SECTION 02057

SOILS AND AGGREGATES

1.1 SUMMARY

A. Section Includes:
   1. Define types of soils and aggregates.
   2. Specify their uses, including required compaction, for each type of construction.
   3. Establish the quality control procedures to verify compliance with the intent of the Contract Documents.
   4. The provisions of this Section apply to all work involving the use of the soils and aggregates defined, and shall govern except where specifically modified in a Section specifying particular work.

B. Related work Specified In Other Sections
   1. Earthwork – Division 2.
   2. Water Distribution – Division 2. .
   3. Sanitary Sewerage Division 2.
   4. Storm Drainage – Division 2.
   5. Flexible Pavement – Division 2.
   6. Cement Concrete Paving – Division 2.
   7. Fire Protection Systems– Division 15.
   8. Underground Electric Service – Division 16.

1.2 SUBMITTALS

A. Furnish submittals for items that are identified in this Section by a different typeface and a bracketed code (e.g., *Item [L]*). Refer to Division 1 General Requirements for definition of codes for types of submittals and the administrative requirements governing submittal procedure.

B. *Qualifications of the Testing Agency [Q]*. Submit and include its personnel for approval prior to retaining the agency.

C. *Test reports [T]*. Each Testing Agency shall submit, in duplicate, tests, investigations, findings and recommendations to the Contractor and to the Architect-Engineer, as soon as each report has been completed.

1.3 QUALITY ASSURANCE

A. Sampling and testing of soil and aggregate materials and of compaction shall be done by independent, well-established and qualified commercial testing agencies. The personnel shall be qualified and shall have had experience on projects equal to the complexity of this project.

B. The Owner will retain a testing agency for field quality control of operations. The Contractor shall retain a testing agency to perform material testing and to prepare test reports and other

submittals. The Contractor-retained agency shall not be the same agency that the Owner retains. The Architect-Engineer reserves the right to request change in personnel or firm at any time.

C. Submit proposed Contractor-furnished material, including off-site borrow material, to the Contractor-retained Testing Agency for its analysis and report, in sufficient time so as not to delay the progress of the Work.

1.4 MATERIAL DEFINITIONS

TYPE	DEFINITION		
General Requirements For Slag	Except as specifically indicated in these documents; blast and reverberatory furnace slags are permitted; basic oxygen, open hearth, and electric furnace slags are not permitted. These requirements supersede the requirements of reference documents.		
CL	Clay per ASTM D 2487-83, "Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)", Classification CL.		
DG-1	Dense-Graded Aggregate with the following gradation:		
	Particle Size	% Passing By Weight	
		Minimum	Maximum
	1-1/2"	100	100
	1"	85	100
	1/2"	50	75
	#8	20	45
DG-2	Dense Graded Aggregate with the following gradation:		
	Particle Size	% Passing By Weight	
		Minimum	Maximum
	1"	100	100
	3/4"	90	100
	3/8"	65	85
	#8	30	50
GM-1	Durable, uniformly graded, crushed stone, crushed gravel or gravel, per the following gradation:		
	Particle Size U.S. Std. Square Mesh	% Passing By Weight	
	Sieve Size	Minimum	Maximum
	2 inch	100	100
	1/2 inch	45	85
	No. 4	20	85
	No. 30	5	30

TYPE	DEFINITION		
GM-2	Granular Material consisting of sand, gravel, crushed stone, iron blast-furnace slag, reverberation-furnace slag or a combination thereof graded as follows:		
	Particle Size	% Passing By Weight	
		Minimum	Maximum
	3”	100	100
	1”	60	100
	#100 Sieve	0	30
GM-2A	Same material as GM-2 except maximum size 1/2 inch.		
CA-1	Coarse Aggregate graded as follows:		
	Particle Size	% Passing By Weight	
		Minimum	Maximum
	1-1/2”	100	100
	1”	95	100
	3/4”	30	60
	#4 Sieve	0	8
E	Selected earth having an in-place density of at least 100 PCF; plasticity index less then 40; less than 4% organic materials; free of peat, rock or gravel larger than 3 inches (75 mm) in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.		
NS	Natural Sand; clean, hard, durable particles of sand resulting from natural disintegration of rock, well graded from coarse to fine with 100% passing the #4 sieve and not over 7% passing the #200 sieve.		
PG	Pea Gravel; clean, hard, durable, free flowing, naturally rounded particles of rock, free from clay lumps, with 100% passing the 3/8” sieve and not over 5% passing the #8 sieve.		
Riprap	Sound, durable boulders or rock, well graded, of sizes 8 inches minimum to 24 inches maximum in either dimension, weighing not less than 50 pounds each, except as needed for filling-in spaces between the larger pieces.		
Topsoil			
For Removal	A surface soil layer containing organic matter such as roots or humus, and having a weight loss of 5% or more on ignition at 600 degC for 3 hours when compared with the oven dry weight as determined by ASTM D 2216-80, “Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass”. Refer to other applicable Contract Documents for topsoil stripping requirements.		

TYPE	DEFINITION
Project-usable	Selected, fertile, friable loam, stripped from the upper 12 inches and having a weight loss of 6 to 12% when tested per "For Removal" above; free from subsoil, heavy clay lumps, stones, grass clumps, and roots larger than 1/8 inch in diameter, or other objectionable matter such as garbage or rubbish. Refer to Earthwork in Division 2 and other applicable Contract Documents for topsoil placement requirements.
Unsuitable soil	Unsatisfactory Soils: ASTM D 2487, "Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)", soil classification groups GC, SC, ML, MH, CL, CH, OL, OH, and PT, or a combination of these group symbols. Unsatisfactory soils also include satisfactory soils not maintained within 2 %of optimum moisture content at time of compaction. Unsuitable soils also include any soil not meeting the requirements of the material definitions in this Section.

