

SECTION 31 00 00

EARTHWORK

PART 1 GENERAL

1.1 Related Requirements (LEED)

Section 01 35 43.98 ENVIRONMENTAL PROTECTION PROCEDURES for disposal of construction and demolition waste.

Section 32 92 19 SEEDING for topsoil placement.

Section 32 93 00 EXTERIOR PLANTS for planting soil mixture placement.

1.2 CRITERIA FOR BIDDING

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. Dewatering is the responsibility of the contractor regardless of when water is encountered.

1.3 REFERENCES

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

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
(AASHTO)

AASHTO T 103	(2008) Standard Method of Test for Soundness of Aggregates by Freezing and Thawing
AASHTO T 180	(2010) Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop
AASHTO T 2	(2000) Sampling of Aggregates
AASHTO T 224	(2001; R 2004) Correction for Coarse Particles in the Soil Compaction Test
AASHTO T 87	(1986; R 2000) the Dry Preparation of Disturbed Soil and Soil Aggregate Samples for Test

ASTM INTERNATIONAL (ASTM)

ASTM C 117	(2004) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 131	(2006) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C 88	(2005) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM D 1140	(2000; R 2006) Amount of Material in Soils Finer than the No. 200 (75-micrometer) Sieve
ASTM D 1556	(2007) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(2009) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft ³) (2700 kN-m/m ³)
ASTM D 2216	(2010) Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 2487	(2006e1) Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 2922	(2005) Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 2940/D 2940M	(2009) Standard Specification for Graded Aggregate Material for Bases or Subbases for Highways or Airports
ASTM D 422	(1963; R 2007) Particle-Size Analysis of Soils
ASTM D 4318	(2010) Liquid Limit, Plastic Limit, and Plasticity Index of Soils

STATE OF OHIO DEPARTMENT OF TRANSPORTATION (ODOT)

ODOT	(2008) Construction and Material Specifications
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1.4 DEFINITIONS FOR GENERAL EARTHWORK

1.4.1 Satisfactory Materials

Satisfactory materials comprise any materials classified by ASTM D 2487 as GW, GP, GM, GP-GM, GW-GM, SW, SP, SM, SW-SM, SP-SM, CL, ML, and CL-ML. Satisfactory materials for grading comprise stones less than 8 inches, except for fill material for pavements which comprise stones less than 3 inches in any dimension. Satisfactory materials for filling and backfilling comprise fill materials able to be compacted as specified and approved by the geotechnical engineer for the specific purpose.

1.4.2 Unsatisfactory 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 when encountering any contaminated materials.

1.4.3 Cohesionless and Cohesive Materials

Cohesionless materials include materials classified in ASTM D 2487 as GW, GP, SW, and SP. Cohesive materials include materials classified as GC, SC, ML, and CL. Materials classified as GM and SM will be identified as cohesionless only when the fines are nonplastic. Perform 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

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

1.4.5 Topsoil

All topsoil shall be stockpiled and used in grass areas per ODOT Item 651.02. Material suitable for topsoils obtained from excavations is defined as: Natural, friable soil representative of productive, well-drained soils in the area, free of subsoil, stumps, rocks larger than 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. All preparation of topsoil areas to be per ODOT Item 659.10. All landscape bed areas and parking lot grass islands shall use natural screened topsoil approved by NASA and NASA testing requirements.

1.4.6 Rock

Solid homogeneous interlocking crystalline material with firmly cemented,

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

1.4.7 Unstable Material

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

1.4.8 Select Granular Material

1.4.8.1 General Requirements

All aggregate to meet ODOT 703 and must be limestone, except slag will not be permitted.

1.4.9 Initial Backfill Material

Initial backfill consists of select granular material or satisfactory materials free from rocks 3 inches 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 3 inches in any dimension or as recommended by the pipe manufacturer, whichever is smaller.

1.4.10 Soils

All earthwork activities shall be per ODOT Items 203 and 204 wherever applicable.

1.5 SYSTEM DESCRIPTION

Subsurface soil boring logs and subsoil investigation report are appended to the SPECIAL CONTRACT REQUIREMENTS. The data represents the best subsurface information available; however, variations may exist in the subsurface between boring locations. This information is provided for informational purposes only.

1.5.1 Classification of Excavation

Finish the specified excavation on a classified basis, in accordance with the following designations and classifications.

1.5.1.1 Common Excavation

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

1.5.2 Blasting

Blasting will not be permitted.

1.5.3 Dewatering Work Plan

Submit procedures for accomplishing dewatering work.

