RECLAMATION
Managing Water in the West

Drill Hole DH05-1 Geologic Log, Core Photographs & Surface Joint Identification

December 2005



U.S. Department of the Interior
Bureau of Reclamation

Date of Report – March 2006

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1.0 SUMMARY

A 415 foot-deep boring (DH05-1) was completed November 21, 2005 by the Bureau of Reclamation Provo Area Office drill crew from Pleasant Grove, Utah near the possible future location of the Page – Lachee Pumping Plant. The rock core samples obtained from the triple-tube core barrel as the hole was drilled were broken as needed and placed in cardboard core boxes. The core boxes were taken to the US Bureau of Reclamation warehouse in Page, AZ. for safe keeping.

On December 16, 2005 an agreement was reached between the Provo Area Office and the City of Page AZ to have the core samples inspected and photographed by a Reclamation geologist (see section 6.0). Following the examination, a geologic log of the boring would be prepared containing; % core recovery, % rock quality designation (RQD), brief description of the rock, and the depths and the angles from the core axis of fractures, both mechanical and natural. A cursory examination of the surface geology, with the primary purpose of identifying surface exposures of fractures/joints/discontinuities near the drill hole was also agreed to. The location of any joints would be marked on photographs.

The field work was completed the week of December 19, 2005 by Mark Neeley, Geologist, Power Office, Salt Lake City, UT. The geologic log, core box photographs and joint photographs were completed in January 2006. This summary document was prepared in March 2006.

1.1 Core Photographs

There are a total of 42 cardboard core boxes, each box containing about 10 linear feet of rock core samples. A picture was taken of each box of core. Later two pictures were placed on a single 8-1/2 x 11 inch sheet of paper. Included with the core photographs is a close-up picture of the core sample obtained from the depth interval between the depths of 300.2 and 301.0 feet. The core photographs can be found in section 3.0 of this document.

1.2 Examine Core

Determining the presence, depth, frequency and orientation of natural fractures in the rock penetrated by the boring is probably the most important data to obtain from the core samples. However, making this determination by inspecting the boxed core samples and reading daily drill reports was very difficult. Many of the breaks in the core samples occurred along cross-bedding. It was impossible to determine if the breaks were present when the core was removed from the core barrel or if the breaks occurred when the core was placed in the box. The driller reports that many of the 5-foot long drilling runs obtained continuous 5-foot-long "sticks" of core. These "sticks" needed to be broken 2, 3 or more times in order to be placed in the relatively small cardboard core boxes. For this reason nearly all of the breaks noted on the geologic log are marked as mechanical breaks. Mechanical breaks parallel to the cross-bedding were noted as such, along with the angle of the cross-bedding measured from the core axis.

Having a geologist present during drilling to determine and note the natural/mechanical breaks as the core samples were removed from the core barrel would have been the

preferred method of logging the core samples and also the most accurate. Inspecting (logging) the core took place over a month after the drilling was completed.

1.3 Prepare a Geologic Log

The geologist measured and noted the depth of all of the breaks in the core with considerable difficulty. Most (+95%) were logged as mechanical breaks because there was no way to easily and rapidly determine if they were natural fractures. Therefore RQD (Rock Quality Designation) is near 100% for most of the hole. RQD is a fracture index used in many rock classification systems. To determine RQD value, add the total length of solid core that is 4-inches or more long regardless of the core diameter. If the core is broken by handling or the drilling process (mechanical breaks), the broken pieces are fitted together and counted as one piece, provided that they form the requisite length of 4-inches. The length of these pieces is measured along the centerline of the core. This sum is divided by the length of the run (drill interval) and recorded on the drill log as a percentage of each run.

At the direction of the owner, the hole was filled with grout following completion. No downhole camera or geophysical logging was done before the hole was filled with grout.

A 10 page geologic log (35 feet/page) was prepared using GINT 7 software and exported to a PDF file (see section 2.0) Very few natural fractures were noted. Natural fractures were logged at depths of 87.5, 87.8, 88.5, 153.6, 205.9, 247.8, 248.0, 300.2-301.0 and 325.0-325.3 feet. The only significant area of natural fractures was identified at a depth of 300.2 to 301.0 feet or about elevation 3507. The zone of fractured core was significantly eroded by drill water so descriptions of the fracture surfaces were not possible.

The daily drill reports prepared by the driller are included with this document in section 5.0.

1.4 Surface Geology Inspection

A joint is prominently exposed on the surface near the location of the drill hole. A surface topography map was not available at the time of the site visit so the joint trace was followed in the field and marked on photographs (see photographs 1 through 5, in section 4).

A prominent joint is exposed in the north wall of inlet channel of the left (east) side spillway (see photograph 1) for Glen Canyon Dam. The joint trends or strikes N 9° E, and dips or slopes 60° from horizontal toward the southwest into the reservoir (see photograph 4). The trace of the joint extends vertically from the top of the inlet channel cut to the floor of the inlet channel or about 135 feet. In may extend below the inlet channel (see photograph 2). The trace of the subject joint is exposed on the ground surface about 80 feet east of DH05-1. The joint can be traced from the spillway inlet channel on the south end toward the north for about 800 feet. The surface extent of the joint is shown on photograph 5, a black and white photograph taken before construction of Glen Canyon Dam. The approximate location of DH05-1 is shown on the photograph. The possible extent of the joint is marked on the photograph as well.

Section 2.0

GEOLOGIC LOG OF DRILL HOLE NO. DH05-1

FEATURE: Page Pumping Plant
LOCATION: U/S Left Side Spillway Inlet
BEGUN: 11/3/05 FINISHED: 11/21/05
DEPTH AND ELEV OF WATER LEVEL AND DATE MEASURED: ▽ ()WL not noted

PROJECT: Page - Lachee Pumping Plant
COORDINATES: N 2,162,005.2 E 626,984.1
TOTAL DEPTH: 415.0
DEPTH TO BEDROCK: 0

STATE: ARIZONA
GROUND ELEVATION: 3772.5
ANGLE FROM HORIZONTAL: -62.0 AZIMUTH: 253.0
HOLE LOGGED BY: Mark Neeley
REVIEWED BY: O. Ira Terry

NOTES

The primary reason for this hole was to determine physical characteristics of the rock at this location. The presence, depth, frequency and orientation of natural fractures present in the rock would be the most important data to collect. Determining if breaks/fractures present in the boxed core samples were natural fractures or mechanical breaks was very difficult. The driller reports that many of the 5-foot long drilling runs obtained continuous 5-foot-long "sticks" of core. These "sticks" needed to be broken 2, 3 or more times in order to be placed in the relatively small cardboard core boxes. Having a geologist present during drilling to determine and note the natural/mechanical breaks as the core samples were removed from the core barrel would have been the preferred method of logging the core samples and also the most accurate. Inspecting (logging) the core took place over a month after the drilling was completed. The geologist attempted to accurately measure and note the depth of all of the breaks in the core. Most (+95%) were logged as mechanical breaks because there was no way to easily and rapidly determine if they were natural fractures. Therefore RQD (Rock Quality Designation) is near 100% for most of the hole. At the direction of the owner, the hole was filled with grout following completion. No downhole camera or geophysical logging was done before the hole was filled with grout.

PURPOSE
This hole was drilled to determine rock properties at a location near the the Page-Lachee pumping plant location.

NOTES
The % Core Recovery column sometimes gives percentages greater than 100%. This occurs when a "nub" of rock core remains in the hole from an earlier core run and is picked up in a subsequent

DEPTH	GEOL UNIT SYMBOL	% CORE RECOVERY	PENETRATION RATE (Minutes)	FRAC DENSITY	WEATHERING	HARDNESS	MATERIAL GRAPHIC	FLD CLASS/ LITH	CLASSIFICATION AND PHYSICAL CONDITION
					?	?		CONCRETE	0.0 - 9.4 feet; No Report - The 11-03-05 drill report gives no explanation of how the hole was started. The report starts at 9.4 feet. From inspecting the core in box #1, 0.0 to 9.4, it looks as if a larger diameter hole was drilled to about 2.5 feet after which a larger diameter pipe was grouted at the correct angle and bearing. After the grout was allowed to set, the drilling of the hole began through the standpipe. 0.0 - 2.5 feet; GROUT 2.5 - 4.0 feet; SANDSTONE; red to light red, composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately soft (H5), core breaks with light hammer blow or with heavy manual pressure. Unaffected by weathering. Numerous breaks in the core; impossible to determine if they are natural fractures or mechanical breaks. 4.0 - 9.4 feet SANDSTONE; red to light red, composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately soft (H5), core breaks with light hammer blow or with heavy manual pressure. Unaffected by weathering. There are 7 breaks in the core; all are interpreted to be mechanical breaks, 3 are parallel with crossbedding at depths and angles from the core axis as follows, 5.3@58°; 6.3@59°; 7.7@54°. The other mechanical breaks occur at the following approximate depths; 8.3, 8.6, 8.7, 9.2.
					W4	H5			
					W4	H5		SANDSTONE	
10		100			W4	H5			9.4 - 14.4 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately soft (H5), core breaks with light hammer blow or with heavy manual pressure; moderately to slightly weathered (W4). There are 6 breaks in the core; all are interpreted to be mechanical breaks at the following approximate depths; 9.6, 9.7, 11.0, 11.4, 11.6, and 13.4
		100			W4	H5		SANDSTONE	14.4 - 19.4 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately soft (H5), core breaks with light hammer blow or with heavy manual pressure; moderately to slightly weathered (W4). There are 7 breaks in the core; all are interpreted to be mechanical breaks, 1 is parallel with crossbedding at the depth and angle from the core axis as follows, 15.7@45°. The other mechanical breaks occur at the following approximate depths; 14.4, 15.2, 15.5, 16.9, 17.5, and 18.0.
20		100			W4	H5		SANDSTONE	19.4 - 24.4 feet SANDSTONE; red to light red, faint crossbedding and small dark red rust colored mottles in the upper part of the interval; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately soft (H5), core breaks with light hammer blow or with heavy manual pressure; moderately to slightly weathered (W4). There are 8 breaks in the core; all are interpreted to be mechanical breaks at the following approximate depths; 19.4, 20.8, 21.4, 22.7, 23.4, 23.8, 24.0, 24.2.
		100			W5	H5		SANDSTONE	24.4 - 29.4 feet SANDSTONE; red to light red, faint crossbedding and numerous small dark red rust colored mottles throughout the core; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately soft (H5), core breaks with light hammer blow or with heavy manual pressure; moderately weathered (W5). There are 10 breaks in the core; all are interpreted to be mechanical breaks and are present at the following approximate depths; 25.0, 25.4, 25.8, 26.1, 27.2, 27.4, 27.5, 27.7, 28.8, and 29.1.
30		102				H5			29.4 - 34.4 feet SANDSTONE; red to light red, faint crossbedding and numerous small dark red rust colored mottles throughout the core interval from about 29.4 to 30.5; less numerous mottles throught the remainder of the core; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately soft (H5), core breaks with light hammer blow or with heavy manual pressure; moderately to slightly weathered (W4) except for 29.4 to 31.0 which is moderately weathered (W5). There are 9 breaks in the core; all are interpreted to be mechanical breaks and are present at the following approximate depths; 29.6, 29.7, 30.3, 30.8, 31.2, 33.1, 33.3, 33.4, 34.0.
					W4			SANDSTONE	
		98			W4	H5		SANDSTONE	34.4 - 39.4 feet SANDSTONE; red to light red, faint to distinct crossbedding and

COMMENTS:

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GEOLOGIC LOG OF DRILL HOLE NO. DH05-1

FEATURE: Page Pumping Plant
LOCATION: U/S Left Side Spillway Inlet
BEGUN: 11/3/05 FINISHED: 11/21/05
DEPTH AND ELEV OF WATER LEVEL AND DATE MEASURED: ▽ ()WL not noted

PROJECT: Page - Lachee Pumping Plant
COORDINATES: N 2,162,005.2 E 626,984.1
TOTAL DEPTH: 415.0
DEPTH TO BEDROCK: 0

STATE: ARIZONA
GROUND ELEVATION: 3772.5
ANGLE FROM HORIZONTAL: -82.0 AZIMUTH: 253.0
HOLE LOGGED BY: Mark Neeley
REVIEWED BY: O. Ira Terry

NOTES	DEPTH	GEOL UNIT SYMBOL	% CORE RECOVERY	PENETRATION RATE (Minutes)	FRAC DENSITY	WEATHERING	HARDNESS	MATERIAL GRAPHIC	FLD CLASS/ LITH	CLASSIFICATION AND PHYSICAL CONDITION
core run. This sometimes happens when the core breaks above the bottom of the hole due to weaker rock.									SANDSTONE	faint small dark red rust colored mottles throughout the core; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately soft (H5), core breaks with light hammer blow or with heavy manual pressure; moderately to slightly weathered (W4). There are 8 mechanical breaks, 5 are parallel with crossbedding at the following depths and angles from the core axis; 35.7@65°, 37.1@62° 37.9@60°, 38.5@65° and 38.9@65°. The other mechanical breaks occur at the following approximate depths; 35.1, 36.3, and 39.2.
LOCATION Drill hole DH05-1 is located upstream (north) of the left (west) spillway intake channel for Glen Canyon Dam. It is located outside the fenced perimeter.	40		100			W4	H5		SANDSTONE	39.4 - 44.4 feet SANDSTONE; red to light red, faint crossbedding and very faint small dark red rust colored mottles throughout the core; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately soft (H5), core breaks with light hammer blow or with heavy manual pressure; moderately to slightly weathered (W4). There are 7 breaks in the core; all 7 are interpreted to be mechanical breaks at the following approximate depths; 41.0, 41.8, 42.3, 43.0, 43.8, 44.0, and 44.2.
AZIMUTH & PLUNGE These values were determined using a BRUNTON compass. The plunge was measured by placing the BRUNTON directly on the standpipe and determining the inclination of the pipe. The bearing/azimuth was determined by sighting along the standpipe and reading the bearing from the BRUNTON.			100			W4	H5		SANDSTONE	44.4 - 49.4 feet SANDSTONE; red to light red, faint to distinct crossbedding throughout the core; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately soft (H5), core breaks with light hammer blow or with heavy manual pressure; moderately to slightly weathered (W4). There are 11 breaks in the core; all are interpreted to be mechanical breaks, 4 are parallel with crossbedding at the following depths and angles from the core axis; 46.7@66°, 47.5@66°, 48.0@66° and 48.2@66°. The other mechanical breaks occur at the following approximate depths; 44.9, 45.0, 45.1, 46.2, 48.7, 48.9, and 49.2.
DRILLING AND SAMPLING METHODS Drill Rig - TERRAMAC crawler mounted diesel engine; with an HQ³ diamond bit and 5-foot-long triple-tube wireline core barrel. Water with DRISPAC PF POLY was used as a drilling additive. Water was hauled to the site. Drilling fluid was recirculated. Drilling proressed as follows: DATE DEPTH 11-03-05 0.0 to 89.4 11-04-05 89.4 to 139.4 11-05-05 139.4 to 189.4 11-06-05 189.4 to 214.4 11-07-05 214.4 to 274.4 11-09-05 274.4 to 299.4 11-16-05 299.4 to 314.4 11-17-05 314.4 to 353.9 11-20-05 353.9 to 388.7 11-21-o5 388.7 to 415.0	50		100			W3	H5		SANDSTONE	**NOTE - The surface of the recovered core obtained from the hole from this point forward is covered with a thin film of dry drilling fluid which masks the physical properties such as color, weathering, and crossbedding; these properties were estimated in these areas by scratching the surface of the core.** 49.4 - 54.4 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately soft (H5), core breaks with light hammer blow or with heavy manual pressure; slightly weathered (W3). . There are 3 breaks in the core; all 3 are interpreted to be mechanical breaks, 1 is parallel with crossbedding at the following depth and angle from the core axis; 54.0@58°. The other mechanical breaks occur at the approximate depths of 50.5 and 52.4.
DRILLING FLUID RETURN DEPTH % LOST 9.4 to 353.9 0 353.9 to 415.0 10			100			W3	H5		SANDSTONE	54.4 - 59.4 feet SANDSTONE; red to light red, faint to distinct crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately soft (H5), core breaks with light hammer blow or with heavy manual pressure; slightly weathered (W3). There are 2 breaks in the core; both are interpreted to be mechanical breaks that occur at approximate depths of 54.4, and 56.3.
DEFINITIONS Hardness descriptors, H1 through H7, are defined in Table 4-6-Hardness/strength descriptors, page 83 of the Engineering Geology Field Manual, second edition, Volume 1, USBR, 1998. H1=extremely hard; H7=very soft.	60		100			W4 W5	H5		SANDSTONE	59.4 - 64.4 feet SANDSTONE; red to light red, faint to distinct crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately soft (H5), core breaks with light hammer blow or with heavy manual pressure; moderately to slightly weathered (W4). There are 10 breaks in the core; all 10 are interpreted to be mechanical breaks, 6 are parallel with crossbedding at the following depths and angles from the core axis; 59.9@58°, 60.1@63°, 60.9@62°, 61.4@56°, 61.8@56° and 62.1@56°. The other mechanical breaks occur at the following approximate depths; 63.0, 63.6, 63.8 and 64.0.
Weathering descriptors, W1 through W9, are defined in Table 4-4 - Weathering descriptors, page 77 of the Engineering Geology Field Manual, second edition, Volume 1, USBR, 1998. W1=fresh; W9=decomposed			100			W4 W5	H5		SANDSTONE	64.4 - 69.4 feet SANDSTONE; red to light red, faint to distinct crossbedding and frequent dark red rust colored mottles; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately soft (H5), core breaks with light hammer blow or with heavy manual pressure; moderately to slightly weathered (W4). Except for 67.6 to 67.8 which is intensely to moderately weathered (W6). There are 8 breaks in the core; all 8 are interpreted to be mechanical breaks, 4 are parallel with crossbedding at the following depths and angles from the core axis; 67.8@67°, 68.0@67°, 68.2@67°, 68.8@56° and 61.8@67°. The other mechanical breaks occur at the following approximate depths; 65.8, 66.5, 67.2, and 67.6.
Fracture density descriptors, FD0 through FD9, are defined in Table 5-1- Fracture density descriptors, page 97 of the Engineering Geology Field Manual, second edition, Volume 1, USBR, 1998. FD0 = Unfractured; FD9=very intensely fractured	70		100			W4	H5		SANDSTONE	69.4 - 74.4 feet SANDSTONE; red to light red, very faint crossbedding and frequent dark red rust colored mottles; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately soft (H5), core breaks with light hammer blow or with heavy manual pressure; moderately to slightly weathered (W4). There are 8 breaks in the core; all 8 are interpreted to be mechanical breaks, 2 are parallel with crossbedding at the following depths and angles from the core axis; 69.7@68° and 69.5@68°. The other mechanical breaks occur at the following approximate depths; 70.5, 71.2, 71.7, 72.2, 73.5, and 73.7.
			92			W4	H5		SANDSTONE	74.4 - 79.4 feet SANDSTONE; red to light red, very faint crossbedding and frequent dark red rust colored mottles; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately soft (H5), core breaks with light hammer blow or with heavy manual pressure; moderately to slightly weathered (W4). There are 7 breaks in the core; all 7 are interpreted to be mechanical breaks, 1 is parallel with crossbedding at the depth and angle from the core axis of 78.9@61°. The other mechanical breaks occur at the following approximate depths; 75.1, 75.8, 76.3, 77.9, and 79.3.

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GEOLOGIC LOG OF DRILL HOLE NO. DH05-1

FEATURE: Page Pumping Plant
LOCATION: U/S Left Side Spillway Inlet
BEGUN: 11/3/05 FINISHED: 11/21/05
DEPTH AND ELEV OF WATER LEVEL AND DATE MEASURED: ▽ ()WL not noted

PROJECT: Page - Lachee Pumping Plant
COORDINATES: N 2,162,005.2 E 626,984.1
TOTAL DEPTH: 415.0
DEPTH TO BEDROCK: 0

STATE: ARIZONA
GROUND ELEVATION: 3772.5
ANGLE FROM HORIZONTAL: -62.0 AZIMUTH: 253.0
HOLE LOGGED BY: Mark Neeley
REVIEWED BY: O. Ira Terry

NOTES	DEPTH	GEOL UNIT SYMBOL	% CORE RECOVERY	PENETRATION RATE (Minutes)	FRAC DENSITY	WEATHERING	HARDNESS	MATERIAL GRAPHIC	FLD CLASS/ LITH	CLASSIFICATION AND PHYSICAL CONDITION
RQD Rock Quality Designation is defined on pages 95 and 96, Figure 5.1 of the Engineering Geology Field Manual, second edition, volume 1, USBR, 1998.									SANDSTONE	
	80		100			W4	H5		SANDSTONE	79.4 - 84.4 feet SANDSTONE; red to light red, faint to distinct crossbedding and few faint dark red rust colored mottles; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately soft (H5), core breaks with light hammer blow or with heavy manual pressure; moderately to slightly weathered (W4). There are 9 breaks in the core; all 9 are interpreted to be mechanical breaks, 8 are parallel with crossbedding at the following depths and angles from the core axis; 80.6@64°, 81.3@65°, 81.8@64°, 82.8@69°, 83.0@64°, 83.2@65°, 83.5@65°and 84.1@62°. The other mechanical break occurs at an approximate depth of 79.4.
			100		FD5	W4	H5		SANDSTONE	84.4 - 89.4 feet SANDSTONE; red to light red, faint crossbedding and few faint dark red rust colored mottles; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately soft (H5), core breaks with light hammer blow or with heavy manual pressure; moderately to slightly weathered (W4). There are 8 breaks in the core; 5 are interpreted to be mechanical breaks, 2 of the 5 are parallel with crossbedding at the following depths and angles from the core axis; 88.7@70° and 89.2@70°. The other 3 mechanical breaks occur at approximate depths of 85.0, 86.0, and 86.9. The remaining 3 breaks are natural fractures at depths and angles from the core axis as follows; 87.5@68°, 87.8@70° and 88.5@70°. Two of the three natural fractures have faint iron staining on the surfaces of the joints.
	90		100			W4	H5		SANDSTONE	89.4 - 94.4 feet SANDSTONE; red to light red, faint crossbedding and very apparent dark red rust colored mottles; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately soft (H5), core breaks with light hammer blow or with heavy manual pressure; moderately to slightly weathered (W4), very porous. There are 5 breaks in the core; all 5 are interpreted to be mechanical breaks, 1 is parallel with the crossbedding at a depth and angle from the core axis of 87.5@68°. The other 4 mechanical breaks occur at approximate depths of 92.0, 92.7, 92.8 and 93.9.
			90			W3	H5 H4		SANDSTONE	94.4 - 99.4 feet SANDSTONE; red to light red, faint crossbedding and few dark red rust colored mottles; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately soft (H5) to moderately hard (H4), core breaks with moderate to heavy hammer blow or with heavy manual pressure; slightly weathered (W3). There are 6 breaks in the core; all 6 are interpreted to be mechanical breaks, 5 are parallel with crossbedding at depths and angles from the core axis as follows 95.1@59°, 96.6@59°, 98.2@59°, 98.9@59° and 99.2@61°. The other mechanical break occurs at an approximate depth of 94.3.
	100		106			W3	H4		SANDSTONE	99.4 - 104.4 feet SANDSTONE; red to light red, faint crossbedding composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4), core breaks with moderate hammer blow; slightly weathered (W3). There are 8 breaks in the core; all 8 are interpreted to be mechanical breaks, 6 are parallel with crossbedding at depths and angles from the core axis as follows 101.1@59°, 100.7@59°, 101.8@59°, 102.7@59°, 103.8@59° and 104.1@61°. The other 2 mechanical breaks occur at approximate depths of 100.8 and 104.3.
			100			W3	H4		SANDSTONE	104.4 - 109.4 feet SANDSTONE; red to light red, faint crossbedding composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4), core breaks with moderate hammer blow; slightly weathered (W3). There are 5 breaks in the core; all 5 are interpreted to be mechanical breaks, all 5 are parallel with crossbedding at depths and angles from the core axis as follows 105.7@56°,107.2@56°, 107.6@56°, 108.3@56° and 109.2@56°.
	110		100			W3	H4		SANDSTONE	109.4 - 114.4 feet SANDSTONE; red to light red, faint crossbedding ; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4), core breaks with moderate hammer blow; slightly weathered (W3). There are 7 breaks in the core; 6 are interpreted to be mechanical breaks, 5 of these are parallel with crossbedding at the following depths and angles from the core axis; 109.7@56°, 110.8@56°, 111.4@56°, 113.3@56° and 113.8@56°. The other mechanical break occurs at an approximate depth of 111.8. The remaining break is a natural fracture at a depth and angle from the core axis of 114.4@56°.
			100		FD1	W3	H4		SANDSTONE	114.4 - 119.4 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4), core breaks with moderate hammer blow; slightly weathered (W3). There are 7 breaks in the core; 6 are interpreted to be mechanical breaks, 3 o fthese are parallel with crossbedding at the following depths and angles from the core axis; 116.0@54°, 116.5@54° and 116.8@56°. The other 3 mechanical breaks occur at approximate depths of 117.8, 118.7, and 119.3. The remaining break is a natural fracture at a depth and angle from the core axis of 119.4@54°.
	120		100			W3	H4		SANDSTONE	119.4 - 124.4 feet SANDSTONE; red to light red, faint crossbedding ; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4), core breaks with moderate hammer blow; slightly weathered (W3). There are 7 breaks in the core; 7 are interpreted to be mechanical breaks, 7 are parallel with crossbedding at the following depths and

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GEOLOGIC LOG OF DRILL HOLE NO. DH05-1

FEATURE: Page Pumping Plant
LOCATION: U/S Left Side Spillway Inlet
BEGUN: 11/3/05 FINISHED: 11/21/05
DEPTH AND ELEV OF WATER LEVEL AND DATE MEASURED: ▽ ()WL not noted

PROJECT: Page - Lachee Pumping Plant
COORDINATES: N 2,162,005.2 E 626,984.1
TOTAL DEPTH: 415.0
DEPTH TO BEDROCK: 0

STATE: ARIZONA
GROUND ELEVATION: 3772.5
ANGLE FROM HORIZONTAL: -62.0 AZIMUTH: 253.0
HOLE LOGGED BY: Mark Neeley
REVIEWED BY: O. Ira Terry

NOTES	DEPTH	GEOL UNIT SYMBOL	% CORE RECOVERY	PENETRATION RATE (Minutes)	FRAC DENSITY	WEATHERING	HARDNESS	MATERIAL GRAPHIC	FLD CLASS/ LITH	CLASSIFICATION AND PHYSICAL CONDITION
									SANDSTONE	angles from the core axis; 119.9@55°, 120.4@55°, 121.1@55°, 121.8@55°, 122.2@55° and 122.8@55°.
			100			W3	H4		SANDSTONE	124.4 - 129.4 feet SANDSTONE; red to light red, faint crossbedding ; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4), core breaks with moderate hammer blow ; slightly weathered (W3). There are 7 breaks in the core; 7 are interpreted to be mechanical breaks, 4 are parallel with crossbedding at the following depths and angles from the core axis; 127.0@62°, 127.2@62°, 127.8@62°, @56° and 128.4@62°. The other 3 mechanical breaks occur at approximate depths of 129.3, 129.2 and 129.0.
	130		100			W3	H4		SANDSTONE	129.4 - 134.4 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4), core breaks with moderate hammer blow; slightly weathered (W3). There are 4 breaks in the core all 4 are interpreted to be mechanical breaks, 3 are parallel with the crossbedding at the following depths and angles from the core axis; 131.4@55°, 132.5@55° and 133.4@55°. The other mechanical break occurs at an approximate depth of 130.7.
			100			W3	H4		SANDSTONE	134.4 - 139.4 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4), core breaks with moderate hammer blow; slightly weathered (W3). There are 2 breaks in the core both are interpreted to be mechanical breaks at approximate depths of 136.5 and 138.4.
	140		100			W3	H4		SANDSTONE	139.4 - 144.4 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4), core breaks with moderate hammer blow; slightly weathered (W3). There are 5 breaks in the core, all 5 are interpreted to be mechanical breaks at approximate depths of 139.8, 140.4, 140.6, 142.4.5 and 144.0.
			100			W3	H4		SANDSTONE	144.4 - 149.4 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4), core breaks with moderate hammer blow; slightly weathered (W3). There are 6 breaks in the core; all 6 are interpreted to be mechanical breaks, 2 are parallel with crossbedding at the following depths and angles from the core axis; 146.4@70° and 147.0@70°. The other 4 mechanical breaks occur at approximate depths of 146.0, 148.3, 149.2 and 149.0.
	150		100		FD1	W3	H4		SANDSTONE	149.4 - 154.4 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4), core breaks with moderate hammer blow; slightly weathered (W3). There are 7 breaks in the core; 6 are interpreted to be mechanical breaks, 4 of these are parallel with crossbedding at the following depths and angles from the core axis; 150.8@70°, 151.4@70°, 153.0@70° and 154.1@70°. The other 2 mechanical breaks occur at approximate depths of 150.1 and 152.4. The remaining break is a natural fracture at a depth and angle from the core axis of 153.6@70°.
			100		FD1	W3	H4		SANDSTONE	154.4 - 159.4 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4), core breaks with heavy hammer blow; slightly weathered (W3). There are 6 breaks in the core; all 6 are interpreted to be mechanical breaks, 2 of these are parallel with crossbedding at the following depths and angles from the core axis; 153.6@63° and 156.5@63°. The other 4 mechanical breaks occur at approximate depths of 156.2, 157.7, 158.2 and 158.8.
	160		100			W3	H4		SANDSTONE	159.4 - 164.4 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4), core breaks with heavy hammer blow; slightly weathered (W3). There are 7 breaks in the core; 6 are interpreted to be mechanical breaks, 3 are parallel with crossbedding at the following depths and angles from the core axis; 162.4@67°, 162.6@67° and 163.1@67°. The other 3 mechanical breaks occur at approximate depths of 160.4, 161.4 and 163.8. The remaining break is a natural fracture at a depth and angle from the core axis of 159.4@80°.
						W3	H4		SANDSTONE	164.4 - 169.4 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4), core breaks with moderate hammer blow; slightly

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GEOLOGIC LOG OF DRILL HOLE NO. DH05-1

FEATURE: Page Pumping Plant
LOCATION: U/S Left Side Spillway Inlet
BEGUN: 11/3/05 FINISHED: 11/21/05
DEPTH AND ELEV OF WATER LEVEL AND DATE MEASURED: ▽ ()WL not noted

PROJECT: Page - Lachee Pumping Plant
COORDINATES: N 2,162,005.2 E 626,984.1
TOTAL DEPTH: 415.0
DEPTH TO BEDROCK: 0

STATE: ARIZONA
GROUND ELEVATION: 3772.5
ANGLE FROM HORIZONTAL: -62.0 AZIMUTH: 253.0
HOLE LOGGED BY: Mark Neeley
REVIEWED BY: O. Ira Terry

NOTES	DEPTH	GEOL UNIT SYMBOL	% CORE RECOVERY	PENETRATION RATE (Minutes)	FRAC DENSITY	WEATHERING	HARDNESS	MATERIAL GRAPHIC	FLD CLASS/ LITH	CLASSIFICATION AND PHYSICAL CONDITION
									SANDSTONE	weathered (W3). There are 4 breaks in the core, all 4 are interpreted to be mechanical breaks at approximate depths of 165.2, 166.2, 164.2 and 168.3.
	170		100			W3	H4		SANDSTONE	169.4 - 174.4 feet SANDSTONE; red to light red, faint crossbedding and frequent rust colored mottles; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4), core breaks with moderate hammer blow; slightly weathered (W3). There are 8 breaks in the core, all 8 are interpreted to be mechanical breaks at approximate depths of 170.4, 171.6, 172.0, 172.4, 172.6, 172.7, 173.2 and 174.2.
			100			W3	H4		SANDSTONE	174.4 - 179.4 feet SANDSTONE; red to light red, faint crossbedding; scattered red rust colored mottles; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4), core breaks with moderate hammer blow; slightly weathered (W3). There are 7 breaks in the core, all 7 are interpreted to be mechanical breaks, 2 of these are parallel with crossbedding at the following depths and angles from the core axis; 178.9@70° and 179.1@70°. The other 5 mechanical breaks occur at approximate depths of 175.6, 176.4, 176.6, 178.0 and 178.4.
	180		100			W3	H4		SANDSTONE	179.4 - 184.4 feet SANDSTONE; red to light red, faint crossbedding; except predominantly gray because of black sand size grains from 179.9 - 180.5; the remainder composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4), core breaks with moderate hammer blow; slightly weathered (W3). There are 3 breaks in the core; all 3 are interpreted to be mechanical breaks, 1 is parallel with crossbedding at the following depth and angle from the core axis; 183.2@70°. The other 2 mechanical breaks occur at approximate depths of 181.6 and 182.4.
			100			W3	H4		SANDSTONE	184.4 - 189.4 feet SANDSTONE; red to light red, faint crossbedding; except some are predominantly gray because of black sand size grains; the remainder composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4), core breaks with moderate hammer blow; slightly weathered (W3). There are 8 breaks in the core; all 8 are interpreted to be mechanical breaks, 2 are parallel with crossbedding at the following depths and angles from the core axis; 184.9@71° and 185.3@70°. The other 6 mechanical breaks occuring at the approximate depths of 185.7, 186.3, 186.5, 188.3, 188.4 and 188.6.
	190		100			W3	H4		SANDSTONE	189.4 - 194.4 feet SANDSTONE; red to light red, faint crossbedding; faint red rust colored mottles; banding seems to mark changes between high and moderate porosity; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4), core breaks with moderate hammer blow; slightly weathered (W3). There are 8 breaks in the core; all 8 are interpreted to be mechanical breaks, 1 is parallel with crossbedding at the following depth and angle from the core axis; 193.0@61°. The other 7 mechanical breaks occur at approximate depths of 189.5, 190.7, 191.0, 191.6, 192.5, 193.6 and 194.7.
			100			W3	H4		SANDSTONE	194.4 - 199.4 feet SANDSTONE; red to light red, faint crossbedding; faint red rust colored mottles; banding seems to mark changes between high and moderate porosity; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4), core breaks with moderate hammer blow; slightly weathered (W3). There are 4 breaks in the core, all 4 are interpreted to be mechanical breaks, 1 is parallel with crossbedding at the following depth and angle from the core axis; 198.3@61°. The other 3 mechanical breaks occur at approximate depths of 195.9, 196.3 and 199.2.
	200		100			W3	H4		SANDSTONE	199.4 - 204.4 feet SANDSTONE; red to light red, faint crossbedding ; faint red rust colored mottles; banding seems to mark changes between high and moderate porosity; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4), core breaks with moderate hammer blow; slightly weathered (W3). There are 4 breaks in the core; all 4 are interpreted to be mechanical breaks, 2 are parallel with crossbedding at the following depths and angles from the core axis; 200.4@60° and 201.3@68°. The other 2 mechanical breaks occur at approximate depths of 202.4 and 202.8.
			100		FD1	W3	H4		SANDSTONE	204.4 - 209.4 feet SANDSTONE; red to light red, faint crossbedding; faint red rust colored mottles; high porosity; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4), core breaks with moderate hammer blow; slightly weathered (W3). There are 5 breaks in the core; 4 are interpreted to be mechanical breaks at approximate depths of 206.4, 206.9, 207.6, and 208.3. The remaining break is a natural fracture at a depth and angle from the core axis of 205.9@15°.
			100			W3	H4		SANDSTONE	209.4 - 214.4 feet SANDSTONE; same as 204.4 - 209.4. There are 5 breaks in

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GEOLOGIC LOG OF DRILL HOLE NO. DH05-1

FEATURE: Page Pumping Plant
LOCATION: U/S Left Side Spillway Inlet
BEGUN: 11/3/05 FINISHED: 11/21/05
DEPTH AND ELEV OF WATER LEVEL AND DATE MEASURED: ▽ ()WL not noted

PROJECT: Page - Lachee Pumping Plant
COORDINATES: N 2,162,005.2 E 626,984.1
TOTAL DEPTH: 415.0
DEPTH TO BEDROCK: 0

STATE: ARIZONA
GROUND ELEVATION: 3772.5
ANGLE FROM HORIZONTAL: -62.0 AZIMUTH: 253.0
HOLE LOGGED BY: Mark Neeley
REVIEWED BY: O. Ira Terry

NOTES	DEPTH	GEOL UNIT SYMBOL	% CORE RECOVERY	PENETRATION RATE (Minutes)	FRAC DENSITY	WEATHERING	HARDNESS	MATERIAL GRAPHIC	FLD CLASS/ LITH	CLASSIFICATION AND PHYSICAL CONDITION
									SANDSTONE	the core; all 5 are interpreted to be mechanical breaks at approximate depths of 210.4, 211.4, 211.7, 212.4 and 212.6.
						W3	H4		SANDSTONE	
						W4				
						W3				
	220		100				H4		SANDSTONE	214.4 - 219.4 feet SANDSTONE; red to light red, faint crossbedding; faint red rust colored mottles; high porosity; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4), core breaks with moderate hammer blow; slightly weathererd (W3) except for 216.7 to 218.3 which is moderately to slightly weathered (W4). There are 4 breaks in the core; all 4 are interpreted to be mechanical breaks at approximate depths of 216.3, 216.7, 218.3 and 218.9.
			100			W3	H4 H3		SANDSTONE	219.4 - 224.4 feet SANDSTONE; red to light red, faint crossbedding; faint red rust colored mottles; high porosity; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4), core breaks with moderate hammer blow; slightly weathered (W3). There are 5 breaks in the core; all 5 are interpreted to be mechanical breaks 219.6, 220.5, 221.3, 222.4 and 222.6.
	230		100			W3	H4 H3		SANDSTONE	224.4 - 229.4 feet SANDSTONE; red to light red, faint crossbedding; faint red rust colored mottles; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4) to hard (H3), core breaks with moderate to heavy hammer blow; slightly weathered (W3). There are 4 breaks in the core; all 4 are interpreted to be mechanical breaks, 3 are parallel with crossbedding at the following depths and angles from the core axis; 226.4@49°, 227.0@51°and 229.0@58°. The other mechanical break occurs at an approximate depth of 228.3.
			100			W3	H4 H3		SANDSTONE	229.4 - 234.4 feet SANDSTONE; red to light red, faint crossbedding; faint red rust colored mottles; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4) to hard (H3), core breaks with moderate to heavy hammer blow; slightly weathered (W3). There are 4 breaks in the core; all 5 are interpreted to be mechanical breaks, 4 are parallel with crossbedding at the following depths and angles from the core axis; 230.0@57°, 230.5@56°, 231.4@59° and 232.5@60°. The other mechanical break occurs at an approximate depth of 232.0.
	240		100			W3	H4 H3		SANDSTONE	234.4 - 239.4 feet SANDSTONE; red to light red, faint crossbedding; faint red rust colored mottles; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4) to hard (H3), core breaks with moderate to heavy hammer blow; slightly weathered (W3). There are 5 breaks in the core; all 5 are interpreted to be mechanical breaks, 4 are parallel with crossbedding at the following depths and angles from the core axis; 230.0@57°, 230.5@56°, 231.4@59°, and 232.5@60°. The other mechanical break occurs at an approximate depth of 232.0.
			100			W3	H4 H3		SANDSTONE	239.4 - 244.4 feet SANDSTONE; red to light red, faint crossbedding; faint red rust colored mottles; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4) to hard (H3), core breaks with moderate to heavy hammer blow; slightly weathered (W3). There are 5 breaks in the core, all 5 are interpreted to be mechanical breaks, 2 are parallel with crossbedding at the following depths and angles from the core axis; 239.4@60° and 244.2@60°. The remaining 3 mechanical breaks occur at approximate depths of 240.5, 240.8 and 242.5.
			100		FD3	W3	H4		SANDSTONE	244.4 - 249.4 feet SANDSTONE; red to light red, faint crossbedding; high porosity; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4), core breaks with moderate hammer blow; slightly weathered (W3). There are 7 breaks in the core, 5 of these are interpreted to be a mechanical breaks at approximate depths of 246.4, 246.6, 247.0, 247.3 and 248.5. The remaining breaks are natural fractures at the following depths; 247.8, and 248.
	250		100			W2	H4 H3		SANDSTONE	249.4 - 254.4 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4) to hard (H3) core breaks with moderate to heavy hammer blow; slightly weathered to fresh (W2). There are 5 breaks in the core; 4 are interpreted to be mechanical breaks, all 4 are parallel with crossbedding at the following depths and angles from the core axis; 250.1@61°, 251.0@55°, 252.2@60° and 253.0@56°. The remaining break is a natural fracture at a depth of 249.4.

