

1.7 CLASSIFICATION OF EXCAVATION

****
NOTE: Inapplicable portions will be deleted. Other classifications of excavation may be utilized as

required.
****

[No consideration will be given to the nature of the materials, and all excavation will be designated as unclassified excavation.] [Finish excavation specified on a classified basis, in accordance with the following designations and classifications.]

1.7.1 Common Excavation

Include common excavation with the satisfactory removal and disposal of all materials not classified as rock excavation.

1.7.2 Rock Excavation

Include rock excavation with blasting, excavating, grading, and disposing of material classified as rock and include the satisfactory removal and disposal of boulders 1/2 cubic meter yard or more in volume; solid rock; rock material that is in ledges, bedded deposits, and unstratified masses, which cannot be removed without systematic drilling and blasting; firmly cemented conglomerate deposits possessing the characteristics of solid rock impossible to remove without systematic drilling and blasting; and hard materials (see Definitions). Include the removal of any concrete or masonry structures, except pavements, exceeding 1/2 cubic meter yard in volume that may be encountered in the work in this classification. If at any time during excavation, including excavation from borrow areas, the Contractor encounters material that may be classified as rock excavation, uncover such material and the Contracting Officer notified by the Contractor. The Contractor is responsible for not proceeding with the excavation of this material until the Contracting Officer has classified the materials as common excavation or rock excavation and has taken cross sections as required. Failure on the part of the Contractor to uncover such material, notify the Contracting Officer, and allow ample time for classification and cross sectioning of the undisturbed surface of such material will cause the forfeiture of the Contractor's right of claim to any classification or volume of material to be paid for other than that allowed by the Contracting Officer for the areas of work in which such deposits occur.

1.7.3 BLASTING

[Perform blasting [in accordance with EM 385-1-1] and in conformance with Federal, State, and local safety regulations. The Contractor is responsible for submitting a Blasting Plan, prepared and sealed by a registered professional engineer that includes calculations for overpressure and debris hazard. Provide blasting mats and use the non-electric blasting caps. Obtain written approval prior to performing any blasting and notify the Contracting Officer 24 hours prior to blasting. Contain provisions for storing, handling and transporting explosives as well as for the blasting operations for each plan. The Contractor is responsible for damage caused by blasting operations.][Do not permit blasting.]

1.8 CRITERIA FOR BIDDING

****
NOTE: For most projects, the scope of earthwork can accurately be determined. However, if earthwork is approximately known, a unit price for earth work

should be provided in the Bid Schedule.

Unit-price items are multiplied by the approximated and stated quantity giving a sum that is then added to the price for the rest of the work. The result is a lump sum bid with automatic provision for payment or credit due to variations in earthwork within 15 percent of that shown and bid upon. Variations exceeding 15 percent of that shown and bid upon will become the subject of negotiations in accordance with FAR 52.212.11, "VARIATION IN ESTIMATED QUANTITY."

****

Base bids on the following criteria:

a. Surface elevations are as indicated.

b. Pipes or other artificial obstructions, except those indicated, will not be encountered.

c. [Ground water elevations indicated by the boring log were those existing at the time subsurface investigations were made and do not necessarily represent ground water elevation at the time of construction.] [Ground water elevation is [_____] meters feet below existing surface elevation.]

d. [Ground water elevation is [_____] meters feet below existing surface elevation.]

e. [Material character is indicated by the boring logs.]

****

NOTE: Choose the following option if no boring information is available, or if the boring information is insufficient to permit a bidder to develop an accurate estimate of hard material or rock to be encountered. If hard material or rock is to be encountered, the following option should be modified to include a percent figure or an approximate depth at which hard material or rock will be encountered.

****

f. [Do] [Do not] encounter [Hard materials [and rock] [in [_____] percent of the excavations] [at [_____] meter feet below existing surface elevations]].

1.9 DEWATERING WORK PLAN

****

NOTE: Include this paragraph where water levels will impact excavation operations.

****

Submit procedures for accomplishing dewatering work.

PART 2 PRODUCTS

2.1 REQUIREMENTS FOR OFFSITE SOILS

****
NOTE: Check with regional and local authorities as well as the activity to determine actual requirements of bracketed items; values shown come from the Commonwealth of Virginia. Remove this paragraph if not required by the project.
****

Test offsite soils brought in for use as backfill for TPH, BTEX and full TCLP including ignitability, corrosivity and reactivity. Consist backfill of a maximum [100] [_____] parts per million (ppm) of total petroleum hydrocarbons (TPH) and maximum [10] [_____] ppm of the sum of Benzene, Toluene, Ethyl Benzene, and Xylene (BTEX) and passes the TCPL test. Determine TPH concentrations by using EPA 600/4-79/020 Method 418.1. Determine BTEX concentrations by using EPA 530/F-93/004 Method 5030/8020. Perform TCLP in accordance with EPA 530/F-93/004 Method 1311. Provide Borrow Site Testing for TPH, BTEX and TCLP from a composite sample of material from the borrow site, with at least one test from each borrow site. Do not bring material on site until tests have been approved by the Contracting Officer.

2.2 BURIED WARNING AND IDENTIFICATION TAPE

****
NOTE: Delete paragraph if tape is not required in the project. The use of a plastic warning tape for identification is mandatory for buried hazardous utilities such as electrical conduit, gas lines, fuel lines, high pressure nitrogen, high pressure water and steam lines, domestic sewage force mains, industrial waste force mains and industrial sewers carrying hazardous, explosive, or toxic waste. Coordinate color codes with other specification sections and conform, if possible, to local practice for identifying buried utilities.
****

[Polyethylene plastic] [and] [metallic core or metallic-faced, acid- and alkali-resistant, polyethylene plastic] warning tape manufactured specifically for warning and identification of buried utility lines. Provide tape on rolls, 75 mm 3 inch minimum width, color coded as specified below for the intended utility with warning and identification imprinted in bold black letters continuously over the entire tape length. Warning and identification to read, "CAUTION, BURIED (intended service) LINE BELOW" or similar wording. Provide permanent color and printing, unaffected by moisture or soil.

Warning Tape Color Codes

[Yellow:]	[Electric]
[Yellow:]	[Gas, Oil; Dangerous Materials]
[Orange:]	[Telephone and Other Communications]
[Blue:]	[Water Systems]
[Green:]	[Sewer Systems]

Warning Tape Color Codes

[White:]	[Steam Systems]
[Gray:]	[Compressed Air]

2.2.1 Warning Tape for Metallic Piping

Acid and alkali-resistant polyethylene plastic tape conforming to the width, color, and printing requirements specified above. Provide a 0.08 mm 0.003 inch minimum thickness of tape. Provide a minimum strength of 10.3 MPa 1500 psi lengthwise, and 8.6 MPa 1250 psi crosswise, with a maximum 350 percent elongation.

2.2.2 Detectable Warning Tape for Non-Metallic Piping

Polyethylene plastic tape conforming to the width, color, and printing requirements specified above. Provide a 0.10 mm 0.004 inch minimum thickness of tape. Provide a minimum strength of 10.3 MPa 1500 psi lengthwise and 8.6 MPa 1250 psi crosswise. Manufacture tape with integral wires, foil backing, or other means of enabling detection by a metal detector when tape is buried up to 920 mm 3 feet deep. Encase metallic element of the tape in a protective jacket or provide with other means of corrosion protection.

2.3 DETECTION WIRE FOR NON-METALLIC PIPING

Insulate a single strand, solid copper detection wire with a minimum of 12 AWG.

2.4 MATERIAL FOR RIP-RAP

****

NOTE: Make sure there is no duplication of rip-rap requirements between this and other specification sections. In this paragraph refer to standard specifications for rip-rap if local specifications are satisfactory and available. Delete this paragraph or subparagraphs not required in the project.

****

Provide [Bedding material] [Grout] [Filter fabric] and rock conforming to [these requirements] [DOT] [SSS-[_____] State Standard] for construction indicated.

2.4.1 Bedding Material

Provide bedding material consisting of sand, gravel, or crushed rock, well graded, [or poorly graded] with a maximum particle size of 50 mm 2 inch. Compose material of tough, durable particles. Allow fines passing the 75 micrometers No. 200 standard sieve with a plasticity index less than six.

2.4.2 Grout

Composed of cement, water, an air-entraining admixture, and sand mixed in proportions of one part portland cement to [two] [_____] parts of sand, sufficient water to produce a workable mixture, and an amount of admixture which will entrain sufficient air to produce durable grout, as determined by the Contracting Officer. Mix grout in a concrete mixer. Allow a

sufficient mixing time to produce a mixture having a consistency permitting gravity flow into the interstices of the rip-rap with limited spading and brooming.

