19 February, 2018
Amec Foster Wheeler Project No. 17-517-00060

Navajo Tribal Utility Authority
P. O. Box 170
Ft. Defiance, Arizona 86504

Attention: Mr. David Shoultz, P.E., Senior Staff Engineer

RE: GEOTECHNICAL ENGINEERING FIELD STUDY
PINON WASTEWATER FACILITY
PINON, ARIZONA

Our Geotechnical Engineering Study Report on the referenced project is enclosed. This letter report contains boring logs, a map of soil boring locations and laboratory test results of the geotechnical field study.

Should any questions arise concerning this report, we would be pleased to discuss them with you.

Respectfully submitted,

Amec Foster Wheeler
Environment & Infrastructure, Inc.

RALPH E. CROCKETT NEW MEXICO 10867 REGISTERED PROFESSIONAL ENGINEER

Ralph E. Crockett, P.E.
Associate Geotechnical Engineer

Reviewed by:

Carlo Evangelisti, P.E.
Associate Geotechnical Engineer

REC:rrk

Copies: Addressee (3)

Amec Foster Wheeler Environment & Infrastructure, Inc.
8519 Jefferson, N.E.
Albuquerque, New Mexico 87113
Telephone: 505-821-1801
Fax: 505-821-7371
www.amecfw.com

19 February 2018
Amec Foster Wheeler Project No. 17-517-00060

GEOTECHNICAL ENGINEERING FIELD STUDY

PINON WASTEWATER FACILITY
PINON, ARIZONA

Submitted To:

Navajo Tribal Utility Authority
P. O. Box 170
Ft. Defiance, Arizona 86504

Submitted By:

Amec Foster Wheeler Environment & Infrastructure
8519 Jefferson, N.E.
Albuquerque, New Mexico 87113

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1.0 INTRODUCTION AND PROJECT DESCRIPTION

This report is submitted pursuant to a geotechnical engineering study made by this firm of the site of the wastewater treatment facility located in Pinon, Arizona. We understand that the project consists of expansion of the existing wastewater treatment plant lagoon system. In order to proceed with design of lagoon expansion, the existing soils require characterization.

2.0 SUBSURFACE INVESTIGATION

Three (3) exploratory borings were drilled to depths of 21.5 feet below existing grade, and one (1) boring to a depth of 5 feet utilizing a truck- mounted CME rotary drill rig equipped with 8-inch O.D. hollow stem auger. Standard penetration testing and open-end drive sampling was performed at selected intervals in the borings. During the field study, the soils encountered were continuously examined, visually classified, and logged. Results of the field study are presented in Appendix A, which includes a brief description of drilling and sampling equipment and procedures, a site plan showing the boring locations, and logs of the test borings.

3.0 LABORATORY ANALYSIS

Moisture content determinations (ASTM D2216) were made on all open-end drive samples recovered. Results of these tests are shown on the boring logs. Grain-size analysis (ASTM C117 and C136) and Atterberg limits tests (P.I.) (ASTM D4318) were performed on selected samples to aid in soil classification. Hydraulic conductivity tests (ASTM D5084) were performed on relatively undisturbed ring samples. Test results are presented in Appendix B, along with a brief description of soil mechanics testing procedures.

4.0 GEOTECHNICAL PROFILE

As indicated by the exploratory borings, the soils at the lagoon site consist of clay (CL, CH), silty sand (SM) and sand (SP-SM). The near surface clay is of medium plasticity and firm. The deeper clay is of medium to high plasticity, contains traces of sand and is firm to very firm. The silty sand, encountered in Boring No. 2 from the surface to about 5.5 feet below existing grade, is fine grained, nonplastic and moderately firm. The clean sand, encountered in Boring No. 2 from 5.5 to 8.5 feet, contains some silt, is fine grained, nonplastic and medium dense.

5.0 SOIL MOISTURE AND GROUNDWATER CONDITIONS

At the time of our field study, no groundwater was observed in the exploratory borings within the explored depths. Soil moisture contents were between 1 percent and 13 percent, with the clay moisture contents between 4 and 13 percent.

6.0 DISCUSSION AND RECOMMENDATIONS

6.1 Analysis of Results

The soils in the lagoon area are a mixture of clays and sands at the proposed lagoon bottom depth of 5 to 6 feet below existing grade. Hydraulic conductivities of relatively undisturbed samples ranged from 3.7×10^{-4} centimeters per second (^{cm}/sec) to 3.4×10^{-8} ^{cm}/sec.

6.2 Excavation Conditions and Slopes

Based on the results of the field study, excavations at the project site are not anticipated to be difficult using conventional earthwork equipment. Earthwork contractors should verify the suitability of their equipment for use for the varied soil types and conditions observed at the site.

Based upon the results of our study, the soils encountered at the project site classify as OSHA Type A, B and C soils. Side slopes of temporary excavations should be no steeper than 1.5 to 1 (horizontal to vertical) to a depth of 15 feet. It is anticipated that some caving and sloughing will be encountered, especially within the uncemented sands encountered at the project site. As a result, excavations at the site should be prepared to be benched or flattened to 2:1 side slopes as necessary, or alternate methods of soil support, should be used should stability issues be encountered as a result of excessive caving and sloughing.

It is recommended that a representative of the geotechnical engineer periodically observe temporary cut slopes at the time of excavation to assess their stability. All excavations should be provided with berms or other installations to prevent surface runoff from entering the excavation or impacting the excavation slopes. Construction equipment and materials, including soil stockpiles should not be placed within 5 feet or 1/2 of the total excavation depth; whichever is greater, from the crest of open excavations. The exception to this recommendation is the presence of soil berms constructed for temporary drainage purposes.

The above recommendations for temporary excavation slopes are based on geotechnical considerations only. These recommendations do not consider requirements that might be imposed by OSHA, the State of Arizona, or other governmental agencies. For all open excavations and trenches OSHA and other governing entities' regulations should be followed in the process of planning.

6.3 Erosion Control

The soils encountered at the project site are considered to be susceptible to erosion by flowing water. As a result, slopes steeper than 3:1 horizontal to vertical should be protected against erosion. Several options are available to provide protection against erosion including rock rip rap, gunite or shotcrete, soil cement, and geotextile materials. Based on anticipated local availability, recommendations for a rock rip rap are presented below.