1.5 MATERIAL USE AND COMPACTION

A. Definitions
1. Maximum density. The dry density at optimum moisture content per ASTM D 1557, "Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3))", or ASTM D 698, "Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))".
2. In-place density. The dry density, dry unit weight, or dry unit mass as applicable per ASTM D 1556, "Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method", D 2167, "Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method", D 2922, "Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)" and D 3017, "Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)", or D 2937, "Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method", as appropriate.
3. Required compaction. The ratio of in-place density to maximum density, expressed as a percentage.
4. Compacted. Material at the required compaction or higher.
5. Subgrade. The in-place compacted soil, aggregate, fill or backfill that receives subsequent construction such as structures or overlying courses.
6. Exterior. Any area outside of building wall lines.
7. Interior. Any area within building wall lines.

B. Moisture Content And Tolerance
1. Material to be compacted shall contain the amount of moisture to obtain the required compaction uniformly throughout its depth. Add moisture to or dry out soils or aggregates being used so that the soils or aggregates are within 2%, plus or minus, of the optimum moisture content during compaction.

C. Schedule

1. When using hand-guided compaction equipment or hand tamping tools, the maximum loose measure lift shall be 4 inches in lieu of maximum lifts specified below when using machine compaction.

APPLICATION	TYPE	MAXIMUM LIFT THICKNESS, IN INCHES — LOOSE MEASURE FOR MACHINE COMPACTION	REQUIRED COMPACTION (%)
Fill			
Interior areas to bottom of aggregate base, including exterior areas to 5 feet outside building wall lines	GM-2	8	95
Under exterior slabs, pavements, or other improved surfaces of concrete, bituminous, or aggregate beyond 5 feet outside building wall lines			
(1) More than 18 inches below subgrade	E	8	90
(2) Subgrade to 18 inches below subgrade	E	8	95
Other locations	E	12	90
Backfill (To Subgrade)			
Under portland cement or bituminous concrete, or aggregate surfaced areas, such as floors, roads, floors, walks, parking lots, shoulders, or railroad trackage, including work in existing or future locations	GM-2	8	95
Where trench shoulder adjacent to areas described above is 2 feet or less	GM-2	8	95
Where new work crosses under previously constructed utilities	GM-2	8	95
Other exterior areas not described above	E OR GM-2	8	90
Interior areas to bottom of aggregate base, and exterior to 5 feet outside building wall lines	GM-2	8	95
Subgrade			
* Coordinate aggregate subbase with design details. * Compaction same as noted for fill or backfill for same type of area.			
Aggregate Subbase			
Flexible pavement	GM-2	8	95
Aggregate Base			
Flexible pavement	DG-1	6	95
Concrete pavement	DG-2	6	95
Interior concrete slabs	GM-1	6	95
Walks	GM-2	6	95

APPLICATION	TYPE	MAXIMUM LIFT THICKNESS, IN INCHES — LOOSE MEASURE FOR MACHINE COMPACTION	REQUIRED COMPACTION (%)
Embedment (Bedding And Initial Backfill)			
Requirements For Non-Corrosive Embedment. Provide the embedment material as specified, with the additional requirements as follows: having a specific soil resistivity tested per ASTM G57-78, "Standard Test Method for Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method", greater than or equal to 7500 ohm-centimeters when measured in a damp condition; having a uniform soil resistivity throughout and having aggregates with no sharp edges.			
Exterior pipes, including culverts, and irrigation, but excluding Underdrains	NS	6	90
Interior pipes, excluding Underdrains	NS	6	90
Steel tanks	NS	6	90
FRP tanks	PG	12	*
Anodes and associated cable	GM-2A	6	90
** Consolidate the material thoroughly, by probing or tamping near the tank, giving special attention to bedding under tank and between ribs.*			
Direct burial cable & direct burial conduit	NS	6	90
Underdrains	CA-1	6	90
Clay Seal			
At ends of culverts	CL	6	90
Under exterior slabs or pavements of concrete, bituminous or aggregate, as a seal for tops of excavations where shown	CL	6	95
All other exterior locations as a seal for tops of excavations where shown	CL	8	90
Aggregate Surface And Aggregate Shoulders			
General Purpose	DG-2	6	90
Topsoil	(Project-usable)	8	Same as adjacent natural soil
Riprap			
For use in erosion control, at end of culvert end sections and to line the ditches.			

1.6 FIELD QUALITY CONTROL

A. Refer to "Definitions" Article for the standards for test methods to be used for field quality control.

B. The Testing Agency for field quality control of operations shall determine the compaction of all material placed and shall conduct the following minimum number of in-place density tests after monitoring the placing and compacting of each lift.
   1. One test per lift of fill for each 2000 square yards.
   2. One test per final lift (subgrade) of fill or backfill within building wall lines, for each 600 square yards, both after compaction and before base or slab construction.
   3. Three tests per lift of trench backfill for each 500 lineal feet.

C. If compaction tests indicate that a layer has not been brought to the required compaction, recompact the area, prior to placement of additional material, until the required compaction is obtained. If the layer has been covered by a subsequent operation, remove such material before re-compacting the defective layer.

END OF SECTION

Revision History	
Date	**Rev. No.**
A	0
B	0
C	0
D	0
E	0
F	0
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