2.4.3 Rock

****
NOTE: Adjust weights in brackets to fit application. Take local practice into consideration.
****

Rock fragments sufficiently durable to ensure permanence in the structure and the environment in which it is to be used. Free rock fragments from cracks, seams, and other defects that would increase the risk of deterioration from natural causes. Provide the size of the fragments such that no individual fragment exceeds a weight of [68] [_____] kg [150] [_____] pounds and that no more than 10 percent of the mixture, by weight, consists of fragments weighing 0.91 kg 2 pounds or less each. Provide a specific gravity of the rock with a minimum of [2.50] [_____]. Do not permit the inclusion of more than trace [1 percent] [_____] quantities of dirt, sand, clay, and rock fines.

2.5 CAPILLARY WATER BARRIER

Provide capillary Water Barrier of clean, poorly graded crushed rock, crushed gravel, or uncrushed gravel placed beneath a building slab with or without a vapor barrier to cut off the capillary flow of pore water to the area immediately below. Conform to ASTM C 33 for fine aggregate grading with a maximum of 3 percent by weight passing ASTM D 1140, 75 micrometers No. 200 sieve, [or] [37.5 mm 1-1/2 inch and no more than 2 percent by weight passing the 4.75 mm No. 4 size sieve] [or coarse aggregate Size 57, 67, or 77].

2.6 PIPE CASING

****
NOTE: Indicate, on the contract drawings, limits of right-of-way and any other site requirements or dimensions conforming to the standards of the railroad or highway owner. Where traffic can be interrupted, trenching in a pipeline casing is more economical with the same advantages of allowing future work without interruption of traffic.
****

2.6.1 Casing Pipe

ASTM A 139, Grade B, or ASTM A 252, Grade 2, smooth wall pipe. Match casing size to the outside diameter and wall thickness as indicated on Drawing Sheet No. [_____]. Protective coating is not required on casing pipe.

2.6.2 Wood Supports

Treated Yellow Pine or Douglas Fir, rough, structural grade. Provide wood with nonleaching water-borne pressure preservative (ACA or CCA) and treatment conforming to AWPA P5 and AWPA C2, respectively. Secure wood supports to carrier pipe with stainless steel or zinc-coated steel bands.

PART 3 EXECUTION

****
NOTE: Coordinate requirements with Section 02231 CLEARING AND GRUBBING.
****

3.1 STRIPPING OF TOPSOIL

****
NOTE: Topsoil will be separately excavated, stored, and used for surface finish in preparation for seeding, sodding, or other planting, only where topsoil is definitely superior for grass and plant growth as compared with the remainder of the excavated material. Surface soil that is a heavy clay, predominantly sandy, or is lean in grass- and plant-growth qualities, will not be saved. The hauling, spreading, smoothing, and maintenance of the topsoil in preparation for the seeding and planting operations are generally considered under a separate section, and therefore are not considered in this specification. The blank will be filled with the appropriate depth dimension.
****

Where indicated or directed, strip topsoil to a depth of [100] [_____] mm [4] [_____] inch. Spread topsoil on areas already graded and prepared for topsoil, or transported and deposited in stockpiles convenient to areas that are to receive application of the topsoil later, or at locations indicated or specified. Keep topsoil separate from other excavated materials, brush, litter, objectionable weeds, roots, stones larger than 50 mm 2 inch in diameter, and other materials that would interfere with planting and maintenance operations. [Stockpile in locations indicated] [Remove from the site] any surplus of topsoil from excavations and gradings.

3.2 GENERAL EXCAVATION

Perform excavation of every type of material encountered within the limits of the project to the lines, grades, and elevations indicated and as specified. Conform with the tolerances specified in paragraph FINISHING for grading. Transport satisfactory excavated materials and place in fill or embankment within the limits of the work. Excavate unsatisfactory materials encountered within the limits of the work below grade and replace with satisfactory materials as directed. Include such excavated material and the satisfactory material ordered as replacement in excavation. Dispose surplus satisfactory excavated material not required for fill or embankment in areas approved for surplus material storage or designated waste areas. Dispose unsatisfactory excavated material in designated waste or spoil areas. During construction, perform excavation and fill in a manner and sequence that will provide proper drainage at all times. Excavate material required for fill or embankment in excess of that produced by excavation within the grading limits from the borrow areas indicated or from other approved areas selected by the Contractor as specified.

3.2.1 Ditches, Gutters, and Channel Changes

Finish excavation of ditches, gutters, and channel changes by cutting

accurately to the cross sections, grades, and elevations shown on Drawing Sheet No. [_____]. Do not excavate ditches and gutters below grades shown. Backfill the excessive open ditch or gutter excavations with satisfactory, thoroughly compacted, material or with suitable stone or cobble to grades shown. Dispose excavated material as shown or as directed, except in no case allow material be deposited a maximum 1 meter 4 feet from edge of a ditch. Maintain excavations free from detrimental quantities of leaves, brush, sticks, trash, and other debris until final acceptance of the work.

3.2.2 Drainage Structures

****
NOTE: The last two sentences will be removed except when pile foundations are to be used.
****

Make excavations to the lines, grades, and elevations shown, or as directed. Provide trenches and foundation pits of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown. Clean rock or other hard foundation material of loose debris and cut to a firm, level, stepped, or serrated surface. Remove loose disintegrated rock and thin strata. Do not disturb the bottom of the excavation when concrete or masonry is to be placed in an excavated area. Do not make excavation to the final grade level until just before the concrete or masonry is to be placed. Where pile foundations are to be used, stop the excavation of each pit at an elevation 300 mm 1 foot above the base of the footing, as specified, before piles are driven. After the pile driving has been completed, remove loose and displaced material and complete excavation, leaving a smooth, solid, undisturbed surface to receive the concrete or masonry.

3.2.3 Drainage

Provide for the collection and disposal of surface and subsurface water encountered during construction. Completely drain construction site during periods of construction to keep soil materials sufficiently dry. Construct storm drainage features (ponds/basins) at the earliest stages of site development, and throughout construction grade the construction area to provide positive surface water runoff away from the construction activity [and] [or] provide temporary ditches, swales, and other drainage features and equipment as required to maintain dry soils. When unsuitable working platforms for equipment operation and unsuitable soil support for subsequent construction features develop, remove unsuitable material and provide new soil material as specified herein. It is the responsibility of the Contractor to assess the soil and ground water conditions presented by the plans and specifications and to employ necessary measures to permit construction to proceed.

3.2.4 Dewatering

****
NOTE: Check depth of proposed utilities and foundations relative to the existing ground water elevation prior to editing.
****

Control groundwater flowing toward or into excavations to prevent sloughing of excavation slopes and walls, boils, uplift and heave in the excavation and to eliminate interference with orderly progress of construction. Do

not permit French drains, sumps, ditches or trenches within 0.9 m 3 feet of the foundation of any structure, except with specific written approval, and after specific contractual provisions for restoration of the foundation area have been made. Take control measures by the time the excavation reaches the water level in order to maintain the integrity of the in situ material. While the excavation is open, maintain the water level continuously, at least [_____] m feet below the working level. [Operate dewatering system continuously until construction work below existing water levels is complete. Submit performance records weekly.] [Measure and record performance of dewatering system at same time each day by use of observation wells or piezometers installed in conjunction with the dewatering system.] [Relieve hydrostatic head in previous zones below subgrade elevation in layered soils to prevent uplift.]

3.2.5 Trench Excavation Requirements

****
NOTE: The width of the trench below the top of the pipe will depend on the type of pipe used and soil conditions. The pipe manufacturer's installation manual should provide this information, and if so, it will be followed. In general, the width of trench will be 300 mm 12 inch to 600 mm 24 inch, plus pipe O.D. for smaller pipe sizes, and 600 mm 24 inch to 900 mm 36 inch plus pipe O.D. for larger pipe sizes. Sloping walls below the top of the pipe are allowed for certain types of pipe in special ground conditions.
****

Excavate the trench as recommended by the manufacturer of the pipe to be installed. Slope trench walls below the top of the pipe, or make vertical, and of such width as recommended in the manufacturer's printed installation manual. Provide vertical trench walls where no manufacturer's printed installation manual is available. Shore trench walls more than [_____] meters feet high, cut back to a stable slope, or provide with equivalent means of protection for employees who may be exposed to moving ground or cave in. Shore vertical trench walls more than [_____] meters feet high. Excavate trench walls which are cut back to at least the angle of repose of the soil. Give special attention to slopes which may be adversely affected by weather or moisture content. Do not exceed the trench width below the top of pipe of 600 mm 24 inch plus pipe outside diameter (O.D.) for pipes of less than 600 mm 24 inch inside diameter and do not exceed 900 mm 36 inch plus pipe outside diameter for sizes larger than 600 mm 24 inch inside diameter. Where recommended trench widths are exceeded, redesign, stronger pipe, or utilize special installation procedures by the Contractor. The Contractor is responsible for the cost of redesign, stronger pipe, or special installation procedures without any additional cost to the Government.