The rock rip rap should consist of angular, sound and durable stone ranging from 4 to 8 inches in diameter. The rock blanket should be a minimum of 12 inches in thickness and should be placed as required for erosion control. Dependent on the type of rip rap materials used, tie-downs or anchors may be needed to maintain the rip rap material along a slope.

7.0 CONSTRUCTION CONSIDERATIONS

To prevent seepage through the pervious sands encountered in the area of Boring No. 2, it is recommended that this area of the lagoon be overexcavated to the underlying clay encountered at about 8.5 feet below grade. The sandy material should be replaced with clay soils to the bottom of the proposed lagoon. The clays which are predominant in the lagoon area can be used to replace the sandy soils.

8.0 CONSTRUCTION OBSERVATION AND TESTING

Recommendations presented in previous sections of this report are predicated on the assumption that there will be continuous observation and testing by the geotechnical engineer during earthwork operations. Verification of recommended moisture increases, site grading and required degree of compaction should be informed in accordance with "Guide Specifications for Earthwork," Appendix C.

The recommendations presented in this report are based upon a limited number of subsurface samples obtained from six sampling locations. The samples may not fully indicate the nature and extent of the variations that actually exist throughout the site. For that reason, among others, Amec recommends that the geotechnical consultant be retained to observe earthwork construction. It should be noted, if variations or other latent conditions become evident during earthwork construction, it will be necessary for Amec to review these conditions and modify its recommendations.

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APPENDIX A

Test Drilling Equipment & Procedures

Unified Soil Classification

Terminology Used to Describe the Relative Density, Consistency or Firmness of Soils

Site Plan

Logs of Test Borings

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TEST DRILLING EQUIPMENT & PROCEDURES

Drilling Equipment - Truck-mounted drill rigs powered with gasoline or diesel engines are used in advancing test borings. Drilling through soil or softer rock is performed with hollow-stem auger or continuous flight auger. Carbide insert teeth are normally used on the auger bits so they can often penetrate rock or very strongly cemented soils which require blasting or very heavy equipment for excavation. Where refusal is experienced in auger drilling, the holes are sometimes advanced with tricone gear bits and NX rods using water or air as a drilling fluid.

Sampling Procedures - Dynamically driven tube samples are usually obtained at selected intervals in the borings by the ASTM D1586 procedures. In most cases, 2-inch O.D., 1-3/8-inch I.D. samplers are used to obtain the standard penetration resistance. "Undisturbed" samples of firmer soils are often obtained with 3-inch O.D. samplers lined with 2.42-inch I.D. brass rings. The driving energy is generally recorded as the number of blows of a 140-pound, 30-inch free-fall drop hammer required to advance the samplers in 6-inch increments. However, in stratified soils, driving resistance is sometimes recorded in 2 or 3-inch increments so that soil changes and the presence of scattered gravel or cemented layers can be readily detected and the realistic penetration values obtained for consideration in design. These values are expressed in blows per foot on the logs. "Undisturbed" sampling of softer soils is sometimes performed with thin-walled Shelby tubes (ASTM D1587). Where samples of rock are required, they are obtained by NX diamond core drilling (ASTM D2113). Tube samples are labeled and placed in water-tight containers to maintain field moisture contents for testing. When necessary for testing, larger bulk samples are taken from auger cuttings.

Continuous Penetration Tests - Continuous penetration tests are performed by driving a 2-inch O.D. blunt nosed penetrometer adjacent to or in the bottom of borings. The penetrometer is attached to 1-5/8-inch O.D. drill rods to provide clearance to minimize side friction so that penetration values are as nearly as possible a measure of end resistance. Penetration values are recorded as the number of blows of a 140-pound, 30-inch free-fall drop hammer required to advance the penetrometer in one-foot increments or less.

Boring Records - Drilling operations are directed by our field engineer or geologist who examines soil recovery and prepares boring logs. Soils are visually classified in accordance with the Unified Soil Classification System (ASTM D2487), with appropriate group symbols being shown on the logs.

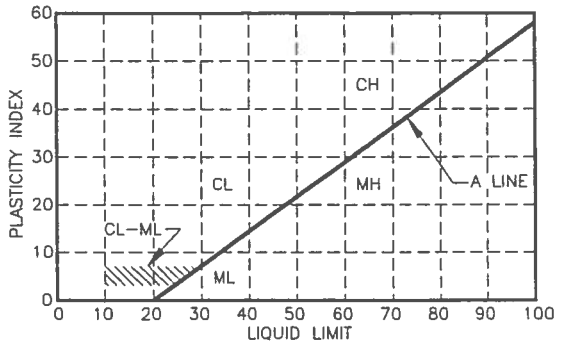
UNIFIED CLASSIFICATION SYSTEM FOR SOILS

Soils are visually classified by the Unified Soil Classification System on the boring logs presented in this report. Grain-size analysis and Atterberg Limits Tests are often performed on selected samples to aid in classification. The classification system is briefly outlined on this chart. For a more detailed description of the system, see "The Unified Soil Classification System" ASTM Designation: D2487.

MAJOR DIVISION				GRAPH SYMBOL	GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE-GRAINED SOILS (Less than 50% passes No. 200 sieve)	GRAVELS (50% or less of coarse fraction passes No. 4 sieve)	CLEAN GRAVELS (Less than 5% passes No. 200 sieve)			GW	Well graded gravels, gravel-sand mixtures or sand-gravel-cobble mixtures.
					GP	poorly graded gravels, gravel-sand mixtures, or sand-gravel-cobble mixtures.
		GRAVELS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity chart		GM	Silty gravels, gravel-sand-silt mixtures.
			Limits plot above "A" line & hatched zone on plasticity chart		GC	Clayey gravels, gravel-sand-clay mixtures.
	SANDS (More than 50% of coarse fraction passes No. 4 sieve)	CLEAN SANDS (Less than 5% passes No. 200 sieve)			SW	Well graded sands, gravelly sands.
					SP	Poorly graded sands, gravelly sands.
		SANDS WITH FINES (More than 12% passes No. 200 sieve)	Limits plot below "A" line & hatched zone on plasticity chart		SM	Silty sands, sand-silt mixtures.
			Limits plot above "A" line & hatched zone on plasticity chart		SC	Clayey sands, sand-clay mixtures.
FINE-GRAINED SOILS (50% or more passes No. 200 sieve)	SILTS LIMITS PLOT BELOW "A" LINE & HATCH ZONE ON PLASTICITY CHART	SILTS OF LOW PLASTICITY (Liquid Limit Less Than 50)			ML	Inorganic silts, clayey silts with slight plasticity.
		SILTS OF HIGH PLASTICITY (Liquid Limit More Than 50)			MH	Inorganic silts of high plasticity, silty soils, elastic silts.
	CLAYS LIMITS PLOT ABOVE "A" LINE & HATCH ZONE ON PLASTICITY CHART	CLAYS OF LOW PLASTICITY (Liquid Limit Less Than 50)			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
		CLAYS OF HIGH PLASTICITY (Liquid Limit More Than 50)			CH	Inorganic clays of high plasticity, fat clays, silty and sandy clays of high plasticity.