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GEOLOGIC LOG OF DRILL HOLE NO. DH05-1

FEATURE: Page Pumping Plant
LOCATION: U/S Left Side Spillway Inlet
BEGUN: 11/3/05 FINISHED: 11/21/05
DEPTH AND ELEV OF WATER LEVEL AND DATE MEASURED: ▽ (WL not noted

PROJECT: Page - Lachee Pumping Plant
COORDINATES: N 2,162,005.2 E 626,984.1
TOTAL DEPTH: 415.0
DEPTH TO BEDROCK: 0

STATE: ARIZONA
GROUND ELEVATION: 3772.5
ANGLE FROM HORIZONTAL: -62.0 AZIMUTH: 253.0
HOLE LOGGED BY: Mark Neeley
REVIEWED BY: O. Ira Terry

NOTES	DEPTH	GEOL UNIT SYMBOL	% CORE RECOVERY	PENETRATION RATE (Minutes)	FRAC DENSITY	WEATHERING	HARDNESS	MATERIAL GRAPHIC	FLD CLASS/ LITH	CLASSIFICATION AND PHYSICAL CONDITION
									SANDSTONE	
			100			W2	H4 H3		SANDSTONE	254.4 - 259.4 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4) to hard (H3), core breaks with moderate to heavy hammer blow; slightly weathered to fresh (W2). There are 9 breaks in the core, all 9 are interpreted to be mechanical breaks, 3 are parallel with crossbedding at the following depths and angles from the core axis; 257.0@82°, 257.9@80° and 258.7@80°. The other 6 mechanical breaks occur at the following approximate depths 255.1, 255.5, 255.8, 255.9, 256.0 and 256.7.
	260		100			W2	H4 H3		SANDSTONE	259.4 - 264.4 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4) to hard (H3), core breaks with moderate to heavy hammer blow; slightly weathered to fresh (W2). There are 4 breaks in the core, all 4 are interpreted to be mechanical breaks, 1 is parallel with crossbedding at a depth and an angle from the core axis of 264.0@54°. The other 3 mechanical breaks occur at the following approximate depths; 260.3, 261.5, and 263.3.
			100			W2	H4		SANDSTONE	264.4 - 269.4 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4), core breaks with moderate hammer blow; slightly weathered to fresh (W2). There are 5 breaks in the core; all 5 are interpreted to be mechanical breaks. They occur at the following approximate depths; 265.5, 266.2, 267.4, 267.5 and 269.0.
	270		100			W2	H4 H3		SANDSTONE	269.4 - 274.4 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4) to hard (H3), core breaks with moderate to heavy hammer blow; slightly weathered to fresh (W2). There are 4 breaks in the core, all 4 are interpreted to be mechanical breaks, they are all parallel with crossbedding at depths and angles from the core axis of 270.6@60°, 271.9@67°, 272.5@65° and 273.7@65°.
			100			W2	H4 H3		SANDSTONE	274.4 - 279.4 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4) to hard (H3), core breaks with moderate to heavy hammer blow; slightly weathered to fresh (W2). There are 6 breaks in the core, all 6 are interpreted to be mechanical breaks, 5 are parallel with crossbedding at the following depths and angles from the core axis; 274.7@60°, 274.9@61°, 276.0@59°, 276.9@60° and 278.0 @57°. The other mechanical break occurs at an approximate depth of 278.8.
	280		100			W2	H4 H3		SANDSTONE	279.4 - 284.4 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4) to hard (H3), core breaks with moderate to heavy hammer blow; slightly weathered to fresh (W2). There are 3 breaks in the core, all 3 are interpreted to be mechanical breaks, all are parallel with crossbedding at the following depths and angles from the core axis; 279.8@67°, 280.5@66° and 282.4@67°.
			96			W2	H4 H3		SANDSTONE	284.4 - 289.4 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4) to hard (H3), core breaks with moderate to heavy hammer blow; slightly weathered to fresh (W2). There are 5 breaks in the core, all 5 are interpreted to be mechanical breaks, 2 are parallel with crossbedding at depths and angles from the core axis as follows; 286.9@65°and 289.2@62°. The other 3 mechanical breaks occur at the following approximate depths 284.4, 286.5 and 288.6.
	290		104			W2	H4 H3		SANDSTONE	289.4 - 294.4 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4) to hard (H3), core breaks with moderate to heavy hammer blow; slightly weathered to fresh (W2). There are 5 breaks in the core; all 5 are interpreted to be mechanical breaks, 1 is parallel with crossbedding at e depth and an angle from the core axis of 290.4@62°. The other 4 mechanical breaks occur at the following approximate depths 290.0, 290.5, 290.6 and 292.4.
			100			W2			SANDSTONE	294.4 - 299.4 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4) to hard (H3), core breaks with moderate to heavy hammer blow; slightly weathered to fresh (W2). There are 4 breaks in the core, all 4 are interpreted to be mechanical breaks at the following approximate

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GEOLOGIC LOG OF DRILL HOLE NO. DH05-1

FEATURE: Page Pumping Plant
LOCATION: U/S Left Side Spillway Inlet
BEGUN: 11/3/05 FINISHED: 11/21/05
DEPTH AND ELEV OF WATER LEVEL AND DATE MEASURED: ▽ ()WL not noted

PROJECT: Page - Lachee Pumping Plant
COORDINATES: N 2,162,005.2 E 626,984.1
TOTAL DEPTH: 415.0
DEPTH TO BEDROCK: 0

STATE: ARIZONA
GROUND ELEVATION: 3772.5
ANGLE FROM HORIZONTAL: -62.0 AZIMUTH: 253.0
HOLE LOGGED BY: Mark Neeley
REVIEWED BY: O. Ira Terry

NOTES	DEPTH	GEOL UNIT SYMBOL	% CORE RECOVERY	PENETRATION RATE (Minutes)	FRAC DENSITY	WEATHERING	HARDNESS	MATERIAL GRAPHIC	FLD CLASS/ LITH	CLASSIFICATION AND PHYSICAL CONDITION
									SANDSTONE	depths 294.2, 296.1, 297.9 and 299.1.
	300		100		FD7	W4	H4 H3 H4		SANDSTONE	299.4 - 304.4 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4) to hard (H3), core breaks with moderate to heavy hammer blow; slightly weathered to fresh (W2). The interval from 300.2 to 301.0 contains 12 closely spaced fractures; intensely fractured (FD7), that are nearly perpendicular to the core axis; this interval is moderately to slightly weathered (W4). These fractures appear to be natural fractures. Could not measure or determine roughness or planarity of the natural fractures because the fracture surfaces have been eroded during the drilling process. The remainder of the interval has 5 breaks in the core; all 5 are interpreted to be mechanical breaks at the following approximate depths; 302.0, 303.1, 303.8, 307.9 and 308.2.
			100			W2	H4 H3			
			102						SANDSTONE	304.4 - 309.4 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4) to hard (H3), core breaks with moderate to heavy hammer blow; slightly weathered to fresh (W2). There are 6 breaks in the core, all 6 are interpreted to be mechanical breaks at the following approximate depths 304.6, 306.0, 307.7, 307.8, 307.9 and 308.2.
	310		100			W2	H3		SANDSTONE	309.4 - 314.4 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; hard (H3), core breaks with heavy hammer blow; slightly weathered to fresh (W2). There are 5 breaks in the core, all 5 are interpreted to be mechanical breaks, 1 is parallel with crossbedding at a depth and an angle from the core axis of 290.4@62°. The other 4 mechanical breaks occur at the following approximate depths; 310.1, 310.5, 312.2 and 313.9.
			96			W2	H3		SANDSTONE	314.4 - 319.4 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; hard (H3), core breaks heavy hammer blow; slightly weathered to fresh (W2). There are 4 breaks in the core, all 4 are interpreted to be mechanical breaks, 1 is parallel with crossbedding at a depth and an angle from the core axis of 318.5@68°. The other 3 mechanical breaks occur at the following approximate depths; 314.9, 315.8 and 317.8.
	320		82			W2	H3		SANDSTONE	319.4 - 324.4 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; hard (H3), core breaks with heavy hammer blow; slightly weathered to fresh (W2). There are 5 breaks in the core, all 5 are interpreted to be mechanical breaks, 1 is parallel with crossbedding at a depth and an angle from the core axis of 323.1@67°. The other 4 mechanical breaks occur at the following approximate depths 319.4, 320.5, 321.0 and 324.3.
			102		FD7	W2	H3		SANDSTONE	324.4 - 328.7 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; hard (H3), core breaks with heavy hammer blow; slightly weathered to fresh (W2). There are 5 breaks in the core, all 5 are interpreted to be mechanical breaks, 1 is parallel with crossbedding at a depth and an angle from the core axis of 326.3@66°. The other 4 mechanical breaks occur at the following approximate depths 325.3, 325.5, 327.5 and 328.3. The interval from 325.0 to 325.3 is intensely fractured (FD7).
	330		104			W2	H3		SANDSTONE	328.7 - 333.7 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; hard (H3), core breaks with heavy hammer blow; slightly weathered to fresh (W2). There are 3 breaks in the core, all 3 are interpreted to be mechanical breaks at the following approximate depths 329.4, 331.9 and 333.1.
			100			W2	H3		SANDSTONE	333.7 - 338.7 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; hard (H3), core breaks with heavy hammer blow; slightly weathered to fresh (W2). There are 7 breaks in the core; all 7 are interpreted to be mechanical breaks at the following approximate depths 333.7, 334.9, 336.5, 336.8, 337.7, 338.5 and 338.6.
	340		100			W2	H3		SANDSTONE	338.7 - 343.7 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; hard (H3), core breaks with heavy hammer blow; slightly weathered to fresh (W2). There are 4 breaks in the core, all 4 are interpreted to be

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GEOLOGIC LOG OF DRILL HOLE NO. DH05-1

FEATURE: Page Pumping Plant
LOCATION: U/S Left Side Spillway Inlet
BEGUN: 11/3/05 FINISHED: 11/21/05
DEPTH AND ELEV OF WATER LEVEL AND DATE MEASURED: ▽ ()WL not noted

PROJECT: Page - Lachee Pumping Plant
COORDINATES: N 2,162,005.2 E 626,984.1
TOTAL DEPTH: 415.0
DEPTH TO BEDROCK: 0

STATE: ARIZONA
GROUND ELEVATION: 3772.5
ANGLE FROM HORIZONTAL: -62.0 AZIMUTH: 253.0
HOLE LOGGED BY: Mark Neeley
REVIEWED BY: O. Ira Terry

NOTES	DEPTH	GEOL UNIT SYMBOL	% CORE RECOVERY	PENETRATION RATE (Minutes)	FRAC DENSITY	WEATHERING	HARDNESS	MATERIAL GRAPHIC	FLD CLASS/ LITH	CLASSIFICATION AND PHYSICAL CONDITION
									SANDSTONE	mechanical breaks, 2 are parallel with crossbedding at depths and angles from the core axis of 341.0@63° and 343.4@63°. The other 2 mechanical breaks occur at the following approximate depths 342.4 and 342.6.
			100			W2	H4 H3		SANDSTONE	343.7 - 348.9 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderatey hard (H4) to hard (H3), core breaks with moderate to heavy hammer blow; slightly weathered to fresh (W2). There are 7 breaks in the core, all 7 are interpreted to be mechanical breaks, all 7 are parallel with the crossbedding at depths and angles from the core axis as follows; 344@61°, 344.1@61, 344.2@61°, 344.8@61°, 345.0@61°, 346.5@61° and 347.5@61°.
	350		96			W2	H3		SANDSTONE	348.9 - 353.9 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; hard (H3), core breaks with heavy hammer blow; slightly weathered to fresh (W2). There are 6 breaks in the core; all 6 are interpreted to be mechanical breaks, 4 are parallel with crossbedding at depths and angles from the core axis of 349.5@66°, 350.9@66°, 351.5@66°and 352.5@66°. The other 2 mechanical breaks occur at the following approximate depths 353.4 and 353.5.
						W2	H4 H3		SANDSTONE	353.9 - 358.4 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4) to hard (H3), core breaks with moderate to heavy hammer blow; slightly weathered to fresh (W2). There are 9 breaks in the core, all 9 are interpreted to be mechanical breaks, 2 are parallel with crossbedding at depths and angles from the core axis of 355.9@68° and 357.9@64°. The other 7 mechanical breaks occur at the following approximate depths 353.9, 354.1, 354.9, 355.1, 355.4, 356.4 and 357.0.
			100			W2	H3		SANDSTONE	358.4 - 363.5 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; hard (H3), core breaks with heavy hammer blow; slightly weathered to fresh (W2). There are 7 breaks in the core; all 7 are interpreted to be mechanical breaks, 7 are parallel with crossbedding at depths and angles from the core axis of 360.5@62°and 361.9@62°. The other 5 mechanical breaks occur at the following approximate depths 359.1, 361.0, 362.5, 363.0 and 363.3.
	360		100			W2	H3		SANDSTONE	363.5 - 368.5 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; hard (H3), core breaks with heavy hammer blow; slightly weathered to fresh (W2). There are 3 breaks in the core, all 3 are interpreted to be mechanical breaks that occur at the following approximate depths 363.5, 364.9 and 366.8.
			98			W2	H3		SANDSTONE	368.5 - 373.6 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; hard (H3), core breaks with heavy hammer blow; slightly weathered to fresh (W2). There are 5 breaks in the core, all 5 are interpreted to be mechanical breaks, 1 is parallel with crossbedding at a depth and angle from the core axis of 369.8@68. The other 4 mechanical breaks occur at the following approximate depths 368.7, 370.6, 371.9 and 372.6.
	370		104			W2	H3		SANDSTONE	373.6 - 378.7 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; hard (H3), core breaks with heavy hammer blow; slightly weathered to fresh (W2). There are 5 breaks in the core; all 5 are interpreted to be mechanical breaks, 2 are parallel with crossbedding at depths and angles from the core axis of 376.1@66 and 377.7@66°. The other 3 mechanical breaks occur at the following approximate depths 374.4, 376.4 and 373.6.
			100			W2	H3		SANDSTONE	378.7 - 383.7 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; hard (H3), core breaks with heavy hammer blow; slightly weathered to fresh (W2). There are 3 breaks in the core, all 3 are interpreted to be mechanical breaks, 2 are parallel with crossbedding at depths and angles from the core axis of 382.9@64 and 380.2@64°. The other mechanical break occurs at the following approximate depth 382.
	380		100			W2	H3		SANDSTONE	383.7 - 388.7 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz

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GEOLOGIC LOG OF DRILL HOLE NO. DH05-1

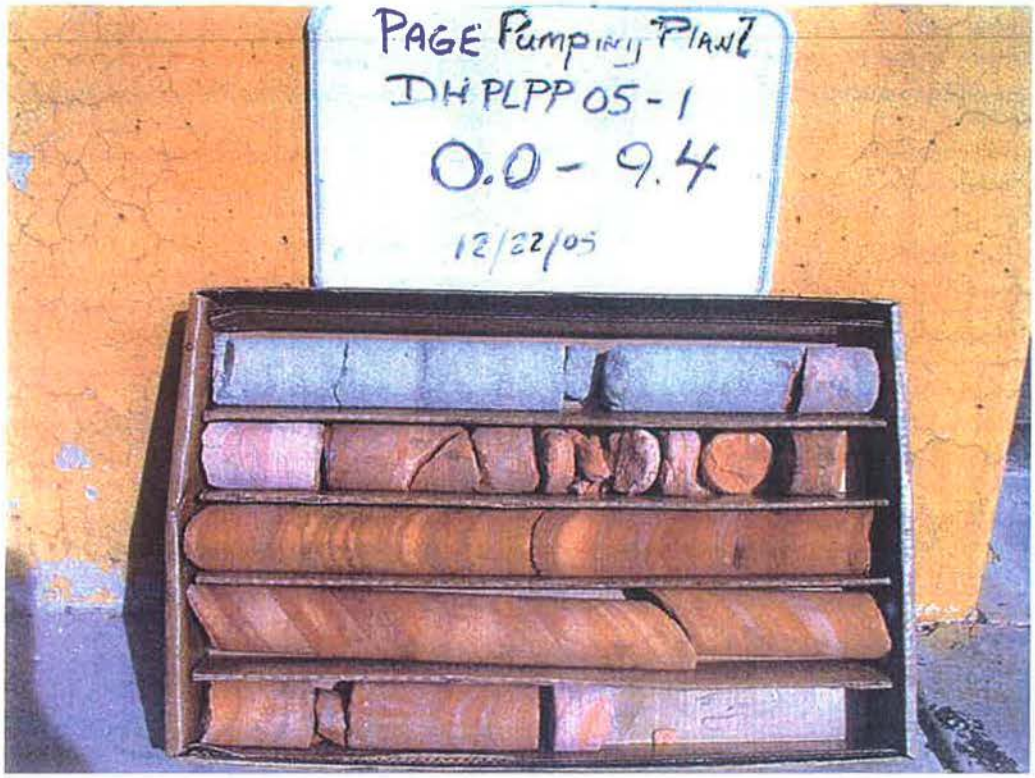
FEATURE: Page Pumping Plant
LOCATION: U/S Left Side Spillway Inlet
BEGUN: 11/3/05 FINISHED: 11/21/05
DEPTH AND ELEV OF WATER LEVEL AND DATE MEASURED: ▽ ()WL not noted

PROJECT: Page - Lachee Pumping Plant
COORDINATES: N 2,162,005.2 E 626,984.1
TOTAL DEPTH: 415.0
DEPTH TO BEDROCK: 0

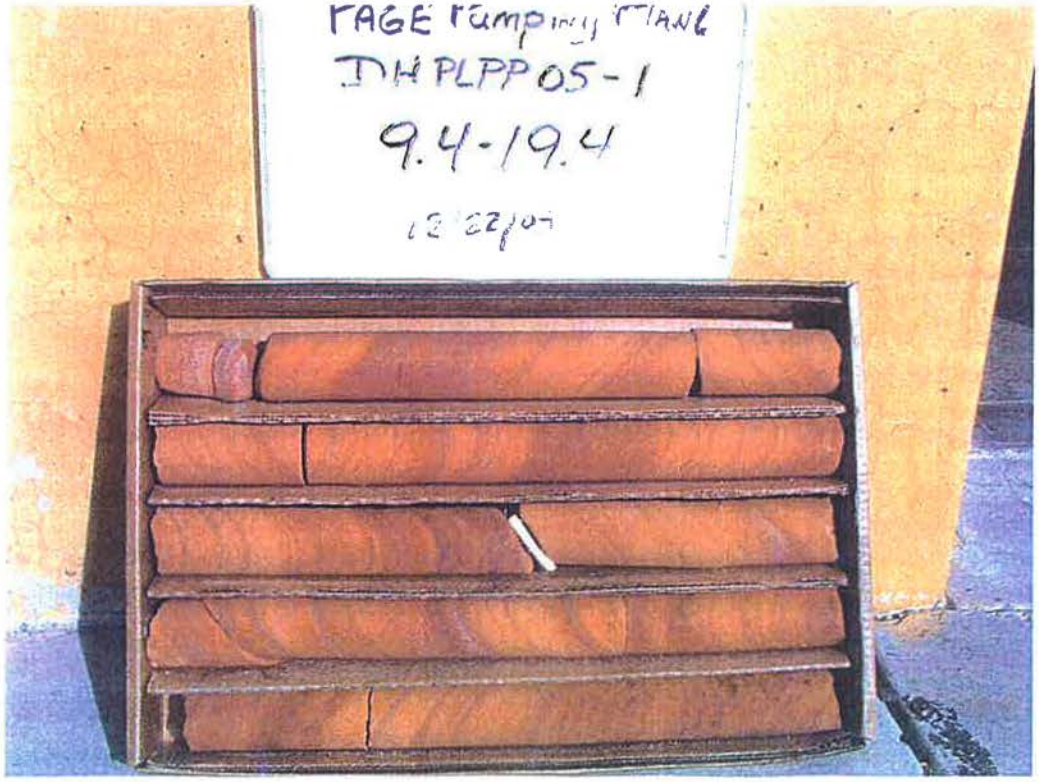
STATE: ARIZONA
GROUND ELEVATION: 3772.5
ANGLE FROM HORIZONTAL: -62.0 AZIMUTH: 253.0
HOLE LOGGED BY: Mark Neeley
REVIEWED BY: O. Ira Terry

NOTES	DEPTH	GEOL UNIT SYMBOL	% CORE RECOVERY	PENETRATION RATE (Minutes)	FRAC DENSITY	WEATHERING	HARDNESS	MATERIAL GRAPHIC	FLD CLASS/ LITH	CLASSIFICATION AND PHYSICAL CONDITION
									SANDSTONE	sand; hard (H3), core breaks with heavy hammer blow; slightly weathered to fresh (W2). There are 5 breaks in the core, all 5 are interpreted to be mechanical breaks, 4 are parallel with crossbedding at depths and angles from the core axis of 383.7@67°, 384.8@67°, 385.8@67°and 386.8@67°. The other mechanical break occurs at the following approximate depth 387.7.
	390		100			W2	H3		SANDSTONE	388.7 - 393.7 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; hard (H3), core breaks with heavy hammer blow; slightly weathered to fresh (W2). There are 8 breaks in the core, all 8 are interpreted to be mechanical breaks, 1 is parallel with crossbedding at a depth and angle from the core axis of 389.9@66°. The other 7 mechanical breaks occur at the following approximate depths 388.7, 390.2, 390.3, 390.5, 391.7, 393.1 and 393.4.
			104			W2	H3		SANDSTONE	393.7 - 398.7 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; hard (H3), core breaks with heavy hammer blow; slightly weathered to fresh (W2). There are 6 breaks in the core, all 6 are interpreted to be mechanical breaks, 3 are parallel with crossbedding at depths and angles from the core axis of 395.6@62°, 396.3@62°and 398.2@62°. The 3 other mechanical breaks occur at the following approximate depths 393.7, 397.2 and 398.6.
	400		100			W2	H4 H3		SANDSTONE	398.7 - 403.7 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderatley hard (H4) to hard (H3), core breaks with moderate to heavy hammer blow; slightly weathered to fresh (W2). There are 8 breaks in the core, all 8 are interpreted to be mechanical breaks, 5 are parallel with crossbedding at depths and angles from the core axis of 398.7@62°, 399.9@62°, 400.8@62°, 401.1@62° and 401.6@62°. The 3 other mechanical breaks occur at the following approximate depths; 399.2, 403.0 and 403.4.
			100			W2	H4 H3		SANDSTONE	403.7 - 408.7 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderatley hard (H4) to hard (H3), core breaks with moderate to heavy hammer blow; slightly weathered to fresh (W2). There are 7 breaks in the core; all 7 are interpreted to be mechanical breaks, 2 are parallel with crossbedding at depths and angles from the core axis of 403.7@65° and 404.7@65. The 5 other mechanical breaks occur at the following approximate depths; 403.7, 404.7, 406.7, 407.8 and 408.7.
	410		104			W2	H4 H3		SANDSTONE	408.7 - 413.7 feet SANDSTONE; red to light red, faint crossbedding; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderatley hard (H4) to hard (H3), core breaks with moderate to heavy hammer blow; slightly weathered to fresh (W2). There are 6 breaks in the core, all 6 are interpreted to be mechanical breaks, 4 are parallel with crossbedding at depths and angles from the core axis of 409.6@65°, 410.2@65, 410.7@65 and 412.1@65. The 2 other mechanical breaks occur at the following approximate depths; 412.8 and 413.4.
			100			W2	H4 H3		SANDSTONE	413.7 - 415.0 feet SANDSTONE; red to light red; composed predominantly of weakly cemented, fine to medium grained, rounded quartz sand; moderately hard (H4) to hard (H3), core breaks with moderate to heavy hammer blow; slightly weathered to fresh (W2).
	420									

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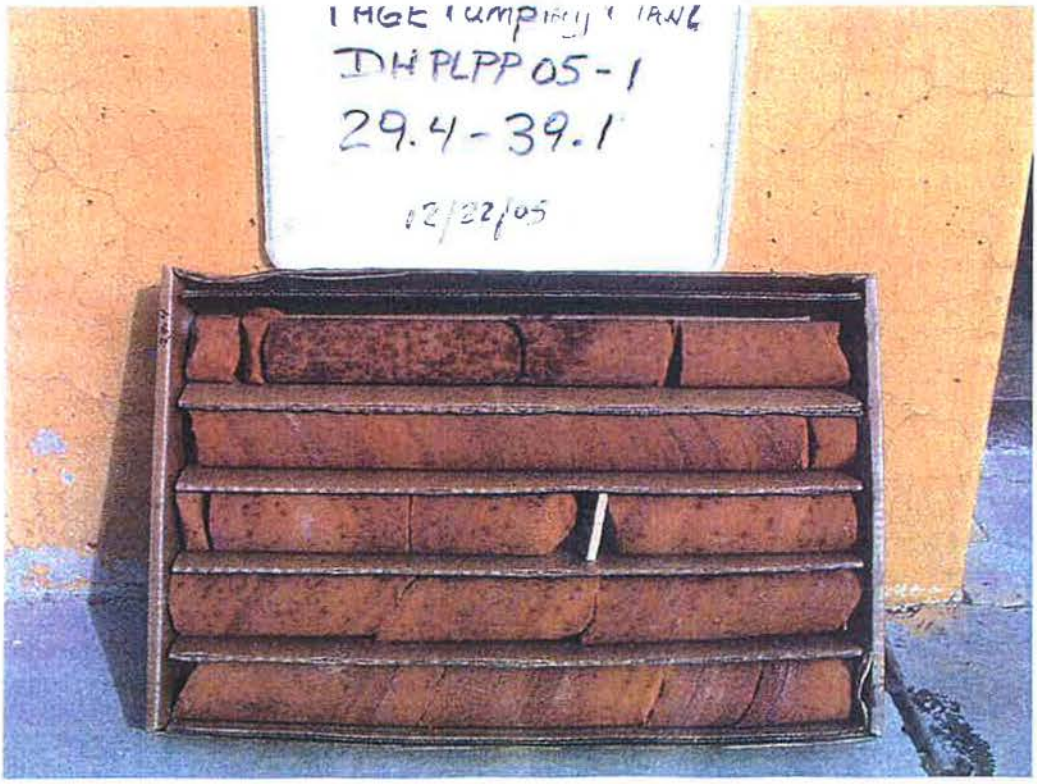
000.0 - 009.4.JPG



009.4 - 019.4.JPG



019.4 - 029.4.JPG



Section 3



039.1 - 048.7.JPG





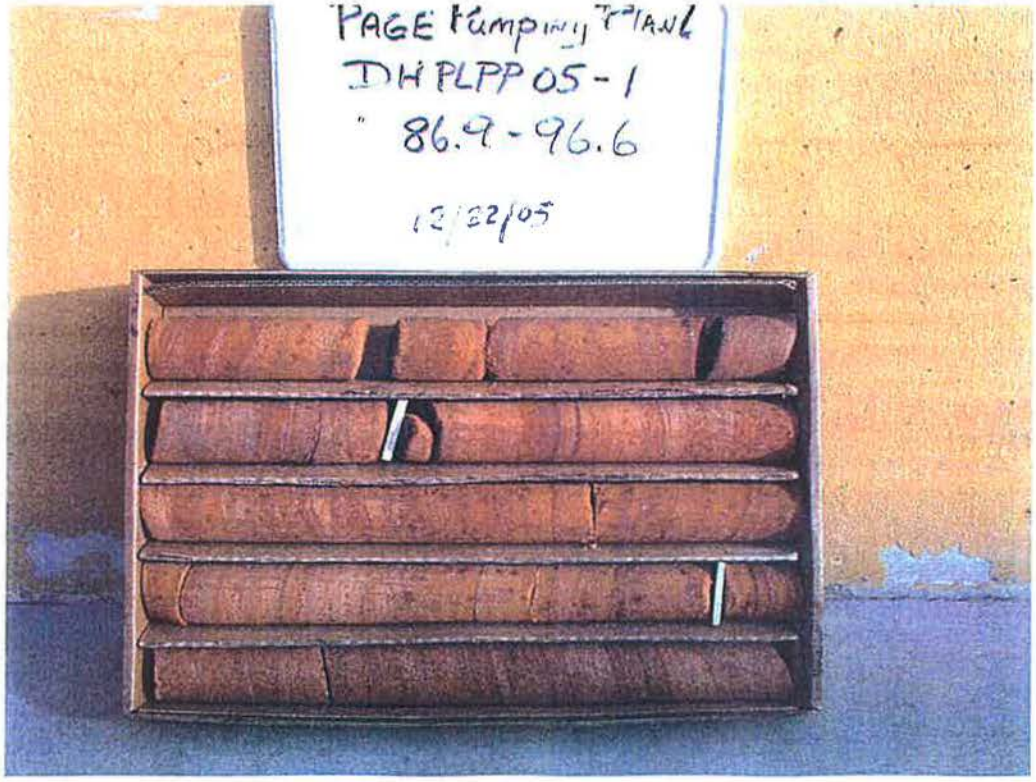
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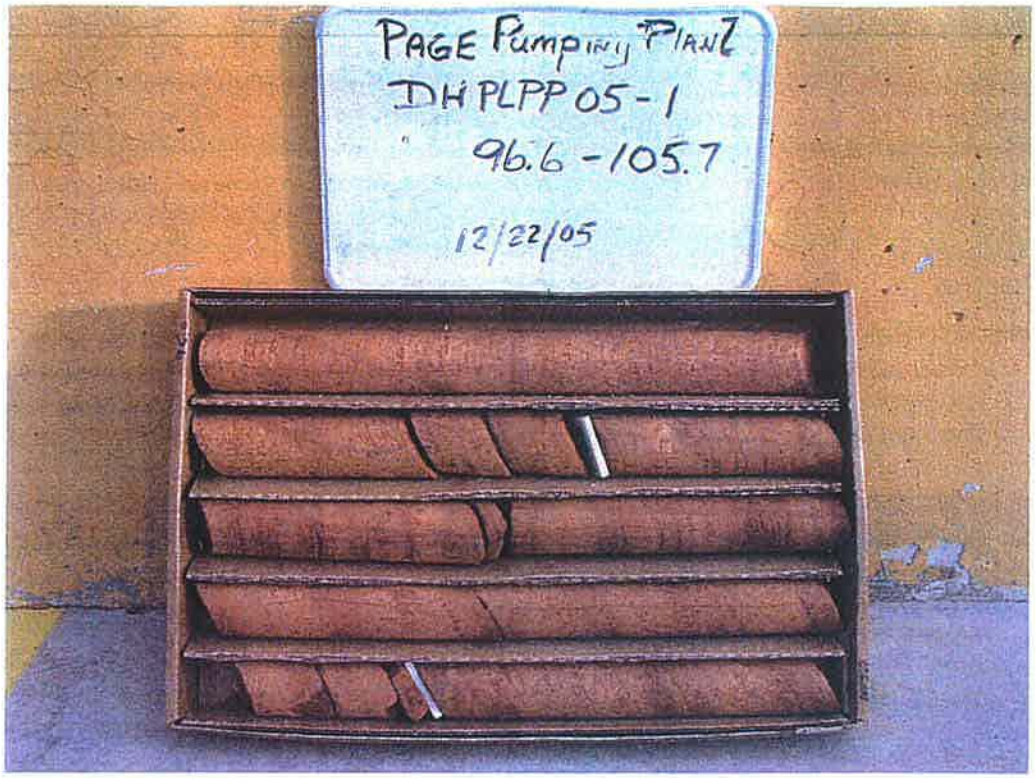