1.6 SUBMITTALS

Government approval is required for all submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Utilization of Excavated Materials
 Opening of any Excavation or Borrow Pit

Procedure and location for disposal of unused satisfactory material. Proposed source of borrow material. Advance notice on the opening of excavation or borrow areas.

SD-06 Test Reports

Testing; G
 Borrow Site Testing; G

Within 24 hours of conclusion of physical tests, 6 copies of test results, including calibration curves and results of calibration tests. Results of testing at the borrow site.

SD-07 Certificates

Testing; G

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

Qualifications of Contractor's geotechnical engineer.

1.7 SAMPLING AND TESTING

1.7.1 Tests for Proposed Soil Materials

Materials shall be approved by the Contracting Officer prior to start of work.

Soil materials proposed for use in the work shall be tested as follows.

<u>MATERIAL</u>	<u>REQUIREMENT</u>	<u>TEST METHOD</u>	<u>NUMBER OF TESTS</u>
Satis- factory soil materials	Sampling	AASHTO T 2	One from each source of materials to determine con- formance to definition of satisfactory soil materials; additional tests whenever there is any apparent change
	Preparation of samples	AASHTO T 87	
	Sieve analysis is of fine and coarse aggre- gates	ASTM C 136	

<u>MATERIAL</u>	<u>REQUIREMENT</u>	<u>TEST METHOD</u>	<u>NUMBER OF TESTS</u>
	Amount of material passing No. 200 sieve	ASTM C 117	
	Liquid limit	ASTM D 4318	
	Plastic limit and plasticity index	ASTM D 4318	
	Mechanical analysis	ASTM D 422	
	Moisture-density relations	ASTM D 1557	As required to determine moisture-density requirement of materials from each source
	Los Angeles abrasion of coarse aggregates	ASTM C 131	One for each soil material from each source if called for in reference specification
	Freezing and thawing soundness of aggregates	AASHTO T 103	
	Magnesium Sulfate Soundness Test	ASTM C 88	

1.7.2 Quality Control Testing During Construction

Soil materials shall be tested during construction as follows:

<u>MATERIAL</u>	<u>REQUIREMENT</u>	<u>TEST METHOD</u>	<u>NUMBER OF TESTS</u>
Soil materials specified	Sieve analysis of fine and coarse aggregates	ASTM C 136	One daily for each soil material from each source; additional test whenever there is any apparent change
	Amount of material passing No. 200	ASTM C 117	

<u>MATERIAL</u>	<u>REQUIREMENT</u>	<u>TEST METHOD</u>	<u>NUMBER OF TESTS</u>
	sieve		
	Moisture content of subbase material	ASTM D 2216	
Soil materials prior to compaction	Moisture-density relations of soil	ASTM D 1557	One of each type of subgrade soil material except under backfill for structures; one for each backfill and fill material from each source
Soil material-in-place after compaction	Density of soil-in-place	ASTM D 1556, Sand Cone Method or ASTM D 2922, Nuclear Method (when approved by Contracting Officer)	At least three daily for each subgrade soil material and for each layer of backfill and fill material; additional test whenever there is any change in moisture conditions

1.7.3 Test Reports

No soil material shall be used until test reports have been reviewed and approved.

1.7.4 Evaluation of Test Results

Results of density of soil-in-place tests shall be considered satisfactory if the average of any group of four consecutive density tests which may be selected is in each instance equal to or greater than the specified density, and if not more than one density test in five has a value more than 2 percentage points below the specified density.

PART 2 PRODUCTS

2.1 OFFSITE SOILS

2.1.1 Requirements for Office Soils

All testing shall conform to NASA Environmental and SHED standards. The testing for the soil shall be per contractor at no additional cost to the Government. All testing and offsite soil shall be approved by NASA. Do not bring material onsite until tests have been approved by the Contracting Officer.

2.1.2 Environment Testing Requirements

Contractor shall provide the source of the soil. If the soil is taken from multiple areas and then taken to the suppliers site to manufacture soil then a list of locations that the soil was sourced from will be required.

Contractor shall provide chemical analysis of the soil coming into NASA GRC. The parameters that the soil shall be tested for are as follows:

- Volatile Organic Compounds (VOCs)
- Semi-Volatile Organic Compounds (SVOCs)
- RCRA Metals
- Polychlorinated Biphenyl (PCBs)

For non-manufactured soil from a single virgin source, existing soil analysis data may be used if it meets the list of analysis parameters above. If no analytical data exists, the contractor may need to have a sample analyzed for the parameters listed above. If Phase 1 Environmental Site Assessment (ESA) and Phase 2 ESA reports exist then this data may be supplied to NASA for review to determine if the soil meets NASA GRC's Environmental Standards. If data is not acceptable by NASA GRC, soil tests must be completed at no additional cost to the government.