3.2.5.1 Bottom Preparation

****
NOTE: Stones 75 mm 3 inch or greater should be removed. However, pipe manufacturer's criteria, if any, should be used.
****

Grade the bottoms of trenches accurately to provide uniform bearing and

support for the bottom quadrant of each section of the pipe. Excavate bell holes to the necessary size at each joint or coupling to eliminate point bearing. Remove stones of [_____] millimeters inch or greater in any dimension, or as recommended by the pipe manufacturer, whichever is smaller, to avoid point bearing.

3.2.5.2 Removal of Unyielding Material

****
NOTE: Minimum of 100 mm 4 inch should be removed to produce a suitable cushion for the pipe.
****

Where [overdepth is not indicated and] unyielding material is encountered in the bottom of the trench, remove such material [_____] millimeters inch below the required grade and replaced with suitable materials as provided in paragraph BACKFILLING AND COMPACTION.

3.2.5.3 Removal of Unstable Material

Where unstable material is encountered in the bottom of the trench, remove such material to the depth directed and replaced to the proper grade with select granular material as provided in paragraph BACKFILLING AND COMPACTION. When removal of unstable material is required due to the Contractor's fault or neglect in performing the work, the Contractor is responsible for excavating the resulting material and replace without additional cost to the Government.

3.2.5.4 Excavation for Appurtenances

Provide excavation for manholes, catch-basins, inlets, or similar structures [sufficient to leave at least 300 mm 12 inch clear between the outer structure surfaces and the face of the excavation or support members] [of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown.] Rock shall be cleaned of loose debris and cut to a firm surface either level, stepped, or serrated, as shown or as directed. Remove loose disintegrated rock and thin strata. Specify removal of unstable material. When concrete or masonry is to be placed in an excavated area, take special care not to disturb the bottom of the excavation. Do not make excavation to the final grade level until just before the concrete or masonry is to be placed.

3.2.5.5 Jacking, Boring, and Tunneling

****
NOTE: In situations where utility lines must be installed more than 5 to 7 meters 15 to 20 feet below ground surface, through embankments, under minor roads or parking areas, or where surface conditions make it difficult or impractical to excavate open trenches, utility lines may be installed by jacking, boring, or tunneling as a contractor option. Where operational requirements preclude installation by trenching, the use of jacking, boring, or tunneling should be specified as mandatory alternatives. This requirement will normally exist where utilities must cross railroads, highways, primary access roads and airfield

pavements. Pipe and conduit smaller than 900 mm 36 inch in diameter will normally be installed in smooth steel pipe casing. Designing engineers must coordinate with installation facility engineers to identify and validate utility crossings where jacking, boring, or tunneling will be specified as mandatory.

****

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

3.2.6 Underground Utilities

****

NOTE: Delete this paragraph in its entirety if no known utilities or subsurface construction is located below or adjacent to work covered in this specification.

****

The Contractor is responsible for movement of construction machinery and equipment over pipes and utilities during construction. [Perform work adjacent to non-Government utilities as indicated in accordance with procedures outlined by utility company.] [Excavation made with power-driven equipment is not permitted within [600] [_____] mm [two] [_____] feet of known Government-owned utility or subsurface construction. For work immediately adjacent to or for excavations exposing a utility or other buried obstruction, excavate by hand. Start hand excavation on each side of the indicated obstruction and continue until the obstruction is uncovered or until clearance for the new grade is assured. Support uncovered lines or other existing work affected by the contract excavation until approval for backfill is granted by the Contracting Officer.] Report damage to utility lines or subsurface construction immediately to the Contracting Officer.

3.2.7 Structural Excavation

Ensure that footing subgrades have been inspected and approved by the Contracting Officer prior to concrete placement. Excavate to bottom of pile cap prior to placing or driving piles, unless authorized otherwise by the Contracting Officer. Backfill and compact over excavations and changes in grade due to pile driving operations to 95 percent of ASTM D 698 maximum density.

3.3 SELECTION OF BORROW MATERIAL

****

NOTE: Where a substantial quantity of borrow excavation is anticipated, the drawings and specifications will indicate the location or locations within the project site, and the conditions under which borrow may be obtained.

****

Select borrow material to meet the requirements and conditions of the particular fill or embankment for which it is to be used. Obtain borrow

material from the borrow areas [shown on Drawing Sheet No. [_____]] [within the limits of the project site, selected by the Contractor] [or] [from approved private sources]. Unless otherwise provided in the contract, the Contractor is responsible for obtaining the right to procure material, pay royalties and other charges involved, and bear the expense of developing the sources, including rights-of-way for hauling from the owners. Borrow material from approved sources on Government-controlled land may be obtained without payment of royalties. Unless specifically provided, do not obtain borrow within the limits of the project site without prior written approval. Consider necessary clearing, grubbing, and satisfactory drainage of borrow pits and the disposal of debris thereon related operations to the borrow excavation.

3.4 OPENING AND DRAINAGE OF EXCAVATION AND BORROW PITS

****

NOTE: The first sentence will be deleted when all work covered by Invitation for Bids is to be included in one lump-sum contract price.

****

The Contractor is responsible for notifying the Contracting Officer sufficiently in advance of the opening of any excavation or borrow pit to permit elevations and measurements of the undisturbed ground surface to be taken. Except as otherwise permitted, excavate borrow pits and other excavation areas providing adequate drainage. Transport overburden and other spoil material to designate spoil areas or otherwise dispose of as directed. Provide neatly trimmed and drained borrow pits after the excavation is completed. Ensure that excavation of any area, operation of borrow pits, or dumping of spoil material results in minimum detrimental effects on natural environmental conditions.

3.5 SHORING

3.5.1 General Requirements

****

NOTE: Include this paragraph when scope of work requires excavations which are greater than 1.5 m 5 feet or where it is known that in-situ soils lack the stability to hold near vertical faces. Where sufficient room is available, the Contractor may slope back trench walls rather than having to use a shoring system. However, the Contractor should not be given the opportunity to slope the faces of excavations in lieu of providing shoring unless all the following conditions are met:

1. The excavation is less than 6 m 20 feet in depth.

2. There are no adjacent structures, roads, or pavements that will affect the excavation.

3. No equipment, stored material, or overlying material will affect the excavation.

4. Vibration from equipment, traffic, or blasting will not affect the excavation.

5. There will be no ground water problems.

6. Surcharges will not affect the excavation.

7. Station operational considerations permit laying back the slopes of the excavation.

****

Submit a Shoring and Sheeting plan for approval 15 days prior to starting work. Submit drawings and calculations, certified by a registered professional engineer, describing the methods for shoring and sheeting of excavations. Finish shoring, including sheet piling, and install as necessary to protect workmen, banks, adjacent paving, structures, and utilities. Remove shoring, bracing, and sheeting as excavations are backfilled, in a manner to prevent caving.

3.5.2 Geotechnical Engineer

****

NOTE: Where site conditions require extensive monitoring of excavations and water levels include the following requirement.

****

The Contractor is required to hire a Professional Geotechnical Engineer to provide inspection of excavations and soil/groundwater conditions throughout construction. The Geotechnical Engineer is responsible for performing pre-construction and periodic site visits throughout construction to assess site conditions. The Geotechnical Engineer is responsible for updating the excavation, sheeting and dewatering plans as construction progresses to reflect changing conditions and submit an updated plan if necessary. Submit a monthly written report, informing the Contractor and Contracting Officer of the status of the plan and an accounting of the Contractor's adherence to the plan addressing any present or potential problems. The Contracting Officer is responsible for arranging meetings with the Geotechnical Engineer at any time throughout the contract duration.