067.8 - 077.6.JPG



077.6 - 086.9.JPG





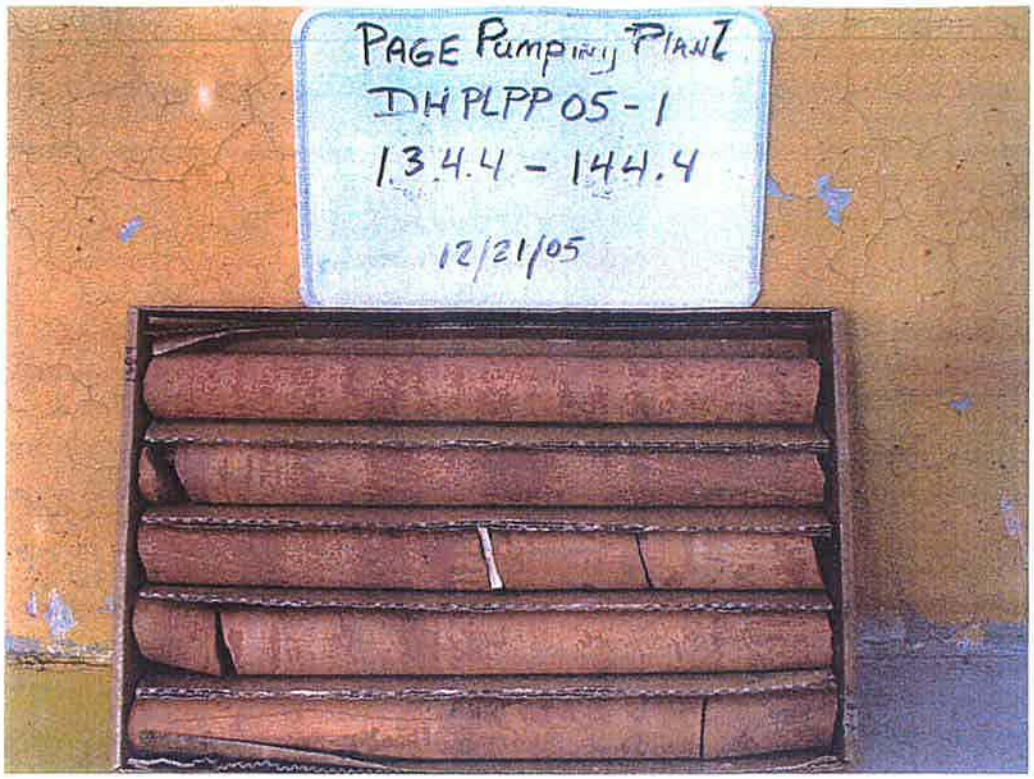
096.6 - 105.7.JPG



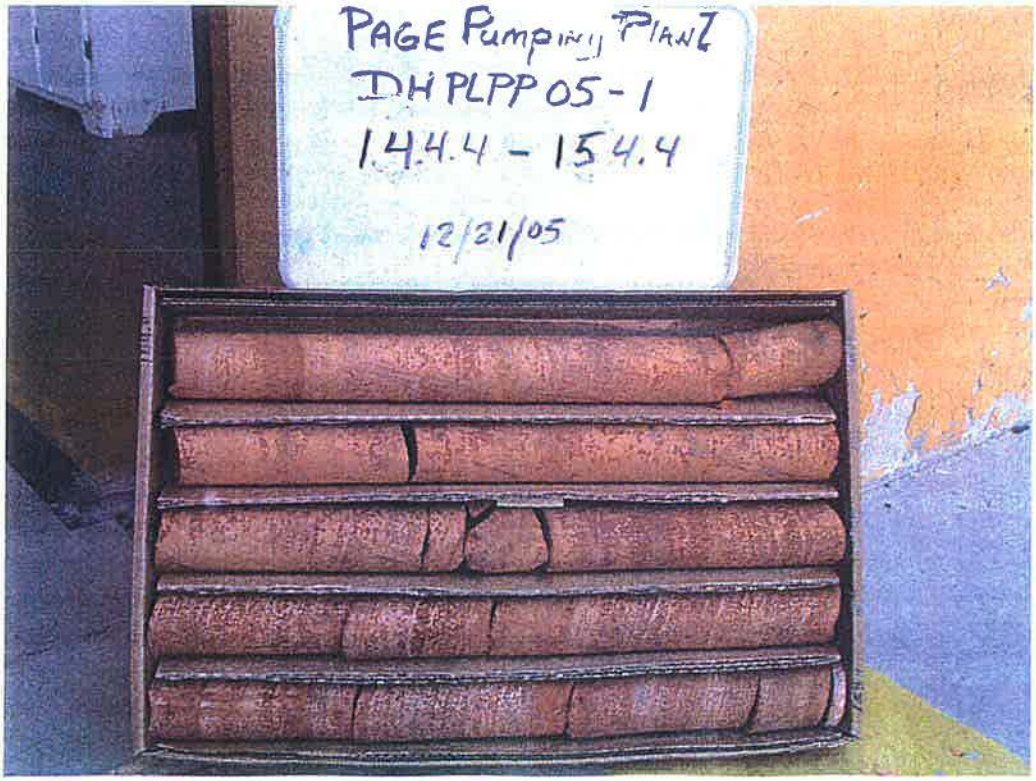


114.4 - 124.4.JPG

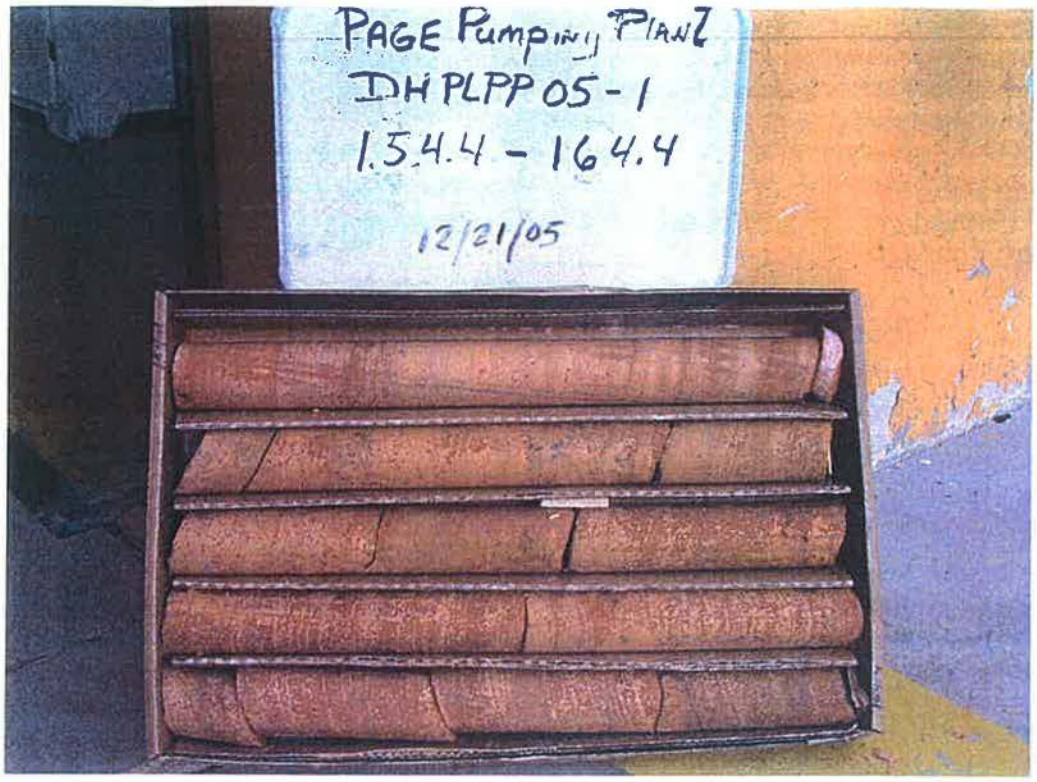




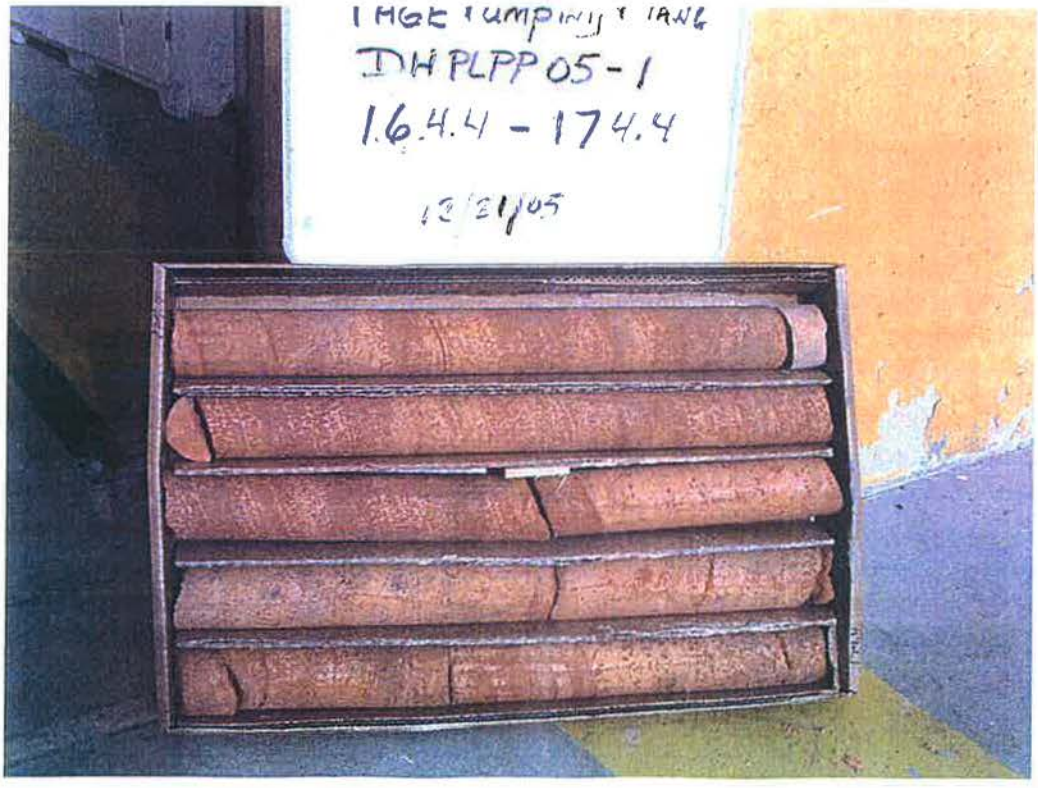
134.4 - 144.4.JPG

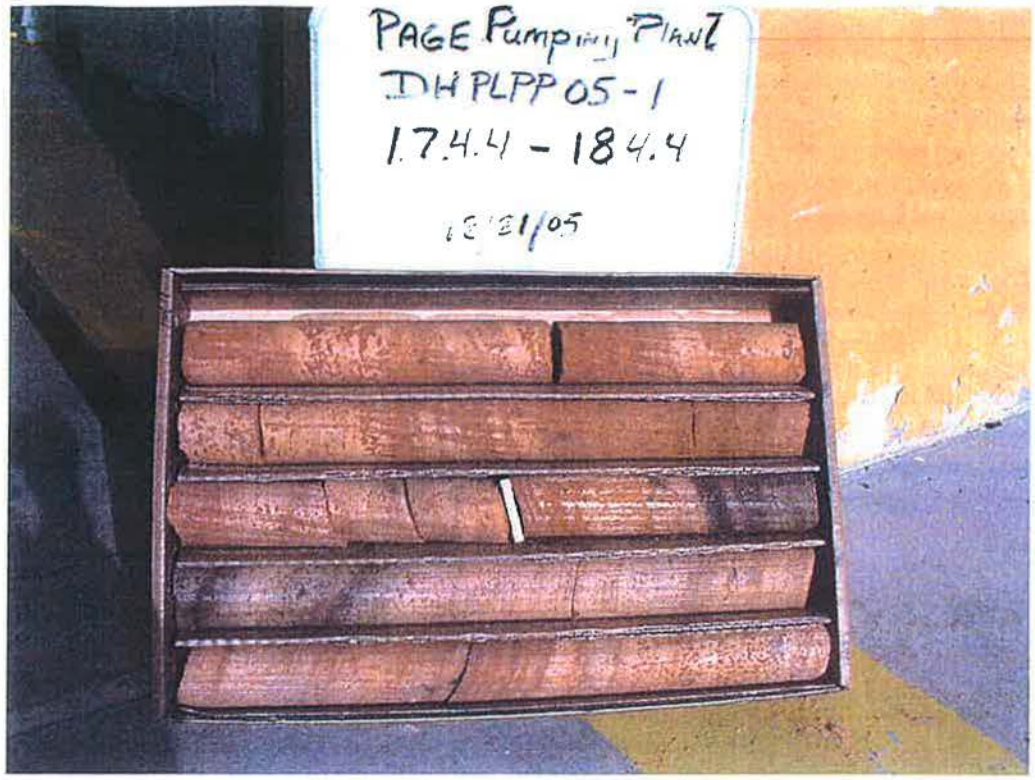


144.4 - 154.4.JPG

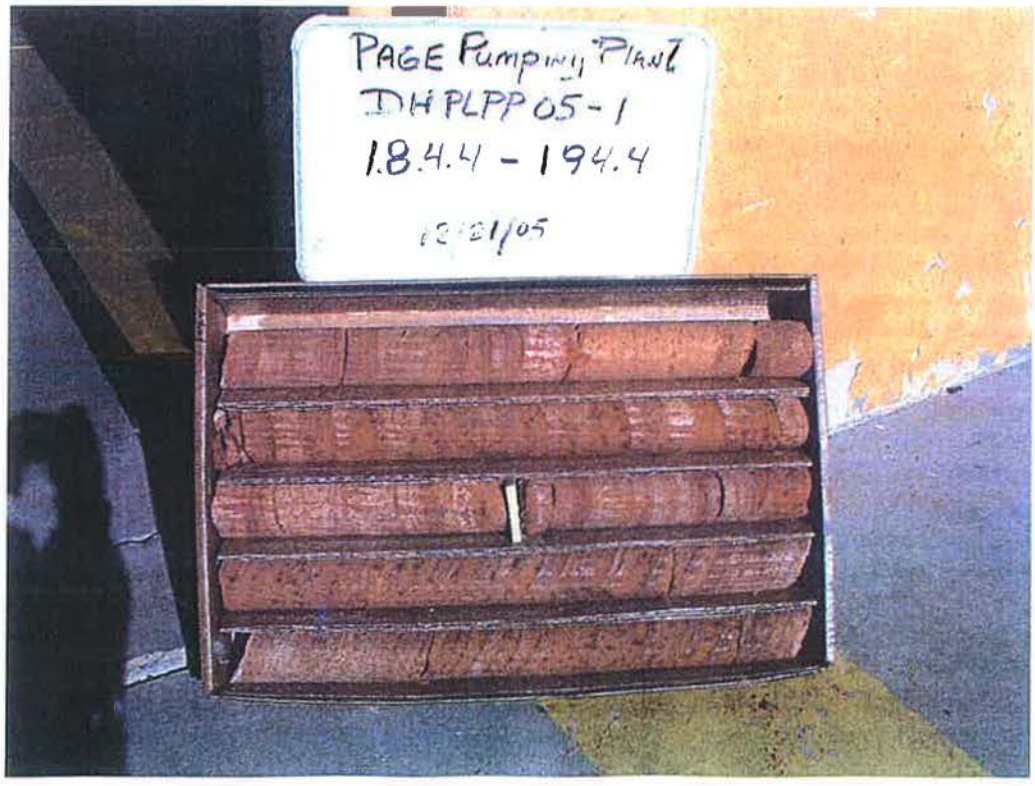


154.4 - 164.4.JPG

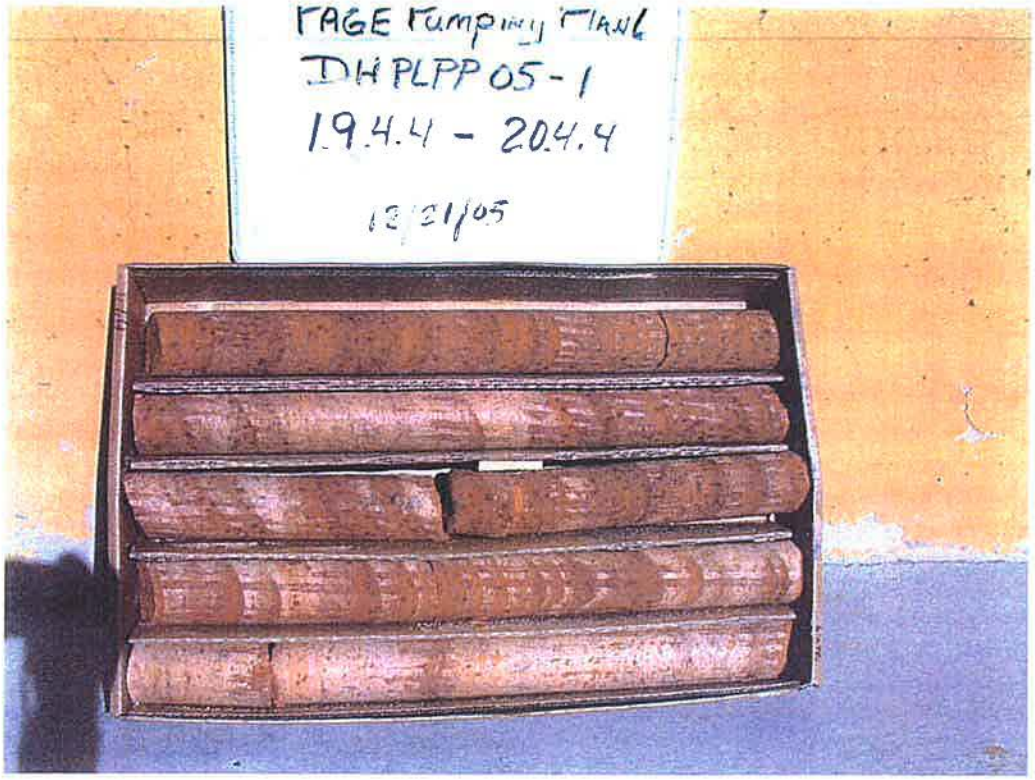




174.4 - 184.4.JPG



184.4 - 194.4.JPG



194.4 - 204.4.JPG



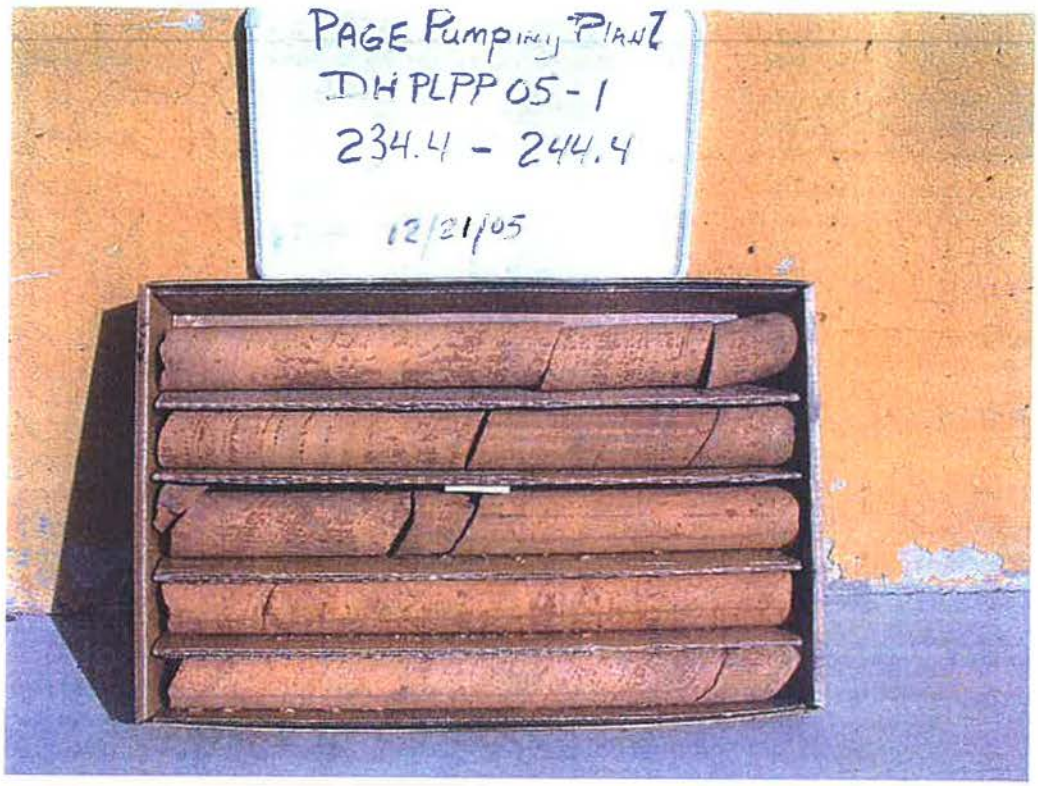
204.4 - 214.4.JPG



214.4 - 224.4.JPG



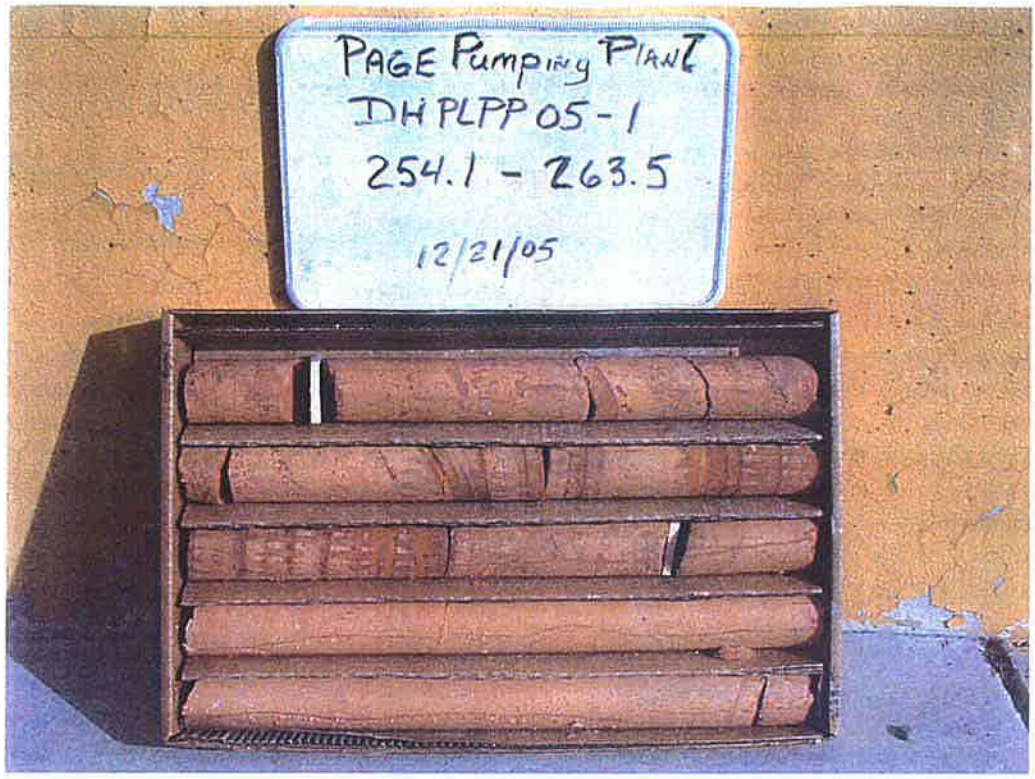
224.4 - 234.4.JPG



234.4 - 244.4.JPG



244.4 - 254.1.JPG

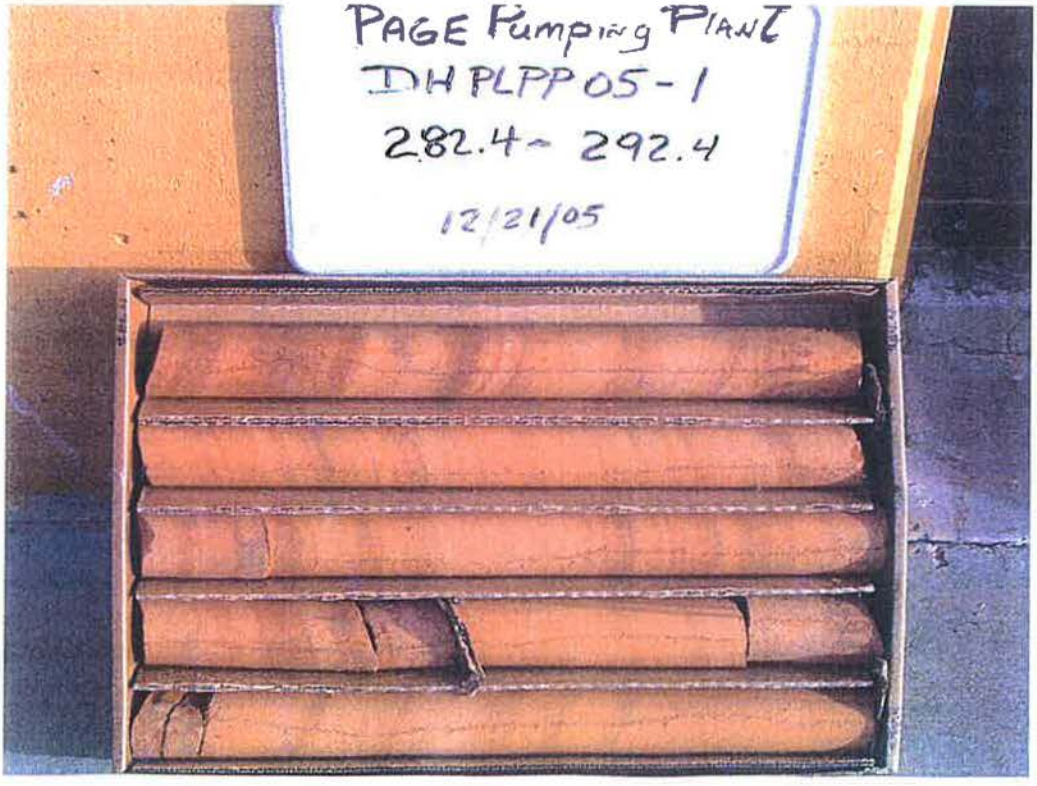


254.1 - 263.5.JPG





272.4 - 282.4.JPG





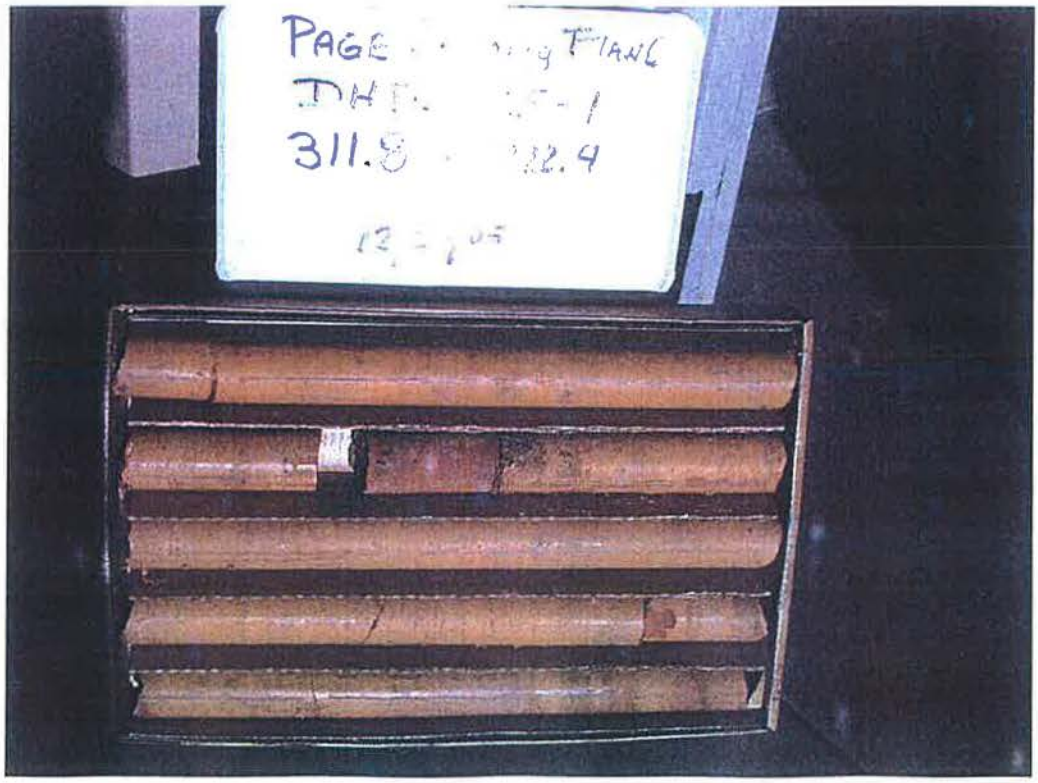
292.4 - 302.2.JPG



300.2 - 301.0.JPG

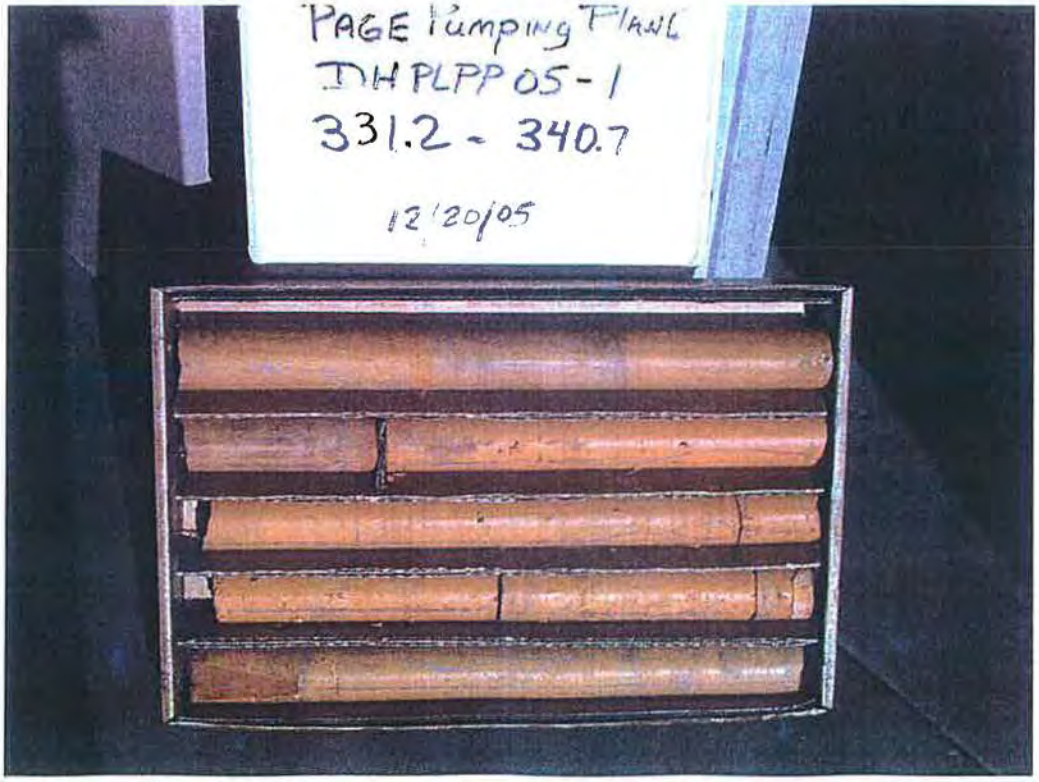


302.2 - 311.8.JPG

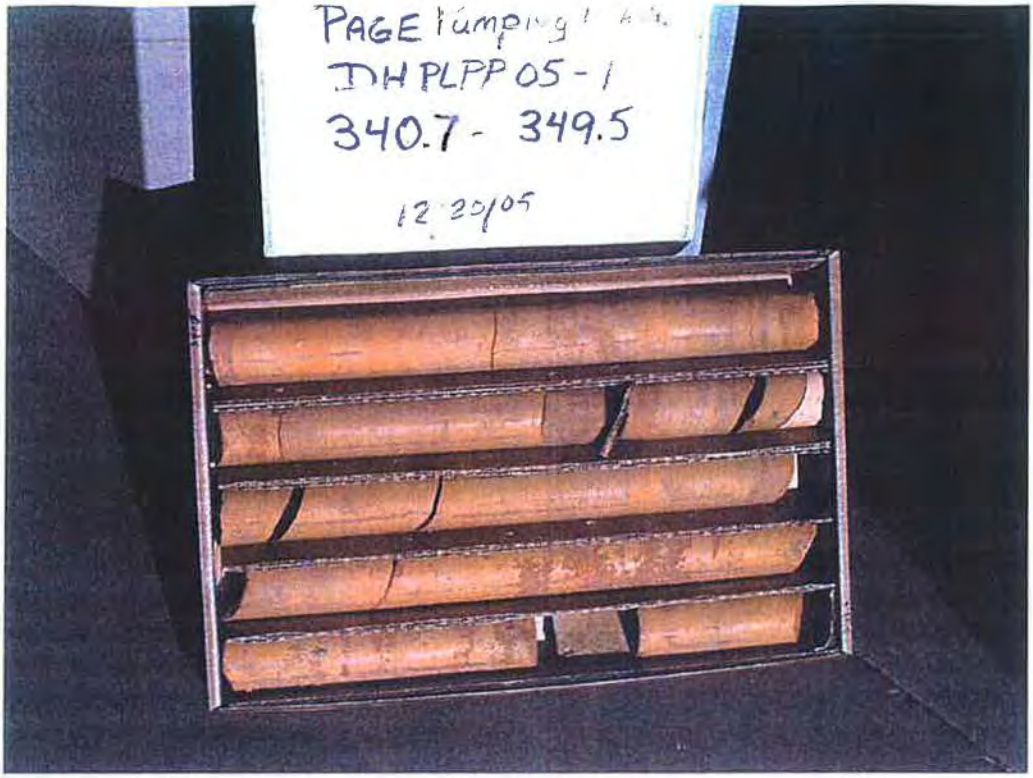




322.4 - 331.2.JPG



331.2 - 340.7.JPG



340.7 - 349.5.JPG

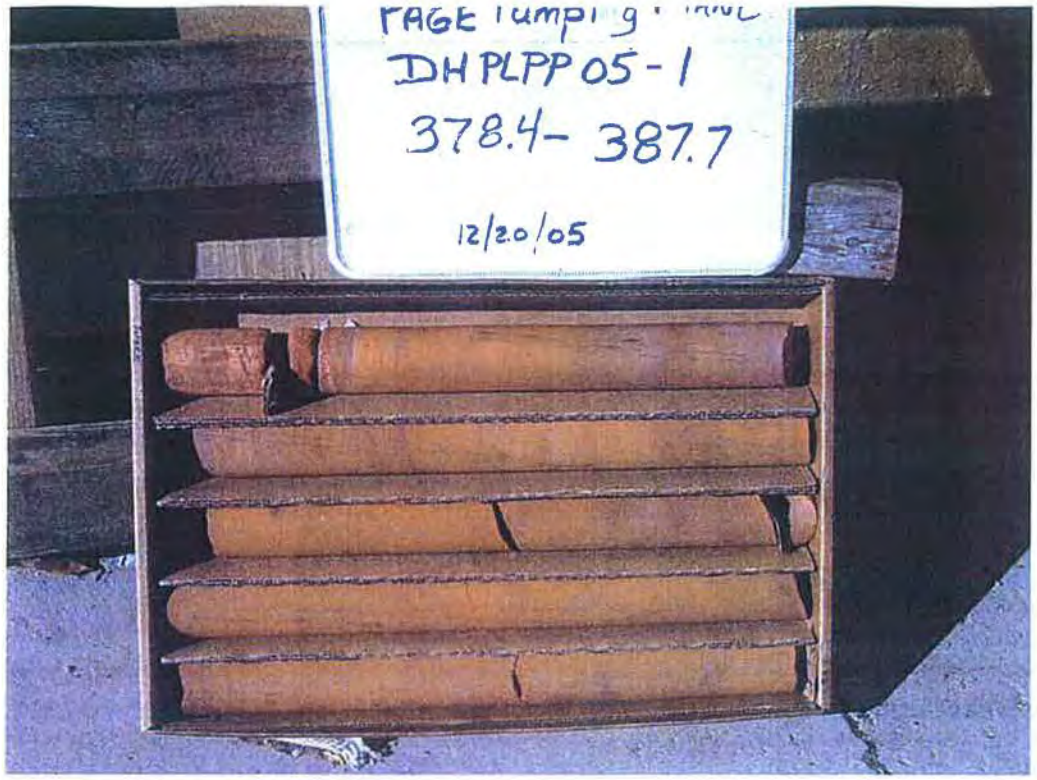


349.5 - 359.1.JPG



359.1 - 368.7.JPG

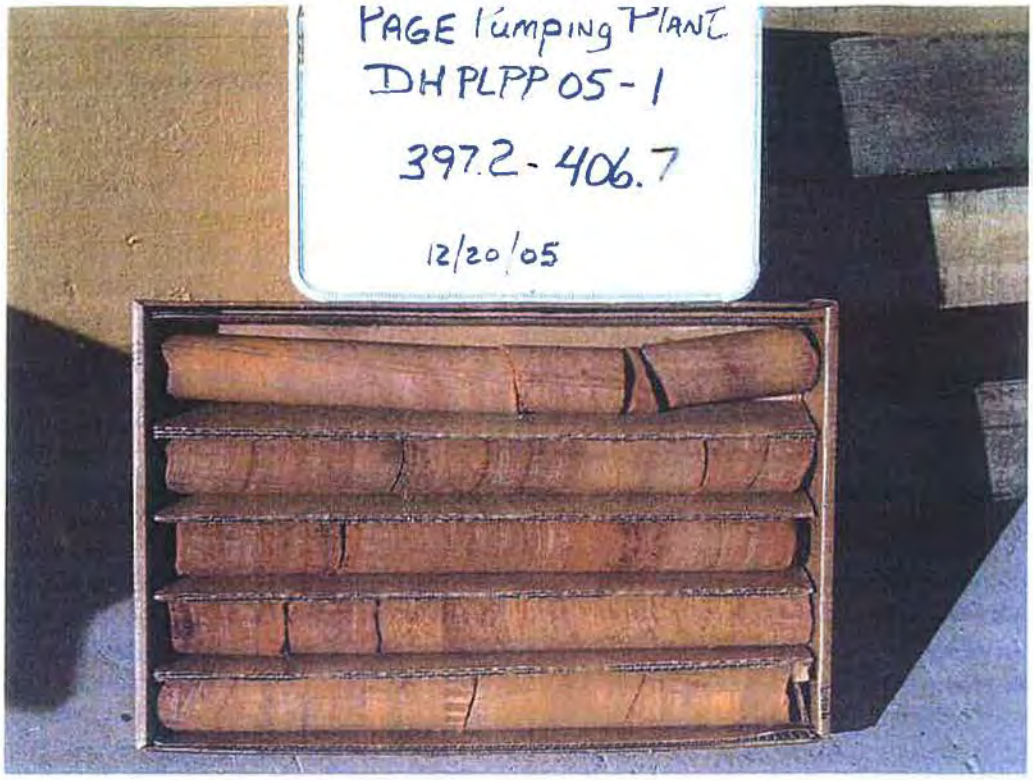




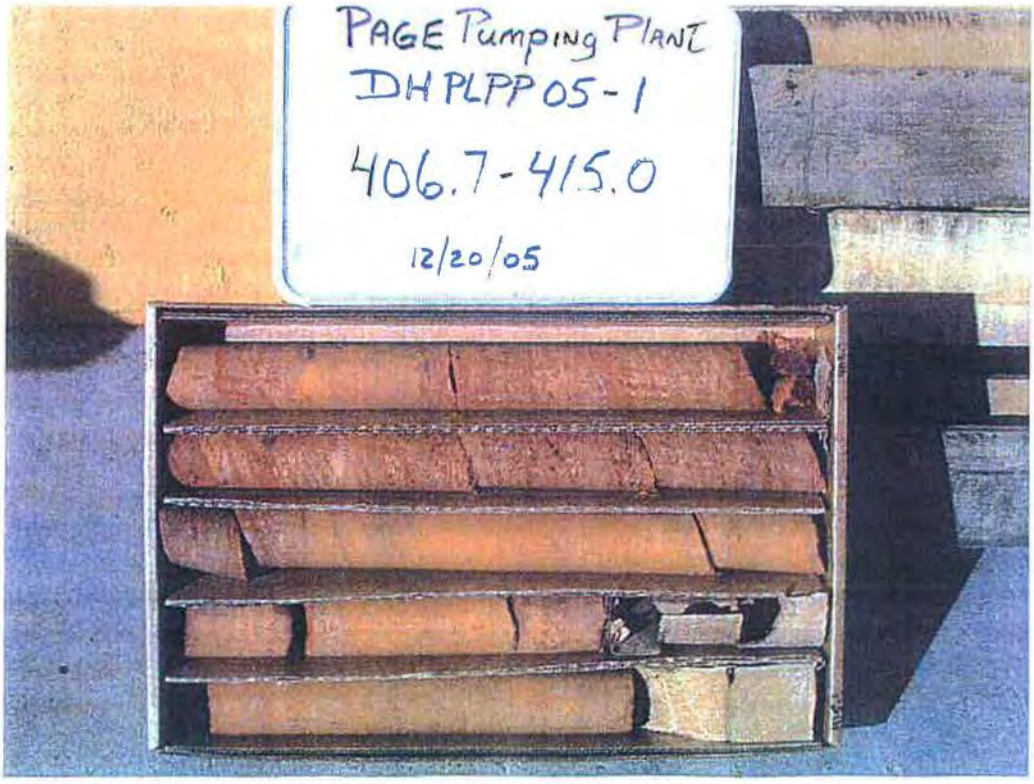
378.4 - 387.7.JPG



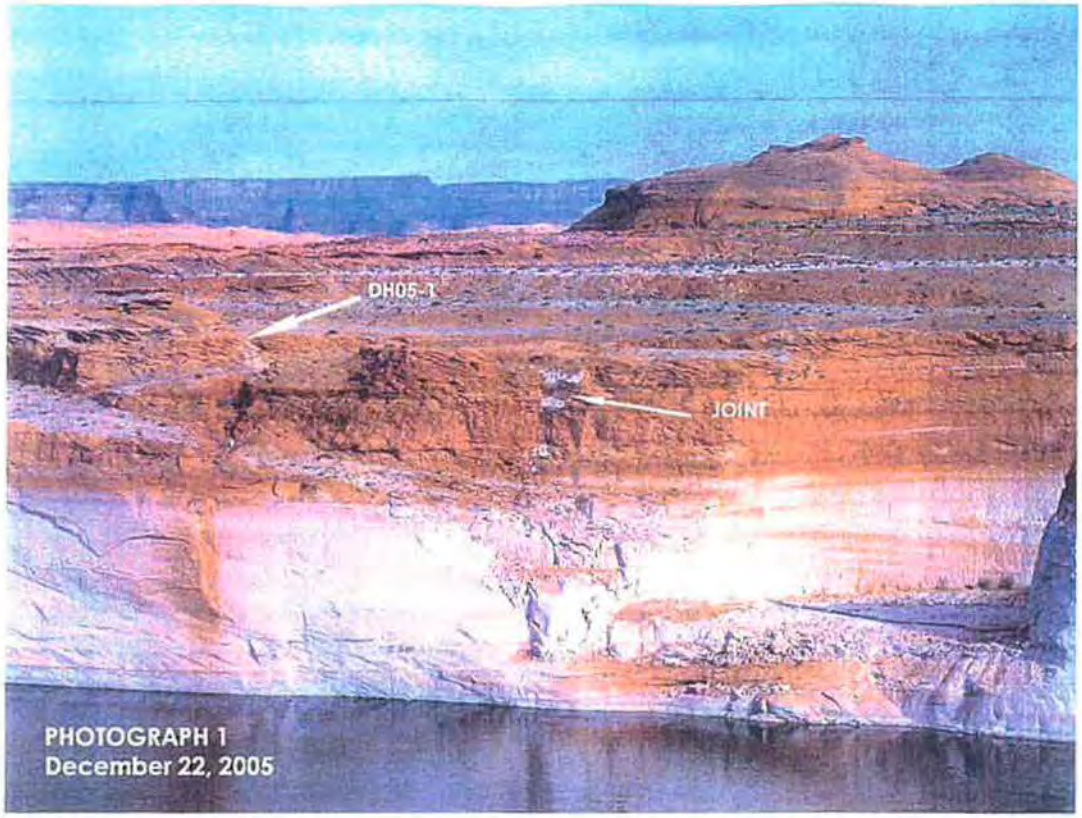
387.7 - 397.2.JPG



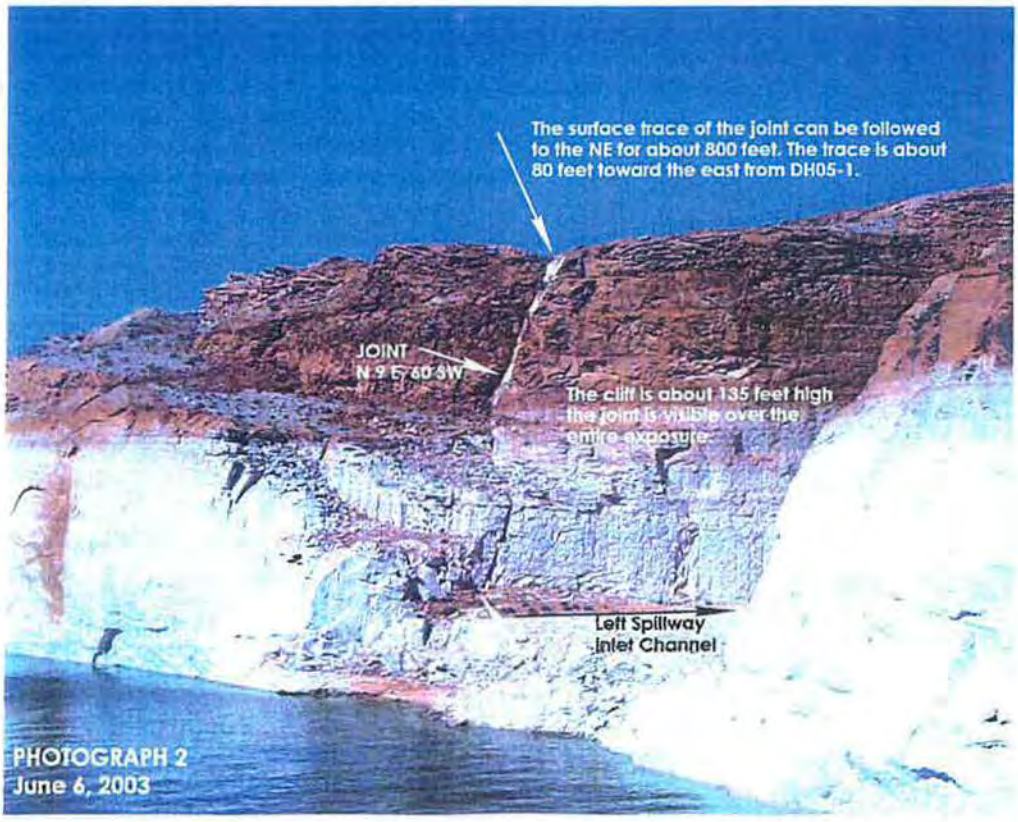
397.2 - 406.7 .JPG



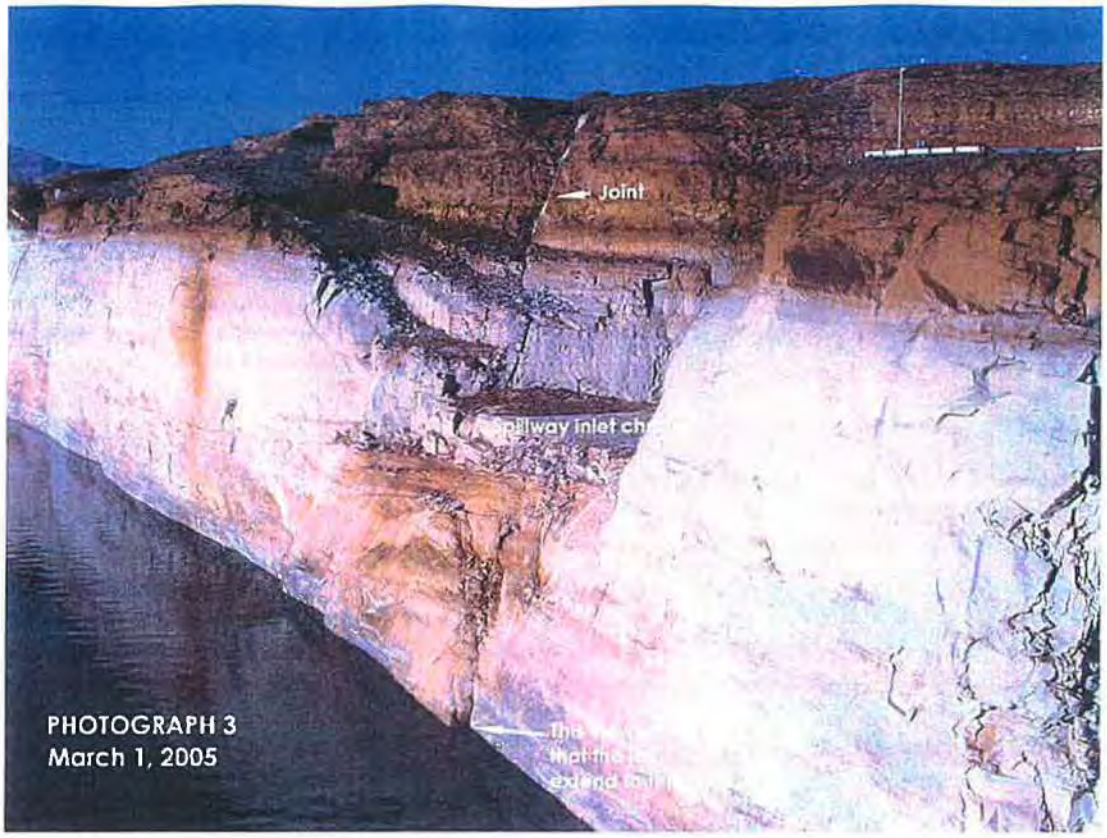
Section 4



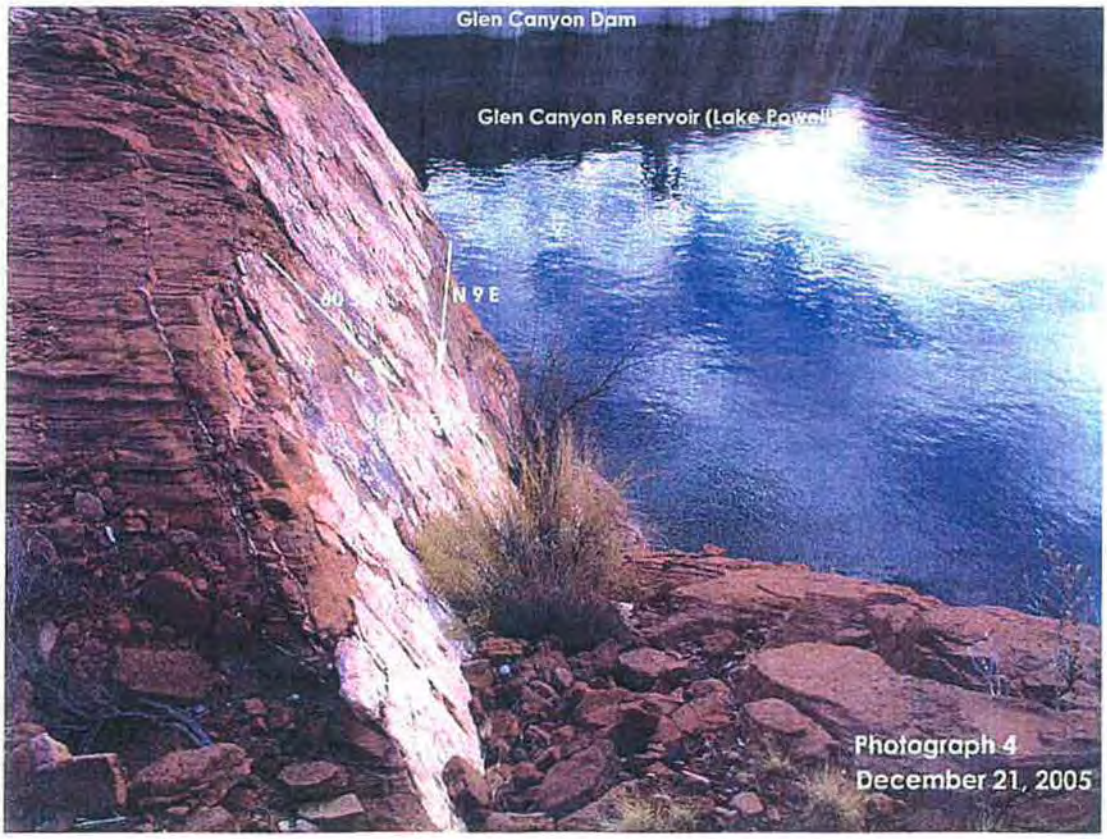
Photograph 1 – Page – Lachee Pumping Plant – View looking east from the west side of Lake Powell just upstream from Glen Canyon Dam showing the approximate location of DH05-1 relative to the inlet channel to the left abutment spillway tunnel. This photograph also shows, the relative position of a significant joint to the approximate location of DH05-1. Photograph taken December 22, 2005 by Mark Neeley.



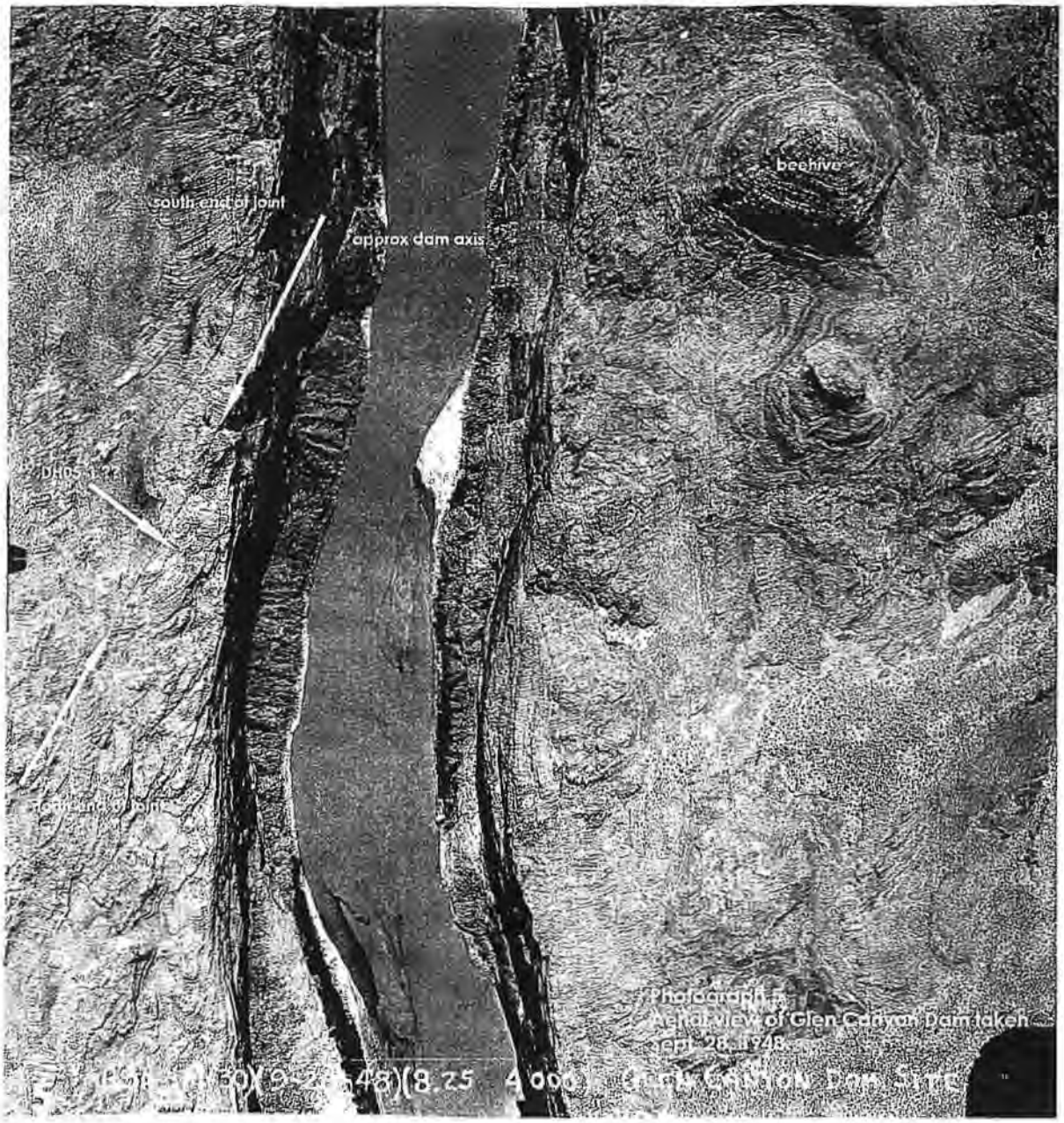
Photograph 2 – Page – Lachee Pumping Plant – View looking northeast from the top of Glen Canyon Dam showing the approximate location of a significant joint in relation to the approximate location of DH05-1. Photograph taken December 22, 2005 by Mark Neeley.



Photograph 3 - Page – Lachee Pumping Plant – View looking northeast from the top of Glen Canyon Dam showing the approximate location of a significant joint in relation to the spillway inlet channel with the reservoir at a lower elevation than photograph 2. Photograph taken March 1, 2005 by Mark Neeley.



Photograph 4 - Page – Lachee Pumping Plant – View looking southwest toward Glen Canyon Dam along the strike (N 9° E) of the joint. The joint slopes (dips) into the reservoir at about 60° from horizontal. Photograph taken December 21, 2005 by Mark Neeley.



Photograph 5 - Page – Lachee Pumping Plant – Digital scan of an aerial view taken in 1948 showing the future site of Glen Canyon Dam. The photograph has been marked with arrows pointing along a lineation that seems to be in the location of the joint shown in the previous 4 photographs. The general location of DH05-1 is also indicated by an arrow. The upper arrow point is about where the existing left abutment spillway inlet channel is located. Text and arrows added digitally by Mark Neeley in January 2006.

Section 5

UC-140

UC REGION DAILY DRILL REPORT

Title of Hole: DH PLPP 05-1
Date: 11-03-05 (page 1)

Feature: GLEN CANYON DAM
Project: PAGE LE-CHEE WATER SUPPLY
State: ARIZONA

Depth to water begin of shift _____ Measuring point (describe) _____ at _____ ft. (height) above ground

Interval		Recovery Ft. Or Meter	Overburden Or Rock Type And Drilling Conditions	Drilling Method			Drill Casing		Pr Test (18" Total)			Drilling Medium				
				Bit Or Sampler					Blows							
From	To			Size	Type (1)	Length Of Sampler	Size	Depth	6"	6"	6"	Air (Cfm)	Water (Describe Quality)	Additives (2) (Describe)	Color Of Fluid	% Per Of Return
9.4	14.4	5.0	Sandstone	HQ 3	CORE	5 FT	4"	3 FT.					clear	DRISPAC	rd	100
14.4	19.4	5.0	Sandstone	"	"	"	"	"					"	PF POLY	"	"
19.4	24.4	5.0	Sandstone	"	"	"	"	"					"	"	"	"
24.4	29.4	5.0	sandstone	"	"	"	"	"					"	"	"	"
29.4	34.4	4.9	sandstone	"	"	"	"	"					"	"	"	"
34.9	39.9	5.1	Sandstone	"	"	"	"	"					"	"	"	"
39.4	44.4	5.0	Sandstone	"	"	"	"	"					"	"	"	"
44.4	49.4	5.0	Sandstone	"	"	"	"	"					"	"	"	"
49.4	54.4	5.0	Sandstone	"	"	"	"	"					"	"	"	"
54.4	59.4	5.0	Sandstone	"	"	"	"	"					"	"	"	"

Remarks: Core from 9.4 ft. to 89.4 ft. Formation has been tight for the most part. Most breaks have been mechanical. Sandstone is soft and poorly cemented.
Secure rig for the night. Cover mud tanks

EQUIPMENT	NO. OR TYPE	HOURS	FUEL	SHIFTS	HOURS
DRILL	TERRAMAC			DRILLING	
COMPRESSOR				DOWN	
PUMP	TRASH PUMPS			MOVING	
OTHER				OTHER	

Notes: Following are examples of descriptive words and symbols used.
(1) Type bit or sampler: D=Diamond, RB= Tricone Rock Bit, DN=Dension etc.
(2) Additives: Bentonite, Polymers, foam, etc.

Driller Lenny Washburn
Helper William Marshall
Helper Tyler Hansen

Geologist
Drill Rig Terramac 1000
Title of Hole DH PLPP 05-1

UC-140

UC REGION DAILY DRILL REPORT

Title of Hole: DH PLPP 05-1
Date: 11-03-05 (page 2)

Feature: GLEN CANYON DAM
Project: PAGE LE-CHEE WATER SUPPLY
State: ARIZONA

Depth to water begin of shift _____ Measuring point (describe) _____ at _____ ft. (height) above ground

Interval		Recovery Ft. Or Meter	Overburden Or Rock Type And Drilling Conditions	Drilling Method			Drill Casing		Pr Test (18" Total)			Drilling Medium				
				Bit Or Sampler					Blows							
From	To			Size	Type (1)	Length Of Sampler	Size	Depth	6"	6"	6"	Air (Cfm)	Water (Describe Quality)	Additives (2) (Describe)	Color Of Fluid	% Per Of Return
59.4	64.4	5.0	Sandstone	HQ 3	CORE	5 FT	4"	3 FT.					clear	DRISPAC	rd	100
64.4	69.4	5.0	Sandstone	"	"	"	"	"					"	PF POLY	"	"
69.4	74.4	5.0	Sandstone	"	"	"	"	"					"	"	"	"
74.4	79.4	4.6	Sandstone	"	"	"	"	"					"	"	"	"
79.4	84.4	5.0	Sandstone	"	"	"	"	"					"	"	"	"
84.4	89.4	5.0	Sandstone	"	"	"	"	"					"	"	"	"
				"	"	"	"	"					"	"	"	"
				"	"	"	"	"					"	"	"	"
				"	"	"	"	"					"	"	"	"
				"	"	"	"	"					"	"	"	"

Remarks: continued from page 1

EQUIPMENT	NO. OR TYPE	HOURS	FUEL	SHIFTS	HOURS
DRILL	TERRAMAC			DRILLING	
COMPRESSOR				DOWN	
PUMP	TRASH PUMPS			MOVING	
OTHER				OTHER	

Notes: Following are examples of descriptive words and symbols used.

(1) Type bit or sampler: D=Diamond, RB= Tricone Rock Bit, DN=Dension etc.

(2) Additives: Bentonite, Polymers, foam, etc.

Driller Lenny Washburn
Helper William Marshall
Helper Tyler Hansen

Geologist _____
Drill Rig Terramac 1000
Title of Hole DH PLPP 05-1

UC-140

UC REGION DAILY DRILL REPORT

Title of Hole: DH PLPP 05-1
Date: 11-04-05
Feature: GLEN CANYON DAM
Project: PAGE LE-CHEE WATER SUPPLY
State: ARIZONA

Depth to water begin of shift _____ Measuring point (describe) _____ at _____ ft. (height) above ground

Interval		Recovery Ft. Or Meter	Overburden Or Rock Type And Drilling Conditions	Drilling Method			Drill Casing		Pr Test (18" Total)			Drilling Medium				
				Bit Or Sampler		Length Of Sampler			Blows			Air (Cfm)	Water (Describe Quality)	Additives (2) (Describe)	Color Of Fluid	% Per Of Return
From	To			Size	Type (1)		Size	Depth	6"	6"	6"					
89.4	94.4	5.0	Sandstone	HQ 3	CORE	5 FT	4"	3 FT.					clear	DRISPAC	rd	100
94.4	99.4	4.5	Sandstone	"	"	"	"	"					"	PF POLY	"	"
99.4	104.4	5.3	Sandstone	"	"	"	"	"					"	"	"	"
104.4	109.4	5.0	Sandstone	"	"	"	"	"					"	"	"	"
109.4	114.4	5.0	Sandstone	"	"	"	"	"					"	"	"	"
114.4	119.4	5.0	Sandstone	"	"	"	"	"					"	"	"	"
119.4	124.4	5.0	Sandstone	"	"	"	"	"					"	"	"	"
124.4	129.4	5.0	Sandstone	"	"	"	"	"					"	"	"	"
129.4	134.4	5.0	Sandstone	"	"	"	"	"					"	"	"	"
134.4	139.4	5.0	Sandstone	"	"	"	"	"					"	"	"	"

Remarks: Drill from 89.4 to 139.4 with hq3 core bit. Sandstone was ratty at 110 ft. and at 130 ft. Hole was trying to collar off. Pipe getting tight had to work it in places. Cover mud tanks and secure rig and equipment for night.

EQUIPMENT	NO. OR TYPE	HOURS	FUEL	SHIFTS	HOURS
DRILL	TERRAMAC	8	10	DRILLING	8
COMPRESSOR				DOWN	
PUMP	TRASH PUMPS	8	5	MOVING	
OTHER				OTHER	2

Notes: Following are examples of descriptive words and symbols used.

(1) Type bit or sampler: D=Diamond, RB= Tricone Rock Bit, DN=Dension etc.

(2) Additives: Bentonite, Polymers, foam, etc.

Driller Lenny Washburn
Helper William Marshall
Helper Tyler Hansen

Geologist _____
Drill Rig Terramac 1000
Title of Hole DH PLPP 05-1

UC-140

UC REGION DAILY DRILL REPORT

Title of Hole: DH PLPP 05-1
Date: 11-05-05

Feature: GLEN CANYON DAM
Project: PAGE LE-CHEE WATER SUPPLY
State: ARIZONA

Depth to water begin of shift _____ Measuring point (describe) _____ at _____ ft. (height) above ground

Interval		Recovery Ft. Or Meter	Overburden Or Rock Type And Drilling Conditions	Drilling Method			Drill Casing		Pr Test (18" Total)			Drilling Medium				
				Bit Or Sampler		Length Of Sampler			Blows			Air (Cfm)	Water (Describe Quality)	Additives (2) (Describe)	Color Of Fluid	% Per Of Return
From	To			Size	Type (1)		Size	Depth	6"	6"	6"					
139.4	144.4	5.0	Sandstone	HQ 3	CORE	5 FT	4"	3 FT.					clear	DRISPAC	rd	100
144.4	149.4	5.0	Sandstone	"	"	"	"	"					"	PF POLY	"	"
149.4	154.4	5.0	sandstone	"	"	"	"	"					"	"	"	"
154.4	159.4	5.0	Sandstone	"	"	"	"	"					"	"	"	"
159.4	164.4	5.0	Sandstone	"	"	"	"	"					"	"	"	"
164.4	169.4	5.0	Sandstone	"	"	"	"	"					"	"	"	"
169.4	174.4	5.0	Sandstone	"	"	"	"	"					"	"	"	"
174.4	179.4	5.0	Sandstone	"	"	"	"	"					"	"	"	"
179.4	184.4	5.0	Sandstone	"	"	"	"	"					"	"	"	"
184.4	189.4	5.0	Sandstone	"	"	"	"	"					"	"	"	"

Remarks: Drill from 139.4 to 189.4. Sandstone somewhat harder and better cemented most of the fractures are mechanical. Cover mud tanks and secure rig And equipment for the night.

EQUIPMENT	NO. OR TYPE	HOURS	FUEL	SHIFTS	HOURS
DRILL	TERRAMAC	8	10	DRILLING	8
COMPRESSOR				DOWN	
PUMP	TRASH PUMPS	8	5	MOVING	
OTHER				OTHER	2

Notes: Following are examples of descriptive words and symbols used.

(1) Type bit or sampler: D=Diamond, RB= Tricone Rock Bit, DN=Dension etc.

(2) Additives: Bentonite, Polymers, foam, etc.