NASA GRC base line levels in Appendix "Z". Levels must be less than or equal to numbers provided.

2.2 SOIL MATERIALS

2.2.1 RIP-RAP

All material shall conform to ODOT Item 600; however no concrete shall be used.

2.2.2 Bedding Material

All items shall meet ODOT specifications. Stone backfill shall conform to ODOT 703.01. All sand shall conform to ODOT 703.06.

2.2.3 Engineered Fill

Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; with at least 90 percent passing a 1-1/2 inch sieve and not more than 12 percent passing a No. 200 sieve.

PART 3 EXECUTION

3.1 STRIPPING OF TOPSOIL

Where indicated or directed, completely strip topsoil. 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 2 inch in diameter, and other materials that would interfere with planting and maintenance operations. Stockpile in locations indicated any surplus of topsoil from excavations and gradings.

3.2 FILLING OF SITE

3.2.1 Preparation of Ground Surface to Receive Fill

Vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials shall be removed from ground surface prior to the placement of fills. Sloped surfaces steeper than 1 vertical to 4 horizontal shall be plowed, stripped, or broken up in such manner that fill material will bond with the existing material.

When the ground surface has a density less than that specified for the particular area classification, the ground surface shall be broken up, pulverized, moisture-conditioned to near optimum moisture content of the soil material, and compacted to the required depth and percentage of maximum density.

3.2.2 Placement and Compaction

Fill materials shall be placed in layers not more than 8 inches in loose depth. Before compaction, each layer of fill material shall be moistened or aerated as necessary to provide the optimum moisture content of the soil material and shall then be compacted to the percentage of maximum density for each area classification as specified. Testing is required for each lift. Fill material shall not be placed on surfaces that are muddy, frozen, icy, or contain frost.

Place and compact fill material in layers to required elevations as follows:

Under grass and planted areas, use satisfactory soil material.

Under walks and pavements, use satisfactory soil material.

Under steps and ramps, use satisfactory soil material.

Under building footprint, use satisfactory soil material.

Under footings and foundations, use satisfactory soil material.

Fill materials adjacent to structures shall be brought up evenly around structures and shall be carried up to the indicated elevations.

Compaction adjacent to structures, within a horizontal distance from the face of the structure equal to the depth of fill material (measured from the bottom of footing or bottom of foundation or retaining wall) to final grade, shall be done with power-driven hand tampers.

3.3 GENERAL EXCAVATION

Perform excavation of every type of material encountered within the limits of the project to the lines, grades, and elevations indicated and as specified. Perform the grading in accordance with the typical sections shown and the tolerances specified in paragraph FINISHING. Transport satisfactory excavated materials and place in fill or embankment within the limits of the work. Excavate unsatisfactory materials encountered within the limits of the work below grade and replace with satisfactory materials as 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.

3.3.1 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 grading plan. Do not excavate ditches and gutters below grades shown. Backfill the excessive open ditch or gutter excavation with satisfactory, thoroughly compacted, material or with suitable stone or cobble to grades shown. Dispose excavated material as shown or as directed, except in no case allow material be deposited a maximum 4 feet from edge of a ditch. Maintain excavations free from detrimental quantities of leaves, brush, sticks, trash, and other debris until final acceptance of the work.

3.3.2 Drainage Structures

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. 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 excavate to the final grade level until just before the concrete or masonry is to be placed.

3.3.3 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 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.

3.3.4 Dewatering

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 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 2 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.

3.3.5 Underground Utilities

The Contractor is responsible for movement of construction machinery and equipment over pipes and utilities during construction. Contractor is required to contact NASA to mark all utilities prior to commencing site work. 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. Damage to Government utility/property by the contractor due to heavy equipment shall be repaired to the satisfaction of the Government and at no cost to the Government.

3.3.6 Structural Excavation

Ensure that footing subgrades have been inspected and approved by the Geotechnical Engineer and Contracting Officer prior to concrete placement.

3.4 SELECTION OF BORROW MATERIAL

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

3.5 OPENING AND DRAINAGE OF EXCAVATION

Notify the Contracting Officer sufficiently in advance of the opening of any excavation to permit elevations and measurements of the undisturbed ground surface to be taken. Except as otherwise permitted, excavate excavation areas providing adequate drainage. Transport overburden and other spoil material to designated spoil areas or otherwise dispose of as directed. Ensure that excavation of any area, operation of borrow pits, or dumping of spoil material results in minimum detrimental effects on natural environmental conditions.

3.6 GEOTECHNICAL ENGINEER

Hire a Professional Geotechnical Engineer licensed in the State of Ohio 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.