3.6 GRADING AREAS

****

NOTE: When spoil areas or borrow areas are within the limits of Government-controlled land, additional requirements based on the following, and as appropriate for the project, will be included in the contract document. Locations of areas will be indicated, or the approximate distances from the project site will be specified. Generally, unburned vegetative material and surplus excavated material will be disposed of in inconspicuous spoil areas where no future construction is planned. If economically justifiable, surplus suitable excavated material may be stockpiled or may be disposed of in areas where future construction is planned and where fill will be required. Spoil materials will be so placed and the worked portions of spoil areas and borrow areas will be so graded and shaped as to minimize soil erosion, siltation of drainage channels, and damage to existing vegetation. The

degree of compaction will be specified.
****

Where indicated, divide work into grading areas within which satisfactory excavated material be placed in embankments, fills, and required backfills. Do not haul satisfactory material excavated in one grading area to another grading area except when so directed in writing. Place and grade stockpiles of satisfactory [and unsatisfactory] [and wasted materials] as specified. Keep stockpiles in a neat and well drained condition, giving due consideration to drainage at all times. Clear, grub, and seal by rubber-tired equipment, the ground surface at stockpile locations excavated satisfactory and unsatisfactory materials as separately stockpiled. Protect stockpiles of satisfactory materials from contamination which may destroy the quality and fitness of the stockpiled material. If the Contractor fails to protect the stockpiles, and any material becomes unsatisfactory, remove and replace such material with satisfactory material from approved sources.

3.7 FINAL GRADE OF SURFACES TO SUPPORT CONCRETE

Do not make excavation to final grade until just before concrete is to be placed. [For pile foundations, stop the excavation at an elevation of from 150 to 300 mm 6 to 12 inch above the bottom of the footing before driving piles. After pile driving has been completed, complete the remainder of the excavation to the elevations shown.] Use only excavation methods that will leave the foundation rock in a solid and unshattered condition. Roughen the level surfaces, and cut the sloped surfaces as indicated into rough steps or benches to provide a satisfactory bond. Protect shales from slaking and all surfaces from erosion resulting from ponding or flow of water.

3.8 GROUND SURFACE PREPARATION

3.8.1 General Requirements

Remove and replace unsatisfactory material in surfaces to receive fill or in excavated areas with satisfactory materials as directed by the Contracting Officer. Ensure the surface to a depth of 150 mm 6 inch before the fill is started. Plow, step, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so that the fill material will bond with the existing material. When subgrades are less than the specified density, break up the ground surface to a minimum depth of 150 mm 6 inch, pulverizing, and compacting to the specified density. When the subgrade is part fill and part excavation or natural ground, scarify the excavated or natural ground portion to a depth of 300 mm 12 inch and compacted as specified for the adjacent fill.

3.8.2 Frozen Material

Do not place material on surfaces that are muddy, frozen, or contain frost. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, or other approved equipment well suited to the soil being compacted. Moisten material as necessary [to plus or minus [_____] percent of optimum moisture] [to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used].

3.9 UTILIZATION OF EXCAVATED MATERIALS

****

NOTE: Specifications covering excavated materials authorized to be wasted will usually include the provision that the surface and side slopes formed from such material be shaped and sloped so as to provide for drainage and for later seeding and mowing operations.

****

Dispose unsatisfactory materials removing from excavations in designated waste disposal or spoil areas. Use satisfactory material removed from excavations, insofar as practicable, in the construction of fills, embankments, subgrades, shoulders, bedding (as backfill), and for similar purposes. Do not waste any satisfactory excavated material without specific written authorization. Dispose satisfactory material authorized to be wasted of in designated areas approved for surplus material storage or designated waste areas as directed. Clear and grub newly designated waste areas on Government-controlled land before disposal of waste material thereon. Stockpile and use coarse rock from excavations for constructing slopes or embankments adjacent to streams, or sides and bottoms of channels and for protecting against erosion. Do not dispose excavated material to obstruct the flow of any stream, endanger a partly finished structure, impair the efficiency or appearance of any structure, or be detrimental to the completed work in any way.

3.10 BURIED TAPE AND DETECTION WIRE

3.10.1 Buried Warning and Identification Tape

Provide buried utility lines with utility identification tape. Bury tape 300 mm 12 inch below finished grade; under pavements and slabs, bury tape 150 mm 6 inch below top of subgrade.

3.10.2 Buried Detection Wire

Bury detection wire directly above non-metallic piping at a distance not to exceed 300 mm 12 inch above the top of pipe. Extend the wire continuously and unbroken, from manhole to manhole. Terminate the ends of the wire inside the manholes at each end of the pipe, with a minimum of 0.9 m 3 feet of wire, coiled, remaining accessible in each manhole. Furnish insulated wire over it's entire length. Install wires at manholes between the top of the corbel and the frame, and extend up through the chimney seal between the frame and the chimney seal. For force mains, terminate the wire in the valve pit at the pump station end of the pipe.

3.11 BACKFILLING AND COMPACTION

****

NOTE: It is imperative to specify a high degree of compaction in fills under structures to minimize settlement and to insure stability of a structure. In addition to the criteria set forth in TM 5-818-1, the following factors will be considered in establishing the specific requirements:

a. The sensitivity of the structure to total and/or differential settlement as related to the structural

design. This is particularly true of structures to be founded partly on fill and partly on natural ground.

b. The ability of normal compaction equipment to produce the desired densities in existing or locally available materials within a reasonable range of molding moisture content. If considered essential, special equipment will be specified.

c. The compaction requirements for clean, cohesionless, granular materials will be generally higher than those for cohesive materials because cohesionless materials readily consolidate when subjected to vibration. For structures with critical stability requirements and settlement limitations, the minimum density requirements may be altered. If only a cohesionless soil or only a cohesive soil is used, the inapplicable values will be deleted.

d. The exception to required high degree of compaction in fills and backfills is in expansive soils (see TM 5-818-7). Where it is necessary to use materials having swelling characteristics, usually CL or CH classifications, the specified degree of compaction will be related to laboratory test results for swelling under a considerable range of molding moisture and compactive effort. In swelling soils, it is important to specify a density and molding moisture range that will enable the soil to stay stable, striking a reasonable balance between potential swell and excessive settlement under load, even at the expense of accepting a reduced bearing capacity. A maximum permissible density should be established to minimize swelling. If possible, soils with swelling characteristics will be classified as unsatisfactory material, particularly under critical stability structures.

e. ASTM D 1557 is satisfactory for establishing moisture density characteristics of a material in most cases. However, other modifications may be necessary as discussed in this ASTM and under soil tests in DM 21.3/ TM 5-825-2. The procedures and precautions in the subgrade compaction paragraphs of DM 21.3/TM 5-825-2, will be considered in establishing minimum density requirements for a particular project.

Modifications will be made to meet the backfill requirements for deep-seated or subsurface structures as discussed in TM 5-818-4.

****

Place backfill adjacent to any and all types of structures and compact to at least 90 percent laboratory maximum density for cohesive materials or 95 percent laboratory maximum density for cohesionless materials to prevent wedging action or eccentric loading upon or against the structure. Prepare

ground surface on which backfill is to be placed as specified in paragraph PREPARATION OF GROUND SURFACE FOR EMBANKMENTS. Provide compaction requirements for backfill materials in conformance to the applicable portions of paragraphs PREPARATION OF GROUND SURFACE FOR EMBANKMENTS, EMBANKMENTS. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment.

3.11.1 Trench Backfill

****
NOTE: Most pressure tests require backfilling to at least 600 mm 2 feet over the pipe with the joints and couplings left open for inspection.
****

Backfill trenches to the grade shown. [Backfill the trench to [_____] meters feet above the top of pipe prior to performing the required pressure tests. Leave the joints and couplings uncovered during the pressure test.] [Do not backfill the trench until all specified tests are performed.]

3.11.1.1 Replacement of Unyielding Material

Replace unyielding material removed from the bottom of the trench with select granular material or initial backfill material.

3.11.1.2 Replacement of Unstable Material

Replace unstable material removed from the bottom of the trench or excavation with select granular material placed in layers not exceeding 150 mm 6 inch loose thickness.

3.11.1.3 Bedding and Initial Backfill

****
NOTE: Bedding is provided to level out any irregularities in the foundation and to assure uniform support along the barrel of each pipe section. Bedding is also constructed to distribute the load bearing reaction, due to the weight of the backfill material, around the lower portion of the pipe. If the pipe or conduit is placed directly on a flat or shaped foundation, delete "bedding" from the title and from any reference in the paragraph. If bedding will be specified, determine type and thickness and show on the plans. Specify compaction to 95 percent maximum density for cohesionless soils, and 90 percent maximum density for cohesive soils.