Driller Lenny Washburn
Helper William Marshall
Helper Tyler Hansen

Geologist _____
Drill Rig Terramac 1000
Title of Hole DH PLPP 05-1

UC-140

UC REGION DA[illegible] DRILL REPORT

Title of Hole: DH PLPP 05-1
Date: 11-06-05
Feature: GLEN CANYON DAM
Project: PAGE LE-CHEE WATER SUPPLY
State: ARIZONA

Depth to water begin of shift _____ Measuring point (describe) _____ at _____ ft. (height) above ground

Interval		Recovery Ft. Or Meter	Overburden Or Rock Type And Drilling Conditions	Drilling Method			Drill Casing		Pr Test (18" Total)			Drilling Medium				
				Bit Or Sampler		Length Of Sampler			Blows			Air (Cfm)	Water (Describe Quality)	Additives (2) (Describe)	Color Of Fluid	% Per Of Return
From	To			Size	Type (1)		Size	Depth	6"	6"	6"					
189.4	194.4	5.0	Sandstone	HQ 3	CORE	5 FT	4"	3 FT.					clear	DRISPAC	rd	100
194.4	199.4	5.0	Sandstone	"	"	"	"	"					"	PF POLY	"	"
199.4	204.4	5.0	Sandstone	"	"	"	"	"					"	"	"	"
204.4	209.4	5.0	Sandstone	"	"	"	"	"					"	"	"	"
209.4	214.4	5.0	Sandstone	"	"	"	"	"					"	"	"	"
				"	"	"	"	"					"	"	"	"
				"	"	"	"	"					"	"	"	"
				"	"	"	"	"					"	"	"	"
				"	"	"	"	"					"	"	"	"
				"	"	"	"	"					"	"	"	"

Remarks: Drill from 189.4 to 214.4. Sandstone is fairly hard and cemented. Very few natural fractures. Secure rig for night. Cover mud tanks.

EQUIPMENT	NO. OR TYPE	HOURS	FUEL	SHIFTS	HOURS
DRILL	TERRAMAC	6	10	DRILLING	6
COMPRESSOR				DOWN	2
PUMP	TRASH PUMPS	6	5	MOVING	
OTHER				OTHER	1

Notes: Following are examples of descriptive words and symbols used.

(1) Type bit or sampler: D=Diamond, RB= Tricone Rock Bit, DN=Dension etc.

(2) Additives: Bentonite, Polymers, foam, etc.

Driller Lenny Washburn
Helper William Marshall
Helper Tyler Hansen

Geologist _____
Drill Rig Terramac 1000
Title of Hole DH PLPP 05-1

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UC REGION DAILY DRILL REPORT

Title of Hole: DH PLPP 05-1
Date: 11-07-05 (page 1)
Feature: GLEN CANYON DAM
Project: PAGE LE-CHEE WATER SUPPLY
State: ARIZONA

Depth to water begin of shift _____ Measuring point (describe) _____ at _____ ft. (height) above ground

Interval		Recovery Ft. Or Meter	Overburden Or Rock Type And Drilling Conditions	Drilling Method			Drill Casing		Pr Test (18" Total)			Drilling Medium				
				Bit Or Sampler					Blows							
From	To			Size	Type (1)	Length Of Sampler	Size	Depth	6"	6"	6"	Air (Cfm)	Water (Describe Quality)	Additives (2) (Describe)	Color Of Fluid	% Per Of Return
214.4	219-4	5.0	Sandstone	HQ 3	CORE	5 FT	4"	3 FT.					clear	DRISPAC	rd	100
219.4	224.4	5.0	Sandstone	"	"	"	"	"					"	PF POLY	"	"
224.4	229.4	5.0	Sandstone	"	"	"	"	"					"	"	"	"
229.4	234.4	5.0	Sandstone	"	"	"	"	"					"	"	"	"
234.4	239.4	5.0	Sandstone	"	"	"	"	"					"	"	"	"
239.4	244.4	5.0	Sandstone	"	"	"	"	"					"	"	"	"
244,4	249.4	5.0	Sandstone	"	"	"	"	"					"	"	"	"
249.4	254.4	5.0	Sandstone	"	"	"	"	"					"	"	"	"
254.4	259.4	5.0	Sandstone	"	"	"	"	"					"	"	"	"
259.	264.4	5.0	Sandstone	"	"	"	"	"					"	"	"	"

Remarks: Drill from 214.4 to 274.4 sandstone hard and well cemented for the most part. 268.9 to 269.6 soft and poorly cemented. City came with their vacuum Truck and took cuttings away. Short visit from Fred Ladman today. Secure rig and equipment. Cover mud tanks.

EQUIPMENT	NO. OR TYPE	HOURS	FUEL	SHIFTS	HOURS
DRILL	TERRAMAC	9	10	DRILLING	9
COMPRESSOR				DOWN	
PUMP	TRASH PUMPS	9	5	MOVING	
OTHER				OTHER	1

Notes: Following are examples of descriptive words and symbols used.
(1) Type bit or sampler: D=Diamond, RB= Tricone Rock Bit, DN=Dension etc.
(2) Additives: Bentonite, Polymers, foam, etc.

Driller Lenny Washburn
Helper William Marshall
Helper Tyler Hansen
Geologist
Drill Rig Terramac 1000
Title of Hole DH PLPP 05-1

UC-140

UC REGION DA[illegible] DRILL REPORT

Title of Hole: DH PLPP 05-1
Date: 11-09-05
Feature: GLEN CANYON DAM
Project: PAGE LE-CHEE WATER SUPPLY
State: ARIZONA

Depth to water begin of shift _____ Measuring point (describe) _____ at _____ ft. (height) above ground

Interval		Recovery Ft. Or Meter	Overburden Or Rock Type And Drilling Conditions	Drilling Method			Drill Casing		Pr Test (18" Total)			Drilling Medium				
				Bit Or Sampler					Blows							
From	To			Size	Type (1)	Length Of Sampler	Size	Depth	6"	6"	6"	Air (Cfm)	Water (Describe Quality)	Additives (2) (Describe)	Color Of Fluid	% Per Of Return
274.4	279.4	5.0	Sandstone	HQ 3	CORE	5 FT	4"	3 FT.					clear	DRISPAC	rd	100
279.4	284.4	5.0	Sandstone	"	"	"	"	"					"	PF POLY	"	"
284.4	287.4	4.8	Sandstone	"	"	"	"	"					"	"	"	"
287.4	294.4	5.2	Sandstone	"	"	"	"	"					"	"	"	"
294.4	299.4	5.0	Sandstone	"	"	"	"	"					"	"	"	"
				"	"	"	"	"					"	"	"	"
				"	"	"	"	"					"	"	"	"
				"	"	"	"	"					"	"	"	"
				"	"	"	"	"					"	"	"	"
				"	"	"	"	"					"	"	"	"

Remarks: Drilling very slowly. Pull out of hole to check bit. Pick up location and secure for long weekend.

EQUIPMENT	NO. OR TYPE	HOURS	FUEL	SHIFTS	HOURS
DRILL	TERRAMAC	8	10	DRILLING	5
COMPRESSOR				DOWN	
PUMP	TRASH PUMPS	4	5	MOVING	
OTHER				OTHER	5

Notes: Following are examples of descriptive words and symbols used.
(1) Type bit or sampler: D=Diamond, RB= Tricone Rock Bit, DN=Dension etc.
(2) Additives: Bentonite, Polymers, foam, etc.

Driller Lenny Washburn
Helper William Marshall
Helper Tyler Hansen
Geologist
Drill Rig Terramac 1000
Title of Hole DH PLPP 05-1

UC-140

UC REGION DA[illegible] DRILL REPORT

Title of Hole: DH PLPP 05-1
Date: 11-16-05
Feature: GLEN CANYON DAM
Project: PAGE LE-CHEE WATER SUPPLY
State: ARIZONA

Depth to water begin of shift _____ Measuring point (describe) _____ at _____ ft. (height) above ground

Interval		Recovery Ft. Or Meter	Overburden Or Rock Type And Drilling Conditions	Drilling Method			Drill Casing		Pr Test (18" Total)			Drilling Medium				
				Bit Or Sampler					Blows							
From	To			Size	Type (1)	Length Of Sampler	Size	Depth	6"	6"	6"	Air (Cfm)	Water (Describe Quality)	Additives (2) (Describe)	Color Of Fluid	% Per Of Return
299.4	300.0	.6	Sandstone	HQ 3	CORE	5 FT	4"	3 FT.					clear	DRISPAC	rd	100
300.4	304,4	4.9	Sandstone	"	"	"	"	"					"	PF POLY	"	"
304.4	309.4	5.1	Sandstone	"	"	"	"	"					"	"	"	"
309.4	314.4	5.0	Sandstone	"	"	"	"	"					"	"	"	"
				"	"	"	"	"					"	"	"	"
				"	"	"	"	"					"	"	"	"
				"	"	"	"	"					"	"	"	"
				"	"	"	"	"					"	"	"	"
				"	"	"	"	"					"	"	"	"
				"	"	"	"	"					"	"	"	"

Remarks: Go after equipment at the bureau yard. Set up pumps and mud tanks. Put HQ3 (# 6 diamond impreg) on core bbl. Go in hole with drill pipe. Hit first Tight spot at 30 ft. Hook up to drill head and wash and ream to 60 ft. Trip in hole to 225 ft. tight again. Wash and ream to 250 ft. Trip in hole to 268, tight. Wash and Ream to 299.4. Drill from 299.9 to 300 ft. Retrieve inner bbl and clean out muck. Drill from 300 ft to 314.4. Pull back HQ drill pipe. Secure equipment for night.

EQUIPMENT	NO. OR TYPE	HOURS	FUEL	SHIFTS	HOURS
DRILL	TERRAMAC	8	10	DRILLING	4
COMPRESSOR				DOWN	
PUMP	TRASH PUMPS	4	5	MOVING	
OTHER				OTHER	6

Notes: Following are examples of descriptive words and symbols used.
(1) Type bit or sampler: D=Diamond, RB= Tricone Rock Bit, DN=Dension etc.
(2) Additives: Bentonite, Polymers, foam, etc.

Driller Lenny Washburn
Helper William Marshall
Helper Tyler Hansen
Geologist
Drill Rig Terramac 1000
Title of Hole DH PLPP 05-1

UC-140

UC REGION DA[illegible] DRILL REPORT

Title of Hole: DH PLPP 05-1
Date: 11-17-05
Feature: GLEN CANYON DAM
Project: PAGE LE-CHEE WATER SUPPLY
State: ARIZONA

Depth to water begin of shift _____ Measuring point (describe) _____ at _____ ft. (height) above ground

Interval		Recovery Ft. Or Meter	Overburden Or Rock Type And Drilling Conditions	Drilling Method			Drill Casing		Pr Test (18" Total)			Drilling Medium				
				Bit Or Sampler					Blows							
From	To			Size	Type (1)	Length Of Sampler	Size	Depth	6"	6"	6"	Air (Cfm)	Water (Describe Quality)	Additives (2) (Describe)	Color Of Fluid	% Per Of Return
314.4	319.4	4.8	Sandstone	HQ 3	CORE	5 FT	4"	3 FT.					clear	DRISPAC	rd	100
319.4	324.4	4.1	Sandstone	"	"	"	"	"					"	PF POLY	"	"
324.4	328.7	4.4	Sandstone	"	"	"	"	"					"	"	"	"
328.7	333,7	5,2	Sandstone	"	"	"	"	"					"	"	"	"
333.7	338.7	5.0	Sandstone	"	"	"	"	"					"	"	"	"
338.7	343.7	5.0	Sandstone	"	"	"	"	"					"	"	"	"
343.7	348.9	5.2	Sandstone	"	"	"	"	"					"	"	"	"
348.9	353.9	4.8	Sandstone	"	"	"	"	"					"	"	"	"
				"	"	"	"	"					"	"	"	"
				"	"	"	"	"					"	"	"	"

Remarks: Drill from 314.4 to 353.9. Sandstone some what harder. Unable to get inner bbl to latch. Try to pull inner bbl back. It hung up half way up hole. Had to Cut wire line. Hook up head and circ. Drill pipe stuck. Work pipe and get it free. Pull back 10 ft. secure rig and equipment for night.

EQUIPMENT	NO. OR TYPE	HOURS	FUEL	SHIFTS	HOURS
DRILL	TERRAMAC			DRILLING	
COMPRESSOR				DOWN	
PUMP	TRASH PUMPS			MOVING	
OTHER				OTHER	

Notes: Following are examples of descriptive words and symbols used.
(1) Type bit or sampler: D=Diamond, RB= Tricone Rock Bit, DN=Dension etc.
(2) Additives: Bentonite, Polymers, foam, etc.

Driller Lenny Washburn
Helper William Marshall
Helper Tyler Hansen
Geologist
Drill Rig Terramac 1000
Title of Hole DH PLPP 05-1

UC-140

UC REGION DA[illegible] DRILL REPORT

Title of Hole: DH PLPP 05-1
Date: 11-20-05

Feature: GLEN CANYON DAM
Project: PAGE LE-CHEE WATER SUPPLY
State: ARIZONA

Depth to water begin of shift _____ Measuring point (describe) _____ at _____ ft. (height) above ground

Interval		Recovery Ft. Or Meter	Overburden Or Rock Type And Drilling Conditions	Drilling Method			Drill Casing		Pr Test (18" Total)			Drilling Medium				
				Bit Or Sampler		Length Of Sampler			Blows			Air (Cfm)	Water (Describe Quality)	Additives (2) (Describe)	Color Of Fluid	% Per Of Return
From	To			Size	Type (1)		Size	Depth	6"	6"	6"					
359.4	363.5	5.0	Sandstone	HQ 3	CORE	5 FT	4"	3 FT.					clear	DRISPAC	rd	90
363.5	368.5	5.0	Sandstone	"	"	"	"	"					"	PF POLY	"	"
368.5	373.6	5.0	Sandstone	"	"	"	"	"					"	"	"	"
373.6	378.7	5.2	Sandstone	"	"	"	"	"					"	"	"	"
378.7	383.7	5.0	Sandstone	"	"	"	"	"					"	"	"	"
383.7	388.7	5.0	Sandstone	"	"	"	"	"					"	"	"	"
				"	"	"	"	"					"	"	"	"
				"	"	"	"	"					"	"	"	"
				"	"	"	"	"					"	"	"	"
				"	"	"	"	"					"	"	"	"

Remarks: Replace wire line. Go in hole with 110 ft of drill pipe. Drill from 359.4 to 388.7 Pull back 20 ft. secure rig for night.

EQUIPMENT	NO. OR TYPE	HOURS	FUEL	SHIFTS	HOURS
DRILL	TERRAMAC	9	10	DRILLING	8
COMPRESSOR				DOWN	
PUMP	TRASH PUMPS	8	5	MOVING	
OTHER				OTHER	2

Notes: Following are examples of descriptive words and symbols used.

(1) Type bit or sampler: D=Diamond, RB= Tricone Rock Bit, DN=Dension etc.

(2) Additives: Bentonite, Polymers, foam, etc.

Driller Lenny Washburn
Helper William Marshall
Helper Tyler Hansen

Geologist
Drill Rig Terramac 1000
Title of Hole DH PLPP 05-1

UC-140

UC REGION DA DRILL REPORT

Title of Hole: DH PLPP 05-1
Date: 11-21-05

Feature: GLEN CANYON DAM
Project: PAGE LE-CHEE WATER SUPPLY
State: ARIZONA

Depth to water begin of shift _____ Measuring point (describe) _____ at _____ ft. (height) above ground

Interval		Recovery Ft. Or Meter	Overburden Or Rock Type And Drilling Conditions	Drilling Method			Drill Casing		Pr Test (18" Total)			Drilling Medium				
				Bit Or Sampler		Length Of Sampler			Blows			Air (Cfm)	Water (Describe Quality)	Additives (2) (Describe)	Color Of Fluid	% Per Of Return
From	To			Size	Type (1)		Size	Depth	6"	6"	6"					
388.7	393.7	5.0	Sandstone	HQ 3	CORE	5 FT	4"	3 FT.					clear	DRISPAC	rd	90
393.7	398.7	5.2	Sandstone	"	"	"	"	"					"	PF POLY	"	"
398.7	403.7	5.0	Sandstone	"	"	"	"	"					"	"	"	"
403.7	408.7	5.0	Sandstone	"	"	"	"	"					"	"	"	"
408.7	413.7	5.2	Sandstone	"	"	"	"	"					"	"	"	"
413.7	415,0	1.3	Sandstone	"	"	"	"	"					"	"	"	"
				"	"	"	"	"					"	"	"	"
				"	"	"	"	"					"	"	"	"
				"	"	"	"	"					"	"	"	"
				"	"	"	"	"					"	"	"	"

Remarks: Drill from 388.7 to 415 ft. Total depth of hole, Pipe was getting differentially stuck from 268 to finish of hole. Last 15 ft. was softer and less cemented.
Add Clorox to mud system and circulate through out hole, Pull pipe out of hole, secure rig and equipment for night.

EQUIPMENT	NO. OR TYPE	HOURS	FUEL	SHIFTS	HOURS
DRILL	TERRAMAC	8	10	DRILLING	5
COMPRESSOR				DOWN	
PUMP	TRASH PUMPS	4		MOVING	
OTHER				OTHER	6

Notes: Following are examples of descriptive words and symbols used.
(1) Type bit or sampler: D=Diamond, RB= Tricone Rock Bit, DN=Dension etc.
(2) Additives: Bentonite, Polymers, foam, etc.

Driller Lenny Washburn
Helper William Marshall
Helper Tyler Hansen

Geologist
Drill Rig Terramac 1000
Title of Hole DH PLPP 05-1

Section 6

Page
ARIZONA
THE CENTER OF CANYON COUNTRY

December 16, 2005

Mr. Rick Scott
Provo Area Office
Bureau of Reclamation
302 East 1860 South
Provo, UT 84606

Dear Mr. Scott:

Mr. Mark Neeley has provided the following description of his services to log the drill cores and do some surface mapping with regard to the exploratory hole drilled by the Provo crew for the City at Glen Canyon Dam:

> Examine and photograph the core and provide a geologic log. The geologic log will include % recovery, %RQD, brief description of the rock, determination of natural or mechanical fractures with depth and angle from the core axis noted for natural joints.
>
> In the field, measure the strike and dip of the most prominent jointing that appears to trend toward the drill hole location. Try to locate them on some type of photograph or base map.
>
> Log the core and complete the field work in one 5 day week, including travel to and from Page, Arizona.
>
> Complete a geologic log and photo base map in two days in the office with a covering summary of findings.

Mr. Neeley's cost estimate for completing the above work is:

Field work	$3,100
Travel Expenses	400
Office work	1,240
	$4,740

City of Page
P.O. Box 1180 • 697 Vista Avenue
Page, Arizona 86040
(928) 645-8861 • Fax (928) 645-4244

We understand that Mr. Neeley is scheduled to start work on December 19, 2005. This letter is your authorization to proceed with the work on December 19, under the agreement between the Provo Office and the City for the drilling program. The City will provide a check in the amount of $4,740 to the Provo Office on December 23, 2005.

We appreciate the Bureau's effort on this work and look forward to receiving Mr. Neeley's analyses.

Please call me or Bill Plummer if you have any questions.

Sincerely,

Bo Thomas
City Manager

cc: Bill Plummer

From: <PlummerNW@aol.com>
To: <MNEELEY@uc.usbr.gov>
Date: 1/12/2006 7:08:11 AM
Subject: Re: Geologic Log & Surface Geology Map

Mark,

Here are the coordinates and elevations of the drill hole at the proposed Page-LeChee pumping plant.

400 2162005.44 626985.11 3773.763 WELL PIPE LOWER LIP
401 2162005.43 626984.8 3773.898 PIPE UPPER LIP
402 2162005.23 626984.06 3772.515 PIPE AT GROUND
403 2164074.31 625971.03 3598.63 WATER

Bill
We shot the water and compared the elevation to the NPS reported lake level.
Our elevations are about 0.80 feet higher than the lake. That could change on any given day, of course.
Our elevations are based on the City of Page.

RECLAMATION

Managing Water in the West

Lake Powell Reservoir-Side Pumping Plant Site

Geology Report



U. S. Department of the Interior
Bureau of Reclamation
Phoenix Area Office
Glendale, Arizona

November 2007

Lake Powell Reservoir-Side Pumping Plant Site

Background

An appraisal study for the construction of a water intake and pumping plant for the City of Page was conducted by the Bureau of Reclamation (Reclamation) in June 2004. The intake shafts would be situated within a cliff adjacent to Lake Powell and approximately 1,350 feet upstream of Glen Canyon Dam within the boundary of the Glen Canyon National Recreation Area (GLCA). The City of Page requested a right-of-way across the GLCA to construct the intake. The National Park Service (NPS) requested that the City of Page prepare an environmental assessment (EA) including a design study to analyze the geologic stability of the proposed site to support the project. The City of Page contracted Reclamation to prepare the design study which included a brief summary of the field work completed, core photographs, geologic logs, and a visual inspection of the site for surface expressions of rock jointing.

The NPS determined that the study was insufficient for their purposes, requiring more details to determine whether the site would be suitable from the standpoint of stability to support the facility.

In August of 2007, the Bureau of Reclamation (Reclamation) performed a limited geotechnical evaluation of the site by describing and mapping a number of surface fractures and the local topography. This data will be used to determine if the orientation of the existing joint sets form a removable block or blocks that could potentially lead to slope instability. Also to be determined, is the potential of these same blocks in combination with the proposed inclined shaft excavations upon the global stability.

Geologic Mapping

Mapping was performed within about 500 feet of the proposed pumping plant and along the shore line extending northward. Geologic contacts and continuous joints were mapped at a scale of 1 inch equals 100 feet. The mapping was overlain onto an aerial photograph and is shown on Figure 1. Topographic contours are shown on Figure 2 which includes Cross-Section A-A' drawn along drill hole DH05-1.

Photographs of very continuous joints (joints greater than 100 feet long) designated Joint A and Joint B were taken at various locations along the joint's trend and are presented in the Photographs section of this report.

Geologic Conditions

The bedrock of the pumping plant site consists of Navajo Sandstone. The sandstone is grayish to reddish brown in color and is composed of fine- to predominantly medium-grained sand cemented with calcium carbonate and, to a lesser degree, iron oxide. The sandstone is moderately weathered and moderately soft to moderately hard; fragments break with moderate to light hammer blow or heavy manual pressure. Where the sandstone is exposed, the calcium carbonate has been leached out at the surface, weakening the rock. In these areas, thin lenses of the sandstone can be broken with manual pressure. In general, the sandstone is moderately to slightly fractured (fractures spaced from 0.3 to 3 feet apart) except for localized zones of intense fracturing usually due to bedding planes weathering out on the surface.

One of the most conspicuous characteristics of the Navajo Sandstone is its prominent crossbedding. Bedding orientations vary greatly in strike, but dip generally 10 to 25 degrees, mostly to the southwest and southeast. Beds are spaced 1/16 to 2 inches thick (thinly bedded to laminated).

Fill material, consisting of sand to boulder-size fragments of sandstone, form broad level areas north and east of the pumping plant site where the fill was bull-dozed into place during the construction of Glen Canyon Dam. The thickness of the fill is unknown and was mapped where it is estimated to be greater than 2 feet thick.

A veneer of subrounded gravels is present in areas that were excavated for use as access roads during construction. Mapped as gravel fill; it consisting of sand to angular, gravel-size fragments of sandstone and subrounded gravel. The gravel fill is differentiated from fill in that the material is smaller in size and the thickness is assumed to be less than 2 feet.

Colluvium consists of sand to boulder-size fragments of sandstone derived from weathering of the sandstone. Colluvium is found in areas untouched by construction activities and is usually less than 3 feet thick.

Jointing

Joint surveys were conducted in sandstone outcrops within about 500 feet of the proposed pumping plant site. Joints that were continuous for 2 feet or more were recorded and are shown on Table 1 - Joint Survey Data, located at the end of this narrative. Joint surfaces are usually clean, rough and dry. Most of the joints measured were only continuous for 5 feet or less. A few joints were continuous for over 50 feet. Those were designated as Joints A through J (excepting I) and were described and mapped. Descriptions of each follow.

Joint A

A continuous joint was first described in the area of the proposed pumping plant by Reclamation geologist Mark Neely in his report titled "Drill Hole DH05-1 Geologic Log, Core Photographs & Surface Joint Identification" dated March 2006. It was depicted as a prominent joint that "is exposed in the north wall of inlet channel of the left (east) side spillway for Glen Canyon Dam. The joint trends or strikes N 9˚ E, and dips or slopes 60˚ from horizontal toward the northwest into the reservoir. The trace of the joint extends vertically from the top of the inlet channel cut to the floor of the inlet channel or about 135 feet." That joint has been labeled as Joint A in this report and its surface extent has been mapped and described.

Joint A is continuous for at least 1,900 feet and was mapped from the edge of the fence where it trends up from the spillway approach channel until it disappears beneath fill located 1100 feet northeast of the proposed pumping plant site. The joint is totally healed with up to 1½" of moderately hard, calcium carbonate ($CaCO_3$) and, in localized areas; lenses of sandstone interbedded with the $CaCO_3$. Slickensides are evident on the calcium carbonate in two locations and are oriented down dip. Joint A is generally rough and the wall rock (sandstone) is moderately to intensely weathered and moderately soft.

Joint A is oriented N9°E, 60°NW in the spillway approach channel, but varies in strike as it trends northward by as much as 14 degrees. The dip stays fairly constant at about 63°NW. Orientations measured along the trend of Joint A include:

Orientation	Location on Figure 1
N20°E, 63°NW	PT 1
N9°E, 65-75°NW	PT 2
N21°E, 62°NW	PT 3
N5°E, 61°NW	PT 4

Joint B

Joint B is continuous for over 830 feet. The joint is filled with ½ to 2" of moderately hard $CaCO_3$ and interbedded sandstone lenses totaling up to 3" in thickness. The joint is rough and the sandstone to either side is moderately weathered and moderately soft to moderately hard.

Joint B is oriented N10°W, 65°NE, but can vary as much as 14 degrees in strike. The dip ranges from 54 to 75°NE. Other orientations measured include:

Orientation	Location on Figure 1
N0°E, 65°E	PT 6
N14°W, 54°NE	PT 7
N5°W, 75°NE	PT 9

Table 2 list other joints in the area that are continuous for over 50 feet. All joint surfaces are rough and dry.

Table 2 - Continuous Joints

JOINT	STRIKE	DIP	CONTINUITY (FT)	OPEN (in.)	INFILLING	
					TYPE	THICKNESS
Joint A	N7E	62NW	1900	1-1/2	$CACO_3$	1-1/2
Joint B	N10W	65NE	830	3	$CACO_3$	3
Joint C	N38W	77SW	138	1/32	Clean	
Joint D	N35W	85SW	52	1/32	Clean	
Joint E	N35E	17SE	74	1/32	Clean	
Joint F	N5W	85NE	205	1/2	$CACO_3$	3
Joint G	N45W	3NE	314	1/32	Clean	
Joint H*	N54W	90	93	1/16	Clean	
Joint J	N25E	70NW	93	1/16	$CACO_3$	Coating

* Joint H connects a series of blast holes that were drilled and detonated to excavate an access road and may have been formed during blasting.

Geotechnical Engineering Evaluation

Reclamation's Technical Service Center Geotechnical Branch was asked to perform a limited geotechnical evaluation of the proposed pumping plant site using the data presented earlier in this report. The aim was to determine if the orientations of the existing joint sets have the potential to form a removable block or blocks that could eventually lead to canyon rim slope instability or problems with the inclined shaft excavations.

In order to determine if blocks are formed by the joints presented in Table 1, the orientations were plotted and analyzed. This process was accomplished by converting the planes that were recorded as strike and dip, into poles with bearing and plunge. These poles were then contoured onto an Upper Focal Point, Lower Hemisphere Equal Angle Stereographic Projection (UFP/LHEASP) plot. The computer software Dips 5.1 [1] was used for this process. The contoured poles are shown on Figure 3.

Typically, pole concentrations of greater than 4% of the total population yield a sufficient number of similarly oriented planes to be problematic in block formations if the joints are continuous [2]. When matched in combination with other relatively continuous planes, represented as poles of similar concentrations of greater than 4% or with singular, dominant features, they are traditionally considered as having the potential to form blocks within the study area mapped. Based upon the contoured plots, seven sets of pole concentrations with greater than 4% of the population were identified. These are shown on Figure 3, Contoured Poles Plot, as a UFP/LHEASP plot of the Principal Planes overlying the Contour Poles. The Principal Planes are shown independently on Figure 4, also a UFP/LHEASP plot, as the Principal Planes Plot.

Using the Bureau of Reclamation's Engineering Geology Field Manual (EGFM) [3], joint continuity can be sorted into five classifications. Several joints mapped at the site have extreme continuity (greater than 100 feet) and are classified as C5 - Very Continuous. They are shown on Figure 1 and defined in Tables 2 and 3. Discontinuities of this extreme continuity are classified in this report as "macro scale discontinuities" or "macro joints". Joints A, B, C, D, E, G and J meet this classification. These macro joints are examples of singular, dominant features within the total population. However, other discontinuities were mapped that are representative of more typical continuity. Their continuity is usually less than 50 feet (C4 - Highly Continuous to C2 - Slightly Continuous as defined in the EGFM). They are termed "meso scale discontinuities" or "meso joints" in this report. Other features mapped with a continuity of three feet or less (C1 - Discontinuous), are termed "micro scale discontinuities" or "micro joints" in this report, and are of little consequence relative to rock mass behavior.

Typically, bedding joints at the site are very flat, dipping from 1 to 2 degrees with the maximum dip recorded in Table 1 as 10 degrees and the dip direction ranging from northeast to southeast. Cross-bedding joints dips at a steeper angle, ranging from 17 to 36 degrees in a northwest to southeast direction. Bedding and cross-bedding joints are represented in the macro joints category. They are also represented in the meso scale classification. However, bedding joints are not represented within the micro scale classification, while cross-bedding joints are.

In addition to the six macro joints shown on Figure 1, 69 additional discontinuities were measured at the site varying from meso to micro scale joints. Using the pole plots contoured from the joint survey data (Joint Survey, JP-PLPS1, Figure 3 and the Principal Planes Plot, Figure 4), some similarities between the macro scale joints and the meso/micro scale joints are seen, and conclusions can be made. The similarities between the very continuous macro joints designated by letters on Figure 1 to those joint sets extracted from the pole concentration plots are shown on Table 3, titled Contoured Macro, Meso & Micro Mapped Discontinuities vs. Mapped Macro Joints.

Table 3 – Contoured Macro, Meso & Micro Mapped Discontinuities vs. Mapped Macro Joints

Macro, Meso & Micro Discontinuities				Macro Joints			
Set	Dip	Dip Direction	Type	Joint	Dip	Dip Direction	Type
1	22	180	Cross Bedding Joints	E	17	125	Cross Bedding Joints
2	86	214		C	77	232	
				D	85	235	
3	30	310	Cross-bedding Joints				Cross-bedding Joints
6	57	319					
7	86	90		F	85	85	
8	82	287		J	70	295	
9	1	90	Bedding Joints	G	3	45	Bedding Joints

Macro joints A & B are seen from Figure 1 to have extreme continuity; however there are not sufficient numbers of similarly oriented discontinuities to be represented as a high concentration of poles constituting a joint set (Figure 3). On the other hand, meso joints C and D have significantly less continuity, but there are sufficient numbers of similar discontinuities within the total population to constitute an independent set. This is also true for the F and J joints. Bedding and cross-bedding joints are seen to be more variable in strike and dip as well as continuity than the other joints, registering from meso to micro joints in terms of continuity. The ability to assess block formation will be affected by the limited amount of data collected.

Tables 1 and 2 also describe the joint spacing and continuity as recorded at the site. These two characteristics in combination with the geometries of the planes defining the blocks will establish the typical size of the block. The number of similar fractures contained in a set will define the frequency, recurrence or number of blocks within the population likely to occur across the mapped area.

When considering the recorded continuity, most blocks will likely be of insignificant surface area and volume. Thus, block removals caused by shaft construction are not likely to destabilize the canyon face or the plant site. They are similar to blocks normally seen to "calve-off" of the canyon face as part of the normal weathering process within the canyon along joints of the meso scale classification.

Many of these blocks, though likely removable, are small in size and would not compromise or otherwise destabilize the plant site. Additionally, their typical continuity will prevent them from attaining a size that would capture the plant site in part or total as seen in Figure 3. An example of a removable block relative to the canyon wall below the proposed pumping plant of meso scale would be a block formed with a back plane of an orientation similar to the F Joint and a base plane with an orientation similar to a bedding joint with G Joint orientation. Since the base plane is so flat relative to the likely friction angle, block removal would need to occur by the toppling of a tall thin block into the canyon.

The geometries of discontinuities measured at the site, in particular the macro joints, as shown on Figure 1, have the potential to form removable blocks. In particular, macro joints A and~~,~~ B can combine with other less continuous discontinuities of mapped sets to potentially form blocks; although, they would not all be removable. The less continuous joints, in combination with macro joints likely would form relatively small removable blocks. Smaller removable blocks also have the potential to form in combination with meso scale joints and the micro scale cross-bedding joints. At this time, the macro joints are not seen at the site as intersecting features, but only as independent joints. Therefore, large blocks that would compromise a large portion of the cliff face are unlikely.

In order to form a removable block that could potentially compromise the proposed plant site, additional continuity would be required for the J Joint to form an intersection with the A Joint and also daylight at the canyon face. This block would comprise a significant portion of the cliff face and be visually apparent if it existed. Approximately 400 ± feet of expression of the J Joint extending in a northeasterly direction to form an intersection with the A Joint and southwesterly 250 ± feet to intersect the canyon face would be required to form this geometry. Persistence along both strike and dip into the rock mass would also be necessary for complete continuity to form a removable block.

Further, it is estimated that continuity and persistence of 150 to 200 feet would be required of both the A and J discontinuities individually to form a continuous removable block at any other location on the rim using their respective mapped orientations. Physical features of this extent for the J Joint have not been in evidence at the site. The A joint has ample surface continuity, but unknown and possibly limited persistence into the rock. There is visual evidence, Figure 2 and 3, of the A Joint continuing down the canyon face along dip; however, there is no evidence of its persistence along the strike of the joint into the rock mass. The J Joint as mapped is lacking in sufficient continuity and persistence to extend to an

intersection with the A Joint and daylight at the canyon face. Therefore, the formation of a large detrimental removable block in the vicinity of the proposed plant site is unlikely.

Conclusions

This evaluation is based on limited mapping of exposed features. The primary concern is for large scale continuous joints that could compromise the stability of the canyon rim in the area of the plant. Joint A is of significant continuity and projects toward the canyon rim, but by itself does not form a dangerous block. Although no continuous intersecting discontinuities capable of forming a large block have been identified, additional evaluation is warranted as more information becomes available. Detailed mapping should be performed during the evaluation and design phases of any forthcoming projects.

No combination of surface discontinuities mapped at the site at this time affords conclusive evidence of sufficient continuity and persistence for block formation and removal so as to compromise the canyon rim.

Rock will continue to calve from the canyon face. The potential for this to impact the project features should be evaluated, and rock bolting of the canyon rim performed as needed during construction to protect these features.

Some instability of the inclined shafts should be anticipated due to the presence of intersecting discontinuities of smaller continuity. It is not anticipated that this will create any insurmountable problems relative to drilling and lining the shafts.

References

1. Hoek, E. and M. Diederichs, "DIPS", Version 5.1, Rock Engineering Group, Department of Civil Engineering, University of Toronto, 2005.

2. Hoek, E. and Brown, E. T., Rock Slope Engineering, The Institution of Mining and Metallurgy, London, 2nd ed., pp. 131-133, 1977.

Engineering Geology Field Manual, Second Edition, Volume I, Chapter 5, pp. 91-126, Technical Service Center, Department of the Interior, Bureau of Reclamation, Denver, Colorado, 1998.

Table 1 - Joint Survey Data

Strike	Dip	Continuity		Open (In.)	Wall Rock Hard-ness	Infilling			Joint Rough-ness	Avg Spac-ing (ft)	Area	Remarks
		Feet	Ends			Type	Thick-ness	Hard-ness				
N10W	65NE	830	1	3	4	Ca	3"	5	2			Joint B
N5W	85NE	205	0	1/2	4	Ca	3"	5	2			Joint F
N38W	77SW	138	2	1/32	4	Cl			2			Joint C
N35W	85SW	52	2	1/32	4	Cl			2			Joint D
N35E	17SE	74	2	1/32	4	Cl			2			Joint E
N3W	32NE	25	2	tight	4	Cl			4	3		
N3W	32NE	25	2	tight	4	Cl			4	3		
N3W	32NE	20	2	1/32	5	Cl			1	3	17	
N3W	32NE	20	2	1/32	5	Cl			1	3	17	
N6E	65NW	3	2	1/32-face	4	Cl			2	>20	17	
N7E	62NW	1900	0	1-1/2	4	Ca	1-1/2"	5	2			Joint A
N25E	70NW	93	1	1/16	4	Ca	Ct	5	2			Joint J
N9E	80NW	4	0	1/8-face	4	Ca	Ct	5	4-5	1	4	
N24E	80NW	5	1	1/8-face	4	Ca	Ct	5	3	1	4	
N20E	82NW	3	2	F	4	Cl			4	>30	2	
N16E	88NW	2	1	1/8-face	4	Ca	Ct	5	4	1	4	
N11E	70-88NW	3	1	1/8-face	4	Cl			2-3	1	4	
N18E	87SE	2	1	F	4	Cl			4	5	2	
N35E	86SE	2	1	1/2	4	Cl			4-2	>10	4	
N1E	88NW	3	1	1/8-face	4	Cl			4	5	4	
N0E	87N	8	2	1/8	4	Cl			1-2	2	17	
N0E	87N	8	2	1/8	4	Cl			1-2	2	17	
N0E	87N	8	2	1/8	4	Cl			1-2	2	17	
N85E	79SE	2	1	1/32	4	Cl			4	>10	4	
N55E	80SE	3	1	1/32-face	4	Cl			4	>30	2	
N90E	85N	5	1	F	4	Cl			4	5	2	
N38E	24NW	3	2	1/16-1/8	4	Cl			1-2	3	17	
N38E	24NW	3	2	1/16-1/8	4	Cl			1-2	3	17	
N38E	24NW	3	2	1/16-1/8	4	Cl			1-2	3	17	
N45E	32NW	3	2	1/32	4	Cl			4	0.5	17	
N45E	32NW	3	2	1/32	4	Cl			4	0.5	17	
N45E	32NW	3	2	1/32	4	Cl			4	0.5	17	
N38E	36NW	3	1	1/8	4	Cl			3	2	17	
N38E	36NW	3	1	1/8	4	Cl			3	2	17	
N38E	36NW	3	1	1/8	4	Cl			3	2	17	
N55E	53NW	3	2	1/16	4	Cl			4	0.5	17	
N55E	53NW	3	2	1/16	4	Cl			4	0.5	17	
N55E	53NW	3	2	1/16	4	Cl			4	0.5	17	
N90E	78N	2	1	1/32-face	4	Cl			4	10	17	
N35E	74NW	4	1	1/16	4	Cl			3	3	17	
N35E	74NW	2	2	1/32	4	Cl			3	>10	17	
N45E	62NW	5	1	1/8	4	Cl			1-2	0.6	17	curves
N45E	62NW	5	1	1/8	4	Cl			1-2	0.6	17	curves
N45E	62NW	5	1	1/8	4	Cl			1-2	0.6	17	curves
N45E	62NW	5	1	1/8	4	Cl			1-2	0.6	17	curves

Table 1 - Joint Survey Data (cont.)

Strike	Dip	Continuity		Open (In.)	Wall Rock Hard-ness	Infilling			Joint Rough-ness	Avg Spac-ing (ft)	Area	Remarks
		Feet	Ends			Type	Thick-ness	Hard-ness				
N54W	90	93	2	1/16	4	Cl			2			Joint H
N57W	90	25	2	1/8	4	Cl			2	>30	23	
N55W	85NE	40	2	1/8	4	Cl			2	4	23	irregular
N55W	85NE	20	2	1/8	4	Cl			2	4	23	irregular
N55W	85NE	30	2	1/8	4	Cl			2	4	23	irregular
N55W	85NE	10	2	1/8	4	Cl			2	4	23	irregular
N55W	85NE	20	2	1/8	4	Cl			2	4	23	irregular
N65W	82NE	5	0	face	4	Cl			4	>30	2	
N85W	87NE	2	0	face	4	Cl			4	5	2	
N35W	87NE	5	0	face	4	Cl			4	>30	2	curves
N45W	3NE	314	2	1/32	4	Cl			2			Joint G, bedding
N90E	24SE	25	2	1/32	5	Cl			2	0.8	17	crossbedding
N90E	24SE	25	2	1/32	5	Cl			2	0.8	17	crossbedding
N90E	24SE	25	2	1/32	5	Cl			2	0.8	17	crossbedding
N90E	24SE	25	2	1/32	5	Cl			2	0.8	17	crossbedding
N85E	24SE	3	1	1/32	4	Cl			4	1	17	crossbedding
N85E	24SE	20	1	1/32-face	4	Cl			4	0.8	17	crossbedding
N85E	24SE	20	1	1/32-face	4	Cl			4	0.8	17	crossbedding
N85E	24SE	20	1	1/32-face	4	Cl			4	0.8	17	crossbedding
N85E	24SE	20	1	1/32-face	4	Cl			4	0.8	17	crossbedding
N85E	24SE	20	1	1/32-face	4	Cl			4	0.8	17	crossbedding
N85E	24SE	20	1	1/32-face	4	Cl			4	0.8	17	crossbedding
N85E	24SE	20	1	1/32-face	4	Cl			4	0.8	17	crossbedding
N58E	23SE	4	2	tight	4	Cl			4	3		crossbedding
N85W	23SW	3	2	tight	4	Cl			4	3		crossbedding
N82W	26SW	3	2	tight	4	Cl			4	3		crossbedding
N25E	6NW	40	2	1/32-tight	4	Cl			5	0.4	2	bedding
N45E	3SE	40	2	tight	4-5	Cl			4	2.5	4	bedding
N72E	1NW	20	2	tight	4	Cl			4	3		bedding
N10E	10SE	35	2	tight	4-5	Cl			4	2.5	4	bedding

All joints are dry. Numeric descriptors are based on the Bureau of Reclamation's Engineering Geology Field Manual.

Ca = calcium carbonate
Cl = clean
Ct = coating less than 1/32" thick

FIGURES

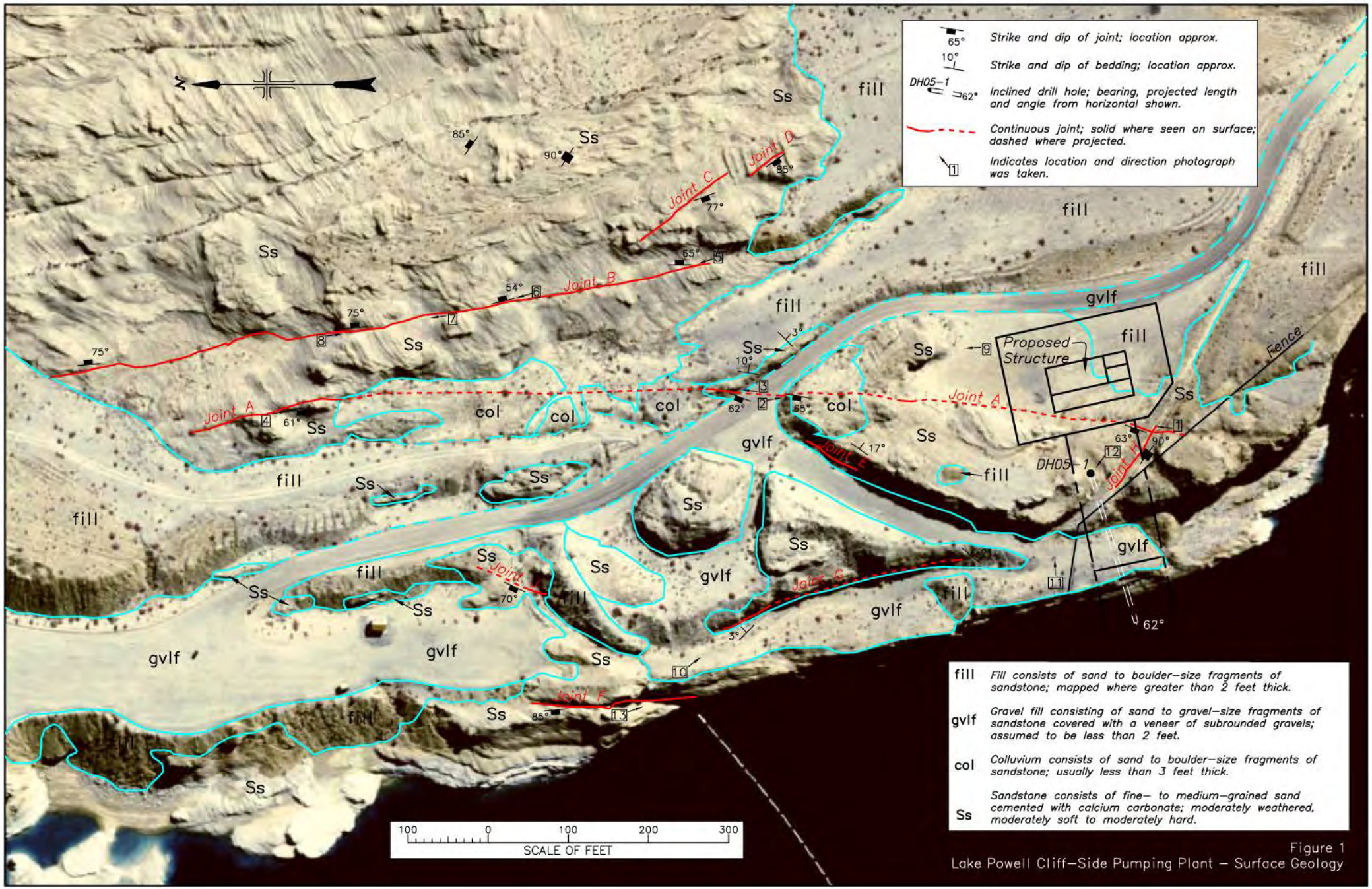
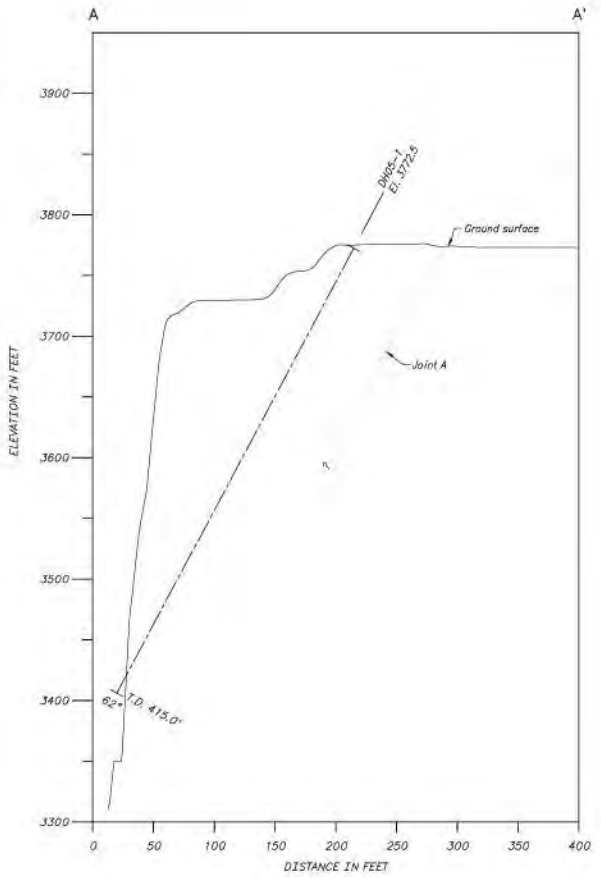
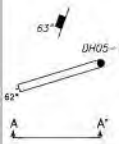


Figure 1
Lake Powell Cliff–Side Pumping Plant – Surface Geology

FIGURE 2







Strike and dip of continuous joint

Inclined drill hole showing bearing, projected length and angle from horizontal.