3.7 GRADING AREAS

Where indicated, divide work into grading areas within which satisfactory excavated material will 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 materials as specified. A Soil Relocation Permit will be required. 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; separately stockpile excavated satisfactory and unsatisfactory materials. 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.

3.8 FINAL GRADE OF SURFACES TO SUPPORT CONCRETE

Do not excavate to final grade until just before concrete is to be placed. Only use 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 water flow.

3.9 GROUND SURFACE PREPARATION

3.9.1 General Requirements

Remove and replace unsatisfactory material with satisfactory materials, as directed by the Contracting Officer, in surfaces to receive fill or in excavated areas. Scarify the surface to a depth of 6 inch before the fill is started. Plow, step, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so that the fill material will bond with the existing material. When subgrades are less than the specified density, break up the ground surface to a minimum depth of 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 12 inch and compact it as specified for the adjacent fill.

3.9.2 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 2 percent of optimum moisture.

3.10 UTILIZATION OF EXCAVATED MATERIALS

Dispose unsatisfactory materials removing from excavations into 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 of satisfactory material, authorized to be wasted, 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.

3.11 COMPACTION OF SOIL FILLS

Place fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

Compact soil materials to not less than the following percentages of maximum dry unit weight according to Paragraph 1.4.4 Degree of Compaction.

Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of fill soil material at 98 percent.

Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of fill soil material at 95 percent.

Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of fill soil material at 90 percent.

3.11.1 Moisture Control

Moisture content in soil material at time of compaction shall be within limits specified.

Where the moisture content of a layer of soil material is below optimum before compaction, the required amount of water shall be uniformly applied to the surface of the layer of soil material and the layer of soil disked or otherwise mixed until a uniform moisture content is reached.

Moisture of a layer of soil material that is above optimum shall be removed by drying.

3.12 EARTHWORK EMBANKMENTS

Construct earth embankments from satisfactory materials free of organic or frozen material and rocks with any dimension greater than 3 inches. Place the material in successive horizontal layers of loose material not more than 8 inches 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 as indicated above. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment.

3.13 SUBGRADE PREPARATION

3.13.1 Proof Rolling

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. Proof roll the existing subgrade with six passes of a 20 ton tandem axle dump truck at speeds between 2.5-3.5 mph. Notify the Geotechnical Engineer and 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 and replace with fill and backfill with fabric and 1's and 2's 6" thick. Prepare bids based on replacing approximately 100 square yards, with an average depth of 6 inch at various locations.

3.13.2 Construction

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 approved material as directed. Excavate rock encountered in the cut section to a depth of 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 approved materials, and shape the entire subgrade to line, grade, and cross section and compact as specified. Do not vary the elevation of the finish subgrade more than 0.05 foot from the established grade and cross section.

3.13.3 Compaction

Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment.

3.14 SHOULDER CONSTRUCTION

Construct shoulders of approved 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 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.

3.15 FINISHING

Finish the surface of excavations, embankments, and subgrades to a smooth and compact surface in accordance with the lines, grades, and cross

sections or elevations shown. Provide the degree of finish for graded areas within 0.1 foot of the grades and elevations indicated. Finish gutters and ditches in a manner that will result in effective drainage and no puddling occurs. 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.

3.15.1 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 disturb the finished subgrade by traffic or other operation. Protect and maintain 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 TESTING

Perform testing by the Contractor's validated testing facility. If the Contractor elects to establish testing facilities, do not permit work requiring testing until the Contractor's facilities have been inspected, NASA validated and approved by the Contracting Officer.

3.16.1 Fill and Backfill Material Gradation

Random testing of stockpiled or in-place source material shall be completed. Determine gradation of fill and backfill material in accordance with ASTM D 422. The testing can be requested by NASA if stockpiled soil is in question for use of fill/backfill.

3.17 DISPOSITION OF SURPLUS MATERIAL

Surplus material or other soil material not required or suitable for filling or backfilling, and brush, refuse, stumps, roots, and timber shall be removed from Government property as directed by the Contracting Officer to a NASA approved disposal site. All materials removed from site shall be approved by NASA GRC Waste Management.

3.18 FIELD QUALITY CONTROL

Special Inspections: Geotechnical engineer will perform the following special inspections and report findings to the Contracting Officer:

Determine prior to placement of fill that site has been prepared in compliance with requirements.

Determine that fill material and maximum lift thickness comply with requirements.

Determine, at the required frequency, that in-place density of compacted fill complies with requirements.

Geotechnical engineer to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results

for previously completed work comply with requirements.

Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities.

When Geotechnical engineer reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

-- End of Section --