Any locally available fine aggregate for concrete or asphalt mixtures will qualify as sand and may be specified by local gradation and specification number in lieu of "SW" or "SP." Drawings (details) should clearly show where sand backfill or bedding is required.

Locally available coarse aggregate for concrete will suffice and may be specified by local gradation and

specification number in lieu of "GW" or "GP." Maximum size of aggregate should not be more than 25 mm per 300 mm one inch per foot of pipe diameter or 75 mm 3 inch maximum. Refer to pipe manufacturer's criteria for more stringent requirements, if any, on aggregate size and gradation. On drawings (details), clearly show where gravel backfill or bedding is required.

****

[Provide begging of the type and thickness shown.] Place initial backfill material and compacted with approved tampers to a height of at least one foot above the utility pipe or conduit. Bring up the backfill evenly on both sides of the pipe for the full length of the pipe. Take care to ensure thorough compaction of the fill under the haunches of the pipe. Except as specified otherwise in the individual piping section, provide bedding for buried piping in accordance with AWWA C600, Type 4, except as specified herein. Compact backfill to top of pipe to 95 percent of ASTM D 698 maximum density. Provide plastic piping with bedding to spring line of pipe. Provide materials as follows:

a. Class I: Angular, 6 to 40 mm 0.25 to 1.5 inch, graded stone, including a number of fill materials that have regional significance such as coral, slag, cinders, crushed stone, and crushed shells.

b. Class II: Coarse sands and gravels with maximum particle size of 40 mm 1.5 inch, including various graded sands and gravels containing small percentages of fines, generally granular and noncohesive, either wet or dry. Soil Types GW, GP, SW, and SP are included in this class as specified in ASTM D 2487.

c. Clean, coarse-grained sand classified as [_____] in accordance with Section 02315N EXCAVATION AND FILL, [gradation [_____] of the [DOT] [State Standard] or [SW] [or] [SP] by ASTM D 2487 for [bedding] [and] [backfill] [as indicated]].

d. Clean, coarsely graded natural gravel, crushed stone or a combination thereof identified as [_____] in accordance with Section 02315N EXCAVATION AND FILL, [gradation [_____] of the [DOT] [State Standard]] or having a classification of [GW] [GP] in accordance with ASTM D 2487 for [bedding] [and] [backfill] [as indicated]. [Do not exceed maximum particle size of [75] [_____] mm [3] [_____] inch.]

3.11.1.4 Final Backfill

Fill the remainder of the trench, except for special materials for roadways, railroads and airfields, with satisfactory material. Place backfill material and compact as follows:

a. Roadways, Railroads, and Airfields: Place backfill up to the required elevation as specified. Do not permit water flooding or jetting methods of compaction.

b. Sidewalks, Turfed or Seeded Areas and Miscellaneous Areas: Deposit backfill in layers of a maximum of 300 mm 12 inch loose thickness, and compacted to 85 percent maximum density for cohesive soils and 90 percent maximum density for cohesionless

soils. [Allow water flooding or jetting methods of compaction for granular noncohesive backfill material. Do not allow water jetting to penetrate the initial backfill.] [Do not permit compaction by water flooding or jetting.] Apply this requirement to all other areas not specifically designated above.

3.11.2 Backfill for Appurtenances

****
NOTE: The number of days the concrete is allowed to cure before backfilling the structure will depend on the type of mix and the concrete strength requirements specified. Three days would be considered as a minimum.
****

After the manhole, catchbasin, inlet, or similar structure has been constructed [and the concrete has been allowed to cure for [_____] days], place backfill in such a manner that the structure is not damaged by the shock of falling earth. Deposit the backfill material and compact as specified for final backfill, and bring up backfill evenly on all sides of the structure to prevent eccentric loading and excessive stress.

3.12 SPECIAL REQUIREMENTS

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

3.12.1 Gas Distribution

Excavate trenches to a depth that will provide a minimum 450 mm 18 inch of cover in rock excavation and a minimum 600 mm 24 inch of cover in other excavation.

3.12.2 Water Lines

****
NOTE: Minimum depth of cover will be that required for frost penetration in the region and for safe operation of the utility. For fire protection yard mains, reference is made to NFPA 24 for recommended depth of cover.
****

Provide a minimum depth for the trenches to cover [_____] meters feet from the existing ground surface, or from the indicated finished grade, whichever is lower, to the top of the pipe. [For fire protection yard mains or piping, an additional [_____] millimeters inch of cover is required.]

3.12.3 Heat Distribution System

Free initial backfill material of stones larger than 6.3 mm 1/4 inch in any dimension.

3.12.4 Electrical Distribution System

Provide a minimum cover of 600 mm 24 inch from the finished grade of direct burial cable and conduit or duct line unless otherwise indicated.

3.12.5 Sewage Absorption Trenches or Pits

****
NOTE: Delete these paragraphs when sewage absorption trenches or pits are not included in the project. Consult a geotechnical engineer and local standards in selecting bracketed information.
****

3.12.5.1 Porous Fill

Provide backfill material consisting of clean crushed rock or gravel having a gradation [such that 100 percent passes the 50 mm 2 inch sieve and zero percent passes the 12.5 mm 1/2 inch sieve.] [conforming to the requirements of gradation [4.75 mm] [No. 4] [_____] for coarse aggregate in ASTM C 33.]

3.12.5.2 Cover

****
NOTE: Select appropriate bracketed information to correspond to the design indicated on the drawings.
****

[Filter fabric] [Concrete] [Kraft paper conforming to FS A-A-203, Grade B, No. 2, 22.7 kg 50 pound weight] [or a layer of straw at least 50 mm 2 inch thick] as indicated.

3.12.6 Underdrainage Systems

****
NOTE: Consult a geotechnical engineer to determine specific grading requirements of granular filters and backfill materials and suitability of filter fabric. Include typical cross section detail of subsurface drain type or options on contract drawings.

The thickness and gradation of granular fill material for subsurface drains will be determined by soil conditions and subsoil drainage requirements.

In Table 1, choose one of the three options for each of the three types. The gradations shown on Table 1 may be altered to fit project requirements or additional gradations may be added to fit requirements of various subsurface drains within the project. The material placed adjacent to perforated pipe and open joints (without filter fabric wrapping) will be of a size that will prevent the entrance of any of the porous material into the drain. This material shall be a minimum of 150 mm (6 inch) thick on the side of the pipe where the perforations are and around all joints. Thicknesses of granular fill, especially for subsurface drains with two types of material, will be clearly shown on the drawings. Where site conditions require more than two types of granular fill for drains, the drawings will indicate the areas of different

gradation and the table will expanded using additional types to show different gradations for different locations.

****

Clean sand, crushed rock, or gravel meeting the following requirements:

****

NOTE: Check gradations against size of pipe openings. Consult a geotechnical engineer if alternate gradations (Type III) of special backfill materials are desired.

****

[a. Perforated or Slotted-Wall Pipe: Backfill meeting requirements of [Type I] material as specified in Table 1.] Place granular material as pipe is laid and extend fit for a minimum of [one] pipe diameter on each side of and 450 mm 18 inch above the top of the pipe. Place a layer of [kraft paper] [_____,] on top of granular filter before continuing with the backfill.

****

NOTE: Open-joint pipe (drain tile) will not be used for general airfield or heliport construction, drainage systems for structures, or for drains crossing or adjacent to paved areas. Open-joint pipe will be used only for subsoil drainage for drill areas, parade grounds, athletic fields, and other areas subject to lightweight vehicle traffic only, and where conditions justify its use. Consult the Government before use.

****

[b. Open Joint Pipe: [Type III] backfill consisting of both Type I and Type II materials as specified in Table 1.] Place both types of granular material specified as pipe is laid forming an aggregate filter around the pipe. Provide [Type II] material to envelope the pipe a minimum of one-half the pipe diameter or twice the maximum aggregate size, whichever is larger, on each side and on top of the pipe. Place [Type I] material next to and on top of the [Type II] material to provide a total fill extending at least [one] pipe diameter on each side of and 450 mm 18 inch above the top of the pipe. Place a layer of [kraft paper] [_____,] on top of the granular filter before continuing with the backfill.

****

NOTE: Consult with a geotechnical engineer to determine coarse aggregate size, which is dependent on the flow anticipated. Specify Type II gradation, if appropriate, or specify a special, Type III gradation. Make sure that detail of this type drain is included on the drawings.

****

[c. Blind or French Drains: Backfill consisting of [Type II] [Type III] material as specified in Table 1.]