NOTE: Coarse-grained soils with between 5% & 12% passing the No. 200 sieve and fine-grained soils with limits plotting in the hatched zone on the plasticity chart to have dual symbol.

PLASTICITY CHART



DEFINITIONS OF SOIL FRACTIONS

SOIL COMPONENT	PARTICLE SIZE RANGE
Boulders	Above 300mm (12in.)
Cobbles	300mm to 75mm (12in. to 3in.)
Gravel	75mm (3in.) to No. 4 sieve
Coarse gravel	75mm to 19mm (3in. to 3/4in.)
Fine gravel	19mm (3/4in.) to No. 4 sieve
Sand	No. 4 to No. 200
Coarse	No. 4 to No. 10
Medium	No. 10 to No. 40
Fine	No. 40 to No. 200
Fines (silt or clay)	Below No. 200 sieve

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TERMINOLOGY USED TO DESCRIBE THE RELATIVE DENSITY, CONSISTENCY OR FIRMNESS OF SOILS

The terminology used on the boring logs to describe the relative density, consistency or firmness of soils relative to the standard penetration resistance is presented below. The standard penetration resistance (N) in blows per foot is obtained by ASTM D1586 procedure using 2" O.D., 1-3/8" I.D. samplers.

1. Relative Density Terms for description of relative density of cohensionless, uncemented sands and sand-gravel mixtures.

N	Relative Density
0-4	Very loose
5-10	Loose
11-30	Medium dense
31-50	Dense
50+	Very dense

2. Relative Consistency Terms for the description of clays which are saturated or near saturation.

N	Relative Consistency	Remarks
0-2	Very Soft	Easily penetrated several inches with fist
3-4	Soft	Easily penetrated several inches with thumb
5-8	Medium stiff	Can be penetrated several inches with thumb with moderate effort
9-15	Stiff	Readily indented with thumb, but penetrated only with great effort
16-30	Very stiff	Readily indented with thumbnail
30+	Hard	Indented only with difficulty by thumbnail

3. Relative Firmness Terms for the description of partially saturated and/or cemented soils which commonly occur in the Southwest including clays, cemented granular materials, silts and silty and clayey granular soils:

N	Relative Density
0-4	Very soft
5-8	Soft
9-15	Moderately firm
16-30	Firm
31-50	Very firm
50+	Hard

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NAVAJO TRIBAL UTILITY AUTHORITY
Fort Defiance, Arizona

PROJECT: PINON WASTEWATER FACILITY

TITLE: BORING LOCATION DIAGRAM

PROJECT No.: 17-517-00060

DRAWN BY :	CP
CHECKED BY :	REC
SCALE:	NTS
DATE:	2-20-2018

FIGURE No. 1

P:\consulting\projects\17\17-517-00060.Pinon Wastewater Facility\CADD\SITEPLAN.dwg

PROJECT Pinon Wastewater Facility
Pinon, Arizona

DATE 1/4/18

BORING NO. B-1

AMEC FOSTER WHEELER PROJECT NO. 17-517-00060

LOCATION See Boring Location Diagram
RIG TYPE CME-75
BORING TYPE 8" Hollow Stem Auger
SURFACE ELEV. N/A
DRILLING CO.

Depth in Feet	Relative Drilling Resistance	Graphical Log	Sample	Sample Type	Blows/ft. 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				A				CL	firm	**CLAY** some sand, medium plasticity, brown tan
				S	30		4			
				S	23		8			
5				S	19		8			thickness of lense at 5'
				U	13	85	13			
10				S	18		6			
15				S	29		13		very firm	thickness of lense at 15'
20				S	38		13			
										Stopped augers at 20.0' Stopped sampler at 21.5' Hole open to 18.0'
25										

GROUNDWATER

	DEPTH	HOUR	DATE
▽	None		
▼			

SAMPLE TYPE
A-Auger Cuttings; NR-No Recovery
BS-Bulk Sample
S-2" O.D., 1.38" I.D. tube sample
U-3" O.D. 2.42" I.D. tube sample
T-3" O.D. thin walled Shelby tube

PROJECT Pinon Wastewater Facility
Pinon, Arizona

DATE 1/4/18

BORING NO. B-2

AMEC FOSTER WHEELER PROJECT NO. 17-517-00060

LOCATION See Boring Location Diagram
RIG TYPE CME-75
BORING TYPE 8" Hollow Stem Auger
SURFACE ELEV. N/A
DRILLING CO.

Depth in Feet	Relative Drilling Resistance	Graphical Log	Sample	Sample Type	Blows/ft. 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				S	13		7	SM	moderately firm	**SILTY SAND** fine grained, nonplastic, brown tan
				S	15		8			
5				U	13		1			
								SP-SM	medium dense	**SAND** some silt, predominantly fine grained, nonplastic, brown
				S	17		8			
								CH	very firm to hard to firm to very firm	**CLAY** trace sand, high plasticity, brown
10				U	35	101	13			
				U	50/5.5"		12			
15				S	19		11			
20				S	38		12			
										Stopped auger at 20.0' Stopped sampler at 21.5' Hole open to 16.0'
25										

GROUNDWATER

	DEPTH	HOUR	DATE
▽	None		
▼			

SAMPLE TYPE
A-Auger Cuttings; NR-No Recovery
BS-Bulk Sample
S-2" O.D., 1.38" I.D. tube sample
U-3" O.D. 2.42" I.D. tube sample
T-3" O.D. thin walled Shelby tube

PROJECT Pinon Wastewater Facility
Pinon, Arizona

DATE 1/4/18

BORING NO. B-3

AMEC FOSTER WHEELER PROJECT NO. 17-517-00060

LOCATION See Boring Location Diagram
RIG TYPE CME-75
BORING TYPE 8" Hollow Stem Auger
SURFACE ELEV. N/A
DRILLING CO.