Location of Cross-Section

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

CITY OF PAGE, ARIZONA – NAVAJO NATION CHAPTER OF LECHEE

PAGE – LECHEE WATER SUPPLY – PART 1

INCLINED SHAFT PUMPING PLANT – OPTION 2

SITE PLAN AND SECTION A-A'

GEOLOGY _____ CHECKED _____

DRAWN _____ TECH. APPR. _____

APPROVED _____

CAD SYSTEM: AutoCAD Rel. 14.0
PHOENIX, ARIZONA

2007-03-23

SHEET 1 OF 1

ADMINISTRATOR
CAD FILENAME:
PLAN.DWG

FIGURE 2

DATE AND TIME PLOTTED:
NOVEMBER 26, 2007 11:46
PLOTTED BY:
AUTOCAD

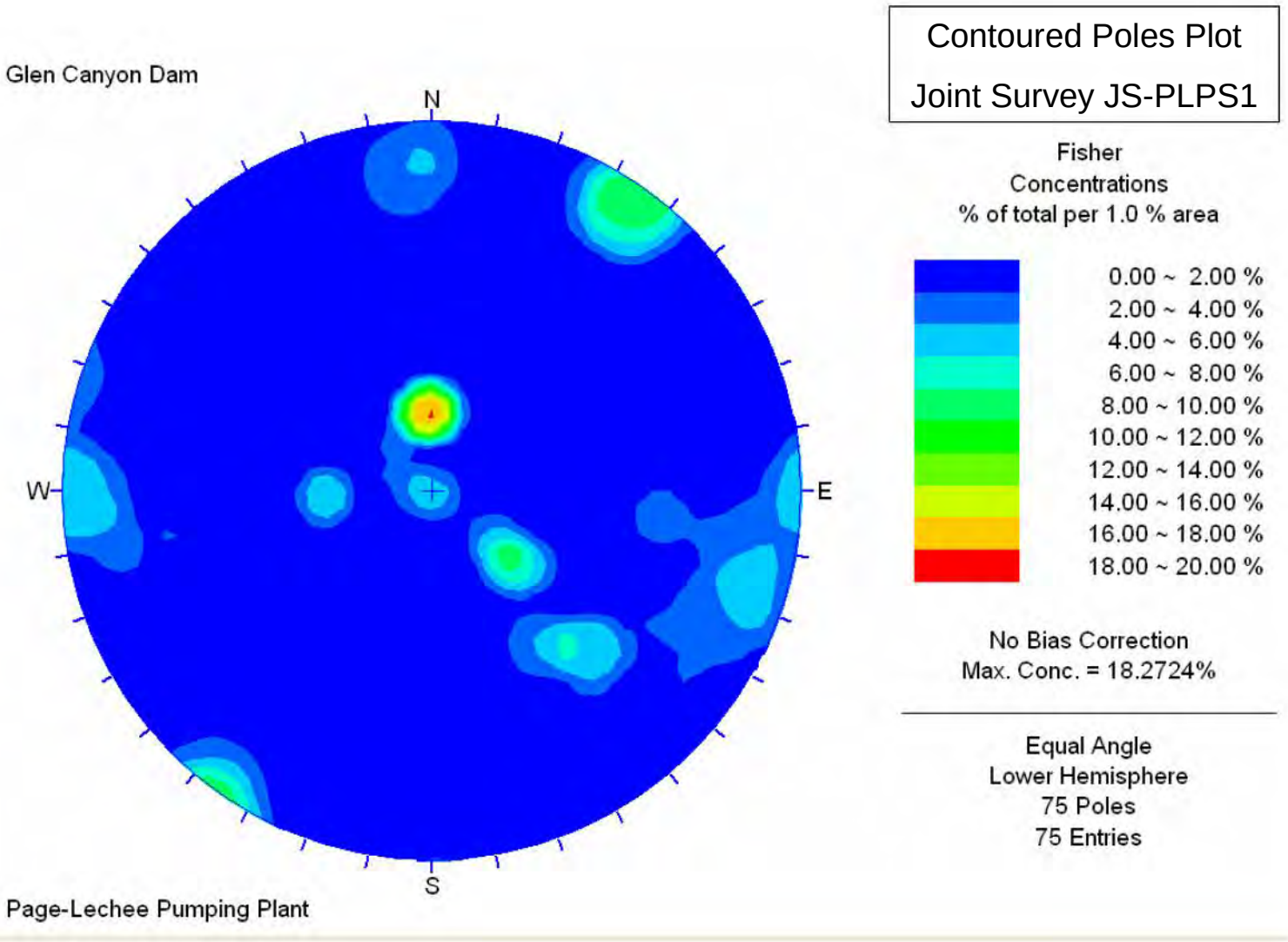
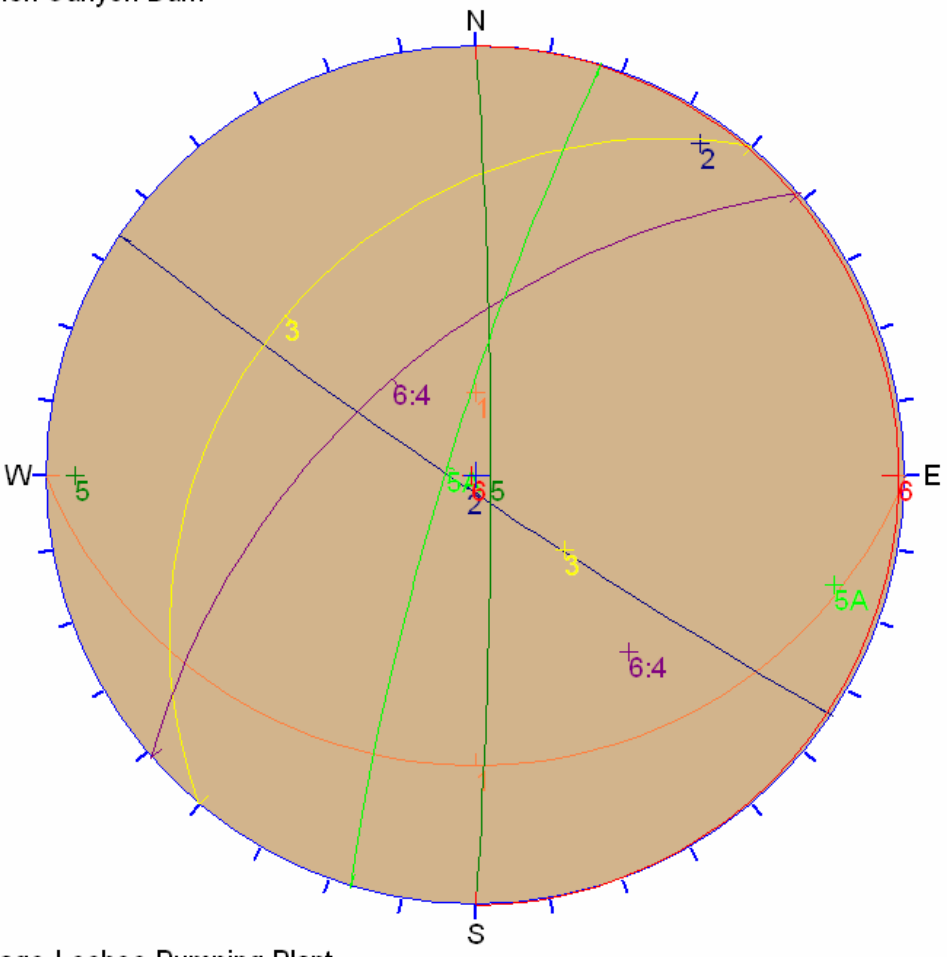

Contoured Poles Plot
Joint Survey JS-PLPS1
Glen Canyon Dam
N
W
E
S
Fisher
Concentrations
% of total per 1.0 % area
0.00 ~ 2.00 %
2.00 ~ 4.00 %
4.00 ~ 6.00 %
6.00 ~ 8.00 %
8.00 ~ 10.00 %
10.00 ~ 12.00 %
12.00 ~ 14.00 %
14.00 ~ 16.00 %
16.00 ~ 18.00 %
18.00 ~ 20.00 %
No Bias Correction
Max. Conc. = 18.2724%
Equal Angle
Lower Hemisphere
75 Poles
75 Entries
Page-Lechee Pumping Plant

Figure 3

Glen Canyon Dam



Page-Lechee Pumping Plant

Principal Planes Plot

Joint Survey JS-PLPS1

Orientations

ID	Dip / Direction
1	22 / 180
2	86 / 214
3	30 / 310
6	57 / 319
7	86 / 090
8	82 / 287
9	01 / 090

Equal Angle
Lower Hemisphere
75 Poles
75 Entries

Figure 4

PHOTOGRAPHS



Lake Powell Lake Tap Bureau of Reclamation
Photo 1: Looking north along the strike of Joint A located on the northeast side of the cut excavated for access to the east spillway during construction of Glen Canyon Dam (Point 1 on Figure 1). The joint is oriented N20°E, 63°NW and is filled with up to 1½" of moderately hard, $CaCO_3$.
Photograph by Michael Miller August 14, 2007



Lake Powell Lake Tap Bureau of Reclamation
Photo 2: Looking southwest along the strike of Joint A located on the southwest road cut excavated for the Chains Area access road (Point 2 on Figure 1). The joint is oriented N9°E, 65-75°NW and is filled mostly with 1½" of moderately hard, $CaCO_3$. Near the top of the exposure, the joint is filled with 6" of $CaCO_3$ and sandstone fragments.
Photograph by Michael Miller August 14, 2007



Lake Powell Lake Tap Bureau of Reclamation

Photo 3: Looking northeast along strike of Joint A located on the northeast side of the road cut excavated for the Chains Area access road (Point 3 on Figure 1). The joint is oriented N21°E, 62°NW and is filled mostly with ⅛" of $CaCO_3$. Slickensides are evident in one area and are oriented down dip. The sandstone to either side is moderately to intensely weathered and moderately soft.

Photograph by Michael Miller August 14, 2007



Lake Powell Lake Tap Bureau of Reclamation

Photo 4: Looking south at Joint A located near the northern end of its mapped exposure (Point 4 on Figure 1). The joint is oriented N5°E, 61°NW and is filled up to with 5" of moderately hard $CaCO_3$ and sandstone lenses. Slickensides are evident at the top of the exposure and are oriented down dip. The sandstone to either side is moderately to intensely weathered and moderately soft.

Photograph by Michael Miller August 14, 2007



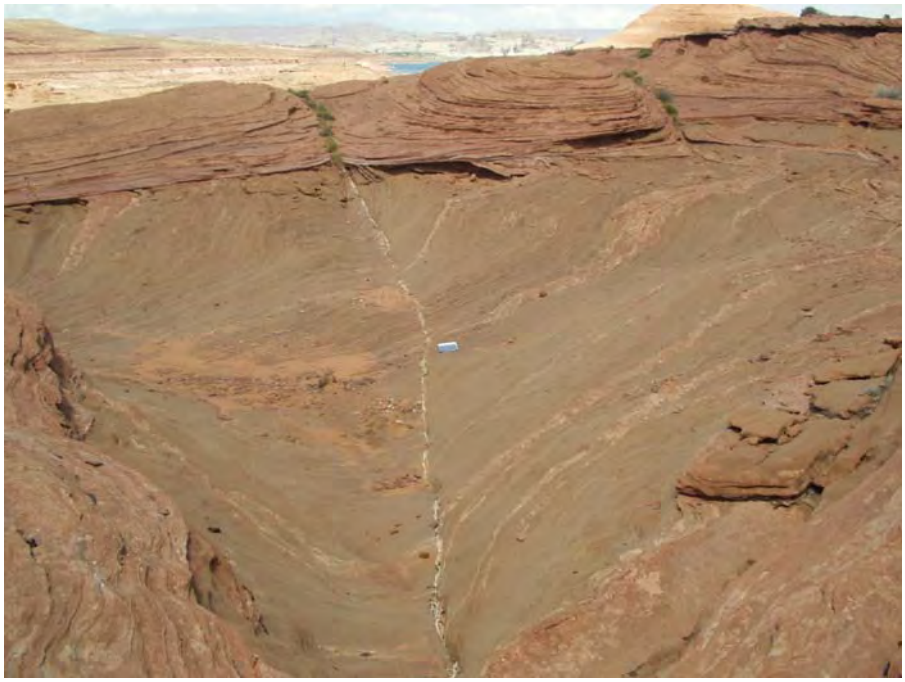
Lake Powell Lake Tap Bureau of Reclamation
Photo 5: Looking down at close-up of slickensides exposed along Joint A mentioned in Photo 4. The slickensides are oriented down dip. The sandstone to either side is moderately to intensely weathered and moderately soft.
Photograph by Michael Miller August 14, 2007



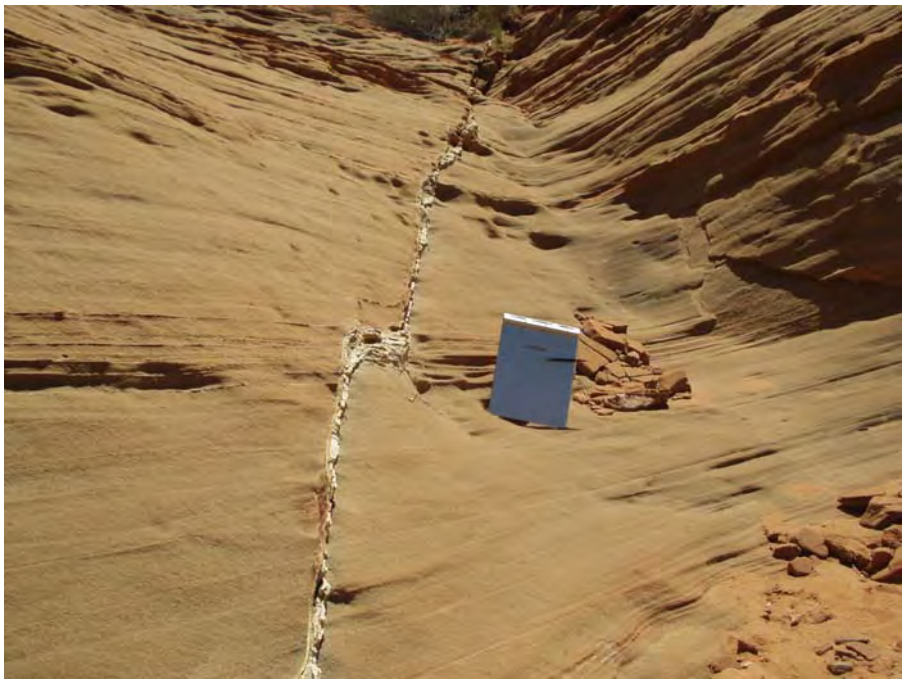
Lake Powell Lake Tap Bureau of Reclamation
Photo 6: Looking north along Joint B near the southern end of its mapped exposure (Point 5 on Figure 1). The joint is oriented N0°E, 65°E and is filled with ⅛-½" of moderately hard $CaCO_3$ and interbedded sandstone lenses totaling up to 3" in thickness. The joint is rough and the sandstone to either side is moderately weathered and moderately soft.
Photograph by Michael Miller August 14, 2007



Lake Powell Lake Tap Bureau of Reclamation
Photo 7: Looking north along Joint B near the middle of its mapped exposure (Point 6 on Figure 1). The joint is oriented N14°W, 54°NE and is filled with 1½" of moderately hard $CaCO_3$ and interbedded sandstone lenses. The joint is rough and the sandstone to either side is moderately weathered and moderately soft to moderately hard.
Photograph by Michael Miller August 14, 2007



Lake Powell Lake Tap Bureau of Reclamation
Photo 8: Looking north along Joint B near the northern middle of its mapped exposure (Point 7 on Figure 1). The joint is rough and planar and the sandstone to either side is moderately weathered and moderately soft to moderately hard.
Photograph by Michael Miller August 14, 2007



Lake Powell Lake Tap Bureau of Reclamation
Photo 9: Looking southeast at Joint B near the middle of its mapped exposure (Point 8 on Figure 1). The joint is oriented N5°W, 75°NE and is filled with ½ to 2" of moderately hard $CaCO_3$. The joint is rough and the sandstone to either side is moderately weathered and moderately soft.
Photograph by Michael Miller August 14, 2007



Lake Powell Lake Tap Bureau of Reclamation
Photo 10: Looking north at exposure of cross-bedded Navajo Sandstone located northeast of drill hole DH05-1 (Point 9 on Figure 1). The sandstone is grayish to reddish brown in color and composed of fine- to predominantly medium-grained sand cemented with calcium carbonate and, to a lesser degree, iron oxide. The sandstone is moderately weathered and moderately soft to moderately hard and thinly bedded to laminated, bedding is spaced 1/16 to 2 inches thick.
Photograph by Michael Miller August 14, 2007



Lake Powell Lake Tap Bureau of Reclamation
Photos 11 and 12: Looking southeast at continuous bedding Joint G located along a cutslope excavated during construction of an access road to the east spillway during construction of Glen Canyon Dam (Point 10 on Figure 1). The left (north) end of the joint is oriented N45°W, 3°NE and the right (south) end is oriented N40°E, 2°SE. The joint is slightly rough and clean. The sandstone to either side is moderately weathered, moderately hard and stained with iron oxide up to 4" on either side of the joint.
Photograph by Michael Miller August 14, 2007



Lake Powell Lake Tap Bureau of Reclamation
Photo 13: Looking east at exposure of cross-bedded Navajo Sandstone located west of drill hole DH05-1. (Point 11 on Figure 1). The sandstone is moderately weathered and moderately soft to moderately hard and moderately to slightly fractured. This slope was blasted as part of the access road excavation.
Photograph by Michael Miller August 14, 2007



Lake Powell Lake Tap Bureau of Reclamation
Photo 14: Looking northwest at the surface casing of drill hole DH05-1 which was drilled in November of 2005, to determine physical rock properties of the pumping plant foundation (Point 12 on Figure 1). The sandstone is moderately weathered and moderately soft to moderately hard.
Photograph by Michael Miller August 14, 2007



Lake Powell Lake Tap Bureau of Reclamation
Photo 15: Looking south at continuous Joint F located along cliff face upstream of Glen Canyon Dam Point 13 on Figure 1). The joint is oriented N10°E, 80°SE at the top of the cliff near the log boom chain and is filled with ½" of moderately hard $CaCO_3$ and is slightly rough and irregular. As the joint trends north (lower left in photo), the strike changes to N5°W. The sandstone on either side is moderately weathered, moderately hard and stained with iron oxide.
Photograph by Michael Miller August 14, 2007



Lake Powell Lake Tap Bureau of Reclamation
Photo 16: Looking northeast across the reservoir at Joint F described in photo 15. The reservoir is at approximate elevation 3606 feet. Maximum reservoir elevation is about 3710 feet.
Photograph by Michael Miller August 14, 2007

Proposed Western Navajo-Hopi Pipeline
Rippability of Materials Based on Seismic Wave Velocities

August 14, 2008

Introduction

The Bureau of Reclamation (Reclamation) in conjunction with the Navajo Nation performed eighty-nine seismic refraction surveys (SRS) along portions of the proposed Western Navajo-Hopi Pipeline in order to determine the rippability of the material that would be encountered during construction. The surveys were performed June 30 through July 17, 2008.

In order to calibrate the seismic refraction surveys with actual excavation conditions, seventeen test pits were excavated in specified areas that had already been surveyed. The test pits were excavated July 7 through July 10, 2008, utilizing two track-mounted excavators contributed by the Navajo Nation. Due to time constraints and accessibility issues, excavators were used in lieu of bulldozers with rippers. It was thought that, although the excavators would not be as powerful as bulldozers, they would still give some indication of the excavatability of the rock. A John Deere 850B dozer with 3-tooth rippers (the equivalent of a D6 Caterpillar dozer) was also used to excavate test trenches alongside seven of the excavator test pits that met early refusal. It was generally found that the dozer did not perform much better than the excavators.

The proposed pipeline alignment was geologically mapped at a scale of 1 inch equals 10,000 feet. Rock types and their engineering characteristics were recorded at each seismic refraction survey site and at selected outcrops along the alignment. Figures 1 and 2 show the proposed Western Navajo-Hopi Pipeline alignment and the locations of the seismic refraction surveys and test pits. Table 1 entitled "Proposed Western Navajo-Hopi Pipeline - Rippability of Materials Based on Seismic Velocities" lists the seismic wave velocity for each section of the proposed pipeline and gives an indication of the rippability of the excavation based on the wave velocity and geologic mapping.

Methodology

The seismic refraction field survey data was analyzed by geophysicist Jim Hasbrouck and average seismic wave velocities were calculated for each survey location. The survey locations and average velocities were plotted on topographic maps showing the proposed pipeline alignment (Figures 1 and 2). The wave velocities were compared to charts published by Caterpillar showing ripper performance related to seismic wave velocities for specific rock types and for various Caterpillar bulldozers. From those charts, it was determined whether the rock at each survey site could be ripped by a Caterpillar D8 bulldozer equipped with multi or single shank No. 8 rippers. It was assumed that the seismic wave velocities would be consistent over short distances within the same rock type, so the geologic mapping was used to extrapolate the rippability of the material along the alignment between survey locations. Colors were assigned to each rippability category as follows: rippable (green), marginally rippable (orange) or non-rippable (red). Areas that were mapped as colluvium or where seismic wave velocities were low (less than about 2,000 ft/sec) were considered as common excavation and assigned the color blue. In cases where a survey contained two layers with seismic wave velocities that resulted in

different rippability categories, the fastest wave velocity (most non-rippable) is represented on Figures 1 and 2.

The length of each segment was measured and recorded in Table 1. In areas where a seismic refraction survey showed two layers with different rippability categories, the percentage of each category was calculated based on the thickness of that layer divided by the depth of excavation presumed for that segment of pipeline. Each percentage was then multiplied by the pipeline length of that segment. For example, if the survey resulted in a seismic wave velocity of 1,900 ft/sec from 0 to 4 feet deep and a velocity of 6,400 ft/sec from 4 to 50 feet deep, along a segment of pipeline that would be excavated to a depth of 9 feet, the depth of the first layer (4 ft) would be divided by the depth of excavation (9 ft) resulting in 44 percent of that segment having an estimated seismic wave velocity of 1,900 ft/sec which would be considered rippable by Caterpillar's standard. The thickness of the 6,400 ft/sec layer would be 5 feet, since the excavation is 9 feet deep (9 ft-4 ft), so the percentage of the segment with a velocity of 6,400 ft/sec would be 56 percent (5 divided by 9). If the segment was 10,000 feet long, 4,400 feet would be considered rippable and 5,600 feet would be marginally rippable. If the ground surface was covered with less than 3 feet of colluvium or unconsolidated overburden, the depth of overburden was considered negligible and was not considered.

Conclusions

The rippability or excavatability of the materials encountered along the proposed Western Navajo-Hopi pipeline is based on limited geotechnical investigations including seismic refraction surveys, geologic mapping and test pit and test trench excavations. The materials were classified based on Caterpillar's D8 Ripping Chart that relates a D8's ripper performance to seismic wave velocities for specific rock types. In general, bedrock with seismic wave velocities over 8,000 ft/sec were classified as non-rippable; wave velocities between 6,000-8,000 ft/ sec were classified as marginally rippable and bedrock having seismic wave velocities below 6,000 were classified as rippable. Colluvium and bedrock having low seismic wave velocities (below about 2,000 ft/sec) were classified as common excavation. Common excavation implies that the material can be excavated with an excavator. Based on the test pit and test trench results, much of the bedrock classified as rippable can also be excavated by an excavator, especially near the ground surface. Table 2 shows the rippability classification of the materials along the pipeline alignment by length and percent total.

Table 2. Classification of Western Navajo-Hopi Pipeline Excavation

Excavation Classification	Pipeline Length (ft)	Percent
Common	366140	40%
Rippable	399469	43%
Marginally Rippable	120578	13%
Non-Rippable	34085	4%
Total	923416	100%

Caterpillar D8 Ripping Chart

D8R

- **Multi or Single Shank No. 8 Ripper**
- **Estimated by Seismic Wave Velocities**

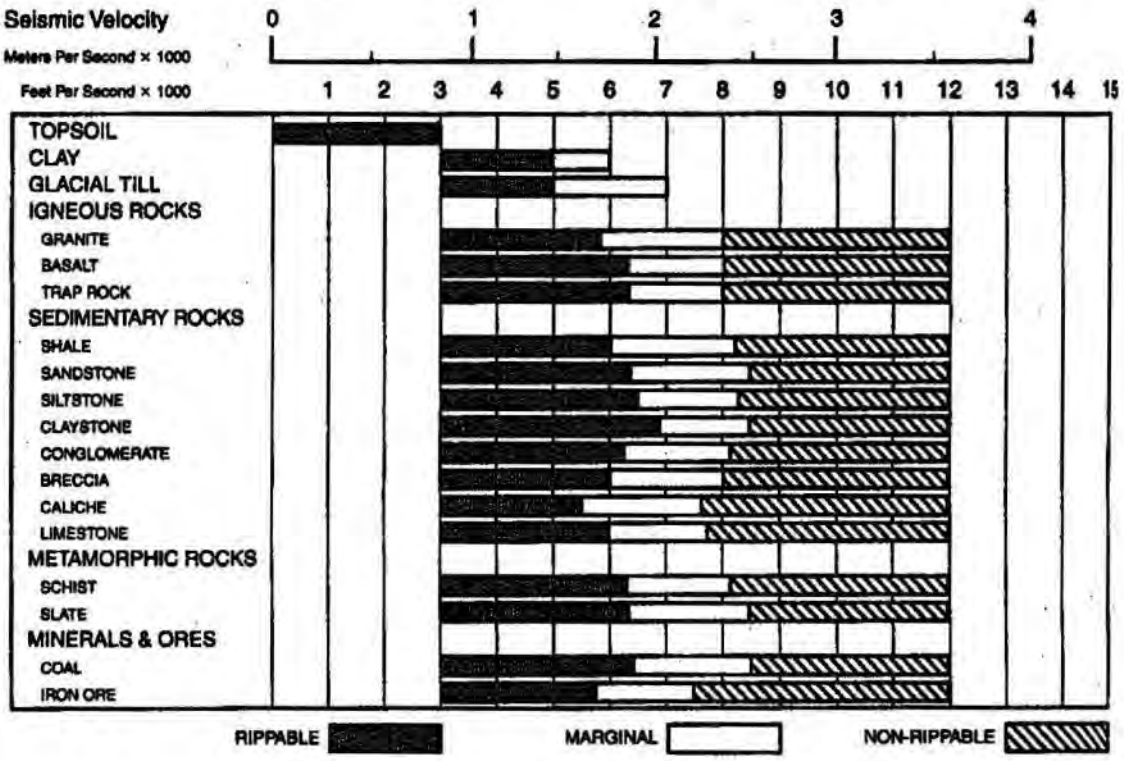


Table 1. Proposed Western Navajo-Hopi Pipeline-Rippability of Materials Based on Seismic Wave Velocities

Area	Seismic Survey Line Number	Seismic Wave Velocity (ft/sec)	Depth of Ex. (ft)	Geology Comments	Pipeline Segment Length (ft)				
					com	rip	marg	non-rip	Total Length
Page - The Gap	67	2200 (0-18') 7600 (>18')	9	Sandy col over red sandstone, crossbedded, v thin-mod bed, int fract (Navajo Sandstone)		55522			55522
	66	4000 (0-50')	9	Red sandstone, crossbedded, v thin-mod bed, int fract (Navajo Sandstone)					
	65	1600 (0-8') 5100 (>8')	9	Red sandstone, mod hard, sl fract (Navajo Sandstone)					
	64	1800 (0-9') 6100 (>9')	9	Assumed rippable based on depth of trench excavation.					
	33 (TP-2)	2500 (0-17') 5700 (>17')	9	Red sandstone, mod hard, beds sp 1/4-6" (Navajo sandstone). Test Pit Data: Cat 320C Track-Hoe met refusal at 8'.					
	63	1600 (0-16') 4300 (>16')	9	Buff sandstone					
	62	1800 (0-5') 3800 (>5')	9	Red sandstone					
	61	2100 (0-5') 5000 (>5')	9	White sandstone, mod soft-mod hard					
	60	2000 (0-5') 4800 (>5')	9	No outcrop; red sand dunes					
	59	3200 (0-29') 7000 (>29')	9	Red sandstone, hard					
	32 (TP-3)	1900 (0-4') 6100 (>4')	9	Red sandstone w/ shale interbeds, mod hard, beds sp 1/4-6". Test Pit Data: Cat 320C Track-Hoe met refusal at 7'.		1887	2402		4289
	58	1500 (0-4') 8200 (>4')	9	Red sandstone, hard and white sandstone, mod soft-mod hard		2101		2675	4776
	57	1700 (0-6') 5400 (>6')	9	No outcrop; red sand dunes. Considered marginally rippable due to geology and results of nearby surveys.			8262		8262
	56	2300 (0-6') 8800 (>6')	9	No outcrop; red sand dunes		4074		2007	6081
	55	2000 (0-4') 6700 (>4')	9	Red sandstone, mod hard-hard, locally int fract		8375	10660		19035
	54	1300 (0-4') 4700 (>4')	9	Included as marginally rippable due to proximity of seismic survey #31.					
	31	2500 (0-4') 6400 (>4')	9	Red sandstone, mod hard, beds sp 1/4-6"					
	53	1600 (0-4') 5600 (>4')	9	Considered marginally rippable based on geology and proximity to seismic survey #31.					

Table 1. Proposed Western Navajo-Hopi Pipeline-Rippability of Materials Based on Seismic Wave Velocities

Area	Seismic Survey Line Number	Seismic Wave Velocity (ft/sec)	Depth of Ex. (ft)	Geology Comments	Pipeline Segment Length (ft)				
					com	rip	marg	non-rip	Total Length
Page - The Gap	52	1100 (0-14') 4500 (>14')	9	Sandstone, crossbedded		20815			20815
	51	1300 (0-5') 5600 (>5')	9	Buff sandstone					
	50	1200 (0-7') 5300 (>7')	9	No outcrop; loose sand					
	30 (TP-5)	1500 (0-15') 5800 (>15')	9	fract. Test Pit Data: Cat 320C Track-Hoe met refusal at 8.5'.		27428			27428
	49	1800 (0-5') 5200 (>5')	9	Buff sandstone					
	48	1800 (0-6') 4400 (>6')	9	Red & buff sandstone					
	47	4600 (0-50')	9	Buff sandstone, mod hard-hard, crossbedded, shaley interbeds					
	29	1800 (0-3') 4700(>3')	9	Buff sandstone, mod soft-mod hard, beds sp 1/4-6", mod-int fract					
	46	6400 (0-50')	9	Lt brown sandstone, mod hard-hard			6693		6693
	45	5100 (0-50')	9	Brown sandstone, mod hard-hard			17241		17241
	44	4300 (0-50')	9	Red brown-buff sandstone, mod hard-hard					
	28 (TP-7)	2200 (0-6') 4200 (>6')	9	Tan Ss, mod soft-mod hard, sl fract. Test Pit Data: Cat 320C Track-Hoe met refusal at 2'. John Deere 850B Dozer w/ 3-tooth ripper (Long Track) met refusal at 2'.		4343	2139		6482
	43	5100	9	Lt red brown sandstone, mod hard-hard, crossbedded			8024		8024
	42	1100 (0-15') 7000 (>15')	9	Lt brown sandstone, soft, m-int wx,		9875			9875
	41	1300 (0-3') 4600 (>3')	9	east. Considered marginally rippable based on TP-7 and geology.			13616		13616
	40	1300 (0-3') 5600 (>3')	9	Red brown sandstone. Considered marginally rippable based on TP-7 and geology.					
	39	1100 (0-4') 6300 (>4')	9	Buff sandstone, soft		1205	1533		2738
	27	2300 (0-3') 5700 (>3')	9	Buff/tan sandstone, mod soft-mod hard, beds sp 1/4-6", vsl fract		19964			19964
	38	1400 (0-5') 3800 (>5')	9	Buff sandstone					
	26	1300 (0-5') 4700 (>5')	9	White/tan sandstone, soft					
	37	1300 (0-7') 4500 (>7')	9	No outcrop; loose sand					

Table 1. Proposed Western Navajo-Hopi Pipeline-Rippability of Materials Based on Seismic Wave Velocities

Area	Seismic Survey Line Number	Seismic Wave Velocity (ft/sec)	Depth of Ex. (ft)	Geology Comments	Pipeline Segment Length (ft)				
					com	rip	marg	non-rip	Total Length
Page - The Gap	36	1800 (0-3') 6400 (>3')	9	Buff sandstone		1851	3758		5609
	25 (TP-10)	2000 (0-4') 6300 (>4')	9	White sandstone, mod soft-mod hard. Test Pit Data: Cat 320C Track-Hoe met refusal at 4'. John Deere 850B Dozer w/ 3-tooth ripper (Long Track) met refusal at 4'.		1414	1799		3213
	35	2100 (0-3') 5500 (>3')	9	Red sandstone, mod hard-hard, crossbedded		3721			3721
	24	3400 (0-3') 6300 (>3')	9	Red tan sandstone mod soft-mod hard, vsl fract		1888	3834		5722
	34	1900 (0-3') 5100 (>3')	9	No outcrop; red sand dunes		12777			12777
	34 - Gap		9	Sandstone and shale					
The Gap - Cameron	71	1700 (0-16') 7400 (>16')	9	White sandstone, bed jts platy-1' apart (Chinle-Shinarump)		60455			60455
	19 (TP-16)	2700 (0-7') 7500 (>7')	9	White, coarse-gr sandstone, mod hard, petr wood (Chinle-Shinarump). Test Pit Data: John Deere 790 ELC Track-Hoe met refusal at 5.5'. John Deere 850B Dozer w/ 3-tooth ripper (Long Track) met refusal at 4'.		3026	854		3880
	1	1700 (0-23') 4100 (>23')	9	Gray/white coarse gr shale-siltstone-sandstone, mod soft-mod hard (Chinle-P.F. Member)	81335				81335
	2 (TP-18)	1700 (0-15') 5500 (>15')	9	Gray/white coarse gr shale-siltstone-sandstone, mod soft-mod hard (Chinle-P.F. Member). Test Pit Data: John Deere 790 ELC Track-Hoe excavated to 10'.					
	70	4500 (0-52')	9	Gray shale-siltstone-sandstone (Chinle-P.F. Member)					
	69	1200 (0-15') 10200 (>15')	9	Gray shale-siltstone-sandstone (Chinle-P.F. Member)					
	11	2500 (0-4') 6400 (>4')	9	Gray shale-siltstone-sandstone (Chinle)	2809		3575		6384
	10	1600 (0-3') 9600 (>3')	9	White & red sandstone-siltstone-shale, mod hard, thinly bedded (Chinle-Shinarump)		1387		2816	4203
			9	Dark, reddish brown shale (Chinle-Shinarump)		2241			2241
	3 (TP-19)	1800 (0-3') 4700 (>3')	9	Dk red brown med-coarse gr sandstone, hard, bed sp 1"-2'(Chinle-Shinarump). Test Pit Data: John Deere 790 ELC Track-Hoe met refusal at 1.5'.			4809		4809
	68	2300 (0-4') 7200 (>4')	9	Med gray-purplish gray sandstone, hard, bed jts sp 1-4", int mod fract. Shale beds 1-3' thick on opposite side of road (Chinle-Shinarump)		1466	1866		3332
	9 (TP-20)	2200 (0-3') 9700 (>3')	9	Red purp/white mottled sandstone mod hard-hard, bed sp 1"-1'(Chinle-Shinarump). Test Pit Data: John Deere 790 ELC Track-Hoe met refusal at 4.5'. John Deere 850B Dozer w/ 3-tooth ripper (Long Track) met refusal at 2.5'.		1347		2735	4082

Table 1. Proposed Western Navajo-Hopi Pipeline-Rippability of Materials Based on Seismic Wave Velocities

Area	Seismic Survey Line Number	Seismic Wave Velocity (ft/sec)	Depth of Ex. (ft)	Geology Comments	Pipeline Segment Length (ft)				
					com	rip	marg	non-rip	Total Length
The Gap - Bitter Springs	Gap-23		6	Interbedded shale-sandstone		7590			7590
	23 (TP-12)	7200 (0-50')	6	Purple red w/ white layers, mod hard-hard, thin beds (Chinle Shinarump). Test Pit Data: Cat 320C Track-Hoe met refusal at 4'. John Deere 850B Dozer w/ 3-tooth ripper (Long Track) excavated to 10'.			4202		4202
	72	2100 (0-29') 7400 (>29')	6	Col over sandstone (Chinle Shinarump)	2945				2945
			6	Sandstone (Chinle Shinarump)		5090			5090
	20	3100 (0-6') 6000 (>6')	6	Buff sandstone, mod hard-hard, beds sp 1"-2', solid (Kaibab). Considered marginally rippable below 3' based on geology.		2114	2114		4228
	73	5900 (0-50')	6	Buff sandstone, hard, bed jts 4"-2' apart (Kaibab); marginally rippable based on geology.			4039		4039
			6	Shale and sandstone.		6196			6196
	74	1200 (0-5') 2700 (>5')	6	Col over sandstone (Kaibab)	47603				47603
	22 (TP-14)	2700 (0-3') 8000 (>3')	6	White sandstone, very hard, massive (Kaibab). Test Pit Data: Cat 320C Track-Hoe met refusal at 1'.				2330	2330
			6	col >6' deep	2067				2067
			6	White sandstone, very hard, massive (Kaibab). Assumed non-rippable based on geology.				1290	1290
			6	Shale					3143
	21 (TP-15)	1900 (0-8') 8900 (>8')	6	Buff sandstone, hard (Kaibab). Test Pit Data: Cat 320C Track-Hoe met refusal at 4.5'. Considered marginally rippable from 4-6' (depth of excavation) based on test pit and geology.		4890	2409		7299
	75	1400 (0-8') 7500 (>8')	6	Col (4-10' deep?) over sandstone (Kaibab). Considered common 0-4', rippable from 4-8'.	5106	2515			7621
			6	White sandstone, hard-v hard, (Kaibab). Assumed marginally rippable based on geology.			509		509
			6	Col >6' deep	3052				3053
	76	1700 (0-6') 10900 (>6')	6	Buff sandstone, hard (Kaibab). Considered rippable from 0-6' (depth of excavation).				6892	6892
			6	4-10' col overlies hard sandstone (Kaibab). Considered common from 0-6'.	7393				7393
	76-B Spgs		6	Col >6' deep	9811				9811

Table 1. Proposed Western Navajo-Hopi Pipeline-Rippability of Materials Based on Seismic Wave Velocities

Area	Seismic Survey Line Number	Seismic Wave Velocity (ft/sec)	Depth of Ex. (ft)	Geology Comments	Pipeline Segment Length (ft)				
					com	rip	marg	non-rip	Total Length
U.S.89/U.S.160 - Tuba City	U.S.89-89		8	hard (Chinle-P.F. Member). Considered common based on TP-18.	12802				12802
	89	9300 (0-50')	8	Pinkish orange hard sandstone interbedded with siltstone-shale (Moenave)				2991	2991
	77	1600 (0-3') 8000 (>3')	8	Orange brown sandstone-shale, mod hard sandstone, bed jts laminated-2' (avg 6") (Moenave)		3365		5491	8856
	12 (TP-23)	5200 (0-45') 13095 (>45')	8	White/red layered sandstone, mod hard, vsl fract (Moenave). Test Pit Data: John Deere 790 ELC Track-Hoe met refusal at 0.5'. John Deere 850B Dozer w/ 3-tooth ripper (Long Track) met refusal at 0.5'. Considered non-rippable based on geology and test pit results.				4859	4859
	78	1700 (0-14') 7500 (>14')	8	Orange brown sandstone-shale, mod hard sandstone, bed jts laminated-2' (avg 6") (Moenave)					
	13 (TP-24)	2000 (0-15') 6000 (>15')	8	Red brown shale-siltstone-sandstone, mod hard. Test Pit Data: John Deere 790 ELC Track-Hoe met refusal at 4'. John Deere 850B Dozer w/ 3-tooth ripper (Long Track) met refusal at 8'.		21756			21756
	88	1400 (0-11') 7700 (>11')	8	Red brown shale-siltstone-sandstone, mod hard					
			8	Red brown sandstone, mod soft, crossbedded, bed jts laminated-2' apart, sl fract			1133		1133
			8	Colluvium	1824				1824

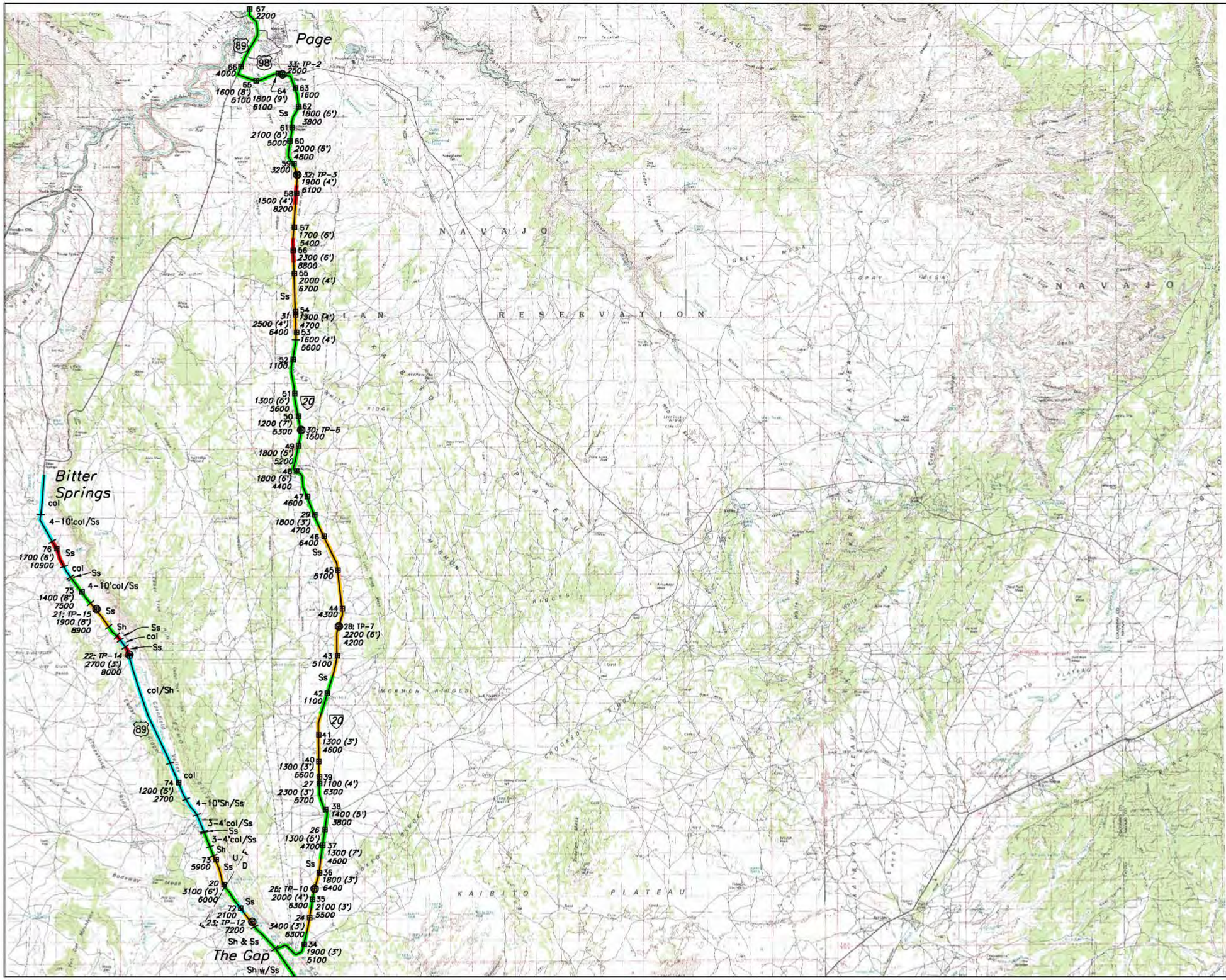
Table 1. Proposed Western Navajo-Hopi Pipeline-Rippability of Materials Based on Seismic Wave Velocities

Area	Seismic Survey Line Number	Seismic Wave Velocity (ft/sec)	Depth of Ex. (ft)	Geology Comments	Pipeline Segment Length (ft)				
					com	rip	marg	non-rip	Total Length
Tuba City - Second Mesa			7	Colluvium	4650				4650
	79	3800 (0-50')	7	Red brown sandstone, mod soft, crossbedded, bed jts laminated-2' apart, sl fract. Considered marginally rippable based on geology.			5052		5052
	14 (TP-25)	4000 (0-34') 6400 (>34')	7	Red sandstone, mod hard, crossbedded. Test Pit Data: John Deere 790 ELC Track-Hoe met refusal at 3'. Considered marginally rippable based on geology and TP-23.					
	80	2000 (0-30') 5700 (>30')	7	Red brown sandstone, mod soft-soft, beds laminated-1' apart overlies gray sandstone, mod soft-soft, closely bedded		53482			53482
	15 (TP-26)	5000 (0-56')	7	Buff sandstone, mod soft-mod hard, vsl fract. Test Pit Data: John Deere 790 ELC Track-Hoe met refusal at 9'.					
	81	1300 (0-5') 4300 (>5')	7	White, f-grained soft sandstone, some limonite stained jts					
	82	1500 (0-40') 8200 (>40')	7	No outcrop - loose sand over white, soft sandstone and some shale	69708				69708
			7	White, mod soft-mod hard sandstone		3860			3860
	83	2300 (0-3') 6000 (>3')	7	Buff med gr sandstone, mod soft-mod hard, vsl fract		6021	7981		14002
	84	4200 (0-50')	7	Buff/white sandstone, mod soft-mod hard		15532			15532
	85	1300 (0-26') 8400 (>26')	7	No outcrop - loose sand over shale-sandstone interbeds	70626				70626
	16 (TP-27)	2500 (0-39') 8000 (>39')	7	Tan med-coarse gr sandstone, mod hard, vsl fract. Test Pit Data: John Deere 790 ELC Track-Hoe met refusal at 7'.		9270			9270
	86	1200 (0-7') 5700 (>7')	7	2-3' Shale over mod soft-mod hard sandstone, bed jts 1"-2' (avg 6"), vsl fract	7522				7522
	87	1400 (0-4') 4500 (>4')	7	Shaley col over mod soft-mod hard sandstone	4298	3242			7540
	18	1200 (0-9') 5200 (>9')	7	massive bed, fract sp 1-5' apart. Includes marginally rippable cliff to the southeast.	2277		2075		4352
			7	Sandy colluvium overlies shale	30312				30312
	17	1300 (0-3') 4900 (>3')	7	White m-c grained sandstone, mod hard, laminated bedding, jts sp 1-3' apart		7382			7382
				Total	366140	399469	120578	34085	923416
				Percent	40%	43%	13%	4%	100%

Table 1. Proposed Western Navajo-Hopi Pipeline-Rippability of Materials Based on Seismic Wave Velocities

Refer to Figures 1 and 2 for locations of seismic refraction surveys. Seismic wave velocitites have been rounded to the nearest 100.	
0-6000 ft/sec	Rippable by a Caterpillar D8 bulldozer equipped with multi or single shank No. 8 ripper.
6000-8000 ft/sec	Marginally Rippable by a Caterpillar D8 bulldozer equipped with multi or single shank No. 8 ripper.
>8000 ft/sec	Non-Rippable by a Caterpillar D8 bulldozer equipped with multi or single shank No. 8 ripper.
Page - The Gap. This segment of the proposed pipeline starts in The Chains Recreational Area located upstream of Glen Canyon Dam and follows U.S. 89 south to U.S. 98; then east along U.S. 98 to Tribal Route 20 (Copper Mine Road); then south along T.R. 20 south to The Gap (intersection U.S. 89/T.R. 20).	
The Gap - Cameron. This segment of the proposed pipeline starts at The Gap (intersection U.S. 89/T.R. 20)and follows U.S. 89 south to Cameron where it ends at State Highway 64.	
The Gap - Bitter Springs. This segment of the proposed pipeline starts at The Gap (intersection U.S. 89/T.R. 20) and follows U.S. 89 north to Bitter Springs.	
U.S.89/U.S.160 - Tuba City. This segment of the proposed pipeline starts at the intersection of U.S. 89 and U.S. 160 and follows U.S. 160 to Tuba City where it ends at State Highway 264.	
Tuba City - Second Mesa. This segment of the proposed pipeline starts at Tuba City (intersection U.S. 160/S.H. 264) and follows State Highway 264 south to the Hopi Cultural Center in Second Mesa.	