****

NOTE: Where filter fabric is used in construction

of backfills, any type of pipe or drain is acceptable unless conditions dictate that only one be used. In critical applications filter fabric should not be used in subsurface drains adjacent to soils with 85 percent or more passing the 75 micrometers No. 200 sieve.

****

[d. Any Type Drain Used With Filter Fabric: [Clean gravel or crushed stone or gravel conforming to ASTM C 33 coarse aggregate grading size 57, 67, or 7] [fill consisting of [Type I] [or] [Type II] [Type III] material as specified in Table 1].]

(1) Perforated or Slotted Wall Pipes: Wrap one layer of filter fabric around pipe in such a manner that longitudinal overlaps are in unperforated or unslotted quadrants of the pipe. Overlap fabric a minimum of 50 mm 2 inch. Secure fabric to pipe so that backfill material does not infiltrate through overlaps. Place granular material and extend it for [one] pipe diameter, minimum of 150 mm 6 inch on each side of and 450 mm 18 inch above top of pipe. Place a layer of filter fabric on top of granular filter before continuing with backfill.

(2) Open-Joint Pipe: Wrap one layer of filter fabric around pipe joints overlapping a minimum of 50 mm 2 inch in the longitudinal direction and extending at least 150 mm 6 inch on both sides of the joint. Secure fabric to pipe so that backfill material does not infiltrate through overlaps. Place granular material specified and extend it for a minimum of [one] pipe diameter on each side of and 450 mm 18 inch above top of pipe. Place a layer of filter fabric on top of granular filter before continuing with backfill.

(3) Blind or French Drains: Install filter cloth in trenches with smoothly graded sides and bottom, free of cavities or projecting rocks. Lay the cloth flat but not stretched [and secure with anchor pins]. Place filter cloth so that drain water must pass through the cloth into the specified granular filter material. Overlap ends at least of 300 mm 12 inch. Place backfill on filter cloth in the direction of overlaps. Where fabric is damaged, place a new piece of filter cloth over damaged area and overlap at least of 300 mm 12 inch in every direction.

****

NOTE: Select the applicable paragraph(s) from the following.

The thickness and gradation of granular fill material for subsurface drains will be determined by soil conditions and subsoil drainage requirements.

In Table 1, choose one of the three options for each of the three types. The gradations shown on Table 1 may be altered to fit project requirements or additional gradations may be added to fit requirements of various subsurface drains within the project. The material placed adjacent to perforated pipe and open joints (without filter fabric wrapping) will be of a size that will prevent the

entrance of any of the porous material into the drain. This material shall be a minimum of 150 mm 6 inch thick on the side of the pipe where the perforations are and around all joints. Thicknesses of granular fill, especially for subsurface drains with two types of material, will be clearly shown on the drawings. Where site conditions require more than two types of granular fill for drains, the drawings will indicate the areas of different gradation and the table will expanded using additional types to show different gradations for different locations.

****

TABLE 1

[[ASTM D 422 Sieve Size]	[Type I [Gradation E 11 ASTM C 33] Percent Passing]	Type II [Gradation 57 ASTM C 33] Percent Passing]	Type III [Gradation [_____] [_____]]] Percent Passing]
37.5 mm	--	100	[_____]
25.0 mm	--	90 - 100	[_____]
9.5 mm	100	25 - 60	[_____]
4.75 mm	95 - 100	5 - 40	[_____]
2.36 mm	--	0 - 20	[_____]
1.18 mm	45 - 80	--	[_____]
300 micrometers	10 - 30	--	[_____]
150 micrometers	0 - 10	--	[_____]]

TABLE 1

[[ASTM D 422 Sieve Size]	[Type I [Gradation E 11 ASTM C 33] Percent Passing]	Type II [Gradation 57 ASTM C 33] Percent Passing]	Type III [Gradation [_____]] [_____]] Percent Passing]
1.5 inch	--	100	[_____]
1 inch	--	90 - 100	[_____]
3/8 inch	100	25 - 60	[_____]
No. 4	95 - 100	5 - 40	[_____]
No. 8	--	0 - 20	[_____]
No. 16	45 - 80	--	[_____]
No. 50	10 - 30	--	[_____]
No. 100	0 - 10	--	[_____]]

3.12.7 Pipeline Casing

Provide new smooth wall steel pipeline casing under [new] [existing] [railroad] [and] [pavement] [in a trench] [by the boring and jacking method of installation]. Provide each new pipeline casing, where indicated and to the lengths and dimensions shown, complete and suitable for use with the new piped utility as indicated. [Install pipeline casing by dry boring and jacking method as follows:]

3.12.7.1 Bore Holes

Mechanically bore holes and case through the soil with a cutting head on a continuous auger mounted inside the casing pipe. Weld lengths of pipe together in accordance with AWS D1.1/D1.1M. Do not use water or other fluids in connection with the boring operation.

3.12.7.2 Cleaning

Clean inside of the pipeline casing of dirt, weld splatters, and other foreign matter which would interfere with insertion of the piped utilities by attaching a pipe cleaning plug to the boring rig and passing it through the pipe.

3.12.7.3 End Seals

After installation of piped utilities in pipeline casing, provide watertight end seals at each end of pipeline casing between pipeline casing and piping utilities. Provide watertight [end seals as indicated.] [segmented elastomeric end seals.]

3.12.8 Rip-Rap Construction

****
NOTE: Select information in brackets to best describe rip-rap construction. Provide detail or typical section through rip-rap on drawings as well as all dimensions necessary for estimating and construction. If DOT standard specifications are referenced for rip-rap construction, paragraphs entitled "Preparation" through "Grouting" may be deleted.
****

Construct rip-rap [on bedding material] [on filter fabric] [with grout] [in accordance with [DOT] [_____] State Standard, paragraph [_____]] in the areas indicated. Trim and dress indicated areas to conform to cross sections, lines and grades shown within a tolerance of 30 mm 0.1 foot.

3.12.8.1 Bedding Placement

Spread [filter fabric] bedding material uniformly to a thickness of at least [75] [_____] mm [3] [_____] inch on prepared subgrade as indicated. [Compaction of bedding is not required. Finish bedding to present even surface free from mounds and windrows.]

3.12.8.2 Stone Placement

Place rock for rip-rap on prepared bedding material to produce a well graded mass with the minimum practicable percentage of voids in conformance with lines and grades indicated. Distribute larger rock fragments, with dimensions extending the full depth of the rip-rap throughout the entire mass and eliminate "pockets" of small rock fragments. Rearrange individual pieces by mechanical equipment or by hand as necessary to obtain the distribution of fragment sizes specified above. [For grouted rip-rap, hand-place surface rock with open joints to facilitate grouting and do not fill smaller spaces between surface rock with finer material. Provide at least one "weep hole" through grouted rip-rap for every 4.65 square meters

50 square feet of finished surface. Provide weep holes with columns of bedding material, 100 mm 4 inch in diameter, extending up to the rip-rap surface without grout.]

3.12.8.3 Grouting

[Prior to grouting, wet rip-rap surfaces. Grout rip-rap in successive longitudinal strips, approximately 3 m 10 feet in width, commencing at the lowest strip and working up the slope. Distribute grout to place of final deposit and work into place between stones with brooms, spades, trowels, or vibrating equipment. Take precautions to prevent grout from penetrating bedding layer. Protect and cure surface for a minimum of 7 days.]

3.13 EMBANKMENTS

3.13.1 Earth Embankments

****

NOTE: Moisture content limits for compaction should be included in these paragraphs when necessary for obtaining strength and stability in embankments and fill, for controlling movement of expansive soils and when, in the opinion of the project geotechnical engineer, moisture control is required for the soils being used.

****

Construct earth embankments from satisfactory materials free of organic or frozen material and rocks with any dimension greater than 75 mm 3 inch. Place the material in successive horizontal layers of loose material not more than [_____] mm[_____] inch in depth. Spread each layer uniformly on a soil surface that has been moistened or aerated as necessary, and scarified or otherwise broken up so that the fill will bond with the surface on which it is placed. After spreading, plow, disk, or otherwise break up each layer; moisten or aerate as necessary; thoroughly mix; and compact to at least 90 percent laboratory maximum density for cohesive materials or 95 percent laboratory maximum density for cohesionless materials. Compaction requirements for the upper portion of earth embankments forming subgrade for pavements identical with those requirements specified in paragraph SUBGRADE PREPARATION. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment.