Depth in Feet	Relative Drilling Resistance	Graphical Log	Sample	Sample Type	Blows/ft. 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				A				CL	moderately firm	**CLAY** medium plasticity, brown tan
				S	10		6			
				S	15		9			
5				A				CL	moderately firm	**SANDY CLAY** medium plasticity, brown-tan
				U	11	84	5			
				S	24		12	CL	firm	**CLAY** some sand, medium plasticity, brown-tan
10				S	19		9			
15				S	19		10			
								SM	moderately firm	**SILTY SAND** fine grained, nonplastic, brown
20				S	14		4			
										Stopped auger at 20.0' Stopped sampler at 21.5' Hole open to 17.0'
25										

GROUNDWATER

	DEPTH	HOUR	DATE
▽	None		
▼			

SAMPLE TYPE
A-Auger Cuttings; NR-No Recovery
BS-Bulk Sample
S-2" O.D., 1.38" I.D. tube sample
U-3" O.D. 2.42" I.D. tube sample
T-3" O.D. thin walled Shelby tube

PROJECT Pinon Wastewater Facility
Pinon, Arizona

DATE 1/4/18

BORING NO. B-4

AMEC FOSTER WHEELER PROJECT NO. 17-517-00060

LOCATION See Boring Location Diagram
RIG TYPE CME-75
BORING TYPE 8" Hollow Stem Auger
SURFACE ELEV. N/A
DRILLING CO.

Depth in Feet	Relative Drilling Resistance	Graphical Log	Sample	Sample Type	Blows/ft. 140 lb. 30" free-fall drop hammer	Dry Density lbs. per cubic foot	Moisture Content Percent of Dry Weight	Unified Soil Classification	REMARKS	VISUAL CLASSIFICATION
0				A			7	CL		**SANDY CLAY** medium plasticity, brown tan
5										Stopped auger at 5.0'
10										
15										
20										
25										

GROUNDWATER

	DEPTH	HOUR	DATE
▽	None		
▼			

SAMPLE TYPE
A-Auger Cuttings; NR-No Recovery
BS-Bulk Sample
S-2" O.D., 1.38" I.D. tube sample
U-3" O.D. 2.42" I.D. tube sample
T-3" O.D. thin walled Shelby tube

APPENDIX B

Classification Test Results

Hydraulic Conductivity Test Results

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Client: Navajo Tribal Utility Authority
P.O. Box 170
Ft. Defiance, AZ 86504-

Attention: Dave Shoultz

Project Name: Pinon Wastewater Facility

Pinon, AZ

Project Manager: Dan Boivin

Report Date: January 24, 2018

Project #: 17-517-00060
Work Order #: 1
Sampled By: Carlton Pine
Date Sampled: 1/4/2018

Sieve Analysis (ASTM C117-04/C136-06)
Plasticity Index (ASTM D4318-10)
Soil Classification (ASTM D2487-10)

SOILS / AGGREGATES

				Sieve Sizes																			Sieve Result are as Percent Passing.
Sample Location	Soil Class.	L.L.	P.I.	#200	#100	#50	#40	#30	#16	#10	#8	#4	1/4"	3/8"	1/2"	3/4'	1"	1 1/4"	1 1/2"	2"	2 1/2"	3"	6"	12"	Lab Number
B-1 @7.5-8.5'	CL	43	22	94	98	100																			18-0008-04
B-2 @ 5.0-6.0'	SP-SM	NV	NP	11	31	78	91	96	99	100															18-0008-11
B-2 @ 10.0-11.0'	CH	56	32	98	99	100																			18-0008-13
B-3 @ 5.0-6.0'	CL	28	11	67	95	100																			18-0008-19
B-4 @ 0.0-5.0'	CL	30	14	73	84	95	98	99	100																18-0008-26

Distribution: **Client** ☑ **File:** ☑ **Supplier:** ☑ **Email:** ☐ **Other:** Addressee (2)

AMEC Environment & Infrastructure, Inc.
8519 Jefferson NE
Albuquerque, NM 87113
Tel 5058211801
Fax 5058217371
www.amec.com

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Client:	Navajo Tribal Utility Authority P.O. Box 170 Ft. Defiance, AZ 86504-	**Report Date:**	January 24, 2018
		Project #:	17-517-00060
		Work Order #:	1
Attn:	Dave Shoultz	**Lab #:**	18-0008-04
Project Name:	Pinon Wastewater Facility	**Sampled By:**	Carlton Pine
		Date Sampled:	1/4/2018
	Pinon, AZ	**Visual Description of Material:**	See Boring Log
		Sample Source:	B-1 @7.5-8.5'
Project Manager:	Dan Boivin	**SOILS / AGGREGATES**	

Particle Size Analysis of Soils (ASTM D422-63)

Specific Gravity of Soils (ASTM D854-10) 2.609

Weight of Sample Dispersed: 55.28

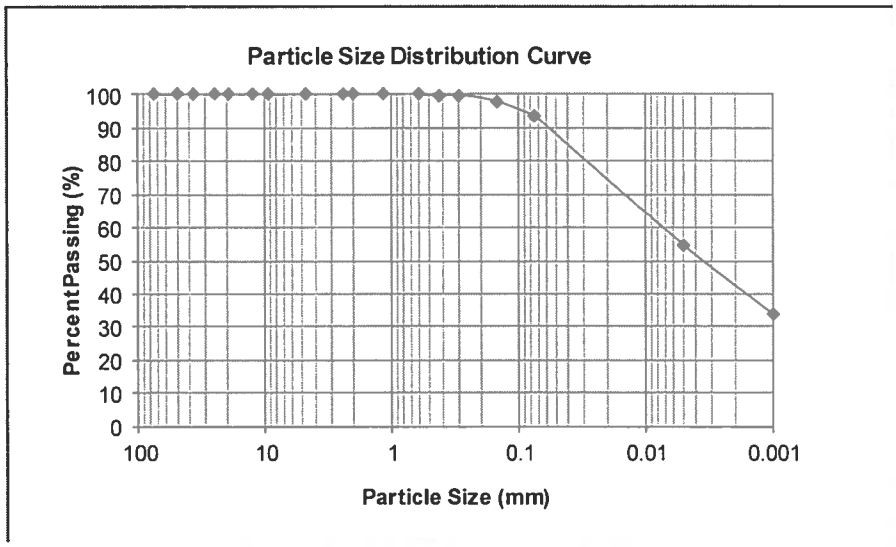
	Sieve Size	Passing
Coarse Portion:	#10	100%