Western Navajo–Hopi Pipeline
Location of Seismic Refraction Surveys and Test Pits
Figure 1



Explanation

⊞64 2200 (6') 4200	Location of Seismic Refraction Survey showing Seismic Wave Velocity. ( ) indicate thickness of upper layer if layers with different velocities are present.
⊕34; TP-2 3700	Location of Seismic Refraction Survey with Test Pit showing Seismic Wave Velocity. ( ) indicate thickness of upper layer if layers with different velocities are present.
	Non-Rippable: Materials having a seismic velocity >8,000 ft/sec.
	Marginally Rippable: Materials having a seismic velocity from 6,000 – 8,000 ft/sec.
	Rippable: Materials having a seismic velocity < 6,000 ft/sec.
	Common: Materials having a seismic velocity usually less than 2,000 ft/sec. (includes mapped colluvium).
89	U.S. Highway
264	State Highway
20	Indian Route

Geologic Mapping

col	Coluvium or soil
Ls	Limestone
Ss	Sandstone
Sh	Shale
Siltst	Siltstone
Sh–Siltst–Ss	Intebedded Shale, Siltstone and Sandstone
Sh/Ss	Shale over Sandstone
4–10'col/Ss	4 to 10 ft. of Colluvium over Sandstone

N

10000 0 10000 20000 30000
SCALE OF FEET

Western Navajo–Hopi Pipeline
Location of Seismic Refraction Surveys and Test Pits
Figure 2

Explanation

- 64 / 2200 (6') / 4200 — Location of Seismic Refraction Survey showing Seismic Wave Velocity. ( ) indicate thickness of upper layer if layers with different velocities are present,
- 34; TP-2 / 3700 — Location of Seismic Refraction Survey with Test Pit showing Seismic Wave Velocity. ( ) indicate thickness of upper layer if layers with different velocities are present,
- Non-Rippable: Materials having a seismic velocity >8,000 ft/sec,
- Marginally Rippable: Materials having a seismic velocity from 6,000 – 8,000 ft/sec,
- Rippable: Materials having a seismic velocity < 6,000 ft/sec,
- Common: Materials having a seismic velocity usually less than 2,000 ft/sec. (includes mapped colluvium).
- 89 — U.S. Highway
- 264 — State Highway
- 20 — Indian Route

Geologic Mapping

col	Coluvium or soil
Ls	Limestone
Ss	Sandstone
Sh	Shale
Siltst	Siltstone
Sh–Siltst–Ss	Intebedded Shale, Siltstone and Sandstone
Sh/Ss	Shale over Sandstone
4–10'col/Ss	4 to 10 ft. of Colluvium over Sandstone

N

10000 0 10000 20000 30000
SCALE OF FEET

North Central Arizona Water Supply Feasibility Study
Test Pit Investigations 2012

INTRODUCTION

The Bureau of Reclamation (Reclamation) is conducting a study to determine the feasibility of constructing the North Central Arizona Pipeline to deliver water from Lake Powell, south to Flagstaff, with laterals to Bitter Springs and Tuba City. The study is being funded under the Rural Water Act and is referred to as the North Central Arizona Water Supply Feasibility Study (NCAWSFS).

PREVIOUS INVESTIGATIONS

Reclamation performed eighty-nine seismic refraction surveys along portions of the proposed pipeline alignment in 2008, to determine the rippability of the material that would be encountered during construction. In order to calibrate the seismic refraction surveys with actual excavation conditions, seventeen test pits were excavated in specified areas that had already been surveyed. The proposed pipeline alignment was geologically mapped at a scale of 1 inch equals 10,000 feet. Rock types and their engineering characteristics were recorded at each seismic refraction survey site and at selected outcrops along the alignment. The report is titled "Proposed Western Navajo-Hopi Pipeline - Rippability of Materials Based on Seismic Wave Velocities". Drawings in the report give an indication of the rippability of the excavation based on the wave velocity and geologic mapping.

CURRENT INVESTIGATION

Reclamation excavated sixty-four test pits along portions of the proposed North Central Arizona Pipeline in order to determine the depth to bedrock and to obtain soil samples for materials testing. The excavations were conducted in June of 2012. Test pits TP-1 through TP-48 were excavated along US Highway 89 or along the old US Highway 89, which runs parallel to US 89. Test pits TP-49 through TP-63 were excavated along Tribal Route 20 (Copper Mine Road) from The Gap to about 6 miles north of Coppermine Chapter. The test pits were approximately 20 feet long by 6 feet wide and 13 to 15 feet deep unless the backhoe met refusal. The pits were visually classified by a Reclamation geologist and representative samples taken and sent to a lab for gradation sieve analysis, testing for moisture content, Atterberg limits, Proctor compaction pH, conductivity, and sulfate, sulfide and chloride content,. Selected soils were tested for shrink/swell potential (expansion index) and in-place densities were measured using a sand cone apparatus in selected test pits at depths ranging from 3 to 5 feet.

Figure 1 (located in the FIGURES Appendix) shows test pits locations including the depth to rock in each test pit, the depth at which refusal was met and the bedrock material. Figures 2 and 3 show test pit locations at a smaller scale along with the depth and type of materials encountered. Test pit logs are provided in the TEST PIT LOGS Appendix and lab test results are provided in the LAB RESULTS Appendix.

FIGURES

CAD SYSTEM
AutoCAD Rel. 19.0s
CAD FILENAME
TEST PIT LOCATION US 89.DWG

DATE AND TIME PLOTTED
NOVEMBER 9, 2012 10:20
PLOTTED BY
MMILLER

GEOLOGIC NOTES

TP-48 ● 1.8-7.5 Clst	*Test pit location showing depth to rock – depth to refusal and bedrock material.*
TP-1 ● * 0.0-12.0 Qal	** indicates bedrock was not encountered and pit was terminated at reach of equipment.*
———	*Proposed pipeline alignment.*

Qal – *Alluvium: loose, unconsolidated sediments, which have been eroded, reshaped by water and redeposited.*

Qe – *Eluvium: fine soil or sand moved and deposited by the wind, such as a sand dune.*

Clst – *Claystone: weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting mostly of clay.*

Slst – *Siltstone: sedimentary rock which has a grain size in the silt range, finer than sandstone and coarser than claystone.*

Ss – *Sandstone: clastic sedimentary rock composed mainly of sand-sized grains.*

12000 0 12000 24000 36000
SCALE OF FEET

LOCATION OF EXPLORATION AND DEPTH TO ROCK

FIGURE 1
SHEET 1 OF 1

DESIGNED
DRAWN
CHECKED
TECH. APPR. NAME PROF. ABBR.
ADMIN. APPROVAL NAME TITLE
PHOENIX, ARIZONA 2012-10-25

REV NO

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COPPER MINE CHAPTER TO CAMERON
PLAN

RECLAMATION
Managing Water in the West

CAD SYSTEM
AutoCAD Rel. 19.0s
CAD FILENAME
TEST PIT LOCATION US 89.DWG

DATE AND TIME PLOTTED
NOVEMBER 9, 2012 10:18
PLOTTED BY
MMILLER

To Page

TP-63
0.0–5.0 SP
5.0–10.0 Ss

TP-62
0.0–5.5 SP
5.5–6.5 Ss

TP-61
0.0–3.5 (SP)cb
3.5–7.0 Ss

TP-60
0.0–6.5 SP
6.5 Ss

TP-59
0.0–5.5 SP
5.5 Ss

TP-58
0–13.0 SP

Copper Mine Chapter

TP-57
0.0–10.0 SP
10.0 Ss

Bitter Springs

TP-1
0.0–8.0 (SM)b
8.0–12.0 (SP–SM)cb

TP-2
0.0–13.0 (SM)g

TP-3
0.0–4.0 (SP)cb
4.0–13.0 (SM)gcb

TP-4
0.0–13.0 (SP–SM)gcb

TP-5
0.0–2.0 SP
2.0–12.0 (CL)s

TP-6
0.0–4.0 (SP)cb
4.0–10.0 (SM)g
10.0–13.5 Ls

TP-7
0.0–14.0 (SC)c

TP-8
0.0–6.0 (SC)c
6.0–7.5 Clst

TP-9
0.0–4.0 (SM)g
4.0–5.8 (GP–GM)sc
5.8–10.0 (SC)g
10.0–12.0 Ss

TP-10
0.0–9.4 (SM)gcb
9.4–13.0 Clst

TP-11
0.0–6.0 (SC)g
6.0–7.5 (GP)s
7.5–11.5 Ss

TP-12
0.0–3.8 (SP)c
3.8–11.5 SC

TP-13
0.0–4.0 SC
4.0–11.0 Clst

TP-14
0.0–8.0 SM
8.0–10.0 (SP)g
10.0–11.0 Ss

TP-15
0.0–0.9 (SP)g
0.9–5.5 SM
5.5–7.0 Ss

Cedar Ridge

TP-16
0.0–3.5 s(CL)
3.5–6.0 Ss

TP-18
0.0–2.5 (CL)s
2.5–9.5 Clst

TP-19
0.0–10.0 (SP–SC)gcb
10.0–14.0 Clst

TP-20
0.0–8.7 (SM)c
8.7–9.5 (GP)sc
9.5–12.0 Clst

The Gap

TP-21
0.0–3.0 SM
3.0–8.5 (GC)sc

TP-67
0.0–7.0 SP
7.0–9.0 Ss

TP-56
0.0–15.0 SP

TP-55
0.0–14.5 SP

TP-68
0.0–3.3 SP
3.3–5.5 Ss

TP-54
0.0–2.4 SP
2.4–6.5 Ss

TP-53
0.0–3.0 SP
3.0–3.5 (SP)g
3.5–8.0 Ss

TP-52
0.0–2.0 SP
2.0–3.8 (SP)g
3.8–7.0 Ss

TP-51
0.0–4.5 (SP)
4.5–6.5 CL
6.5–10.4 SP
10.4–13.0 Ss

TP-50
0.0–5.0 SM
5.0 Ss

TP-49
0.0–3.2 SP
3.2–7.0 Ss

Copper Mine Rd

US 89

SCALE OF FEET
6000 0 6000 12000 18000

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COPPER MINE CHAPTER TO THE GAP TO BITTER SPRINGS PLAN

GEOLOGIC NOTES

TP-49
0.0–3.2 SP
3.2–7.0 Ss

Test pit location showing depth and materials encountered.

Proposed pipeline alignment.

RECLAMATION
Managing Water in the West

LOCATION OF EXPLORATION

FIGURE 2
SHEET 2 OF 2

PHOENIX, ARIZONA 2012-10-25

DESIGNED
DRAWN
CHECKED
TECH. APPR.
ADMIN. APPROVAL
NAME TITLE
NAME PROF. ABBR.

REV NO

CAD SYSTEM
AutoCAD Rel. 19.0s
CAD FILENAME
TEST PIT LOCATION US 89.DWG

DATE AND TIME PLOTTED
NOVEMBER 9, 2012 10:15
PLOTTED BY
MMILLER

TP-50
0.0–5.0 SM
5.0 Ss

TP-19
0.0–10.0 (SP-SC)gcb
10.0–14.0 Clst

TP-49
0.0–3.2 SP
3.2–7.0 Ss

TP-20
0.0–8.7 (SM)c
8.7–9.5 (GP)sc
9.5–12.0 Clst

TP-21
0.0–3.0 SM
3.0–8.5 (GC)sc
8.5–14.0 Clst

TP-22
0.0–4.0 SM
4.0–7.0 (GM)sc
7.0–14.0 (SC)gcb

TP-23
0.0–4.0 SM
4.0–14.0 (GC-GM)scb

TP-24
0.0–4.0 (SC)b
4.0–10.0 (GM)s
10.0–15.0 (GM)sc

TP-25
0.0–5.0 SP
5.0–8.0 (SP)g
8.0–12.0 SP-SC

TP-26
0.0–3.5 (SP)g
3.5–10.5 Ss

TP-27
0.0–6.0 SM

TP-28
0.0–13.5 (SM)gcb

TP-29
0.0–0.5 SM
0.5–10.0 Clst

TP-30
0.0–2.3 SP
2.3–14.0 Clst

TP-31
0.0–1.0 (SC)g
1.0–5.0 Ss

TP-32
0.0–14.0 (SM)g

TP-33
0.0–3.3 SC
3.3–5.5 Ss

TP-34
0.0–1.5 SC
1.5–13.0 Clst

TP-35
0.0–6.0 SC
6.0–9.5 Clst

TP-36
0.0–7.0 SM
7.0–13.5 SP-SC

TP-37
0.0–4.5 SM
4.5–10.5 Ss

TP-38
0.0–1.0 SP
1.0–4.0 Ss

TP-39
0.0–3.5 SC
3.5–7.5 Ss

TP-40
0.0–5.0 CL
5.0–5.5 SP
5.5–13.0Clst

TP-41
0.0–1.5 SM
1.5–3.0 SC
3.0–8.0 Clst
8.0–12.0 Ss

TP-42
0.0–14.5 SC

TP-43
0.0–6.0 SC
6.0–13.0 Clst

TP-44
0.0–0.8 SM
0.8–8.5 Clst/Ss

TP-45
0.0–1.0 SP-SM
1.0–4.5 Slst
4.5–13.4 Clst

TP-46
0.0–8.0 Clst

TP-47
0.0–8.0 (SP-SM)b
8.0–13.5 Clst

TP-48
0.0–1.8 SC
1.8–7.5 Clst

The Gap
Tuba City
Moenkopi
Cameron
US 89
US 160
KAIBITO
NAVAJO
RESERVA
INDIAN
RED POINT HILLS
PAINTED DESERT
PAINTED WARD TERRACE
TOHNALI
Billy Goat Knolls
Hamblin Wash
Sheep Mtn
High Point Mtn
Pillow Mtn
Shadow Mtn
Tuba Butte
Black Peak
Red Butte
Coconino Point
Little Gray Hill
Spring On The Rock
Colorado River Gorge
Little Colorado River Gorge
Canyon
Wash
Valley
Corral
Trail
Spring
Well
Sand Dunes
Rest Area
Radio Facility
Sewage Disposal Ponds
Gaging Station
Water Tank
Trading Post
Powerline
Pipeline
4WD
Trail

SCALE OF FEET
6000 0 6000 12000 18000
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 miles

4000mE. 446000mE. 448000mE. 450000mE. 452000mE. 454000mE. 456000mE. 458000mE. 460000mE. 462000mE. 464000mE. 466000mE. 468000mE. 470000mE. 472000mE. 474000mE. 476000mE. 478000mE. 480000mE.

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PLAN

GEOLOGIC NOTES

TP-48
0.0–1.8 SC
1.8–7.5 Clst

Test pit location showing depth and materials encountered.

Proposed pipeline alignment.

RECLAMATION
Managing Water in the West

FIGURE 3
SHEET 1 OF 2

LOCATION OF EXPLORATION

PHOENIX, ARIZONA 2012-10-25

	NAME	TITLE
DESIGNED	X	ADMIN
CHECKED	X	ADMIN
TECH. APPR.	X	NAME, PROF. ABBR.
ADMIN. APPROVAL		NAME, TITLE

REV NO

TEST PIT LOGS

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-1

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 2046005 **E.** 777169 **GROUND ELEVATION:** 5175

APPROXIMATE DIMENSIONS: 20' x 4' x 12.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/14/2012 **DATE LOGGED:** 6/14/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken))	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM)b Visual Class.	**0.0 - 8.0 ft. Silty Sand with Trace of Boulders (SM)b:** About 85% predominantly fine to medium sand, 15% nonplastic fines with very high dry strength, rapid dilatancy and low toughness and a trace of fine gravel. Max. size, fine gravel. Strong reaction with HCl. Total sample (by volume): Trace of plus 12 in. blocky, hard, sandstone boulders; remainder minus 3 in.; maximum size, 1.6 ft. In-place condition: soft and weakly cemented from 0.0-4.0 ft., grading to very hard and moderately cemented with depth, homogenous, dry, reddish brown material with weak cementation. Lab test data from 0.0-8.0 ft.: 82% sand, 15% fines, 3% gravel; LL and PI not tested; Field Moisture = 2.3%. pH = 8.82, Resistivity = 6,218 ohm/cm, Sulfates = 14 ppm, Sulfides = 2 ppm, Chlorides = 17 ppm. Lab classification is Silty Sand (SM).	0	0	T
Lab sample taken from 0.0-8.0 ft. (SM) Lab Class.				
8.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(SP-SM)cb Visual Class.	**8.0 - 12.0 ft. Poorly Graded Sand with Silt, Cobbles and Boulders (SP-SM)cb:** About 90% predominantly fine to medium sand and 10% nonplastic fines with very high dry strength, rapid dilatancy and low toughness. Max. size, 3 in. Strong reaction with HCl. Total sample (by volume): About 5% 3 to 5 in. platy, moderately hard sandstone cobbles; about 10% 5 to 12 in. angular, blocky, hard, sandstone cobbles; trace of plus 12 in. blocky, hard sandstone boulders; remainder minus 3 in.; maximum size, 1.8 ft. In-place condition: very hard, homogenous, dry, reddish brown material with weak cementation. Difficult digging.	5	10	T
12.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			

REMARKS: Surface: gently sloping to west with loose sand and scattered grasses. Coordinates and elevation obtained from GPS. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-2

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 2037004 **E.** 776281 **GROUND ELEVATION:** 5191

APPROXIMATE DIMENSIONS: 20' x 10' x 13.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/14/2012 **DATE LOGGED:** 6/14/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken))	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM)g Visual Class.	**0.0 - 12.0 ft. Silty Sand with Gravel (SM)g:** About 50% predominantly fine to medium sand, 35% nonplastic fines with medium to high dry strength, rapid dilatancy and low toughness and 15% fine, subrounded to subangular gravel. Max. size, 10 mm. Strong reaction with HCl. From 0.0-4.0 ft., discontinuous gravel layers and pockets present; max. size, 1 in. At around 8 ft., trace of rounded to angular, platy cobbles up to 8 in. in diameter seen in pit wall. In-place condition: very soft to soft, irregular stratification of sand and gravel layers, dry, light brown material with weak cementation.	0	0	0
Lab sample taken from 0.0-12.0 ft. (SM)g Lab Class.	Lab test data from 0.0-12.0 ft.: 47% sand, 37% fines, 16% gravel; Nonplastic; Field Moisture = 4.0%. pH = 8.48, Resistivity = 473 ohm/cm, Sulfates = 1,400 ppm, Sulfides = < 1 ppm, Chlorides = 120 ppm. Lab classification is Silty Sand with Gravel (SM)g. In-place density of 98.4 lb/ft^3 taken at 3.5 ft. with sand cone apparatus.			
12.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(SM)g Visual Class.	**12.0 - 13.0 ft. Silty Sand with Gravel (SM)g:** About 50% predominantly fine to medium sand, 35% fine to coarse, subrounded to rounded gravel and 15% nonplastic fines with very high dry strength, rapid dilatancy and low toughness. Max. size, 3 in. Strong reaction with HCl. In-place condition: soft, irregular stratification, dry, light brown material with weak cementation.	0	0	0
13.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			

REMARKS: Surface: flat with loose sand and scattered bushes about 500 ft. south of bridge crossing Tanner Wash. Kaibab Formation outcrops west across the highway. Coordinates and elevation obtained from GPS. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-3

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 2031517 **E.** 778873 **GROUND ELEVATION:** 5244

APPROXIMATE DIMENSIONS: 20' x 4' x 13.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/14/2012 **DATE LOGGED:** 6/14/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken))	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP)cb Visual Class.	**0.0 - 4.0 ft. Poorly Graded Sand with Trace of Cobbles and Boulders (SP)cb:** About 90% predominantly fine to medium sand, 5% fine, subrounded to subangular gravel and 5% nonplastic fines with very high dry strength, rapid dilatancy and low toughness. Contains clumps of weakly cemented silt up to 10 mm in size that break up with manual pressure. Max. size, 20 mm. Strong reaction with HCl. Total sample (by volume): Trace of 3 to 5 in. subrounded cobbles; trace of plus 12 in. blocky, subrounded, hard boulders; remainder minus 3 in.; maximum size, 3.0 ft. In-place condition: very soft to soft, homogenous, dry, light brown material with weak cementation.	T	0	T
4.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(SM)gcb Visual Class. Lab sample taken from 4.0-13.0 ft. (SP-SM)g Lab Class.	**4.0 - 13.0 ft. Silty Sand with Gravel, Cobbles and Boulders (SM)gcb:** About 55% predominantly fine to coarse sand, 30% fine to coarse, subrounded to subangular, flat gravel and 15% nonplastic fines with very high dry strength, rapid dilatancy and low toughness. Max. size, 3 in. Strong reaction with HCl. Total sample (by volume): About 5% 3 to 5 in. subrounded to subangular, hard, sandstone cobbles; 5% 5 to 12 in. subrounded to subangular, hard, sandstone cobbles; trace of plus 12 in. subangular to angular, hard, sandstone boulders; remainder minus 3 in.; maximum size, 2.0 ft. In-place condition: hard, irregular stratification, dry, light brown material with weak cementation. Lab test data from 4.0-13.0 ft.: 65% sand, 27% gravel, 8% fines; LL and PI not tested; Field Moisture = 1.6%. pH = 9, Resistivity = 3,712 ohm/cm, Sulfates = 25 ppm, Sulfides = < 1 ppm, Chlorides = 62 ppm. Lab classification is Poorly Graded Sand with Silt and Gravel (SP-SM)g.	5	5	T
13.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			

REMARKS: Surface: flat loose sand with scattered bushes. Culvert and drainage runs under highway about 150 ft. south of pit. Sandstone from the Kaibab Formation outcrops west across the highway and is lower in elev. than the pit. Tanner Wash about 300 ft. east of pit. Coordinates and elevation obtained from GPS. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-4**

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 2024279 **E.** 782353 **GROUND ELEVATION:** 5315

APPROXIMATE DIMENSIONS: 20' x 10' x 13.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/14/2012 **DATE LOGGED:** 6/14/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken))	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP-SM)gcb Visual Class.	**0.0 - 4.0 ft. Poorly Graded Sand with Silt, Gravel, Cobbles and Boulders (SP-SM)gcb:** About 60% predominantly fine to coarse sand, 30% fine to coarse, flat, subrounded to subangular gravel and 10% nonplastic fines with very high dry strength, rapid dilatancy and low toughness. Max. size, 3 in. Strong reaction with HCl. From 1.2-1.7 ft., discontinuous gravel layer seen in pit wall; no sample taken. Total sample (by volume): About 5% 5 to 12 in. subangular, hard cobbles; trace of plus 12 in. blocky, hard boulders; remainder minus 3 in.; maximum size, 1.5 ft. In-place condition: soft, irregular stratification, dry, light brown material with weak cementation. In-place density of 91.4 lb/ft^3 taken at 3.8 ft. with sand cone apparatus.	0	5	T
4.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(SP-SM)gcb Visual Class.	**4.0 - 13.0 ft. Poorly Graded Sand with Silt, Gravel, Cobbles and Boulders (SP-SM)gcb:** About 50% predominantly fine to coarse sand, 40% fine to coarse, subrounded to subangular gravel and 10% nonplastic fines with very high dry strength, rapid dilatancy and low toughness. Max. size, 3 in. Strong reaction with HCl. Total sample (by volume): About 10% 3 to 5 in. subrounded to subangular, hard cobbles; 10% 5 to 12 in. subrounded to subangular, hard cobbles; 10% plus 12 in. subangular to angular, hard boulders; remainder minus 3 in.; maximum size, 2.5 ft.	10	10	10
Lab sample taken from 4.0-13.0 ft. (GC-GM)s Lab Class.	In-place condition: soft to firm, irregular stratification, dry, light brown material with weak cementation. Lab test data from 4.0-13.0 ft.: 47% gravel, 38% sand, 15% fines; LL= 22%, PI= 4%; Field Moisture = 2.6%. pH = 8.1, Resistivity = 483 ohm/cm, Sulfates = 530 ppm, Sulfides = < 1 ppm, Chlorides = 170 ppm. Lab classification is Silty Clayey Gravel with Sand (GC-GM)s.			
13.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			

REMARKS: Surface: flat loose sand with scattered grasses; Kaibab Formation outcrop west of highway dipping toward pit. Coordinates and elevation obtained from GPS. Test pit caving from 9.0 to 13.0 ft., edges ragged; terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-5

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 2018245 **E.** 786586 **GROUND ELEVATION:** 5359

APPROXIMATE DIMENSIONS: 20' x 4' x 12.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/14/2012 **DATE LOGGED:** 6/14/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken))	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP) Visual Class.	**0.0 - 2.0 ft. Poorly Graded Sand (SP):** About 60% predominantly fine to coarse sand and 40% nonplastic fines with very high dry strength, rapid dilatancy and low toughness. Max. size, coarse sand. Strong reaction with HCl. In-place condition: very hard, homogenous, dry, light brown material with moderate cementation.	0	0	0
2.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(CL)s Visual Class. Lab sample taken from 2.0-12.0 ft. (CL)s Lab Class.	**2.0 - 12.0 ft. Lean Clay with Sand (CL)s:** About 65% fines with low plasticity, slow dilatancy and low toughness, 25% fine to coarse sand and 10% fine to coarse, subangular to angular, hard gravel. Max. size, 3 in. Strong reaction with HCl. In-place condition: soft grading to very hard, layered, dry, light brown material with weak cementation. Discontinuous and irregular gravel layers throughout. Lab test data from 2.0-12.0 ft.: 72% fines, 28% sand, 0% gravel; LL = 28%, PI = 13%; Field Moisture = 2.0%. pH = 8.45, Resistivity = 1.021 ohm/cm, Sulfates = 30 ppm, Sulfides = < 1 ppm, Chlorides = 92 ppm. Lab classification is Lean Clay with Sand (CL)s.	0	0	0
12.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			

REMARKS: Surface: flat loose sand with scattered grasses; Kaibab Formation outcrop west of highway dipping toward pit. Coordinates and elevation obtained from GPS. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-6

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 2013801 **E.** 790189 **GROUND ELEVATION:** 5400

APPROXIMATE DIMENSIONS: 20' x 4' x 13.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/14/2012 **DATE LOGGED:** 6/14/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP)cb Visual Class.	**0.0 - 4.0 ft. Poorly Graded Sand with Cobbles and Boulders (SP)cb:** About 85% predominantly fine to coarse sand, 10% predominantly fine to coarse, platy gravel and 5% nonplastic fines. Max. size 3 in. Strong reaction with HCl. Total sample (by volume): About 5% 5 to 12 in. subrounded, hard cobbles; trace of plus 12 in. blocky, hard, sandstone boulders; remainder minus 3 in.; maximum size, 1.8 by 0.9 ft. In-place condition: soft grading to very hard, homogeneous, dry, light brown material with weak grading to very strong cementation. Gravel and cobble fraction increases with depth.	0	5	T
4.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(SM)g Visual Class.	**4.0 - 10.0 ft. Silty Sand with Gravel (SM)g:** About 65% predominantly fine to coarse sand, 20% predominantly fine to coarse, angular gravel and 15% nonplastic fines. Max. size 3 in. Strong reaction with HCl.	0	0	0
Lab sample taken from 4.0-10.0 ft.	In-place condition: very hard, stratified, dry, brown material with moderate cementation.			
(SM) Lab Class.	Lab test data from 4.0-10.0 ft.: 72% sand, 15% fines, 13% gravel; LL and PI not tested; Field Moisture = 1.3%. pH = 8.88, Resistivity = 2,783 ohm/cm, Sulfates = 34 ppm, Sulfides = 3 ppm, Chlorides = 24 ppm. Lab classification is Silty Sand (SM).			
10.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(Ls) Visual Class.	**10.0 - 13.5 ft. Limestone (Ls):** Limestone is aphanic to fine grained and calcareous. Moderately hard in hand specimen, breaks with moderate hammer blow, but hard to very hard in outcrop, requiring repeated heavy blow to break; slightly weathered. Bedding spaced 1 to 3 in. apart. Strong reaction with HCl. Color is very light gray. Upon excavation with a backhoe, limestone breaks up into blocky chunks 6 in. or smaller in size. .			
13.5 ft.	**Geologic Interpretation:** Kaibab Formation			

REMARKS: Surface: flat with scattered grass and bushes on loose sand; sandy limestone of the Kaibab Formation outcrops about 100 ft. west, across the highway. Coordinates and elevation obtained from GPS. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-7

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 2008851 **E.** 793831 **GROUND ELEVATION:** 5461

APPROXIMATE DIMENSIONS: 20' x 10' x 14.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/11/2012 **DATE LOGGED:** 6/11/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken))	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SC)c Visual Class.	**0.0 - 14.0 ft. Clayey Sand with Trace of Cobbles (SC)c:** About 60% predominantly fine to coarse sand, 40% fines with low plasticity, slow dilatancy and low toughness and a trace of fine, subrounded gravel. Max. size, 15 mm. Strong reaction with HCl. From about 4.0-4.5 ft. gravelly layer seen in pit wall; no sample taken.	0	T	0
Lab sample taken from 0.0-14.0 ft.	Total sample (by volume): Trace of 5 to 12 in. subangular, sandstone cobbles; remainder minus 3 in.; maximum size, 8 in.			
(SC-SM) Lab Class.	In-place condition: hard to very hard, homogenous, dry, brown material with moderate to strong cementation. Lab test data from 0.0-14.0 ft.: 49% sand, 42% fines, 9% gravel; LL = 20%, PI = 5%, Field Moisture = 3.0%. pH = 8.68, Resistivity = 1,021 ohm/cm, Sulfates = 160 ppm, Sulfides = 2 ppm, Chlorides = 100 ppm. Lab classification is Silty, Clayey Sand (SC-SM). In-place density of 104.0 lb/ft^3 taken at 3.5 ft. with sand cone apparatus.			
14.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			

REMARKS: **S**urface: flat with scattered bushes; poorly graded sand with gravel at surface. Moenkopi shale outcrop about 400 ft. southeast of pit and Kaibab limestone outcrop about 400-500 ft. west across highway. Coordinates and elevation obtained from GPS. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-8

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 2001299 **E.** 798647 **GROUND ELEVATION:** 5531

APPROXIMATE DIMENSIONS: 14' x 4' x 7.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/11/2012 **DATE LOGGED:** 6/11/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken))	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SC)c Visual Class.	**0.0 - 6.0 ft. Clayey Sand with Trace of Cobbles (SC)c:** About 50% fine to coarse sand, 40% fines with low to medium plasticity, slow dilatancy and low toughness and 10% fine to coarse, subangular to angular, flat gravel. Max. size, 3 in. Strong reaction with HCl. Total sample (by volume): Trace of 3 to 5 in. platy, moderately hard, sandstone cobbles; remainder minus 3 in.; maximum size, 5 in.	T	0	0
Lab sample taken from 0.0-6.0 ft.	In-place condition: hard to very hard, homogenous, dry, brown material with moderate cementation.			
(SC)g Lab Class.	Lab test data from 0.0-6.0 ft.: 42% fines, 33% sand, 25% gravel; LL = 26%, PI = 11%, Field Moisture = 3.9%. pH = 8.7, Resistivity = 1,856 ohm/cm, Sulfates = 110 ppm, Sulfides = 6 ppm, Chlorides = 55 ppm. Lab classification is Clayey Sand with Gravel (SC)g.			
6.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(Clst) Visual Class.	**6.0 - 7.5 ft. Claystone (Clst):** Claystone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting of about 90% clay and 10% silt. Moderately soft to moderately hard, thicker fragments require moderate hammer blow to break and slightly weathered. No reaction with HCl. Color is grayish brown.			
\	Upon excavation with a backhoe, sandstone breaks up into angular, mostly hand-size and smaller chunks.			
7.5 ft.	**Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: Surface: flat with scattered grasses. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-9

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1996746 **E.** 800141 **GROUND ELEVATION:** 5588

APPROXIMATE DIMENSIONS: 20' x 4' x 12.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/13/2012 **DATE LOGGED:** 6/13/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken))	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM)g Visual Class. **4.0 ft.**	**0.0 - 4.0 ft. Silty Sand with Gravel (SM)g:** About 65% fine to coarse sand, 20% nonplastic fines with rapid dilatancy and low toughness and 15% predominantly fine to coarse, subangular to angular, hard, flattened gravel. Max. size, 3 in. Strong reaction with HCl. In-place condition: hard to very hard, homogenous, dry, brown material with weak to moderate cementation. **Geologic Interpretation:** Quaternary Alluvium	0	0	0
(GP-GM)sc Visual Class. **5.8 ft.**	**4.0 - 5.8 ft. Poorly Graded Gravel with Silt, Sand and Cobbles (GP-GM)sc:** About 50% predominantly fine to coarse, hard, angular to platy gravel, 40% fine to coarse sand, 10% nonplastic fines. Max. size, 3 in. Strong reaction with HCl. Total sample (by volume): About 5% 5 to 12 in. blocky, hard cobbles; about 5% plus 12 in. subangular to subrounded, hard boulders; remainder minus 3 in.; maximum size, 10 in. In-place condition: very hard, discontinuous layers, dry, medium brown material with strong cementation. **Geologic Interpretation:** Quaternary Alluvium	0	5	0
(SC)g Visual Class. Lab sample taken from 5.8-10.0 ft. (SC-SM)g Lab Class. **10.0 ft.**	**5.8 - 10.0 ft. Clayey Sand with Gravel (SC)g:** About 50% predominantly fine sand , 25% fines with medium plasticity, medium toughness and high dry strength and 25% fine gravel. Max. size 10mm. Strong reaction with HCl. In-place condition: very hard, homogeneous, dry, reddish brown material with strong cementation. Lab test data from 7.0-14.5 ft.: 50% sand, 29% gravel, 21% fines; LL = 21%, PI = 6%, Field Moisture = 3.9%. pH = 8.22, Resistivity = 659 ohm/cm, Sulfates = 1,500 ppm, Sulfides = < 1 ppm, Chlorides = 160 ppm. Lab classification is Silty, Clayey Sand with Gravel (SC-SM)g. **Geologic Interpretation:** Quaternary Alluvium	0	0	0
(Ss) Visual Class. **12.0 ft.**	**10.0 - 12.0 ft. Sandstone (Ss):** Sandstone consists of predominately fine sand moderately cemented with silica. Moderately hard, fragments require a moderate hammer blow to break; moderately weathered. No reaction with HCl. Color is white to light gray with yellowish orange specks (limonite staining). Upon excavation with a backhoe, sandstone breaks up into angular, mostly hand-size and smaller chunks. **Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: Surface: flat; sandstone outcrop west across road. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-10

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1991819 **E.** 801708 **GROUND ELEVATION:** 5633

APPROXIMATE DIMENSIONS: 20' x 4' x 13.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/11/2012 **DATE LOGGED:** 6/11/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken))	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM)gcb Visual Class.	**0.0 - 9.4 ft. Silty Sand with Gravel, Cobbles and Boulders (SM)gcb:** About 55% fine to coarse sand, 25% fine to coarse, subangular to angular, hard gravel and 20% nonplastic fines with rapid dilatancy, low toughness and high dry strength. Max. size, 3 in. Strong reaction with HCl. Total sample (by volume): About 3% 3 to 5 in. angular, moderately hard cobbles; about 2% 5 to 12 in. angular, moderately hard cobbles; trace of plus 12 in. angular, hard boulders; remainder minus 3 in.; maximum size, 1.0 ft. In-place condition: hard, homogenous, dry, brown material with weak cementation. Lab test data from 0.0-9.4 ft.: 37% sand, 33% gravel, 30% fines; LL = 21%, PI = 5%, Field Moisture = 2.6%. pH = 8.48, Resistivity = 2,042 ohm/cm, Sulfates = 400 ppm, Sulfides = < 1 ppm, Chlorides = 140 ppm. Lab classification is Silty, Clayey Sand with Gravel (SC-SM)g.	3	2	T
Lab sample taken from 0.0-9.4 ft. (SC-SM)g Lab Class.				
9.4 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(Clst) Visual Class.	**9.4 - 13.0 ft. Claystone (Clst):** Claystone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting mostly of clay. From 9.4-12.0 ft. soft to moderately soft, hand-size fragment break with manual pressure; from 12.0-13.0 moderately soft to moderately hard, thicker fragments require moderate hammer blow to break and slightly weathered. No reaction with HCl, except on thin veinlets of white $CaCO_3$. Color is medium gray with white veinlets. Upon excavation with a backhoe, sandstone breaks up into angular, mostly hand-size and smaller chunks.			
\				
13.0 ft.	**Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: **S**urface: flat with scattered grasses. Coordinates and elevation obtained from GPS. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-11

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1986910 **E.** 803390 **GROUND ELEVATION:** 5669

APPROXIMATE DIMENSIONS: 20' x 10' x 11.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/13/2012 **DATE LOGGED:** 6/13/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken))	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SC)g Visual Class. Lab sample taken from 0.0-6.0 ft. (SC)g Lab Class. **6.0 ft.**	**0.0 - 6.0 ft. Clayey Sand with Gravel (SC)g:** About 45% fine to coarse sand, 35% fines with low plasticity, slow dilatancy and low toughness and 20% fine to coarse, subangular to angular, hard gravel. Max. size, 3 in. Strong reaction with HCl. In-place condition: firm to hard, layered, dry, light brown material with weak cementation. Discontinuous and irregular gravel layers throughout. Lab test data from 0.0-6.0 ft.: 39% sand, 38% fines, 23% gravel; LL = 22%, PI = 8%, Field Moisture = 3.2%. pH = 7.26, Resistivity = 854 ohm/cm, Sulfates = 1,700 ppm, Sulfides = < 1 ppm, Chlorides = 72 ppm. Lab classification is Clayey Sand with Gravel (SC)g. In-place density of 97.6 lb/ft^3 taken at 4.2 ft. with sand cone apparatus. **Geologic Interpretation:** Quaternary Alluvium	0	0	0
(GP)s Visual Class. **7.5 ft.**	**6.0 - 7.5 ft. Poorly Graded Gravel with Sand (GP)s:** About 60% predominantly fine to coarse, hard, angular to platy gravel, 35% fine to coarse sand, 5% nonplastic fines. Max. size, 3 in. Strong reaction with HCl. In-place condition: very hard, discontinuous layers, dry, medium brown material with moderate cementation. **Geologic Interpretation:** Quaternary Alluvium	0	0	0
(Ss) Visual Class. **11.5 ft.**	**7.5 - 11.5 ft. Sandstone (Ss):** Sandstone consists of predominately fine sand moderately cemented with silica. Moderately hard, fragments require a moderate hammer blow to break; moderately weathered. No reaction with HCl. Color is white to light gray with yellowish orange specks (limonite staining). Upon excavation with a backhoe, sandstone breaks up into angular, mostly hand-size and smaller chunks. Hard digging below 8.0 ft. **Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: Surface: on small berm (Old U.S. Highway 89) with scattered grasses; Moenkopi Formation outcrop about 1,000 ft. west across road. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-12

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1981405 **E.** 805942 **GROUND ELEVATION:** 5706

APPROXIMATE DIMENSIONS: 20' x 4' x 11.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/11/2012 **DATE LOGGED:** 6/11/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP)c Visual Class.	**0.0 - 3.8 ft. Poorly Graded Sand with Cobbles (SP)c:** About 85% fine to coarse sand, 10% fine to coarse, subangular gravel and 10% nonplastic fines. Max. size, 3 in. Strong reaction with HCl. Total sample (by volume): About 5% 3 to 5 in. platy, moderately hard, sandstone cobbles; remainder minus 3 in.; maximum size, 5 in. In-place condition: firm to hard, homogenous, dry, brown material with weak cementation.	5	0	0
3.8 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(SC) Visual Class.	**3.8 - 11.5 ft. Clayey Sand (SC):** About 70% fine to coarse sand, 30% fines with low plasticity, very high dry strength, slow dilatancy and low toughness and a trace of gravel. Max. size, 25 mm. Strong reaction with HCl.	0	0	0
Lab sample taken from 3.8-11.5 ft.	In-place condition: hard, homogeneous, dry, brown material with moderate cementation.			
(SC) Lab Class.	Lab test data from 3.8-11.5 ft.: 61% sand, 30% fines, 9% gravel; LL = 22%, PI = 8%, Field Moisture = 4.8%. pH = 7.66, Resistivity = 1,856 ohm/cm, Sulfates = 51 ppm, Sulfides = < 1 ppm, Chlorides = 57 ppm. Lab classification is Clayey Sand (SC).			
11.5 ft.	**Geologic Interpretation:** Quaternary Alluvium			

REMARKS: Surface: gently slopes toward small wash about 300 ft. east of pit. Coordinates and elevation obtained from GPS. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-13**

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1976939 **E.** 808012 **GROUND ELEVATION:** 5741

APPROXIMATE DIMENSIONS: 20' x 4' x 11.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/11/2012 **DATE LOGGED:** 6/11/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SC) Visual Class. Lab sample taken from 0.0-4.5 ft. (SC-SM) Lab Class. **4.5 ft.**	**0.0 - 4.5 ft. Clayey Sand (SC):** About 85% predominantly fine to coarse sand, 30% fines with low plasticity and trace of fine, subrounded gravel. Max. size 10 mm. Strong reaction with HCl. In-place condition: firm, homogeneous, dry, brown material with weak cementation. Lab test data from 1.8-7.5 ft.: 59% sand, 39% fines, 2% gravel; LL = 21%, PI = 7%, Field Moisture = 4.9%. pH = 8.5, Resistivity = 1,949 ohm/cm, Sulfates = 22 ppm, Sulfides = 2 ppm, Chlorides = 60 ppm. Lab classification is Silty, Clayey Sand (SC-SM). **Geologic Interpretation:** Quaternary Alluvium	0	0	0
(Clst) Visual Class. **11.0 ft.**	**4.5 - 11.0 ft. Claystone (Clst):** Claystone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting mostly of clay with about 10% very fine sand. Moderately soft, fragments break with manual pressure and are intensely to moderately weathered from 4.5 to 8.0 ft.; moderately hard and moderately weathered from 8.0-11.0 ft. Strong reaction with HCl. Color is dark gray with white mottling from 4.5-8.0 ft. and mottled grayish red with light greenish gray spots. Bedding not discernible in pit, but excavated fragments break into 1 to 4 in. thick slabs. **Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: Surface: gently sloping east toward wash with scattered grasses on loose sand. Moderately hard to hard, purplish gray and white sandstone (Shinarump) outcrops west across highway with Moenkopi shale outcrops further west. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-14

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1972911 **E.** 809681 **GROUND ELEVATION:** 5767

APPROXIMATE DIMENSIONS: 20' x 4' x 11.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/11/2012 **DATE LOGGED:** 6/11/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM) Visual Class. Lab sample taken from 0.0-8.0 ft. (SM) Lab Class. **8.0 ft.**	**0.0 - 8.0 ft. Silty Sand (SM):** About 85% predominantly fine to coarse sand and 15% nonplastic fines. Max. size coarse sand. Strong reaction with HCl. In-place condition: soft, homogeneous, dry, light brown material with weak cementation. Lab test data from 0.0-8.0 ft.: 76% sand, 15% fines, 9% gravel; LL and PI not tested; Field Moisture = 1.9%. pH = 8.32, Resistivity = 1,949 ohm/cm, Sulfates = 18 ppm, Sulfides = 2 ppm, Chlorides = 24 ppm. Lab classification is Silty Sand (SM). **Geologic Interpretation:** Quaternary Alluvium	0	0	0
(SP)g Visual Class. **10.0 ft.**	**8.0 - 10.0 ft. Poorly Graded Sand with Gravel (SP)g:** About 80% predominantly fine to coarse sand, 15% fine to coarse, subangular to subrounded gravel and 5% nonplastic fines. Max. size 2.5 in. Strong reaction with HCl. In-place condition: hard, homogeneous, dry, light brown material with weak cementation. **Geologic Interpretation:** Quaternary Alluvium	0	0	0
(Ss) Visual Class. **11.0 ft.**	**10.0 - 11.0 ft. Sandstone (Ss):** Sandstone consists of about 90% fine to predominately coarse sand and 10% flat, angular gravel moderately cemented with $CaCo_3$. Sandstone is moderately soft, fragments break with manual pressure and intensely to moderately weathered. Strong reaction with HCl. Color is medium gray with black and dark yellowish orange streaks mottled with light gray and brown. Upon excavation with a backhoe, sandstone breaks up into angular, 6 in and smaller chunks. Backhoe could only excavate 1.0 ft.; teeth grooved bottom, but could not penetrate. **Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: Surface: flat with moderate cover of bushes; shale fragments derived from the Moenkopi Formation at surface. Small wash about 60 ft. east of pit. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-15

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1966236 **E.** 812753 **GROUND ELEVATION:** 5837