3.13.2 Rock Embankments

****

NOTE: The designer will determine the appropriate values for all blank spaces, except the last one, on the basis of recent experience on similar construction or of test results obtained from construction and testing of a test section. The specific method by which density will be determined in the laboratory and measured in the field will be described in the project specification. The total thickness of the pavement structure, including select material subbase, base, and pavement will be placed in the last blank space in this paragraph.

The first blank space applies to rock fill of small

maximum dimension and maximum lift placement of 200 to 250 mm 8 to 10 inch. Coordinate maximum size with satisfactory material definition. If it is necessary to use larger rock and thicker lifts, the second expression in brackets is applicable. When thicker lifts are used, it may be necessary to specify a minimum number of passes of the compactor. Delete last sentence, unless the rock excavation is engineered to be used under pavements with sufficient fines to prevent consolidation of the embankment.

****

Construct rock embankments from material classified as rock excavation, as defined above, placed in successive horizontal layers of loose material not more than [_____] mm [_____] inch in depth. Do not use pieces of rock larger than [_____] mm [_____] inch in the greatest dimension. Spread each layer of material uniformly, completely saturate, and compact to a minimum density of [_____] kg/cubic meter [_____] pcf. Adequately bond each successive layer of material to the material on which it is placed. Finish compaction with vibratory compactors weighing at least [_____] metric tons, [_____] tons, heavy rubber-tired rollers weighing at least [_____] metric tons, [_____] tons, or steel-wheeled rollers weighing at least [_____] metric tons [_____] tons. [Do not use rock excavation as fill material for the construction of pavements.] [In embankments on which pavements are to be constructed, do not use rock above a point [_____] mm inch below the surface of the pavement.]

3.14 SUBGRADE PREPARATION

3.14.1 Proof Rolling

****

NOTE: Specify proof rolling when the quality of the existing subgrade is questionable. Proof rolling can be used to verify that no unsatisfactory material is present (no bid quantity required, location shown or specified) or to locate suspected unsatisfactory material (indicate a bid quantity to be removed). Remove this paragraph if not required in the project.

****

Finish proof rolling on an exposed subgrade free of surface water (wet conditions resulting from rainfall) which would promote degradation of an otherwise acceptable subgrade. [After stripping,] proof roll the existing subgrade of the [_____] with six passes of a [dump truck loaded with 6 cubic meters 4 cubic yards of soil][13.6 meter tons 15 ton, pneumatic-tired roller.] Operate the [roller] [truck] in a systematic manner to ensure the number of passes over all areas, and at speeds between 4 to 5.5 km/hour 2-1/2 to 3-1/2 mph. [When proof rolling, provide one-half of the passes made with the roller in a direction perpendicular to the other passes.] Notify the Contracting Officer a minimum of 3 days prior to proof rolling. Perform proof rolling in the presence of the Contracting Officer. Undercut rutting or pumping of material [as directed by the Contracting Officer] [to a depth of [_____] mm inch] and replace with [fill and backfill] [select] material. [Prepare bids based on replacing approximately [_____] square meters square yards, with an average depth of [_____] mm [_____] inch at various locations.]

3.14.2 Construction

****
NOTE: Moisture content limits for compaction should be included in these paragraphs when necessary for obtaining strength and stability in embankments and fill, for controlling movement of expansive soils and when, in the opinion of the project geotechnical engineer, moisture control is required for the soils being used.

Special smoothness tolerances are not required for subgrades for railroads; therefore, both sets of brackets will be removed when writing specifications for preparation of railroad subgrade only. When writing specifications for preparation of roadway and/or airfield pavement subgrade, the brackets will be removed from the applicable sentences and the smoothness tolerances showing permissible deviations in fractions of a millimeter inch and the length of straightedge in meters (feet) will be inserted in the blanks as appropriate.
****

Shape subgrade to line, grade, and cross section, and compact as specified. Include plowing, disking, and any moistening or aerating required to obtain specified compaction for this operation. Remove soft or otherwise unsatisfactory material and replace with satisfactory excavated material or other approved material as directed. Excavate rock encountered in the cut section to a depth of 150 mm 6 inch below finished grade for the subgrade. Bring up low areas resulting from removal of unsatisfactory material or excavation of rock to required grade with satisfactory materials, and shape the entire subgrade to line, grade, and cross section and compact as specified. [After rolling, do not show deviations for the surface of the subgrade for roadways greater than [_____] mm [_____] inch when tested with a [_____] meter [_____] foot straightedge applied both parallel and at right angles to the centerline of the area.] [After rolling, do not show deviations for the surface of the subgrade for airfields greater than [_____] mm [_____] inch when tested with a [_____] meter [_____] foot straightedge applied both parallel and at right angles to the centerline of the area.] Do not vary the elevation of the finish subgrade more than 15 mm 0.05 foot from the established grade and cross section.

3.14.3 Compaction

****
NOTE: Use 90 percent of ASTM D 698 or ASTM D 1557 for General Site Compaction of cohesionless materials on Army projects and 85 percent of same for Navy projects. For Army projects see TM 5-818-1, TM 5-818-7, TM 5-825-2 and DM 21.3 for criteria and design guidelines. Specify most jobs using ASTM D 698 compaction, except for roads, airfields, and other heavily loaded areas, which should use ASTM D 1557 compaction. Specify compaction in terms of one compaction effort (ASTM D 698 or ASTM D 1557), if possible.
****

Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment. Except for paved areas and railroads, compact each layer of the embankment to at least [_____] percent of laboratory maximum density.

3.14.3.1 Subgrade for Railroads

Compact subgrade for railroads to at least 90 percent laboratory maximum density for cohesive materials or 95 percent laboratory maximum density for cohesionless materials.

3.14.3.2 Subgrade for Pavements

****

NOTE: If the compaction requirements are not shown in tabular form on the drawings, and the paragraphs as written are not adequate, paragraphs Subgrade for Pavements and Subgrade for Shoulders will be rewritten as follows:

Subgrade for [pavements] [and] [shoulders] shall be compacted to at least the percentage of laboratory maximum density in the following table for the specific depths below the surface of the [pavement] [or] [shoulders] shown.

Depth Below Pavement (or Shoulder) Surface

Percentage of Laboratory Maximum Density Required

		mm Inch Fill		**mm Inch Cut**	
From	**To**	**Cohesive Materials**	**Cohesionless Materials**	**Cohesive Materials**	**Cohesionless Materials**
______	____	____________	_______________	____________	____________

The desired depths and density percentages will be entered in the table in accordance with applicable data from the following manuals, as appropriate: TM 5-822-5, TM 5-825-2, and TM-5-825-3

****

Compact subgrade for pavements to at least [_____] percentage laboratory maximum density for the depth below the surface of the pavement shown. When more than one soil classification is present in the subgrade, thoroughly blend, reshape, and compact the top [_____] mm [_____] inch of subgrade.

3.14.3.3 Subgrade for Shoulders

Compact subgrade for shoulders to at least [_____] percentage laboratory maximum density for the [depth below the surface of shoulder shown] [full

depth of the shoulder].

3.14.3.4 Subgrade for Airfield Pavements

Compact top 600 mm 24 inch below finished pavement or top 300 mm 12 inch of subgrades, whichever is greater, to [100] [_____] percent of ASTM D 1557; compact fill and backfill material to [100] [_____] percent of ASTM D 1557.

3.15 SHOULDER CONSTRUCTION

****
NOTE: Shoulder construction will form a part of the work to be performed under this section of the specifications except when shoulder construction is specified under the subbase, base-course, wearing course, or pavement sections of the specifications and is designated in the contract to be performed and paid for under one of these sections.
****

Construct shoulders of satisfactory excavated or borrow material or as otherwise shown or specified. Construct shoulders immediately after adjacent paving is complete. In the case of rigid pavements, do not construct shoulders until permission of the Contracting Officer has been obtained. Compact the entire shoulder area to at least the percentage of maximum density as specified in paragraph SUBGRADE PREPARATION above, for specific ranges of depth below the surface of the shoulder. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment. Finish shoulder construction in proper sequence in such a manner that adjacent ditches will be drained effectively and that no damage of any kind is done to the adjacent completed pavement. Align the completed shoulders true to grade and shaped to drain in conformity with the cross section shown.

3.16 FINISHING

Finish the surface of excavations, embankments, and subgrades to a smooth and compact surface in accordance with the lines, grades, and cross sections or elevations shown. Provide the degree of finish for graded areas within 30 mm 0.1 foot of the grades and elevations indicated except that the degree of finish for subgrades specified in paragraph SUBGRADE PREPARATION. Finish gutters and ditches in a manner that will result in effective drainage. Finish the surface of areas to be turfed from settlement or washing to a smoothness suitable for the application of turfing materials. Repair graded, topsoiled, or backfilled areas prior to acceptance of the work, and re-established grades to the required elevations and slopes.