Hydrometer Results (% Passing)

Particle Size Diameter (mm)	0.0267	0.0172	0.0105	0.0077	0.0057	0.0029	0.0013	0.0009
Percent of Test Sample:	88.5	84.9	75.7	66.4	57.1	48.0	36.8	33.2
Percent of Total Sample:	88.5	84.9	75.7	66.4	57.1	48.0	36.8	33.2

Size Classification:	Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Colloids
Percent (%):	0.0	0.0	0.5	5.8	38.8	54.8	34.2

Fine Portion:		
	#16	100%
	#30	100%
	#40	99.5%
	#50	99.8%
	#100	97.9%
	#200	93.7%



Hydrometer Portion:

0.074 mm	93.5%
0.005 mm	54.8%
0.001 mm	34.2%

Dispersing Device Used: A

Length of Dispersing Period (min): 1

Description of sand and gravel particles:

Shape: Round

Hardness:

Distribution: Client ☑ File: ☑ Supplier: ☑ Email: ☐ Other: Addressee (2)

AMEC Environment & Infrastructure, Inc.
8519 Jefferson NE
Albuquerque, NM 87113
Tel 5058211801
Fax 5058217371
www.amec.com

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Client:	Navajo Tribal Utility Authority P.O. Box 170 Ft. Defiance, AZ 86504-	**Report Date:**	January 24, 2018
		Project #:	17-517-00060
		Work Order #:	1
Attn:	Dave Shoultz	**Lab #:**	18-0008-13
Project Name:	Pinon Wastewater Facility	**Sampled By:**	Carlton Pine
		Date Sampled:	1/4/2018
	Pinon, AZ	**Visual Description of Material:**	See Boring Log
		Sample Source:	B-2 @ 10.0-11.0'
Project Manager:	Dan Boivin	**SOILS / AGGREGATES**	

Particle Size Analysis of Soils (ASTM D422-63)

Specific Gravity of Soils (ASTM D854-10) 2.643

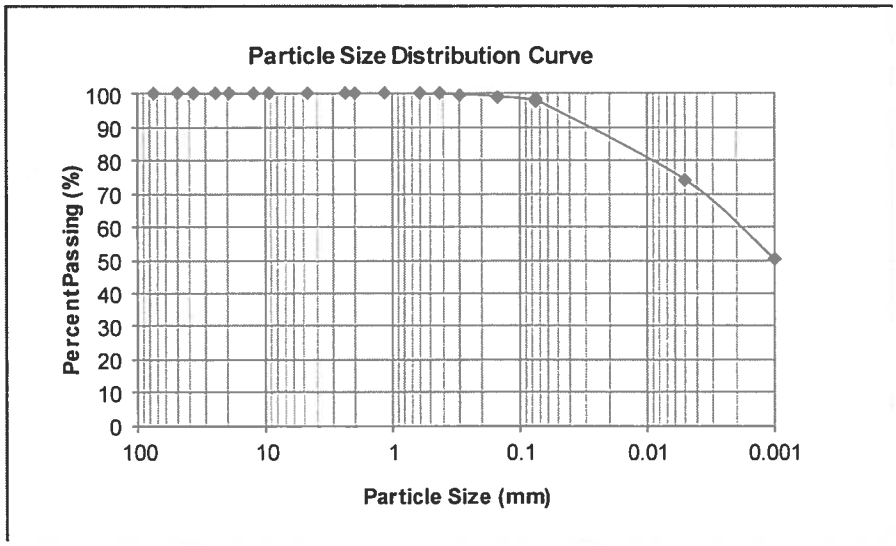
Weight of Sample Dispersed: 53.83

	Sieve Size	Passing
Coarse Portion:	#10	100%

Hydrometer Results (% Passing)

Particle Size Diameter (mm)	0.0262	0.0167	0.0100	0.0072	0.0052	0.0027	0.0012	0.0008
Percent of Test Sample:	92.6	90.6	84.7	80.8	75.0	63.9	52.1	48.8
Percent of Total Sample:	92.6	90.6	84.7	80.8	75.0	63.9	52.1	48.8

Size Classification:	Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Colloids
Percent (%):	0.0	0.0	0.1	1.8	24.0	74.0	50.3



Fine Portion:		
	#16	100%
	#30	99.9%
	#40	99.9%
	#50	99.8%
	#100	99.1%
	#200	98.1%

Hydrometer Portion:

0.074 mm	98.0%
0.005 mm	74.0%
0.001 mm	50.3%

Dispersing Device Used: A

Length of Dispersing Period (min): 1

Description of sand and gravel particles:

Shape: Angular

Hardness: Soft

Distribution: Client ☑ File: ☑ Supplier: ☑ Email: ☐ Other: Addressee (2)

AMEC Environment & Infrastructure, Inc.
8519 Jefferson NE
Albuquerque, NM 87113
Tel 5058211801
Fax 5058217371
www.amec.com

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Client:	Navajo Tribal Utility Authority P.O. Box 170 Ft. Defiance, AZ 86504-	**Report Date:**	January 24, 2018
		Project #:	17-517-00060
		Work Order #:	1
Attn:	Dave Shoultz	**Lab #:**	18-0008-19
Project Name:	Pinon Wastewater Facility	**Sampled By:**	Carlton Pine
		Date Sampled:	1/4/2018
	Pinon, AZ	**Visual Description of Material:**	See Boring Log
		Sample Source:	B-3 @ 5.0-6.0'
Project Manager:	Dan Boivin	**SOILS / AGGREGATES**	

Particle Size Analysis of Soils (ASTM D422-63)