APPROXIMATE DIMENSIONS: 14' x 4' x 7.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/11/2012 **DATE LOGGED:** 6/11/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP)g Visual Class.	**0.0 - 0.9 ft. Poorly Graded Sand with Gravel (SP)g:** About 95% predominantly fine to coarse sand and 5% nonplastic fines. Max. size, coarse sand. Strong reaction with HCl. From 0.3-0.9 ft., encountered asphalt and gravel from Old U.S. Highway 89. In-place condition: soft, homogeneous, dry, light brown material with weak cementation.	0	0	0
0.9 ft.	**Geologic Interpretation:** Quaternary Alluvium and Old U.S. Highway 89			
(SM) Visual Class. Lab sample taken from 0.9-5.5 ft. (SC-SM) Lab Class.	**0.9 - 5.5 ft. Silty Sand (SM):** About 70% fine to coarse sand, 20% nonplastic fines with medium to high dry strength, slow to rapid dilatancy and low toughness and 10% fine, subangular to subrounded gravel. Max. size, 20 mm. Strong reaction with HCl. In-place condition: firm to hard, homogeneous, dry, medium brown material with weak to moderate cementation. Lab test data from 0.9-5.5 ft.: 62% sand, 23% fines, 15% gravel; LL = 20%, PI = 5%, Field Moisture = 3.4%. pH = 8.8, Resistivity = 2.042 ohm/cm, Sulfates = 30 ppm, Sulfides = < 1 ppm, Chlorides = 23 ppm. Lab classification is Silty, Clayey Sand (SC-SM).	0	0	0
5.5 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(Ss) Visual Class.	**5.5 - 7.0 ft. Sandstone (Ss):** Sandstone consists of fine to medium sand moderately cemented with $CaCo_3$. Sandstone is moderately hard, fragments require moderate hammer blow to break and moderately weathered. Bedding not discernible in pit walls, but excavated fragments are 1-5 in. thick. Strong reaction with HCl. Color is white. Upon excavation with a backhoe, sandstone breaks up into angular, slabs 1.5 by 0.5 ft. in size and smaller. Backhoe met refusal at 7.0 ft.			
7.0 ft.	**Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: **S**urface: flat with moderate cover of bushes; encountered asphalt and gravel from Old U.S. Highway 89 at 0.3 ft. below surface. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-16

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1961708 **E.** 815643 **GROUND ELEVATION:** 5881

APPROXIMATE DIMENSIONS: 14' x 4' x 6.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/11/2012 **DATE LOGGED:** 6/11/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
s(CL) Visual Class.	**0.0 - 3.5 ft. Sandy Lean Clay s(CL):** About 50% fines with low plasticity, very high dry strength, slow dilatancy and low toughness, 40% fine to coarse sand and 10% fine, flat, subangular gravel. Max. size, 20 mm. Strong reaction with HCl.	0	0	0
Lab sample taken from 0.0-3.5 ft.	In-place condition: hard to very hard, homogeneous, dry, brown material with moderate to strong cementation.			
s(CL) Lab Class.	Lab test data from 0.0-3.5 ft.: 51% fines, 36% sand, 13% gravel; LL and PI not tested, Field Moisture = 5.4%. pH = 8.48, Resistivity = 2.227 ohm/cm, Sulfates = 11 ppm, Sulfides = 4 ppm, Chlorides = 22 ppm. Lab classification is Sandy Lean Clay s(CL).			
3.5 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(Ss) Visual Class.	**3.5 - 6.0 ft. Sandstone (Ss):** Sandstone consists of fine to medium sand moderately cemented with $CaCo_3$. Sandstone is moderately hard, fragments require moderate hammer blow to break and moderately weathered. Bedding not discernible in pit walls, but excavated fragments are 1-5 in. thick. Strong reaction with HCl. Color is very light gray and white.			
	From 3.5-5.5 ft., sandstone appears intensely fractured and intensely weathered; may indicate original weathered surface.			
	Upon excavation with a backhoe, sandstone breaks up into angular, slabs 1.0 by 0.5 ft. in size and smaller. Backhoe met refusal at 6.0 ft.			
6.0 ft.	**Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: Surface: flat with scattered grasses; shale fragments derived from the Moenkopi Formation at surface. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-18

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: OLD U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1944164 **E.** 823905 **GROUND ELEVATION:** 5450

APPROXIMATE DIMENSIONS: 20' x 4' x 9.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/7/2012 **DATE LOGGED:** 6/7/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(CL)s Visual Class.	**0.0 - 2.5 ft. Lean Clay with Sand (CL)s:** About 75 % fines with medium plasticity, medium toughness and very high dry strength, 25% predominantly fine to medium sand and trace of fine, subrounded gravel. Max. size, 15 mm. Strong reaction with HCl. In-place condition: hard, homogeneous, dry, medium brown material with weak to moderate cementation.	0	0	0
2.5 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(Clst) Visual Class. Lab sample taken from 2.5-9.5 ft. (CL) Lab Class.	**2.5 - 9.5 ft. Claystone (Clst):** Claystone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting mostly of clay; bedding not discernible. Soft to moderately soft, edges of hand-size fragment break with light manual pressure; thicker portions require heavy pressure or light hammer blow to break. No reaction with HCl. Color is medium dark gray to gray. Upon excavation with a backhoe, claystone breaks up into angular, hand-size and smaller chunks. A 75 mm chunk of claystone placed in water broke down into 10 mm pieces within 1 hr., but did not break down further or soften into clay within 48 hrs. Lab test data from 2.5-9.5 ft.: 94% fines, 6% sand, 0% gravel; LL and PI not tested, Field Moisture = 16.0%, Expansion Index = 49. pH = 7.25, Resistivity = 752 ohm/cm, Sulfates = 73 ppm, Sulfides = 3 ppm, Chlorides = 74 ppm. Lab classification is Lean Clay (CL). Note: material originated from claystone.			
9.5 ft.	**Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: **S**urface: scattered grass and bushes on loose sand; low rounded hills of claystone from the Chinle Formation surround area. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-19**

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HAMBLIN WASH **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1934744 **E.** 830704 **GROUND ELEVATION:** 5368

APPROXIMATE DIMENSIONS: 20' x 4' x 14.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/13/2012 **DATE LOGGED:** 6/13/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken))	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SC)gcb Visual Class.	**0.0 - 10.0 ft. Clayey Sand with Gravel, Cobbles and Boulders (SP-SC)gcb:** About 60% fine to coarse sand, 25% fine to coarse, subangular to subrounded, hard gravel and 15% fines with low plasticity, slow dilatancy and low toughness. Max. size, 3 in. Strong reaction with HCl. Total sample (by volume): About 5% 3 to 5 in. platy, hard, sandstone cobbles; about 5% 5 to 12 in. blocky, hard, sandstone cobbles; about 5% plus 12 in. blocky, hard, sandstone boulders; remainder minus 3 in.; maximum size, 2.5 by 1.0 by 1.0 ft.	5	5	5
Lab sample taken from 0.0-10.0 ft. (SC)g Lab Class.	In-place condition: firm to hard, layered, dry, becoming moist at 5.2 ft., medium brown material with weak to moderate cementation. Discontinuous and irregular gravel layers throughout. Lab test data from 0.0-10.0 ft.: 55% sand, 26% gravel, 19% fines; LL = 22%, PI = 9%, Field Moisture = 6.0%. pH = 8.54, Resistivity = 928 ohm/cm, Sulfates = 210 ppm, Sulfides = 2 ppm, Chlorides = 420 ppm. Lab classification is Clayey Sand with Gravel (SC)g.			
10.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(Clst) Visual Class.	**10.0 - 14.0 ft. Claystone (Clst):** Claystone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting mostly of clay. Soft, fragments break with manual pressure: moderately weathered. Moist; no reaction with HCl. Color is medium dark gray from 10.0-12.0 ft., dark greenish gray from 12.0-14.0 ft.. Upon excavation with a backhoe, claystone breaks up into angular, hand-size and smaller chunks.			
14.0 ft.	**Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: Surface: flat with scattered bushes; cobbles and some boulders up to 1.5 ft. on surface; pit is about 100 ft. west of Hamblin Wash. Chinle Formation outcrops about 100 ft. west of pit. Coordinates and elevation obtained from GPS. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-20

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HAMBLIN WASH **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1931844 **E.** 833272 **GROUND ELEVATION:** 5327

APPROXIMATE DIMENSIONS: 20' x 10' x 12.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/13/2012 **DATE LOGGED:** 6/13/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken))	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM)c Visual Class.	**0.0 - 8.7 ft. Silty Sand with Trace of Cobbles (SM)c:** About 75% fine to coarse sand, 20% nonplastic fines and 5% fine to coarse, moderately hard, gravel in the form of platy sandstone fragments. Max. size, 3 in. Strong reaction with HCl. Total sample (by volume): Trace of 5 to 12 in. platy, hard sandstone cobbles; remainder minus 3 in.; maximum size, 6 in.	0	T	0
Lab sample taken from 0.0-8.7 ft.	In-place condition: firm at top grading to very hard at bottom of interval, homogeneous, dry, brown material with weak cementation at top grading to moderate cementation at bottom of interval.			
(SC-SM) Lab Class.	Lab test data from 0.0-8.7 ft.: 66% sand, 28% fines, 6% gravel; LL = 23%, PI = 5%, Field Moisture = 3.8%. pH = 8.41, Resistivity = 1,856 ohm/cm, Sulfates = 29 ppm, Sulfides = < 1 ppm, Chlorides = 66 ppm. Lab classification is Silty Clayey Sand (SC-SM) In-place density of 106.2 lb/ft^3 taken at 5.0 ft. with sand cone apparatus.			
8.7 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(GP)sc Visual Class.	**8.7 -9.5 ft. Poorly Graded Gravel with Sand and Cobbles (GP)sc:** About 55% fine to coarse, hard, subrounded gravel, 40% fine to coarse sand, 5% nonplastic fines. Max. size, 3 in. Strong reaction with HCl. Total sample (by volume): About 10% 3 to 5 in., subrounded, hard cobbles; remainder minus 3 in.; maximum size, 5 in. In-place condition: very hard, homogenous, dry, mottled tan material with moderate cementation.	10	0	0
9.5 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(Clst) Visual Class.	**9.5 - 12.0 ft. Claystone (Clst):** Claystone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting mostly of clay. Moderately soft, fragments break with manual pressure, thicker portion requires light hammer blow to break; moderately weathered. Slightly moist; no reaction with HCl except on thin white veinlets of $CaCO_3$. Color is grayish brown with light greenish gray spots. Upon excavation with a backhoe, claystone breaks up into angular, hand-size and smaller chunks.			
12.0 ft.	**Geologic Interpretation:** Chinle Formation			

REMARKS: **S**urface: flat with scattered bushes; pit is about 50 ft. west of Hamblin Wash. Coordinates and elevation obtained from GPS. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-21**

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HAMBLIN WASH **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1927080 **E.** 837375 **GROUND ELEVATION:** 5248

APPROXIMATE DIMENSIONS: 20' x 10' x 14.0' DEEP **LOGGED BY:** B. PRUDHOM

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/13/2012 **DATE LOGGED:** 6/13/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM) Visual Class. **3.0 ft.**	**0.0 - 3.0 ft. Silty Sand (SM):** About 55% predominantly fine to medium sand, 45% fines with low plasticity, low to medium toughness and medium dry strength and trace of fine, subangular, moderately hard to hard, gravel. Max. size, 15 mm. Strong reaction with HCl. In-place condition: hard, homogeneous and somewhat blocky, dry, moderate to pale reddish brown material with weak cementation. **Geologic Interpretation:** Quaternary Alluvium	0	0	0
(GC)sc Visual Class. Lab sample taken from 3.0-5.0 ft. (SW-SC)g Lab Class. **8.5 ft.**	**3.0 - 8.5 ft. Clayey Gravel with Sand and Cobbles (GC)sc:** About 45% fine to coarse, subrounded to angular (predominantly subangular) moderately hard to hard, flattened and elongated gravel, 35% fine to predominantly medium and coarse, flat, angular sand and 20% fines with medium to high plasticity, high dry strength, no to slow dilatancy and medium toughness. Max. size, 90 mm. Strong reaction with HCl. Total sample (by volume): About 5% 3 to 5 in. blocky, hard, sandstone cobbles; remainder minus 3 in.; maximum size, 5 in. In-place condition: hard, homogeneous, slightly moist from 3.0-5.0 and moist 5.0-8.5 ft., pale to dark reddish brown material with weak cementation. Lab test data from 3.0-5.0 ft.: 57% sand, 38% gravel, 5% fines; LL and PI not tested, Field Moisture = 2.0%. pH = 9.7, Resistivity = 3,526 ohm/cm, Sulfates = 96 ppm, Sulfides = 3 ppm, Chlorides = 67 ppm. Lab classification is Well Graded Sand with Clay and Gravel (SW-SC)g. In-place density of 127.2 lb/ft^3 taken at 3.0 ft. with sand cone apparatus. **Geologic Interpretation:** Quaternary Alluvium	5	0	0
(Clst) Visual Class. Lab sample taken from 8.5-14.0 ft. s(CL) Lab Class. **14.0 ft.**	**8.5 - 14.0 ft. Claystone (Clst):** Claystone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting mostly of clay, but locally silty. Soft to moderately soft, fragments break with manual pressure, becoming moderately hard after drying. Weak to moderate reaction with HCl. Color is pale reddish brown to grayish red. Upon excavation with a backhoe, claystone breaks up into angular, 3 in. and smaller chunks. Lab test data from 8.5-14.0 ft.: 68% fines, 32% sand, 0% gravel,; LL = 42%, PI = 18%, Field Moisture = 13.6%. pH = 8.83, Resistivity = 2,877 ohm/cm, Sulfates = 14 ppm, Sulfides = < 1 ppm, Chlorides = 46 ppm. Lab classification is Sandy Lean Clay s(CL). **Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: Surface: flat with loose sand and sparse bushes, about 100 ft. east of low mesa and terrace deposits. Coordinates and elevation obtained from GPS. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-22

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HAMBLIN WASH **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1923535 **E.** 839803 **GROUND ELEVATION:** 5210

APPROXIMATE DIMENSIONS: 20' x 10' x 14.0' DEEP **LOGGED BY:** B. PRUDHOM

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/13/2012 **DATE LOGGED:** 6/13/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM) Visual Class.	**0.0 - 4.0 ft. Silty Sand (SM):** About 55% predominantly fine to medium sand, 45% fines with low plasticity, low to medium toughness and medium dry strength and trace of fine, subangular, moderately hard to hard, gravel. Max. size, 15 mm. Strong reaction with HCl. In-place condition: hard, homogeneous and somewhat blocky, dry, moderate to pale reddish brown material with weak cementation. Roots from 0.0-1.0 ft.	0	0	0
4.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(GM)sc Visual Class.	**4.0 - 7.0 ft. Silty Gravel with Sand and Cobbles (GM)sc:** About 55% fine to coarse, subrounded to angular (predominantly subangular), moderately hard to hard, flattened and elongated gravel, 30% fine to coarse, subrounded to angular sand and 15% fines with no to low plasticity, low dry strength, slow dilatancy and low toughness. Max. size, 30 mm. Strong reaction with HCl. Total sample (by volume): About 5% 3 to 5 in. subangular to subrounded, hard cobbles; remainder minus 3 in.; maximum size, 7 in. In-place condition: hard, homogeneous, moist, pale to dark reddish brown material with moderate to strong cementation. In-place density of 120.9 lb/ft^3 taken at 4.0 ft. with sand cone apparatus.	5	0	0
7.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(SC)gcb Visual Class. Lab sample taken from 7.0-14.0 ft. (SW-SC)g Lab Class.	**7.0 -14.0 ft. Clayey Sand with Gravel, Cobbles and Boulders (SC)gcb:** About 45% predominantly fine to coarse, subrounded to subangular sand, 40% predominantly fine to coarse, subrounded to predominantly subangular, moderately soft to moderately hard, flat gravel, 15% fines with medium to high plasticity, high dry strength, no dilatancy and medium toughness and. Max. size, 25 mm. Strong reaction with HCl. Total sample (by volume): About 10% 3 to 5 in. subangular to subrounded, hard cobbles; trace of plus 12 in. blocky, hard boulders; remainder minus 3 in.; maximum size, 2.0 ft. In-place condition: hard, homogeneous, moist, dark reddish brown material with weak to moderate cementation. Lab test data from 7.0-14.0 ft.: 45% sand, 43% gravel, 12% fines; LL and PI not tested, Field Moisture = 12.2%. pH = 10.16, Resistivity = 780 ohm/cm. Lab classification is Well Graded Sand with Clay and Gravel (SW-SC)g.	10	0	T
14.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			

REMARKS: **S**urface: flat with loose sand and sparse bushes. Coordinates and elevation obtained from GPS. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-23**

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HAMBLIN WASH **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1921434 **E.** 841152 **GROUND ELEVATION:** 5181

APPROXIMATE DIMENSIONS: 20' x 10' x 14.0' DEEP **LOGGED BY:** B. PRUDHOM

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/13/2012 **DATE LOGGED:** 6/13/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM) Visual Class.	**0.0 - 4.0 ft. Silty Sand (SM):** About 55% predominantly fine to medium sand, 45% fines with low plasticity, low to medium toughness and medium dry strength and trace of fine, subangular, moderately hard to hard, gravel. Max. size, 5 mm. Strong reaction with HCl.	0	0	0
Lab sample taken from 0.0 - 4.0 ft.	In-place condition: hard, homogeneous and somewhat blocky, dry, moderate to pale reddish brown material with weak cementation.			
(SM) Lab Class.	Lab test data from 0.0-4.0 ft.: 68% sand, 31% fines, 1% gravel; Nonplastic, Field Moisture= 2.6%. pH = 9.29, Resistivity = 2,227 ohm/cm, Sulfates = 22 ppm, Sulfides = 2 ppm, Chlorides = 26 ppm. Lab classification is Silty Sand (SM).			
	In-place density of 100.1 lb/ft^3 taken at 4.0 ft. with sand cone apparatus.			
4.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(GC-GM)scb Visual Class.	**4.0 - 14.0 ft. Clayey Silty Gravel with Sand, Cobbles and Boulders (GC-GM)scb:** About 45% predominantly fine to coarse, subrounded to subangular, moderately hard to hard, flat gravel, 35% predominantly fine to coarse, rounded to angular sand and 20% fines with no to low plasticity, medium dry strength, slow dilatancy and low toughness. Max. size, 60 mm. Strong reaction with HCl.	5	10	T
Lab sample taken from 6.0-8.0 ft.	Total sample (by volume): About 5% 3 to 5 in. subangular to subrounded, hard cobbles; about 10% 5 to 12 in. subangular, hard cobbles; trace of plus 12 in. angular, hard boulders; remainder minus 3 in.; maximum size, 1.5 ft.			
(SC)g Lab Class.	In-place condition: hard, gravel lenses up to 6 in. thick in finer grained soil, dry from 4.0-12.0 ft. and moist from 12.0-14.0 ft., moderate reddish brown material with weak to moderate cementation.			
	Lab test data from 6.0-8.0 ft.: 67% sand, 18% fines, 15% gravel; LL = 22%, PI = 9%, Field Moisture = 9.0%. pH = 9.83, Resistivity = 1,949 ohm/cm, Sulfates = 12 ppm, Sulfides = 3 ppm, Chlorides = 17 ppm. Lab classification is Clayey Sand with Gravel (SC)g.			
14.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			

REMARKS: Surface: flat with loose sand and sparse bushes, about 400 ft. west of Hamblin Wash. Coordinates and elevation obtained from GPS. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-24

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: OLD U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1917157 **E.** 844861 **GROUND ELEVATION:** 5128

APPROXIMATE DIMENSIONS: 20' x 10' x 15.0' DEEP **LOGGED BY:** B. PRUDHOM

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/12/2012 **DATE LOGGED:** 6/12/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SC)b Visual Class. **4.0 ft.**	**0.0 - 4.0 ft. Clayey Sand with Trace of Boulders (SC)b:** About 55% predominantly very fine to medium sand and 45% fines with mostly low to medium plasticity, slow to rapid dilatancy, low toughness and high dry strength. Max. size, medium sand. Strong reaction with HCl. Total sample (by volume): Trace of plus 12 in. subrounded to angular, moderately hard boulders; remainder minus 3 in.; maximum size, 2 by 1 ft. In-place condition: hard, homogeneous, dry, pale reddish brown material with mostly weak to moderate cementation. In-place density of 123.7 lb/ft^3 taken at 3.5 ft. with sand cone apparatus. **Geologic Interpretation:** Quaternary Alluvium	0	0	T
(GM)s Visual Class. Lab sample taken from 4.0-10.0 ft. (SP-SM)g Lab Class. **10.0 ft.**	**4.0 - 10.0 ft. Silty Gravel with Sand (GM)s:** About 55% predominantly fine to coarse, subrounded to subangular, moderately hard to hard, flat gravel, 35% predominantly fine and medium to coarse, rounded to angular sand and 15% nonplastic fines with medium to high dry strength, slow to rapid dilatancy and low toughness. Max. size, 45 mm. Strong reaction with HCl. In-place condition: very hard, lensed, fining upward, dry to moist, pale reddish brown to grayish material with moderate cementation. Lab test data from 4.0-10.0 ft.: 51% sand, 42% gravel, 7% fines; LL and PI not tested, Field Moisture = 2.4%. pH = 9.11, Resistivity = 1,578 ohm/cm, Sulfates = 80 ppm, Sulfides = 2 ppm, Chlorides = 34 ppm. Lab classification is Poorly Graded Sand with Silt and Gravel (SP-SM)g. **Geologic Interpretation:** Quaternary Alluvium	0	0	0
(GM)sc Visual Class. **15.0 ft.**	**10.0 - 15.0 ft. Silty Gravel with Sand and Cobbles (GM)sc:** About 55% predominantly fine to coarse, subrounded to subangular, moderately hard to hard, flat gravel, 35% predominantly fine and medium to coarse, rounded to angular sand and 15% nonplastic fines with medium to high dry strength, slow to rapid dilatancy and low toughness. Max. size, 45 mm. Strong reaction with HCl. Total sample (by volume): About 5% 3 to 5 in. subrounded to angular, moderately hard cobbles; trace of 5 to 12 in. subangular, moderately hard cobbles; maximum size, 8 in. In-place condition: very hard, lensed, fining upward, dry to moist, pale reddish brown to grayish material with moderate cementation. **Geologic Interpretation:** Quaternary Alluvium	5	T	0

REMARKS: **S**urface: flat with sparse bushes; pit located about 300 ft. northeast and 300 ft. southeast of Chinle Formation outcrops and about 300 ft. west of Hamblin Wash. Coordinates and elevation obtained from GPS. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-25

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: OLD U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1910810 **E.** 847414 **GROUND ELEVATION:** 5033

APPROXIMATE DIMENSIONS: 20' x 4' x 12' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/7/2012 **DATE LOGGED:** 6/7/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP) Visual Class.	**0.0 - 5.0 ft. Poorly Graded Sand (SP):** About 95% predominantly fine to medium sand and 5% nonplastic fines. Max. size, medium sand. Contains rounded silt pebbles up to 10 mm in diameter. Strong reaction with HCl. In-place condition: very hard, layered, dry, light brown material with weak cementation.	0	0	0
5.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(SP)g Visual Class.	**5.0 - 8.0 ft. Poorly Graded Sand with Gravel (SP)g:** About 60% predominantly fine to coarse sand, 35% predominantly fine to coarse gravel, 5% nonplastic fines. Max. size, 2 in. Strong reaction with HCl. In-place condition: firm, homogeneous, dry, brown material with moderate cementation with $CaCO_3$.	0	0	0
8.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(SP-SC) Visual Class.	**8.0 - 12.0 ft. Poorly Graded Sand with Clay (SP-SC):** About 90% predominantly fine sand and 10% fines with medium plasticity, medium toughness and high dry strength. Max. size fine sand. Strong reaction with HCl.	0	0	0
Lab sample taken from 8.0-12.0 ft.	In-place condition: very hard, homogeneous, dry, reddish brown material with strong cementation.			
(SC-SM) Lab Class.	Lab test data from 8.0-12.0 ft.: 77% sand, 12% fines, 11% gravel; LL and PI not tested, Field Moisture = 2.8%. pH = 7.31, Resistivity = 4,640 ohm/cm, Sulfates = 7 ppm, Sulfides = < 1 ppm, Chlorides = 17 ppm. Lab classification is Silty, Clayey Sand (SC-SM).			
12.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			

REMARKS: **S**urface: in wash floodplain, about 250 ft. west of active channel; Chinle outcrops 150 ft. west of pit. Coordinates and elevation obtained from GPS. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-26

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: OLD U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1906705 **E.** 849741 **GROUND ELEVATION:** 5010

APPROXIMATE DIMENSIONS: 20' x 4' x 10.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/7/2012 **DATE LOGGED:** 6/7/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP)g Visual Class.	**0.0 - 3.5 ft. Poorly Graded Sand with Gravel (SP)g:** About 75% predominantly fine to coarse sand, 20% fine to coarse, subrounded gravel and 5% nonplastic fines. Max. size 2 in. Strong reaction with HCl. In-place condition: hard, layered, dry, tan material with weak cementation. Gravelly lenses varying in thickness from 2-4 in. occur at 0.9 and 2.2 ft.	0	0	0
3.5 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(Ss) Visual Class. Lab sample taken from 3.5-10.5 ft. (SC-SM) Lab Class.	**3.5 - 10.5 ft. Sandstone (Ss):** Sandstone consists of predominately fine sand weakly cemented with silica; beds are ½ to 3 in. thick. Soft to moderately soft, breaks with light manual pressure; thicker portion requires heavy manual pressure. Slightly moist. Weak reaction with HCl. Color is grayish red purple with light greenish gray and white mottling. Upon excavation with a backhoe, sandstone breaks up into angular, hand-size and smaller chunks. Lab test data from 3.5-10.5 ft.: 86% sand, 12% fines, 2% gravel; LL and PI not tested, Field Moisture = 8.9%. pH = 8.8, Resistivity = 1,578 ohm/cm, Sulfates = 7 ppm, Sulfides = 5 ppm, Chlorides = 22 ppm. Lab classification is Silty Clayey Sand (SC-SM). Note: material originated from sandstone.			
10.5 ft.	**Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: Surface: wash floodplain strewn with cobbles and boulders and scattered bushes; low rounded hills of claystone from the Chinle Formation outcrop 150 ft. west. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-27

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: OLD U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1901714 **E.** 852434 **GROUND ELEVATION:** 4954

APPROXIMATE DIMENSIONS: 10' x 4' x 6.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: 4.5 **DATE:** 6/7/2012 **DATE LOGGED:** 6/7/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP) Visual Class.	**0.0 - 6.0 ft. Silty Sand (SP):** About 95% fine to coarse sand, 5% nonplastic fines, trace of subrounded to subangular, hard gravel. No dry strength, rapid dilatancy and low toughness. Max. size, 1 in. Strong reaction with HCl.	0	0	0
Lab sample taken from 0.0-5.0 ft.	In-place condition: very soft, homogenous, moist to wet, medium brown material with weak cementation.			
(SP-SM) Lab Class.	Lab test data from 0.0-5.0 ft.: 82% sand, 10% fines, 8% gravel; LL and PI not tested, Field Moisture = 11.5%. pH = 9.7, Resistivity = 2,042 ohm/cm, Sulfates = 33 ppm, Sulfides = < 1 ppm, Chlorides = 33 ppm. Lab classification is Poorly Graded Sand with Silt (SP-SM).			
6.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			

REMARKS: **S**urface: area surrounded by 15 ft. tall tamarisk, scattered bushes; pit located about 150 ft. west of Hamblin Wash; white salt crust observed on ground surface east of pit area. Coordinates and elevation obtained from GPS. Test pit terminated due to water flowing into pit, collapsing side walls.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336
Bureau of Reclamation

LOG OF TEST PIT OR AUGER HOLE

HOLE NO. TP-28

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: OLD U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1896558 **E.** 854163 **GROUND ELEVATION:** 4910

APPROXIMATE DIMENSIONS: 20' x 4' x 13.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/7/2012 **DATE LOGGED:** 6/7/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	CLASSIFICATION AND DESCRIPTION OF MATERIAL SEE USBR 5000, 5005	% PLUS 3 in (75 mm) BY VOLUME		
		3 – 5 in	5 – 12 in	PLUS 12 in
(SM)gcb Visual Class. Lab sample taken from 0.0-13.5 ft. (SM)g Lab Class. **13.5 ft.**	**0.0 - 13.5 ft. Silty Sand with Gravel, Cobbles and Boulders (SM)gcb:** About 65% fine to coarse sand, 20% platy, subrounded to subangular, hard gravel, 15% nonplastic fines with low dry strength, rapid dilatancy and low toughness. Max. size, 1.5 in.. Strong reaction with HCl. Total sample (by volume): About 5% 3 to 5 in. subangular to subrounded, hard cobbles; about 5% 5 to 12 in. subangular to subrounded, hard cobbles; trace of plus 12 in. hard, subrounded boulders; remainder minus 3 in.; maximum size, 1.5 ft. In-place condition: soft to firm, layered, dry, medium reddish brown material with weak cementation. Thin (1-2 in. thick) lenses of gravel scattered throughout interval. Ratio of coarse sand increases with depth. Lab test data from 0.0-13.5 ft.: 60% sand, 125% gravel, 5% fines; LL and PI not tested, Field Moisture = 5.5%. pH = 8.71, Resistivity = 510 ohm/cm, Sulfates = 28 ppm, Sulfides = 2 ppm, Chlorides = 28 ppm. Lab classification is Silty Sand with Gravel (SM)g. **Geologic Interpretation:** Quaternary Alluvium	5	5	T

REMARKS: **S**urface: scattered bushes; pit located about 450 ft. west of Hamblin Wash; few boulders (1-2 ft.) on surface. Coordinates and elevation obtained from GPS. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-29**

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HAMBLIN WASH **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1891414 **E.** 854873 **GROUND ELEVATION:** 4864

APPROXIMATE DIMENSIONS: 20' x 10' x 10.0' DEEP **LOGGED BY:** B. PRUDHOM

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/12/2012 **DATE LOGGED:** 6/12/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM) Visual Class.	**0.0 - 0.5 ft. Silty Sand (SM):** About 55% predominantly fine to medium sand, 25% fines with medium plasticity, medium toughness and high dry strength and 20% fine, subrounded to angular, moderately soft to moderately hard gravel. Max. size, 20 mm. No reaction with HCl. In-place condition: soft to hard, homogeneous, dry, moderate to pale red material with moderate cementation.	0	0	0
0.5 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(Clst) Visual Class.	**0.5 - 10.0 ft. Claystone (Clst):** Claystone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting mostly of clay, but locally silty. Soft to moderately soft, fragments break with manual pressure, becoming moderately hard after drying. Weak to moderate reaction with HCl. Color is pale reddish brown to grayish red, mottled with greenish gray.			
Lab sample taken from 0.5-10.0 ft.	Lab test data from 0.5-10.0 ft.: 73% fines, 22% sand, 5% gravel; LL = 38%, PI = 20%, Field Moisture = 8.9%. pH = 8.85, Resistivity = 2,970 ohm/cm, Sulfates = 210 ppm, Sulfides = < 1 ppm, Chlorides = 2,400 ppm.			
(CL)s Lab Class.	Lab classification is Lean Clay with Sand (CL)s. Note: material originated from claystone. In-place density of 115.5 lb/ft^3 taken at 3.0 ft. with sand cone apparatus. Upon excavation with a backhoe, claystone breaks up into angular, 5 in. and smaller chunks.			
10.0 ft.	**Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: Surface: flat with no vegetation; weathered claystone outcrops of the Chinle Formation at surface. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-30

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: OLD U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1887625 **E.** 854288 **GROUND ELEVATION:** 4804

APPROXIMATE DIMENSIONS: 20' x 4' x 14.0 DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/7/2012 **DATE LOGGED:** 6/7/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken))	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP) Visual Class. . **2.3 ft.**	**0.0 - 2.3 ft. Poorly Graded Sand (SP):** About 95% fine to coarse sand, 5% nonplastic fines and trace of predominantly fine, hard gravel. Max. size 25 mm. Strong reaction with HCl. In-place condition: soft to firm, homogeneous, dry, brown material with weak cementation. **Geologic Interpretation:** Quaternary Alluvium	0	0	0
(Clst) Visual Class. Lab sample taken from 2.3-14.0 ft. (CL)s Lab Class **14.0 ft.**	**2.3 - 14.0 ft. Claystone (Clst):** Claystone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting of approximately 60% clay, 40% fine sand and a trace of lenticular gravel up to 10 mm long. Moderately soft, fragments break with manual pressure, thicker portion requires moderate hammer blow to break, moderately weathered. No reaction with HCl, except on $CaCO_3$ filled fractures and 1-2 mm grains. Color is medium gray. Upon excavation with a backhoe, claystone breaks up into angular, hand-size and smaller chunks. Lab test data from 2.3-14.0 ft.: 78% fines, 22% sand, 0% gravel; LL = 22%, PI = 8%, Field Moisture = 24.2%, Expansion Index = 129. pH = 7.84, Resistivity = 408 ohm/cm, Sulfates = 86 ppm, Sulfides = < 1 ppm, Chlorides = 180 ppm. Lab classification is Lean Clay with Sand (CL)s. **Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: Surface: flat, scattered bushes on loose sand with some gravel up to 3 in. in diameter; pit located 300 ft. west of wash; sandstone from the Chinle Formation outcrops west across the highway. Coordinates and elevation obtained from GPS. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-31

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: OLD U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1881084 **E.** 853659 **GROUND ELEVATION:** 4760

APPROXIMATE DIMENSIONS: 15' x 10' x 5.0' DEEP **LOGGED BY:** B. PRUDHOM

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/12/2012 **DATE LOGGED:** 6/12/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SC)g Visual Class. **1.0 ft.**	**0.0 - 1.0 ft. Clayey Sand with Gravel (SC)g:** About 60% predominantly fine to coarse sand, 25% fines with medium plasticity, medium to high toughness and high dry strength and 15% predominantly fine to coarse, subrounded to angular, moderately hard gravel. Max. size, 35 mm. Strong reaction with HCl. In-place condition: soft to hard, homogeneous, dry, moderate to grayish red to dark reddish brown material with weak cementation. **Geologic Interpretation:** Quaternary Alluvium	0	0	0
(Ss) Visual Class. Lab sample taken from 1.8-5.0 ft. (SC) Lab Class. **5.0 ft.**	**1.0 - 5.0 ft. Sandstone (Ss):** Sandstone consists of fine to coarse, subrounded to subangular sand in a weakly to moderately cemented fine sand and silt matrix; variably cemented with $CaCO_3$; indistinct bedding. Moderately soft and friable, fragments break with manual pressure; slightly to moderately weathered. Mostly no to weak reaction with HCl. Color is light gray. Lab test data from 1.8-5.0 ft.: 68% sand, 29% fines, 3% gravel; LL = 35%, PI = 16%, Field Moisture = 4.5%. pH = 8.9, Resistivity = 371 ohm/cm, Sulfates = 1800 ppm, Sulfides = 4 ppm, Chlorides = 268 ppm. Lab classification is Clayey Sand (SC). Note: material originated from sandstone. In-place density of 116.8 lb/ft^3 taken at 4.0 ft. with sand cone apparatus. Upon excavation with a backhoe, sandstone breaks up into angular, 5 in. and smaller chunks. **Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: Surface: flat with no vegetation. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-32

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: OLD U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1877655 **E.** 853639 **GROUND ELEVATION:** 4729

APPROXIMATE DIMENSIONS: 20' x 4' x 14' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/7/2012 **DATE LOGGED:** 6/7/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM)g Visual Class. Lab sample taken from 6.0-14.0 ft. (SM)g Lab Class. **14.0 ft.**	**0.0 - 14.0 ft. Silty Sand with Gravel (SM)g:** About 70% fine to coarse sand, 15% nonplastic fines, 15% platy, subrounded to subangular, hard gravel. Low dry strength, rapid dilatancy and low toughness. Max. size, 3 in.. Strong reaction with HCl. In-place condition: very hard, layered, dry, medium reddish brown material with moderate cementation. Thin (1 in. thick) lenses of gravel scattered throughout interval. Lab test data from 6.0-14.0 ft.: 68% sand, 19% gravel, 13% fines; LL and PI not tested, Field Moisture = 3.2%. pH = 8.91, Resistivity = 1,670 ohm/cm. Lab classification is Silty Sand with Gravel (SM)g. **Geologic Interpretation:** Quaternary Alluvium	0	0	0

REMARKS: Surface: flat; scattered bushes; Chinle Formation outcrop located 600 ft. east. Coordinates and elevation obtained from GPS. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-33

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1871372 **E.** 853700 **GROUND ELEVATION:** 4683

APPROXIMATE DIMENSIONS: 15' x 7' x 5.5' DEEP **LOGGED BY:** B. PRUDHOM

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/12/2012 **DATE LOGGED:** 6/12/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SC) Visual Class.	**0.0 - 3.0 ft. Clayey Sand (SC):** About 70% predominantly fine to medium, subangular to angular sand, 25% fines with medium to high plasticity, medium to high toughness and high dry strength and 5% fine subangular to angular, soft to moderately soft sandstone and moderately hard chert gravel. Max. size, 20 mm. Strong reaction with HCl. In-place condition: hard, homogeneous, dry, moderate brown to medium reddish brown to pale reddish brown material with weak to moderate cementation. Lab test data from 0.0-3.0 ft.: 70% sand, 23% fines, 7% gravel; LL = 24%, PI = 5%, Field Moisture = 2.8%. pH = 8.91, Resistivity = 1,021 ohm/cm, Sulfates = 180 ppm, Sulfides = 6 ppm, Chlorides = 49 ppm. Lab classification is Silty, Clayey Sand (SC-SM). In-place density attempted at 3.0 ft., but material too hard to dig.	0	0	0
Lab sample taken from 0.0-3.0 ft. (SC-SM) Lab Class.				
3.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(Ss) Visual Class.	**3.0 - 5.5 ft. Sandstone (Ss):** Sandstone consists of predominantly fine to medium, subrounded to subangular sand in a weakly to moderately cemented fine sand and silt matrix; variably cemented with $CaCO_3$; indistinct bedding. Moderately soft and friable, fragments break with manual pressure, larger pieces require moderate hammer blow to break; slightly to moderately weathered. No to weak reaction with HCl. Color is brownish gray. Upon excavation with a backhoe, sandstone breaks up into angular, slabs 2 ft. and smaller in size.			
5.5 ft.	**Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: **S**urface: flat with no vegetation. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-34

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1864680 **E.** 854232 **GROUND ELEVATION:** 4638

APPROXIMATE DIMENSIONS: 20' x 4' x 13.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/7/2012 **DATE LOGGED:** 6/7/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SC) Visual Class.	**0.0 - 1.5 ft. Clayey Sand (SC):** About 70% predominantly fine to coarse sand, 25% fines with low plasticity and 5% fine, subrounded gravel. Max. size 25 mm. Strong reaction with HCl. In-place condition: soft, homogeneous, dry, tan material with weak cementation.	0	0	0
1.5 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(Clst) Visual Class. Lab sample taken from 1.5-13.0 ft. (CL)s Lab Class.	**1.5 - 13.0 ft. Claystone (Clst):** Claystone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting mostly of clay. Moderately soft to moderately hard, edges of hand-size fragment break with manual pressure; thicker portion requires moderate hammer blow to break. No reaction with HCl. Color is medium gray. Upon excavation with a backhoe, claystone breaks up into angular, hand-size and smaller chunks. Lab test data from 1.5-13.0 ft.: 76% fines, 23% sand, 1% gravel; LL = 42%, PI = 19%, Field Moisture = 11.9%. pH = 7.4, Resistivity = 436 ohm/cm, Sulfates = 3,500 ppm, Sulfides = < 1 ppm, Chlorides = 53 ppm. Lab classification is Lean Clay with Sand (CL)s. Note: material originated from claystone.			
13.0 ft.	**Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: **S**urface: low rounded hills of claystone from the Chinle Formation located 100 ft. north. Coordinates and elevation obtained from GPS. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-35

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1860140 **E.** 854023 **GROUND ELEVATION:** 4575

APPROXIMATE DIMENSIONS: 20' x 8' x 9.5' DEEP **LOGGED BY:** B. PRUDHOM

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/12/2012 **DATE LOGGED:** 6/12/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SC) Visual Class.	**0.0 - 6.0 ft. Clayey Sand (SC):** About 70% fine to medium sand, 30% fines with medium plasticity, medium to high toughness, no to slow dilatancy and medium dry strength and trace of fine, subangular gravel. Max. size 15 mm. Strong reaction with HCl. In-place condition: hard, homogeneous, dry, moderate brown material with moderate cementation. Lab test data from 0.0-4.5 ft.: 57% sand, 35% fines, 8% gravel; LL = 28%, PI = 17%, Field Moisture = 4.3%. pH = 8.86, Resistivity = 780 ohm/cm, Sulfates = 450 ppm, Sulfides = 6 ppm, Chlorides = 17 ppm. Lab classification is Clayey Sand (SC). In-place density of 113.1 lb/ft^3 taken at 4.5 ft. with sand cone apparatus.	0	0	0
Lab sample taken from 0.0-4.5 ft. (SC) Lab Class.				
6.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(Clst) Visual Class.	**6.0 - 9.5 ft. Claystone (Clst):** Claystone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting mostly of clay; locally shaley. Moderately soft to moderately hard, edges of hand-size fragment break with manual pressure; thicker portion requires moderate hammer blow to break. No reaction with HCl. Color is grayish brown. Upon excavation with a backhoe, claystone breaks up into angular, slabs 8 in. and smaller in size.			
9.5 ft.	**Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: Surface: flat with few bushes on loose sand and platy gravel; low rounded hills of claystone from the Chinle Formation located 100 ft. south. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-36

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1856088 **E.** 853962 **GROUND ELEVATION:** 4552

APPROXIMATE DIMENSIONS: 20' x 4' x 13.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/7/2012 **DATE LOGGED:** 6/7/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM) Visual Class.	**0.0 - 7.0 ft. Silty Sand (SM):** About 85% fine to coarse sand and 15% nonplastic fines. Medium dry strength, slow dilatancy, low toughness. Max. size, coarse sand. Moderate reaction with HCl. In-place condition: soft, homogenous, dry, medium brown material with weak cementation.	0	0	0
7.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(SP-SC) Visual Class.	**7.0 - 13.5 ft. Poorly Graded Sand with Clay (SP-SC):** About 90% predominantly fine to medium sand and 10% fines with medium plasticity, medium dry strength, no dilatancy and medium toughness. Max. size, medium sand. Strong reaction with HCl. In-place condition: very hard, layered, dry, medium brown material with strong cementation. Irregular, 1 in. thick layers of fine gravel occur throughout interval (seen in pit walls).	0	0	0
Lab sample taken from 7.0-13.5 ft. (SC) Lab Class.	Lab test data from 7.0-13.5 ft.: 65% sand, 28% fines, 7% gravel; LL = 33%, PI = 19%, Field Moisture = 6.1%. pH = 8.48, Resistivity = 742 ohm/cm, Sulfates = 2,100 ppm, Sulfides = < 1 ppm, Chlorides = 37 ppm. Lab classification is Clayey Sand (SC).			
13.5 ft.	**Geologic Interpretation:** Quaternary Alluvium			

REMARKS: Surface: flat area; Chinle outcrops located 300 ft. northeast. Coordinates and elevation obtained from GPS. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-37

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: OLD U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1850071 **E.** 856145 **GROUND ELEVATION:** 4503

APPROXIMATE DIMENSIONS: 20' x 4' x 10.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/6/2012 **DATE LOGGED:** 6/6/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM) Visual Class.	**0.0 - 4.5 ft. Silty Sand (SM):** About 75% predominantly fine to medium sand, 20% nonplastic fines and 5% fine, subrounded to subangular, flat gravel. Max. size, 10 mm. Strong reaction with HCl. In-place condition: soft, layered, dry, brown material with weak cementation. Lab test data from 1.0-4.5 ft.: 75% sand, 23% fines, 2% gravel; LL = 33%, PI = 8%, Field Moisture = 3.6%. pH = 8, Resistivity = 742 ohm/cm, Sulfates = 1,300 ppm, Sulfides = < 1 ppm, Chlorides = 28 ppm. Lab classification is Silty Sand (SM). In-place density of 113.2 lb/ft^3 taken at 4.5 ft. with sand cone apparatus.	0	0	0
Lab sample taken from 1.0-4.5 ft. (SM) Lab Class.				
4.5 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(Ss) Visual Class.	**4.5 - 10.5 ft. Sandstone (Ss):** Sandstone consists of predominately fine sand variably cemented with silica; bedding spaced less than 1 to 3 in. apart. Moderately soft, breaks with manual pressure, but excavates slowly; slightly to moderately weathered, contains rust colored grains. No reaction with HCl. Color is very light gray. Upon excavation with a backhoe, sandstone breaks up into angular, hand-size and smaller chunks.			
10.5 ft.	**Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: Surface: flat area near small drainage. No vegetation. Cobbles and boulders (silica concretions) on surface. Coordinates and elevation obtained from GPS. Test pit terminated near refusal; backhoe leaking hydraulic fluid.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-38**

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: OLD U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1845472 **E.** 856398 **GROUND ELEVATION:** 4427

APPROXIMATE DIMENSIONS: 10' x 4' x 4.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/6/2012 **DATE LOGGED:** 6/6/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP) Visual Class.	**0.0 - 1.0 ft. Poorly Graded Sand (SP):** About 95% predominantly fine to medium sand and 5% nonplastic fines. Max. size, medium sand. Strong reaction with HCl. In-place condition: soft, homogeneous, dry, brown material with no cementation.	0	0	0
1.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(Ss) Visual Class. Lab sample taken from 1.0-4.0 ft. (SM) Lab Class.	**1.0 - 4.0 ft. Sandstone (Ss):** Sandstone consists of predominately fine sand variably cemented with silica; bedding spaced less than 1 to 3 in. apart. Moderately soft, breaks with manual pressure, but excavates very slowly; at 4.0 ft. becomes harder, hand size fragments require heavy hammer blow to break; slightly to moderately weathered, contains rust colored grains. No reaction with HCl. Color is very light gray. Upon excavation with a backhoe, sandstone breaks up into angular, hand-size and smaller chunks. Lab test data from 0.0-4.0 ft.: 71% sand, 28% fines, 1% gravel; Nonplastic, Field Moisture = 8.2%. pH = 7.73, Resistivity = 1,485 ohm/cm, Sulfates = 2,100 ppm, Sulfides = 2 ppm, Chlorides = 240 ppm. Lab classification is Silty Sand (SM). Note: material derived from sandstone.			
4.0 ft.	**Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: Surface: low rounded hills of white Chinle sandstone, many topped with petrified wood fragments. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-39

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: OLD U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1838834 **E.** 855393 **GROUND ELEVATION:** 4399