3.16.1 Subgrade and Embankments

During construction, keep embankments and excavations shaped and drained. Maintain ditches and drains along subgrade to drain effectively at all times. Do not distrub the finished subgrade by traffic or other operation.The Contractor is responsible for protecting and maintaining the finished subgrade in a satisfactory condition until ballast, subbase, base, or pavement is placed. Do not permit the storage or stockpiling of materials on the finished subgrade. Do not lay subbase, base course, ballast, or pavement until the subgrade has been checked and approved, and in no case place subbase, base, surfacing, pavement, or ballast on a muddy,

spongy, or frozen subgrade.

3.16.2 Capillary Water Barrier

****
NOTE: The compacted thickness of capillary water barrier will be indicated and will not be less than 100 mm 4 inch. The paragraph will be deleted where site conditions make the barrier unnecessary.
****

Place a capillary water barrier under concrete floor and area-way slabs grade directly on the subgrade and compact with a minimum of two passes of a hand-operated plate-type vibratory compactor.

3.16.3 Grading Around Structures

Construct areas within 1.5 m 5 feet outside of each building and structure line true-to-grade, shape to drain, and maintain free of trash and debris until final inspection has been completed and the work has been accepted.

3.17 PLACING TOPSOIL

****
NOTE: Topsoil will be separated, excavated, stored, and used for surface finish in preparation for seeding, sodding, or other planting only where the topsoil is definitely superior for grass and other plant growth as compared to the balance of the excavated materials. Generally, topsoil will be spread after other operations have been completed. When topsoil spreading is covered under a separate section of the specifications, this paragraph will be deleted.
****

On areas to receive topsoil, prepare the compacted subgrade soil to a 50 mm 2 inch depth for bonding of topsoil with subsoil. Spread topsoil evenly to a thickness of [_____] mm [_____] inch and grade to the elevations and slopes shown. Do not spread topsoil when frozen or excessively wet or dry. Obtain material required for topsoil in excess of that produced by excavation within the grading limits from [offsite areas] [areas indicated].

3.18 TESTING

****
NOTE: Density tests other than those specified in this paragraph may be required for certain types of soil, in which case paragraph "Degree of Compaction" will be edited accordingly and the laboratory compaction requirement applicable to the soil encountered will be specified. See TM 5-825-2 for a discussion of conditions requiring nonstandard compaction control tests.
****

Perform testing by an approved commercial testing laboratory or by the Contractor subject to approval. If the Contractor elects to establish testing facilities, do not permit work requiring testing until the

Contractor's facilities have been inspected and approved by the Contracting Officer. Determine field in-place density in accordance with [ASTM D 1556] [ASTM D 2167] [ASTM D 2922]. [When ASTM D 2922 is used, check the calibration curves and adjust using only the sand cone method as described in ASTM D 1556. ASTM D 2922 results in a wet unit weight of soil to determine the moisture content of the soil when using this method ASTM D 3017. Check the calibration curves furnished with the moisture gauges along with density calibration checks as described in ASTM D 3017; check the calibration of both the density and moisture gauges at the beginning of a job on each different type of material encountered and at intervals as directed by the Contracting Officer.] [ASTM D 2937, Use the Drive Cylinder Method only for soft, fine-grained, cohesive soils.] When test results indicate, as determined by the Contracting Officer, that compaction is not as specified, remove the material, replace and recompact to meet specification requirements. Perform tests on recompacted areas to determine conformance with specification requirements. Appoint a registered professional civil engineer to certify inspections and test results. These certifications shall state that the tests and observations were performed by or under the direct supervision of the engineer and that the results are representative of the materials or conditions being certified by the tests. The following number of tests, if performed at the appropriate time, will be the minimum acceptable for each type operation.

3.18.1 Fill and Backfill Material Gradation

One test per [_____] cubic meters [_____] cubic yards stockpiled or in-place source material. Determine gradation of fill and backfill material in accordance with [ASTM C 136] [ASTM D 422] [ASTM D 1140].

3.18.2 In-Place Densities

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NOTE: Density test frequency can vary from one test per 10 square meter (100 square feet) for small areas up to one test per 900 square meter (10,000 square feet). The following table will also help establish test frequency for various situations:

Material Type	Location of Material	Test Frequency
Undisturbed native soil	Structures	Two random tests in building footings and two tests on subgrade within building line.
Fills and backfills	Structures (adjacent to)	One test per structure per 200 sq. m taken 300 mm below finished grade.
Subgrades	Site (except airfields)	One test per lift per 250 sq. m
Embankments or borrow	Any	One test per lift per 400 cubic m placed.
Native soil subgrade other than	Any	One test or one test per 900 sq. m whichever is greater.

Material Type	Location of Material	Test Frequency
structures and parking		
Borrow	Any	One test per lift per 400 cubic m placed.

Material Type	Location of Material	Test Frequency
Undisturbed native soil	Structures	Two random tests in building footings and two tests on subgrade within building line.
Fills and backfills	Structures (adjacent to)	One test per structure per 2,000 sq. ft taken 12 inch below finished grade.
Subgrades	Site (except airfields)	One test per lift per 2,500 sq. ft
Embankments or borrow	Any	One test per lift per 500 cubic yds placed.
Native soil subgrade other than structures and parking	Any	One test or one test per 10,000 sq. ft, whichever is greater.
Borrow	Any	One test per lift per 500 cubic yds placed.

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a. One test per [_____] square meters, [_____] square feet, or fraction thereof, of each lift of fill or backfill areas compacted by other than hand-operated machines.

b. One test per [_____] square meters, feet, or fraction thereof, of each lift of fill or backfill areas compacted by hand-operated machines.

c. One test per [_____] linear meters, feet, or fraction thereof, of each lift of embankment or backfill for [roads] [airfields].

d. One test per [_____] linear meters, feet, or fraction thereof, of each lift of embankment or backfill for railroads.

3.18.3 Check Tests on In-Place Densities

If ASTM D 2922 is used, check in-place densities by ASTM D 1556 as follows:

a. One check test per lift for each [_____] square meters, feet, or fraction thereof, of each lift of fill or backfill compacted by other than hand-operated machines.

b. One check test per lift for each [_____] square meters, feet, of fill or backfill areas compacted by hand-operated machines.

c. One check test per lift for each [_____] linear meters, feet, or fraction thereof, of embankment or backfill for [roads] [airfields].

d. One check test per lift for each [_____] linear meters, feet, or fraction thereof, of embankment or backfill for railroads.

3.18.4 Moisture Contents

In the stockpile, excavation, or borrow areas, perform a minimum of two tests per day per type of material or source of material being placed during stable weather conditions. During unstable weather, perform tests as dictated by local conditions and approved by the Contracting Officer.

3.18.5 Optimum Moisture and Laboratory Maximum Density

Perform tests for each type material or source of material including borrow material to determine the optimum moisture and laboratory maximum density values. One representative test per [_____] cubic meters yards of fill and backfill, or when any change in material occurs which may affect the optimum moisture content or laboratory maximum density.

3.18.6 Tolerance Tests for Subgrades

Perform continuous checks on the degree of finish specified in paragraph SUBGRADE PREPARATION during construction of the subgrades.

3.18.7 Displacement of Sewers

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NOTE: The trench should be backfilled to at least 600 mm (2 feet).

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After other required tests have been performed and the trench backfill compacted to [[_____] meters [_____] feet above the top of the pipe] [the finished grade surface], inspect the pipe to determine whether significant displacement has occurred. Conduct this inspection in the presence of the Contracting Officer. Inspect pipe sizes larger than 900 mm 36 inch, while inspecting smaller diameter pipe by shining a light or laser between manholes or manhole locations, or by the use of television cameras passed through the pipe. If, in the judgement of the Contracting Officer, the interior of the pipe shows poor alignment or any other defects that would cause improper functioning of the system, replace or repair the defects as directed at no additional cost to the Government.

3.19 DISPOSITION OF SURPLUS MATERIAL

Provide surplus material or other soil material not required or suitable

for filling or backfilling, and brush, refuse, stumps, roots, and timber as [wasted in Government disposal area [indicated] [which is located within a haul distance of [_____] km miles]] [removed from Government property as directed by the Contracting Officer].

-- End of Section --