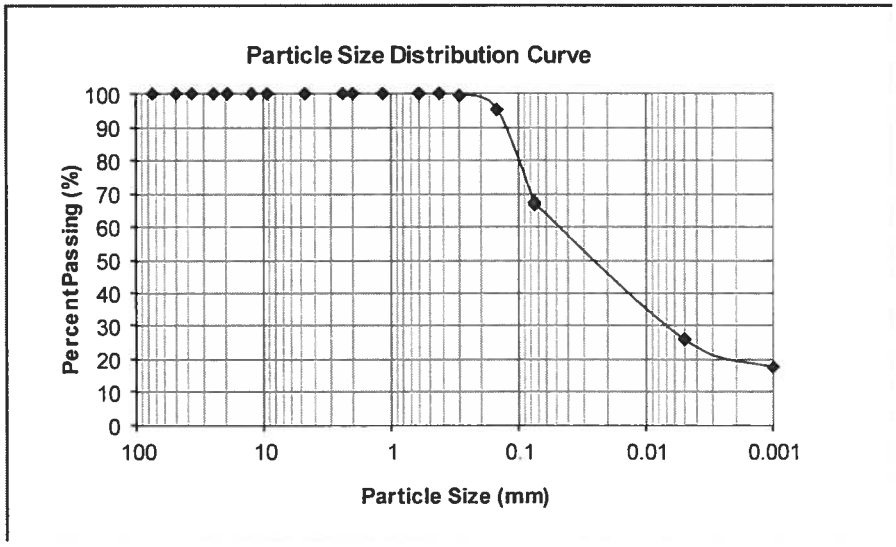
Specific Gravity of Soils (ASTM D854-10) 2.642

Weight of Sample Dispersed: 70.35

Hydrometer Results (% Passing)

Particle Size Diameter (mm)	0.0299	0.0200	0.0120	0.0086	0.0061	0.0031	0.0013	0.0009
Percent of Test Sample:	50.9	40.8	32.1	30.5	27.5	23.3	18.8	17.4
Percent of Total Sample:	50.9	40.8	32.1	30.5	27.5	23.3	18.8	17.4

Size Classification:	Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Colloids
Percent (%):	0.0	0.0	0.0	32.7	41.3	26.0	17.7



Coarse Portion:	Sieve Size	Passing
	#10	100%

Fine Portion:		
	#16	100%
	#30	100%
	#40	100%
	#50	99.7%
	#100	95.5%
	#200	67.2%

Hydrometer Portion:

0.074 mm	66.9%
0.005 mm	26.0%
0.001 mm	17.7%

Dispersing Device Used: A

Length of Dispersing Period (min): 1

Description of sand and gravel particles:

Shape: Angular

Hardness: Soft

Distribution: Client ☑ File: ☑ Supplier: ☑ Email: ☐ Other: Addressee (2)

AMEC Environment & Infrastructure, Inc.
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Albuquerque, NM 87113
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Fax 5058217371
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amec foster wheeler

Client:	Navajo Tribal Utility Authority P.O. Box 170 Ft. Defiance, AZ 86504-	**Report Date:**	January 24, 2018
		Project #:	17-517-00060
		Work Order #:	1
Attn:	Dave Shoultz	**Lab #:**	18-0008-26
Project Name:	Pinon Wastewater Facility	**Sampled By:**	Carlton Pine
		Date Sampled:	1/4/2018
	Pinon, AZ	**Visual Description of Material:**	See Boring Log
		Sample Source:	B-4 @ 0.0-5.0'
Project Manager:	Dan Boivin	**SOILS / AGGREGATES**	

Particle Size Analysis of Soils (ASTM D422-63)

Specific Gravity of Soils (ASTM D854-10) 2.631

Weight of Sample Dispersed: 55.86

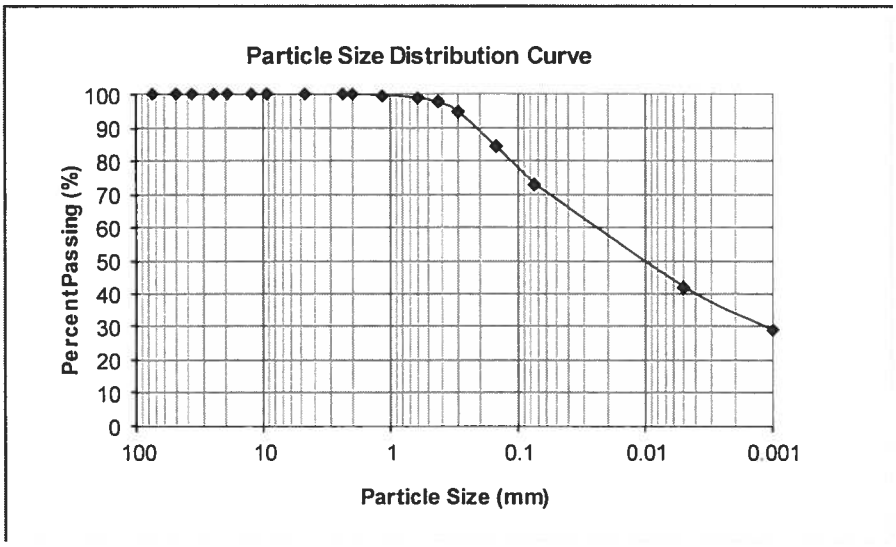
	Sieve Size	Passing
Coarse Portion:	#8	100%
	#10	100%

Hydrometer Results (% Passing)

Particle Size Diameter (mm)	0.0297	0.0193	0.0115	0.0082	0.0060	0.0030	0.0013	0.0009
Percent of Test Sample:	65.9	60.4	53.0	49.3	43.7	38.4	30.9	28.2
Percent of Total Sample:	65.9	60.4	53.0	49.3	43.7	38.4	30.9	28.2

Size Classification:	Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Colloids
Percent (%):	0.0	0.0	2.4	24.5	31.0	42.0	28.9

Fine Portion:	#16	99.7%
	#30	98.8%
	#40	97.5%
	#50	94.8%
	#100	84.3%
	#200	73.0%



Hydrometer Portion:

0.074 mm	72.9%
0.005 mm	42.0%
0.001 mm	28.9%

Dispersing Device Used: A

Length of Dispersing Period (min): 1

Description of sand and gravel particles:

Shape: Angular

Hardness: Hard and Durable

Distribution: Client ☑ File: ☑ Supplier: ☑ Email: ☐ Other: Addressee (2)

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8519 Jefferson NE
Albuquerque, NM 87113
Tel 5058211801
Fax 5058217371
www.amec.com

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Client:	Navajo Tribal Utility Authority P.O. Box 170 Ft. Defiance, AZ 86504-	**Report Date:**	January 23, 2018
		Project #:	17-517-00060
		Work Order #:	1
Attn:	Dave Shoultz	**Lab #:**	18-0008-04
Project Name:	Pinon Wastewater Facility	**Sampled By:**	Carlton Pine
		Date Sampled:	1/4/2018
	Pinon, AZ	**Visual Description of Material:**	See Boring Log
		Sample Source:	B-1 @7.5-8.5'
Project Manager:	Dan Boivin	**SOILS / AGGREGATES**	

Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter (ASTM D5084-10)

Method: C

Sample Preparation: Ring Sample
Compaction Method: Insitu

Initial Diameter (cm):	6.13	**Final Diameter (cm):**	6.14
Initial Length (cm):	7.41	**Final Length (cm):**	7.42
Initial Moisture:	6.7%	**Final Moisture:**	9.1%
Initial Unit Weight (pcf):	94.2	**Final Unit Weight (pcf):**	93.8
Initial Volume (in³):	13.3	**Final Volume (in³):**	13.4
Initial Degree of Saturation:	24%	**Final Degree of Saturation:**	32%

Permeant Liquid:	Tap Water
Magnitude of Total Backpressure:	83.0
Effective Stress:	2.0
Range of Hydraulic Gradient Used:	To
Estimated Specific Gravity:	2.65

Time Interval (sec)	Corrected Hydraulic Conductivity (cm/sec)
44	2.67E-05
44	2.73E-05
45	2.70E-05
46	2.67E-05
Average:	2.7E-05

Note: All final sample dimensions are subject to sample deformation caused by exsolution of air in pore water and handling during removal from cell.

Reviewed By:_____

Distribution: Client ☑ File: ☑ Supplier: ☑ Email: ☐ Other: Addressee (2)

AMEC Environment & Infrastructure, Inc.
8519 Jefferson NE
Albuquerque, NM 87113
Tel 5058211801
Fax 5058217371
www.amec.com

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Client:	Navajo Tribal Utility Authority P.O. Box 170 Ft. Defiance, AZ 86504-	**Report Date:**	January 15, 2018
		Project #:	17-517-00060
		Work Order #:	1
Attn:	Dave Shoultz	**Lab #:**	18-0008-13
Project Name:	Pinon Wastewater Facility	**Sampled By:**	Carlton Pine
		Date Sampled:	1/4/2018
	Pinon, AZ	**Visual Description of Material:**	See Boring Log
		Sample Source:	B-2 @ 10.0-11.0'
Project Manager:	Dan Boivin	**SOILS / AGGREGATES**	

Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter (ASTM D5084-10)

Method: F

Sample Preparation: Ring Sample
Compaction Method: Insitu

Initial Diameter (cm):	6.13	**Final Diameter (cm):**	6.39
Initial Length (cm):	7.41	**Final Length (cm):**	8.02
Initial Moisture:	14.2%	**Final Moisture:**	28.2%
Initial Unit Weight (pcf):	109.7	**Final Unit Weight (pcf):**	93.3
Initial Volume (in³):	13.3	**Final Volume (in³):**	15.7
Initial Degree of Saturation:	74%	**Final Degree of Saturation:**	96%

Permeant Liquid:	Tap Water
Magnitude of Total Backpressure:	38.0
Effective Stress:	2.0
Range of Hydraulic Gradient Used:	To
Estimated Specific Gravity:	2.65

	Time Interval (sec)	Corrected Hydraulic Conductivity (cm/sec)
	175	3.36E-08
	182	3.40E-08
	183	3.34E-08
	188	3.32E-08
Average:		3.4E-08

Note: All final sample dimensions are subject to sample deformation caused by exsolution of air in pore water and handling during removal from cell.

Reviewed By:_____

Distribution: Client ☑ File: ☑ Supplier: ☑ Email: ☐ Other: Addressee (2)

AMEC Environment & Infrastructure, Inc.
8519 Jefferson NE
Albuquerque, NM 87113
Tel 5058211801
Fax 5058217371
www.amec.com

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Client:	Navajo Tribal Utility Authority P.O. Box 170 Ft. Defiance, AZ 86504-	**Report Date:**	January 22, 2018
		Project #:	17-517-00060
		Work Order #:	1
Attn:	Dave Shoultz	**Lab #:**	18-0008-19
Project Name:	Pinon Wastewater Facility	**Sampled By:**	Carlton Pine
		Date Sampled:	1/4/2018
	Pinon, AZ	**Visual Description of Material:**	See Boring Log
		Sample Source:	B-3 @ 5.0-6.0'
Project Manager:	Dan Boivin	**SOILS / AGGREGATES**	

Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter (ASTM D5084-10)

Method: C

Sample Preparation: Ring Sample
Compaction Method: Insitu

Initial Diameter (cm):	6.13	**Final Diameter (cm):**	6.10
Initial Length (cm):	7.41	**Final Length (cm):**	7.66
Initial Moisture:	11.7%	**Final Moisture:**	38.6%
Initial Unit Weight (pcf):	78.3	**Final Unit Weight (pcf):**	76.5
Initial Volume (in³):	13.3	**Final Volume (in³):**	13.7
Initial Degree of Saturation:	28%	**Final Degree of Saturation:**	88%

Permeant Liquid:	Tap Water
Magnitude of Total Backpressure:	83.0
Effective Stress:	2.0
Range of Hydraulic Gradient Used:	**To**
Estimated Specific Gravity:	2.65

	Time Interval (sec)	Corrected Hydraulic Conductivity (cm/sec)
	17	3.74E-04
	18	3.74E-04
	21	3.64E-04
	17	3.49E-04
Average:		3.7E-04

Note: All final sample dimensions are subject to sample deformation caused by exsolution of air in pore water and handling during removal from cell.

Reviewed By:_____

Distribution: Client ☑ File: ☑ Supplier: ☑ Email: ☐ Other: Addressee (2)

AMEC Environment & Infrastructure, Inc.
8519 Jefferson NE
Albuquerque, NM 87113
Tel 5058211801
Fax 5058217371
www.amec.com

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APPENDIX C

Specifications for Earthwork

Navajo Tribal Utility Authority
Pinon Wastewater Facility
Pinon, Arizona
Amec Foster Wheeler Project No. 17-517-00060
19 February 2018

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SPECIFICATIONS FOR EARTHWORK

1.0 SCOPE

Includes all clearing and grubbing, removal of obstructions, general excavating, grading and filling, and any related items necessary to complete the grading for the entire project in accordance with these specifications.

2.0 SUBSURFACE SOIL DATA

Subsurface soil investigations have been made, and the results are available for examination by the contractor. The contractor is expected to examine the site and determine for himself the character of materials to be encountered.

No additional allowance will be made for rock removal, site clearing and grading, filling, compaction, disposal, or removal of any unclassified materials.

3.0 CLEARING & GRUBBING

A. General: Clearing and grubbing will be required for all areas shown on the plans to be excavated or on which fill is to be constructed.

B. Clearing: Clearing shall consist of removal and disposal of trees and other vegetation as well as down timber, snags, brush, existing foundations, slabs, and rubbish within the areas to be cleared.

C. Grubbing: Stumps, matted roots, and roots larger than 2 inches in diameter shall be removed from within 6 inches of the surface of areas on which fills are to be constructed except in roadways. Materials as described above within 18 inches of finished subgrade of roadways in either cut or fill sections shall be removed. Areas disturbed by grubbing will be filled as specified herein for EMBANKMENT.

D. Grass & Topsoil: Grass, grass roots, and incidental topsoil shall not be left beneath a fill area, nor shall this material be used as fill material. Grass, grass roots, and topsoil may be stockpiled and later used in the top 6 inches of fills outside roadways and building pads.

4.0 EARTH EXCAVATION

A. Earth excavation shall consist of the excavation and removal of suitable soils for use as embankment, as well as the satisfactory disposal of all vegetation, existing man-made fill, debris, and deleterious materials encountered within the area to be graded and/or in a borrow area.

B. Excavated areas shall be continuously maintained such that the surface shall be smooth and have sufficient slope to allow water to drain from the surface.

5.0 EMBANKMENT

A. General: Embankments and lagoon berms shall consist of a controlled fill constructed in areas indicated on the grading plans.

B. Materials:

(1) Physical Characteristics: Engineered fill material shall consist of soils that conform to the following physical characteristics:

Sieve Size (Square Openings)	Percent Passing by Weight
3 inch	100
No. 4	50-100

The plasticity index of the material, as determined in accordance with ASTM D4318, shall not exceed 18. Results of our investigation indicate that most of the on-site soils will meet these requirements. The fill materials shall be free from roots, grass, other vegetable matter, clay lumps, rocks larger than 6 inches, or other deleterious materials.

(2) Borrow: When the quantity of suitable material required for embankments is not available within the limits of the jobsite, the contractor shall provide sufficient materials to construct the embankments to the lines, elevations, and cross sections shown on the drawings from borrow areas. The contractor shall obtain from owners of said borrow areas the right to excavate material, shall pay all royalties and other charges involved, and shall pay all expenses in developing the source, including the cost of right-of-way required for hauling the material.

C. Construction:

(1) Test Pad: The on-site clay soils without amendment can be used for embankment provided that a test pad be constructed to determine the constructability of the clays. The test pad should be about 104 feet x 34 feet x 4 feet high. The pad should be constructed in 8-inch compacted lifts. The test pad should be monitored during construction to determine the density of each lift. The test pad can be used as part of the proposed embankment.

(2) Embankment Area Treatment: The embankment area shall be overexcavated so as to provide for a minimum of 2.0 feet of engineered fill below all embankments. Prior to placement of any fill, the exposed native soils, and the soils at the bottom of the lagoon area, shall be scarified to a minimum depth of 8 inches and watered as necessary to bring upper 1.0 foot to the optimum moisture content or above, and compacted to a minimum of 95 percent of ASTM D1557 maximum dry density.

Prior to placement of fill, the embankment areas shall be inspected and approved by a representative of the geotechnical engineer to insure satisfactory removal of native soils and the removal of any existing man-made fill.

(3) Compaction: Fill shall be spread in layers not exceeding 8 inches, watered as necessary, and compacted. Moisture content at the time of compaction shall be 2 percent below optimum moisture or higher. A density of not less than 95 percent of maximum dry density within the embankment areas shall be obtained for the structural fill. Structural fill, as well as the native soils, outside the dam embankments and paved areas shall be compacted to 90 percent of maximum dry density.

Optimum moisture content and maximum dry density for each soil type used shall be determined in accordance with ASTM D1557.

Where vibratory compaction equipment is used, it shall be the contractor's responsibility to insure that the vibrations do not damage nearby buildings or other adjacent property.

(3) Weather Limitations: Controlled fill shall not be constructed when the atmospheric temperature is below 35 degrees F. When the temperature falls below 35 degrees, it shall be the responsibility of the contractor to protect all areas of completed work against any detrimental effects of ground freezing by methods approved by the geotechnical engineer. Any areas that are damaged by freezing shall be reconditioned, reshaped, and compacted by the contractor in conformance with the requirements of this specification without additional cost to the owner.

D. Slope Protection & Drainage: The edges of the controlled fill embankments shall be graded to the contours shown on the drawings and compacted to the density required in paragraph 5.C(3). Slopes steeper than 1 vertical to 3 horizontal shall be protected from erosion.

6. INSPECTION & TESTS

A. Field Inspection & Testing: The owner shall employ the services of a registered, licensed geotechnical engineer to observe and test all controlled earthwork. The geotechnical engineer shall provide continuous on-site observation by experienced personnel during construction of controlled earthwork. The contractor shall notify the engineer at least two working days in advance of any field operations of controlled earthwork, or of any resumption of operations after stoppages. Tests of fill materials and embankments will be made at the following suggested minimum rates:

(1) One field density test for each 500 square feet of original ground surface prior to placing fill or constructing floor slabs.

(2) One field density test for each 250 cubic yards of fill placed or each layer of fill for each work area, whichever is the greater number of tests.

(3) One moisture-density curve for each type of material used, as indicated by sieve analysis and plasticity index.

B. Report of Field Density Tests: The geotechnical engineer shall submit, daily, the results of field density tests required by these specifications.

C. Costs of Tests & Inspection: The costs of tests, inspection and engineering, as specified in this section of the specifications, shall be borne by the owner.