APPROXIMATE DIMENSIONS: 20' x 4' x 7.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/6/2012 **DATE LOGGED:** 6/6/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SC) Visual Class. Lab sample taken from 0.0-3.5 ft. (SC) Lab Class. **3.5 ft.**	**0.0 - 3.5 ft. Clayey Sand (SC):** About 70% predominantly fine to coarse sand, 25% fines with low plasticity, slow dilatancy and low toughness and 5% fine gravel. Max. size, 10 mm. Strong reaction with HCl. In-place condition: firm, homogeneous, dry, brown material with no cementation. Lab test data from 0.0-3.5 ft.: 69% sand, 25% fines, 6% gravel; LL = 27%, PI = 11%, Field Moisture = 4.3%. pH = 7.89, Resistivity = 195 ohm/cm, Sulfates = 450 ppm, Sulfides = < 1 ppm, Chlorides = 260 ppm. Lab classification is Clayey Sand (SC). **Geologic Interpretation:** Quaternary Alluvium	0	0	0
(Clst) Visual Class. **7.5 ft.**	**3.5 - 7.5 ft. Sandstone (Ss):** Sandstone consists of predominately fine sand moderately cemented with silica; bedding spaced ½ to 2 in. apart. Moderately soft to moderately hard, edges break with manual pressure, larger pieces require moderate hammer blow to break; slightly to moderately weathered. No reaction with HCl. Color is light gray. Upon excavation with a backhoe, sandstone breaks up into angular, hand-size and smaller chunks. **Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: Surface: flat area south of drainage, white Chinle sandstone rounded hills west of highway. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-40**

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: OLD U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1834203 **E.** 853922 **GROUND ELEVATION:** 4380

APPROXIMATE DIMENSIONS: 20' x 10' x 13.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/6/2012 **DATE LOGGED:** 6/6/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(CL) Visual Class. Lab sample taken from 0.0-5.0 ft. (CL) Lab Class. **5.0 ft.**	**0.0 - 5.0 ft. Lean Clay (CL):** About 90% fines with low to medium plasticity, low toughness and high dry strength and 10% predominantly fine sand. Max. size, fine sand. Strong reaction with HCl. In-place condition: very hard, homogeneous, moist, medium grayish brown material with moderate cementation. Lab test data from 0.0-5.0 ft.: 74% fines, 24% sand, 2% gravel; LL = 59%, PI = 40%, Field Moisture = 18.6%, Expansion Index = 137. pH = 8.85, Resistivity = 436 ohm/cm, Sulfates = 3,800 ppm, Sulfides = < 1 ppm, Chlorides = 2,300 ppm. Lab classification is Lean Clay (CL). In-place density of 72.9 lb/ft^3 taken at 4.0 ft. with sand cone apparatus. **Geologic Interpretation:** Quaternary Alluvium	0	0	0
(SP) Visual Class. **5.5 ft.**	**5.0 - 5.5 ft. Poorly Graded Sand (SP):** About 95% predominantly medium sand and 5% nonplastic fines.. Max. size, coarse sand. Strong reaction with HCl. In-place condition: hard, homogeneous, dry, brown material with weak cementation. **Geologic Interpretation:** Quaternary Alluvium	0	0	0
(Clst) Visual Class. **13.0 ft.**	**5.5 - 13.0 ft. Claystone (Clst):** Claystone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting mostly of clay. Moderately soft, hand-size fragment break with manual pressure; moderately weathered. Weak reaction with HCl. Color is medium brownish gray with yellowish brown mottling. Encountered a piece of petrified wood log at 9.5 ft. Upon excavation with a backhoe, claystone breaks up into angular, hand-size and smaller chunks. **Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: Surface: low area, about 200-300 ft. north of Moenkopi Wash which has cut through claystone and sandstone. Coordinates and elevation obtained from GPS. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-41

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1829414 **E.** 853563 **GROUND ELEVATION:** 4346

APPROXIMATE DIMENSIONS: 20' x 4' x 12.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/6/2012 **DATE LOGGED:** 6/6/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM) Visual Class.	**0.0 - 1.5 ft. Silty Sand (SM):** About 85% predominantly fine to coarse sand, 15% nonplastic fines and trace of fine, subrounded gravel (surface). Max. size, 15 mm. Strong reaction with HCl. In-place condition: firm, homogeneous, dry, brown material with weak cementation.	0	0	0
1.5 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(SC) Visual Class.	**1.5 - 3.0 ft. Clayey Sand (SC):** About 75% predominantly fine to coarse sand and 25% fines with low plasticity. Max. size, coarse sand. Strong reaction with HCl. In-place condition: soft, homogeneous, dry, reddish brown material with weak cementation.	0	0	0
3.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(Clst) Visual Class. Lab sample taken from 3.0-8.0 ft. (CH) Lab Class.	**3.0 - 8.0 ft. Claystone (Clst):** Claystone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting mostly of clay. Moderately hard, edges of hand-size fragment break with manual pressure; thicker portion requires moderate hammer blow to break. Weak reaction with HCl. Color is medium brownish gray. Upon excavation with a backhoe, claystone breaks up into angular, hand-size and smaller chunks. Lab test data from 3.0-8.0 ft.: 91% fines, 9% sand, 0% gravel; LL and PI not tested; Field Moisture = 14.7%. pH = 7.09, Resistivity = 752 ohm/cm, Sulfates = 3,900 ppm, Sulfides = < 1 ppm, Chlorides = 720 ppm. Lab classification is Fat Clay (CH). Note material originated from claystone.			
8.0 ft.	**Geologic Interpretation:** Chinle Formation, Petrified Forest Member			
(Ss) Visual Class.	**8.0 - 12.0 ft. Sandstone (Ss):** Sandstone consists of predominately medium sand weaky cemented with $CaCo_3$; bedding not apparent. Moderately soft, fragments break with manual pressure; intensely weathered, appears hydrothermally altered. Strong reaction with HCl. Color is yellowish greenish brown. Upon excavation with a backhoe, claystone breaks up into angular, hand-size and smaller chunks.			
12.0 ft.	**Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: Surface: low area, about 200-300 ft. north of Moenkopi Wash which has cut through claystone and sandstone. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-42

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1824402 **E.** 854270 **GROUND ELEVATION:** 4337

APPROXIMATE DIMENSIONS: 20' x 10' x 14.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/6/2012 **DATE LOGGED:** 6/6/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SC) Visual Class. **7.0 ft.**	**0.0 - 7.0 ft. Clayey Sand (SC):** About 80% predominantly very fine to fine sand and 20% fines with medium plasticity, very high dry strength and low toughness. Max. size, fine sand. Strong reaction with HCl. In-place condition: very soft, homogeneous, dry, tan material with weak cementation. In-place density of 93.5 lb/ft^3 taken at 5.0 ft. with sand cone apparatus. **Geologic Interpretation:** Quaternary Alluvium	0	0	0
(Clst) Visual Class. Lab sample taken from 7.0-14.5 ft. (SC) Lab Class. **14.5 ft.**	**7.0 - 14.5 ft. Clayey Sand (SC):** About 50% predominantly very fine to fine sand, 45% fines with medium plasticity, very high dry strength and low toughness and 5% fine gravel. Max. size, 10 mm. Strong reaction with HCl. In-place condition: hard, homogeneous, dry, tan material with weak cementation. Lab test data from 7.0-14.5 ft.: 49% sand, 47% fines, 4% gravel; LL = 28%, PI = 10%, Field Moisture = 5.9%. pH = 9.11, Resistivity = 1,392 ohm/cm, Sulfates = 36 ppm, Sulfides = 9 ppm, Chlorides = 38 ppm. Lab classification is Clayey Sand (SC). **Geologic Interpretation:** Quaternary Alluvium			

REMARKS: **S**urface: scattered bushes. Coordinates and elevation obtained from GPS. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-43**

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1819698 **E.** 854955 **GROUND ELEVATION:** 4360

APPROXIMATE DIMENSIONS: 20' x 4' x 7.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/6/2012 **DATE LOGGED:** 6/6/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SC) Visual Class. Lab sample taken from 0.0-6.0 ft. (SC-SM) Lab Class. **6.0 ft.**	**0.0 - 6.0 ft. Clayey Sand (SC):** About 80% predominantly fine to medium sand, 20% fines with medium plasticity and trace of fine, subrounded to subangular gravel. Max. size 15 mm. Strong reaction with HCl. In-place condition: firm to hard, homogeneous, dry, medium brown material with weak to moderate cementation. Lab test data from 0.0-6.0 ft.: 42% fines, 57% sand, 1% gravel; LL = 25%, PI = 7%, Field Moisture = 5.0%. pH = 8.95, Resistivity = 566 ohm/cm, Sulfates = 97 ppm, Sulfides = 2 ppm, Chlorides = 200 ppm. Lab classification is Silty, Clayey Sand (SC-SM). **Geologic Interpretation:** Quaternary Alluvium	0	0	0
(Clst) Visual Class. **13.0 ft.**	**6.0 - 13.0 ft. Claystone (Clst):** Claystone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting mostly of clay. Moderately soft to moderately hard, edges of hand-size fragment break with manual pressure; thicker portion requires moderate hammer blow to break, from 1.8 – 3.5 ft. claystone is soft to moderately soft. No reaction with HCl. Color is grayish red purple with light greenish gray spots and mottling. Claystone layers are 1-2 in. thick. Upon excavation with a backhoe, claystone breaks up into angular, hand-size and smaller chunks. **Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: **S**urface: low area with no drainage outlet, scattered bushes; claystone from the Chinle Formation located south and north. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-44**

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1813749 **E.** 854273 **GROUND ELEVATION:** 4343

APPROXIMATE DIMENSIONS: 20' x 4' x 8.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/5/2012 **DATE LOGGED:** 6/5/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM) Visual Class.	**0.0 - 0.8 ft. Silty Sand (SM):** About 80% predominantly medium to coarse sand, 20% nonplastic fines and a trace of predominantly fine, hard gravel. Max. size 25 mm. Strong reaction with HCl. In-place condition: soft, homogeneous, dry, tan material with no cementation.	0	0	0
0.8 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(Clst/Ss) Visual Class. Lab sample taken from 0.8-8.5 ft. (SC-SM) Lab Class.	**0.8 - 8.5 ft. Claystone (Clst) with Interbedded Sandstone (Ss):** Claystone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting mostly of clay. From 0.8-4.0 ft. moderately soft to moderately hard and moderately weathered, edges of hand-size fragment break with manual pressure, thicker portion requires moderate hammer blow to break; from 4.0-8.5 ft. moderately hard and slightly weathered. No reaction with HCl. Color is dark brown. Claystone layers are 1-4 in. thick. Sandstone interbeds are less than 1 to 2 in. thick and consist of predominately fine sand moderately cemented with $CaCo_3$. Sandstone is moderately soft to moderately hard, fragments break with manual pressure. Weak to strong reaction with HCl. Color is medium gray. Concentration of sandstone lenses is greater in the upper half (0.8-4.0 ft.) of pit. Upon excavation with a backhoe, claystone and sandstone breaks up into angular, hand-size and smaller chunks. Lab test data from 0.8-8.5 ft.: 57% sand, 42% fines, 1% gravel; LL = 24%, PI = 5%, Field Moisture = 7.2%. pH = 9.44, Resistivity = 742 ohm/cm, Sulfates = 110 ppm, Sulfides = 2 ppm, Chlorides = 700 ppm. Lab classification is Silty, Clayey Sand (SC-SM). Note: material originated from claystone.			
8.5 ft.	**Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: Surface: scattered bushes on loose sand; low rounded hills of claystone from the Chinle Formation located east beyond the highway ROW. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-45

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1809488 **E.** 854273 **GROUND ELEVATION:** 4320

APPROXIMATE DIMENSIONS: 20' x 4' x 13.4' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/5/2012 **DATE LOGGED:** 6/5/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP-SM) Visual Class. **1.0 ft.**	**0.0 - 1.0 ft. Poorly Graded Sand with Silt (SP-SM):** About 90% predominantly medium to coarse sand and 10% nonplastic fines and trace of predominantly fine, hard gravel. Max. size 25 mm. Strong reaction with HCl. **Geologic Interpretation:** Quaternary Alluvium	0	0	0
(Clst/Slst) Visual Class. **4.5 ft.**	**1.0 - 4.5 ft. Claystone (Clst) with Interbedded Siltstone (Slst):** Claystone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting mostly of clay. Moderately soft to moderately hard, edges of hand-size fragment break with manual pressure; thicker portion requires moderate hammer blow to break. No reaction with HCl. Color is mottled dark brownish gray. Claystone layers are 1-5 in. thick. Siltstone interbeds are less than 1 to 2 in. thick and consist of moderately indurated silt. Moderately soft, fragments break with manual pressure. Weak reaction with HCl on carbonate grains. Color is very light green. Upon excavation with a backhoe, claystone and siltstone breaks up into angular, hand-size and smaller chunks. **Geologic Interpretation:** Chinle Formation, Petrified Forest Member			
(Clst) Visual Class. Lab sample taken from 4.5-13.4 ft. (CL)s Lab Class. **13.4 ft.**	**4.5 - 13.4 ft. Claystone (Clst):** Claystone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting of approximately 60% clay, 40% fine sand and a trace of lenticular gravel up to 10 mm long. Moderately soft to moderately hard, fragments break with manual pressure, thicker portion requires moderate hammer blow to break, moderately weathered. No reaction with HCl. Color is medium brownish gray. Upon excavation with a backhoe, claystone breaks up into angular, hand-size and smaller chunks. Lab test data from 4.5-13.4 ft.: 72% fines, 28% sand, 0% gravel; LL and PI not tested, Field Moisture = 12.2%. pH = 8.22, Resistivity = 306 ohm/cm, Sulfates = 75 ppm, Sulfides = 3 ppm, Chlorides = 450 ppm. Lab classification is Lean Clay with Sand (CL)s. Note: material originated from claystone. **Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: Surface: scattered bushes. Chinle Formation outcrop east outside of ROW. Coordinates and elevation obtained from GPS. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-46

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1803445 **E.** 853625 **GROUND ELEVATION:** 4313

APPROXIMATE DIMENSIONS: 20' x 4' x 8.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/5/2012 **DATE LOGGED:** 6/5/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(Clst) Visual Class.	**0.0 - 8.0 ft. Claystone (Clst) with Interbedded Sandstone (Ss):** Claystone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting mostly of clay. Moderately soft to moderately hard, edges of hand-size fragment break with manual pressure; thicker portion requires moderate hammer blow to break, from 0.0-0.8 ft. claystone is moderately soft. No reaction with HCl. Color is medium gray with light greenish gray spots and mottling. Claystone layers are 1-5 in. thick. Sandstone interbeds are less than 1 to 3 in. thick and consist of predominately fine to medium sand moderately cemented with $CaCo_3$. Sandstone is moderately soft, fragments break with manual pressure. Weak reaction with HCl. Color is very light gray.	0	0	0
Lab sample taken from 0.0-8.0 ft. (CL) Lab Class.	From 0.8-1.3 ft. Sandstone layer composed of predominately fine sand cemented with silica; crystalline Sandstone is hard to very hard, requires heavy hammer blow to break; slightly weathered. No reaction with HCl. Color is very light gray. Upon excavation with a backhoe, claystone breaks up into angular, hand-size and smaller chunks. Lab test data from 0.0-8.0 ft.: 54% fines, 28% sand, 18% gravel; LL = 41%, PI = 15%, Field Moisture = 7.9%, Expansion Index = 40. pH = 8.35, Resistivity = 807 ohm/cm, Sulfates = 1,500 ppm, Sulfides = < 1 ppm, Chlorides = 620 ppm. Lab classification is Lean Clay (CL). Note: material originated from claystone.			
8.0 ft.	**Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: **S**urface: scattered bushes. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-47

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1798627 **E.** 853115 **GROUND ELEVATION:** 4273

APPROXIMATE DIMENSIONS: 20' x 4' x 13.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/5/2012 **DATE LOGGED:** 6/5/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken))	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP-SM)b Visual Class. Lab sample taken from 0.0-8.0 ft. (SM) Lab Class. **8.0 ft.**	**0.0 - 8.0 ft. Poorly Graded Sand with Silt and Trace of Boulders (SP-SM)b:** About 80% predominantly medium to coarse sand, 10% nonplastic fines and 10% predominantly fine, hard gravel. Max. size, 25 mm. Strong reaction with HCl. Total sample (by volume): Trace of plus 12 in. hard, subangular boulders; remainder minus 3 in.; maximum size, 1.2 ft. In-place condition: soft to firm, homogeneous, dry, tan material with weak cementation. Gravel layer from 5.0-5.5 ft. Lab test data from 0.0-8.0 ft.: 79% sand, 15% fines, 6% gravel; LL and PI not tested, Field Moisture = 2.4%. pH = 9.42, Resistivity = 733 ohm/cm, Sulfates = 300 ppm, Sulfides = < 1 ppm, Chlorides = 83 ppm. Lab classification is Silty Sand (SM). **Geologic Interpretation:** Quaternary Alluvium	0	0	T
(Clst) Visual Class. **13.5 ft.**	**8.0 - 13.5 ft. Claystone (Clst):** Claystone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting of approximately 60% clay, 40% fine sand and a trace of lenticular gravel up to 10 mm long. Moderately soft, fragments break with manual pressure, thicker portion requires moderate hammer blow to break, moderately weathered. Strong reaction with HCl. Color is medium gray. Upon excavation with a backhoe, claystone breaks up into angular, hand-size and smaller chunks. **Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: **S**urface: scattered bushes on loose sand. Coordinates and elevation obtained from GPS. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-48**

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1792253 **E.** 852467 **GROUND ELEVATION:** 4252

APPROXIMATE DIMENSIONS: 20' x 4' x 7.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/5/2012 **DATE LOGGED:** 6/5/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SC) Visual Class.	**0.0 - 1.8 ft. Clayey Sand (SC):** About 70% predominantly fine to coarse sand, 30% fines with low plasticity and trace of fine, subrounded gravel. Max. size, 25 mm. Strong reaction with HCl. In-place condition: soft, homogeneous, dry, tan material with weak cementation.	0	0	0
1.8 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(Clst/Ss) Visual Class.	**1.8 - 7.5 ft. Claystone (Clst) with Interbedded Sandstone (Ss):** Claystone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting mostly of clay. Moderately soft to moderately hard, edges of hand-size fragment break with manual pressure; thicker portion requires moderate hammer blow to break, from 1.8-3.5 ft. claystone is soft to moderately soft. No reaction with HCl. Color is grayish red purple with light greenish gray spots and mottling. Claystone layers are 1-2 in. thick. Sandstone interbeds are less than 1 to 2 in. thick and consist of predominately fine to medium sand moderately cemented with $CaCo_3$. Sandstone is moderately soft, fragments break with manual pressure. Concentration of sandstone lenses is greater in the upper half (1.8-3.8 ft.) of pit. Weak reaction with HCl. Color is very light gray. Upon excavation with a backhoe, claystone breaks up into angular, hand-size and smaller chunks. Lab test data from 1.8-7.5 ft.: 51% fines, 46% sand, 3% gravel; LL and PI not tested, Field Moisture = 10.0%, Expansion Index = 20. pH = 8.15, Resistivity = 1,021 ohm/cm, Sulfates = 2,100 ppm, Sulfides = < 1 ppm, Chlorides = 390 ppm. Lab classification is Sandy Lean Clay s(CL). Note: material originated from claystone.			
Lab sample taken from 1.8-7.5 ft. s(CL) Lab Class.				
7.5 ft.	**Geologic Interpretation:** Chinle Formation			

REMARKS: Surface: scattered bushes on loose sand; low rounded hills of claystone from the Chinle Formation located east beyond the highway ROW. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-49**

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: COPPER MINE ROAD **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1932123 **E.** 841355 **GROUND ELEVATION:** 5403

APPROXIMATE DIMENSIONS: 14' x 4' x 7.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/18/2012 **DATE LOGGED:** 6/18/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP) Visual Class. Lab sample taken from 0.0-3.2 ft. (SP-SM) Lab Class **3.2 ft.**	**0.0 - 3.2 ft. Poorly Graded Sand (SP):** About 100% predominantly fine to medium sand and a trace of nonplastic fines. Low dry strength, rapid dilatancy and low toughness. Max. size, medium sand. No reaction with HCl. In-place condition: very soft to soft, homogenous, dry, light reddish brown material with no cementation. Lab test data from 0.0-3.2 ft.: 91% sand, 9% fines, 0% gravel; LL and PI not tested, Field Moisture = 1.1%. pH = 8.9, Resistivity = 6,125 ohm/cm, Sulfates = 3 ppm, Sulfides = < 1 ppm, Chlorides = 7 ppm. Lab classification is Poorly Graded Sand with Silt (SP-SM). **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
(Ss) Visual Class. **7.0 ft.**	**3.2 - 7.0 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand moderately cemented with iron oxide and silica; crossbedded, beds are 1/2 to 2 in. thick. Moderately soft to moderately hard, edges of hand-size fragment break with manual pressure, thicker portions require moderate hammer blow to break; moderately weathered. No reaction with HCl, except on $CaCO_3$ coating fractures from 3.2-5.2 ft. Color is light reddish brown. Upon excavation with a backhoe, the sandstone breaks up into platy fragments 6 in. in size and smaller. **Geologic Interpretation:** Navajo Sandstone Formation			

REMARKS: Surface: top of small dune, loose sand with scattered Mormon Tea. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-50**

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: COPPER MINE ROAD **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1943021 **E.** 843301 **GROUND ELEVATION:** 5430

APPROXIMATE DIMENSIONS: 10' x 4' x 5.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/18/2012 **DATE LOGGED:** 6/18/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM) Visual Class. Lab sample taken from 0.0-5.0 ft. (SM) Lab Class **5.0 ft.**	**0.0 - 5.0 ft. Silty Sand (SM):** About 85% predominantly fine to medium sand, 15% nonplastic fines and a trace of fine gravel at about 5.0 ft. Low dry strength, rapid dilatancy and low toughness. Max. size, 2 in. Strong reaction with HCl. In-place condition: very soft to soft, homogenous, dry, light reddish brown material with no cementation. Lab test data from 0.0-5.0 ft.: 87% sand, 13% fines, 0% gravel; LL and PI not tested, Field Moisture = 1.4%. pH = 8.34, Resistivity = 8,816 ohm/cm, Sulfates = 2 ppm, Sulfides = < 1 ppm, Chlorides = 7 ppm. Lab classification is Silty Sand (SM). **Geologic Interpretation:** QuaternaryEluvium (wind-blown sand)	0	0	0
(Ss) Visual Class. **5.0 ft.**	**5.0 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand moderately cemented with silica; crossbedded, beds are 1/2 to 2 in. thick. Moderately hard, edges of hand-size fragment break with manual pressure; thicker portions require moderate hammer blow to break; moderately weathered, 2 mm rust spots apparent. No reaction with HCl. Color is very pale orange. Backhoe only grooved surface of sandstone, could not excavate. **Geologic Interpretation:** Navajo Sandstone Formation			

REMARKS: Surface: flat loose sand with scattered grass clumps. Sandstone outcrop about 200 ft. north; land surface drops off 5-10 ft. to the west. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336
Bureau of Reclamation

LOG OF TEST PIT OR AUGER HOLE

HOLE NO. TP-51

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: COPPER MINE ROAD **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1952941 **E.** 845453 **GROUND ELEVATION:** 5430

APPROXIMATE DIMENSIONS: 20' x 4' x 13.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/18/2012 **DATE LOGGED:** 6/18/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	CLASSIFICATION AND DESCRIPTION OF MATERIAL SEE USBR 5000, 5005	% PLUS 3 in (75 mm) BY VOLUME		
		3 – 5 in	5 – 12 in	PLUS 12 in
(SP) Visual Class.	**0.0 - 4.5 ft. Poorly Graded Sand (SP):** About 95% predominantly fine sand, 5% nonplastic fines and a trace of fine subrounded to rounded gravel. Low dry strength, rapid dilatancy and low toughness. Max. size, 15 mm. Strong reaction with HCl. In-place condition: soft, homogenous, dry, light brown material with weak cementation.	0	0	0
4.5 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
(CL) Visual Class.	**4.5 - 6.5 ft. Lean Clay (CL):** About 90% fines with medium plasticity, medium toughness and high dry strength and 10% predominantly fine sand. Max. size fine sand. Strong reaction with HCl. In-place condition: very hard, homogeneous, slightly moist, medium light gray material with strong cementation.	0	0	0
Lab sample taken from 4.5-6.5 ft. s(CL) Lab Class.	Lab test data from 4.5-6.5 ft.: 61% fines, 39% sand, 0% gravel; LL = 33%, PI = 18%, Field Moisture = 13.5%. pH = 8.84, Resistivity = 817 ohm/cm, Sulfates = 100 ppm, Sulfides = < 1 ppm, Chlorides = 143 ppm. Lab classification is Sandy Lean Clay s(CL).			
6.5 ft.	**Geologic Interpretation:** Quaternary Eluvium			
(SP) Visual Class.	**6.5 - 10.4 ft. Poorly Graded Sand (SP):** About 95% predominantly fine sand and 5% nonplastic fines. Low dry strength, rapid dilatancy and low toughness. Max. size, fine sand. Strong reaction with HCl. From 6.5-8.0 ft. color is light gray, from 8.0 to 10.4 ft. color is white. In-place condition: soft, homogenous, dry material with weak cementation.	0	0	0
10.4 ft.	**Geologic Interpretation:** Quaternary Eluvium			
(Ss) Visual Class.	**10.4 - 13.0 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand weakly cemented with silica; crossbedded, beds are 1/2 to 2 in. thick. Soft to moderately soft, fragment break with manual pressure. No reaction with HCl. Color is very pale orange. Upon excavation with a backhoe, the sandstone breaks up into platy fragments 10 in. in size and smaller.			
13.0 ft.	**Geologic Interpretation:** Navajo Sandstone Formation			

REMARKS: **S**urface: flat with scattered grass and Mormon Tea. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-52**

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: COPPER MINE ROAD **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1958219 **E.** 846142 **GROUND ELEVATION:** 5435

APPROXIMATE DIMENSIONS: 15' x 4' x 7.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/18/2012 **DATE LOGGED:** 6/18/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP) Visual Class.	**0.0 - 2.0 ft. Poorly Graded Sand (SP):** About 95% predominantly fine sand and 5% nonplastic fines. Low dry strength, rapid dilatancy and low toughness. Max. size, fine sand. No reaction with HCl. In-place condition: soft, homogenous, dry, light brown material with weak cementation.	0	0	0
2.0 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
(SP)g Visual Class. Lab sample taken from 2.0-3.8 ft. (SP) Lab Class.	**2.0 - 3.8 ft. Poorly Graded Sand with Gravel (SP)g:** About 75% predominantly fine sand, 20% fine to coarse gravel in the form of platy, angular sandstone fragments and 5% nonplastic fines. Low dry strength, rapid dilatancy and low toughness. Max. size, 3 in. No reaction with HCl. In-place condition: soft, homogenous, dry, very pale orange material with weak cementation. Lab test data from 2.0-3.8 ft.: 96% sand, 4% fines, 0% gravel; LL and PI not tested, Field Moisture = 0.6%. pH = 8.82, Resistivity = 9,187 ohm/cm, Sulfates = 6 ppm, Sulfides = < 1 ppm, Chlorides = 8 ppm. Lab classification is Poorly Graded Sand (SP).			
3.8 ft.	**Geologic Interpretation:** Quaternary Eluvium (weathered sandstone)			
(Ss) Visual Class.	**3.8 - 7.0 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand weakly cemented with silica; crossbedded, beds are 1/2 to 2 in. thick. Soft to moderately soft, fragment break with manual pressure. No reaction with HCl. Color is very pale orange. Upon excavation with a backhoe, the sandstone breaks up into platy fragments 4 in. in size and smaller.			
7.0 ft.	**Geologic Interpretation:** Navajo Sandstone Formation			

REMARKS: Surface: furrowed sand dunes with scattered grass and Mormon Tea. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-53**

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: COPPER MINE ROAD **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1964315 **E.** 846472 **GROUND ELEVATION:** 5442

APPROXIMATE DIMENSIONS: 15' x 4' x 8.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/18/2012 **DATE LOGGED:** 6/18/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP) Visual Class. **3.0 ft.**	**0.0 - 3.0 ft. Poorly Graded Sand (SP):** About 95% predominantly fine sand and 5% nonplastic fines. Low dry strength, rapid dilatancy and low toughness. Max. size, fine sand. No reaction with HCl. In-place condition: soft, homogenous, dry, brown grading with depth to tan material with weak cementation. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
(SP)g Visual Class. **3.5 ft.**	**3.0 - 3.5 ft. Poorly Graded Sand with Gravel (SP)g:** About 80% predominantly fine sand and 20% fine to coarse gravel in the form of platy, angular sandstone fragments. Low dry strength, rapid dilatancy and low toughness. Max. size, 3 in. No reaction with HCl. In-place condition: soft, homogenous, dry, very pale orange material with weak cementation. **Geologic Interpretation:** Quaternary Eluvium (weathered sandstone)	0	0	0
(Ss) Visual Class. **8.0 ft.**	**3.5 - 8.0 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand moderately cemented with silica; crossbedded, beds are 1/8 to 3 in. thick. Moderately hard, edges of hand-size fragment break with manual pressure; thicker portions require moderate hammer blow to break. No reaction with HCl. Color is very pale orange. Upon excavation with a backhoe, the sandstone breaks up into platy fragments 4 in. in size and smaller. **Geologic Interpretation:** Navajo Sandstone Formation			

REMARKS: Surface: furrowed sand dunes with scattered grass and Mormon Tea. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-54

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: COPPER MINE ROAD **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1968137 **E.** 845058 **GROUND ELEVATION:** 5453

APPROXIMATE DIMENSIONS: 15' x 4' x 6.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/18/2012 **DATE LOGGED:** 6/18/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP) Visual Class.	**0.0 - 2.4 ft. Poorly Graded Sand (SP):** About 95% predominantly fine sand and 5% nonplastic fines. Low dry strength, rapid dilatancy and low toughness. Max. size, fine sand. No reaction with HCl. In-place condition: soft, homogenous, dry, grayish brown material with weak cementation.	0	0	0
2.4 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
(Ss) Visual Class.	**2.4 - 6.5 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand moderately cemented with silicaand iron oxide; crossbedded, beds are 1/8 to 3 in. thick. Moderately hard, edges of hand-size fragment break with manual pressure; thicker portions require moderate hammer blow to break. No reaction with HCl. Color is light gray to yellowish gray (due to limonite staining). Upon excavation with a backhoe, the sandstone breaks up into platy fragments 8 in. in size and smaller.			
6.5 ft.	**Geologic Interpretation:** Navajo Sandstone Formation			

REMARKS: **S**urface: flat; scattered grass and Mormon Tea; sandstone outcrops in roadway located about 70 ft. east. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-55

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: COPPER MINE ROAD **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1987294 **E.** 845104 **GROUND ELEVATION:** 5573

APPROXIMATE DIMENSIONS: 20' x 4' x 14.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/18/2012 **DATE LOGGED:** 6/18/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP) Visual Class. **5.0 ft.**	**0.0 - 5.0 ft. Poorly Graded Sand (SP):** About 95% predominantly fine to medium sand and 5% nonplastic fines. Low dry strength, rapid dilatancy and low toughness. Max. size, medium sand. No reaction with HCl except at 3.0 and 5.0 ft. where CaCO3 forms diffuse layers about 3-5 in. thick.. Color is light brown from 0.0 to 3.0 ft. and tan from 3.0 to 5.0 ft. In-place condition: soft, homogenous, dry material with weak cementation. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
(SP) Visual Class. Lab sample taken from 5.0-14.5 ft. (SP) Lab Class. **14.5 ft.**	**5.0 - 14.5 ft. Poorly Graded Sand (SP):** About 100% fine sand with a trace of nonplastic fines. Low dry strength, rapid dilatancy and low toughness. Max. size, fine sand. No reaction with HCl. In-place condition: soft at top grading to very hard at the bottom of the interval, homogenous, dry, grayish orange material with weak cementation. Lab test data from 5.0-14.5 ft.: 93% sand, 3% fines, 4% gravel; LL and PI not tested, Field Moisture = 1.1%. pH = 9.09, Resistivity = 2,877 ohm/cm, Sulfates = 23 ppm, Sulfides = < 1 ppm, Chlorides = 36 ppm. Lab classification is Poorly Graded Sand (SP). **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0

REMARKS: **S**urface: loose sand with scattered bushes. Coordinates and elevation obtained from GPS. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-56

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: COPPER MINE ROAD **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1995421 **E.** 847673 **GROUND ELEVATION:** 5607

APPROXIMATE DIMENSIONS: 20' x 4' x 14.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/18/2012 **DATE LOGGED:** 6/18/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP) Visual Class.	**0.0 - 15.0 ft. Poorly Graded Sand (SP):** About 95% predominantly fine to medium sand and 5% nonplastic fines. Low dry strength, rapid dilatancy and low toughness. Max. size, medium sand. No reaction with HCl, except from 1.7 to 2.3 ft., where CaCO3 forms a diffuse layer. Color is light brown from 0.0 to 1.7 ft. and tan from 1.7 to 2.7 ft.	0	0	0
Lab sample taken from 2.7-15.0 ft.	In-place condition: soft, homogenous, dry, light brown material from 0.0 to 2.7 ft., very pale orange from 2.7 to 15.0 ft, weak cementation.			
(SP-SM) Lab Class.	Lab test data from 2.7-15.0 ft.: 93% sand, 7% fines, 0% gravel; LL and PI not tested, Field Moisture = 1.1%. pH = 8.39, Resistivity = 2,320 ohm/cm, Sulfates = 38 ppm, Sulfides = < 1 ppm, Chlorides = 55 ppm. Lab classification is Poorly Graded Sand with Silt (SP-SM).			
15.0 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			

REMARKS: **S**urface: loose sand with scattered bushes. Coordinates and elevation obtained from GPS. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-57

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: COPPER MINE ROAD **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 2043381 **E.** 841242 **GROUND ELEVATION:** 5934

APPROXIMATE DIMENSIONS: 20' x 12' x 10.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/19/2012 **DATE LOGGED:** 6/19/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP) Visual Class. Lab sample taken from 0.0-10.0 ft. (SP-SM) Lab Class **10.0 ft.**	**0.0 - 10.0 ft. Poorly Graded Sand (SP):** About 95% predominantly fine sand and 5% nonplastic fines. Low dry strength, rapid dilatancy and low toughness. Max. size, fine sand. No reaction with HCl. In-place condition: very soft, homogenous, dry, tan material with no cementation. Lab test data from 0.0-10.0 ft.: 94% sand, 6% fines, 0% gravel; LL and PI not tested, Field Moisture = 1.4%. pH = 8.84, Resistivity = 13,920 ohm/cm, Sulfates = 1 ppm, Sulfides = < 1 ppm, Chlorides = 7 ppm. Lab classification is Poorly Graded Sand with Silt (SP-SM). **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
(Ss) Visual Class. **10.0 ft.**	**10.0 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand moderately cemented with silica; crossbedded, beds are 1/2 to 2 in. thick. Hard, fragments require moderate to heavy hammer blow to break; slightly weathered. No reaction with HCl. Color is very pale orange. Backhoe only grooved surface of sandstone, could not excavate. **Geologic Interpretation:** Navajo Sandstone Formation			

REMARKS: **S**urface: low area with scattered shrubs; cobbles and boulders up to 2 ft. diameter on surface. Coordinates and elevation obtained from GPS. Test pit terminated at refusal; pit walls caving.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-58

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: COPPER MINE ROAD **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 2050224 **E.** 838884 **GROUND ELEVATION:** 5981

APPROXIMATE DIMENSIONS: 20' x 10' x 13.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/19/2012 **DATE LOGGED:** 6/19/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP) Visual Class.	**0.0 - 13.0 ft. Poorly Graded Sand (SP):** About 95% predominantly fine sand and 5% nonplastic fines. Low dry strength, rapid dilatancy and low toughness. Max. size, fine sand. No reaction with HCl. In-place condition: very soft, homogenous, dry, tan material with no cementation. Lab test data from 0.0-13.0 ft.: 96% sand, 4% fines, 0% gravel; LL and PI not tested, Field Moisture = 0.5%. pH = 9.2, Resistivity = 16,704 ohm/cm, Sulfates = 4 ppm, Sulfides = < 1 ppm, Chlorides = 11 ppm.	0	0	0
Lab sample taken from 0.0-13.0 ft. (SP-SM) Lab Class	Lab classification is Poorly Graded Sand with Silt (SP-SM). In-place density of 101.6 lb/ft^3 taken at 4.5 ft. with sand cone apparatus.			
13.0 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			

REMARKS: Surface: flat with scattered shrubs; sandstone outcrop about 350 ft. east across road. Coordinates and elevation obtained from GPS. Test pit terminated at reach of equipment; pit walls caving.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-59

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: COPPER MINE ROAD **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 2057408 **E.** 840426 **GROUND ELEVATION:** 5890

APPROXIMATE DIMENSIONS: 10' x 4' x 5.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/19/2012 **DATE LOGGED:** 6/19/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP) Visual Class. Lab sample taken from 0.0-5.5 ft. (SM) Lab Class **5.5 ft.**	**0.0 - 5.5 ft. Poorly Graded Sand (SP):** About 95% predominantly fine sand, 5% nonplastic fines and a trace of fine gravel. Low dry strength, rapid dilatancy and low toughness. Max. size, 1 in. No reaction with HCl. In-place condition: very soft, homogenous, dry, light brown material with weak cementation. Lab test data from 0.0-5.5 ft.: 88% sand, 12% fines, 0% gravel; LL and PI not tested, Field Moisture = 0.7%. pH = 8.0, Resistivity = 12,992 ohm/cm, Sulfates = 1 ppm, Sulfides = < 1 ppm, Chlorides = 7 ppm. Lab classification is Silty Sand (SM). **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
(Ss) Visual Class. **5.5 ft.**	**5.5 ft. Sandstone (Ss):** Unable to retrieve sample; description taken from nearby outcrops. Sandstone consists of predominately fine, subrounded sand moderately cemented with silica; crossbedded, beds are 1/2 to 2 in. thick. Hard, fragments require moderate to heavy hammer blow to break; slightly weathered. No reaction with HCl. Color is very pale orange. Backhoe only grooved surface of sandstone, could not excavate. **Geologic Interpretation:** Navajo Sandstone Formation			

REMARKS: **S**urface: gently sloping east toward road; loose sand with scattered shrubs; sandstone outcrop about 200 ft. east across road. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-60

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: COPPER MINE ROAD **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 2063729 **E.** 839298 **GROUND ELEVATION:** 5867

APPROXIMATE DIMENSIONS: 10' x 4' x 6.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/19/2012 **DATE LOGGED:** 6/19/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP) Visual Class. Lab sample taken from 0.0-6.5 ft. (SP) Lab Class **6.5 ft.**	**0.0 - 6.5 ft. Poorly Graded Sand (SP):** About 95% predominantly fine sand, 5% nonplastic fines and a trace of fine gravel. Low dry strength, rapid dilatancy and low toughness. Max. size, 1 in. No reaction with HCl. In-place condition: very soft, homogenous, dry, light brown material with weak cementation. Lab test data from 0.0-6.5 ft.: 96% sand, 4% fines, 0% gravel; LL and PI not tested, Field Moisture = 0.4%. pH = 9.13, Resistivity = 16,704 ohm/cm, Sulfates = 3 ppm, Sulfides = < 1 ppm, Chlorides = 7 ppm. Lab classification is Poorly Graded Sand (SP). **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
(Ss) Visual Class. **6.5 ft.**	**6.5 ft. Sandstone (Ss):** Unable to retrieve sample; description taken from nearby outcrops. Sandstone consists of predominately fine, subrounded sand moderately cemented with silica; crossbedded, beds ½ to 3 in. thick. Hard, fragments require moderate to heavy hammer blow to break; slightly weathered. No reaction with HCl. Color is very pale orange. Backhoe only grooved surface of sandstone, could not excavate. **Geologic Interpretation:** Navajo Sandstone Formation			

REMARKS: **S**urface: low area with scattered bushes; sandstone outcrops about 200 ft. east and northeast of pit. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-61

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: COPPER MINE ROAD **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 2068954 **E.** 838733 **GROUND ELEVATION:** 5822

APPROXIMATE DIMENSIONS: 15' x 4' x 7.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/19/2012 **DATE LOGGED:** 6/19/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP)cb Visual Class. Lab sample taken from 0.0-3.5 ft. (SP-SM) Lab Class **3.5 ft.**	**0.0 - 3.5 ft. Poorly Graded Sand with Cobbles and Boulders (SP)cb:** About 85% predominantly fine sand, 10% fine to coarse gravel in the form of platy, angular sandstone fragments and 5% nonplastic fines. Low dry strength, rapid dilatancy and low toughness. Max. size, 1 in. No reaction with HCl. Total sample (by volume): About 10% 3 to 5 in. platy, moderately hard sandstone cobbles; about 5% 5 to 12 in. blocky, moderately hard sandstone cobbles; about 5% plus 12 in. blocky, moderately hard sandstone boulders; remainder minus 3 in.; maximum size, 1.5 ft. In-place condition: soft grading to hard with depth, homogenous, dry, light brown material with weak cementation. Lab test data from 0.0-3.5 ft.: 91% sand, 7% fines, 2% gravel; LL and PI not tested, Field Moisture = 0.6%. pH = 8.92, Resistivity = 13,920 ohm/cm, Sulfates = 3 ppm, Sulfides = < 1 ppm, Chlorides = 7 ppm. Lab classification is Poorly Graded Sand with Silt (SP-SM). **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand and in-place weathering of sandstone)	10	5	5
(Ss) Visual Class. **7.0 ft.**	**3.5 - 7.0 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand moderately cemented with silica; crossbedded, beds ½ to 3 in. thick. Hard, fragments require moderate to heavy hammer blow to break; slightly weathered. No reaction with HCl. Color is very pale orange. Backhoe excavated upper jointed portion, but encountered sandstone surface that could not even groove. **Geologic Interpretation:** Navajo Sandstone Formation			

REMARKS: **S**urface: gently dipping to north; loose sand with scattered bushes. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-62

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: COPPER MINE ROAD **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 2074220 **E.** 838226 **GROUND ELEVATION:** 5802

APPROXIMATE DIMENSIONS: 20' x 10' x 6.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/19/2012 **DATE LOGGED:** 6/19/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP) Visual Class. Lab sample taken from 0.0-5.5 ft. (SP-SM) Lab Class **5.5 ft.**	**0.0 - 5.5 ft. Poorly Graded Sand (SP):** About 95% predominantly fine sand and 5% nonplastic fines. Low dry strength, rapid dilatancy and low toughness. Max. size, fine sand. No reaction with HCl. In-place condition: very soft to soft, homogenous, dry, light brown material with weak cementation. Lab test data from 0.0-5.5 ft.: 94% sand, 6% fines, 0% gravel; LL and PI not tested, Field Moisture = 0.4%. pH = 7.88, Resistivity = 12,992 ohm/cm, Sulfates = 1 ppm, Sulfides = 2 ppm, Chlorides = 14 ppm. Lab classification is Poorly Graded Sand with Silt (SP-SM). In-place density of 112.0 lb/ft^3 taken at 5.5 ft. with sand cone apparatus. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
(Ss) Visual Class. **6.5 ft.**	**5.5 - 6.5 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand moderately cemented with silica. Hard, fragments require moderate to heavy hammer blow to break; slightly weathered. No reaction with HCl. Color is very pale orange. Backhoe could only excavate 1 ft., grooved sandstone with teeth. **Geologic Interpretation:** Navajo Sandstone Formation			

REMARKS: **S**urface: gently sloping to east; loose sand with scattered bushes; small drainage located north of pit. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-63**

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: COPPER MINE ROAD **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 2080261 **E.** 839292 **GROUND ELEVATION:** 5836

APPROXIMATE DIMENSIONS: 20' x 10' x 10.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/19/2012 **DATE LOGGED:** 6/19/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP) Visual Class. Lab sample taken from 0.0-5.0 ft. (SP-SM) Lab Class **5.0 ft.**	**0.0 - 5.0 ft. Poorly Graded Sand (SP):** About 95% predominantly fine sand and 5% nonplastic fines. Low dry strength, rapid dilatancy and low toughness. Max. size, fine sand. No reaction with HCl. In-place condition: very soft to soft, homogenous, dry, light brown material with weak cementation. Lab test data from 0.0-5.0 ft.: 93% sand, 7% fines, 0% gravel; LL and PI not tested, Field Moisture = 0.8%. pH = 8.57, Resistivity = 8,909 ohm/cm, Sulfates = 5 ppm, Sulfides = 2 ppm, Chlorides = 14 ppm. Lab classification is Poorly Graded Sand with Silt (SP-SM). In-place density of 104.3 lb/ft^3 taken at 4.5 ft. with sand cone apparatus. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
(Ss) Visual Class. **10.0 ft.**	**5.0 - 10.0 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand moderately cemented with $CaCO_3$ and iron oxide; crossbedded, beds are ¼-2 in. thick. Moderately hard, fragments require moderate hammer blow to break; moderately weathered. Strong reaction with HCl. Color is light brown. Upon excavation with a backhoe, the sandstone breaks up into blocky chunks 6 in. in size and smaller. **Geologic Interpretation:** Navajo Sandstone Formation			

REMARKS: **S**urface: flat, loose sand with scattered bushes. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-67

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: COPPER MINE ROAD **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 2000911 **E.** 849102 **GROUND ELEVATION:** 5665

APPROXIMATE DIMENSIONS: 15' x 4' x 9.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/18/2012 **DATE LOGGED:** 6/18/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP) Visual Class. Lab sample taken from 0.0-7.0 ft. (SP-SM) Lab Class. **7.0 ft.**	**0.0 - 7.0 ft. Poorly Graded Sand (SP):** About 95% predominantly fine sand, 5% nonplastic fines and a trace of fine, angular gravel. Low dry strength, rapid dilatancy and low toughness. Max. size, 5 mm.. No reaction with HCl. In-place condition: soft, homogenous, dry, light brown material with weak cementation. Lab test data from 0.0-7.0.0 ft.: 94% sand, 6% fines, 0% gravel; LL and PI not tested, Field Moisture = 0.5%. pH = 8.0, Resistivity = 9,094 ohm/cm, Sulfates = 4 ppm, Sulfides = < 1 ppm, Chlorides = 8 ppm. Lab classification is Poorly Graded Sand with Silt (SP-SM). **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
(Ss) Visual Class. **9.0 ft.**	**7.0 - 9.0 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand weakly cemented with silica. Moderately soft, fragments break with manual pressure. No reaction with HCl, except on fracture surfaces coated with $CaCO_3$. Color is grayish orange. Upon excavation with a backhoe, the sandstone breaks up into platy fragments 4 in. and smaller. **Geologic Interpretation:** Navajo Sandstone Formation			

REMARKS: **S**urface: gently dipping toward small wash; scattered scrub bushes; sandstone outcrop located about 200 ft. southeast. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-68**

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: COPPER MINE ROAD **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1974019 **E.** 844872 **GROUND ELEVATION:** 5473

APPROXIMATE DIMENSIONS: 10' x 4' x 5.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/18/2012 **DATE LOGGED:** 6/18/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP) Visual Class. Lab sample taken from 0.0-3.3 ft. (SP-SM) Lab Class. **3.3 ft.**	**0.0 - 3.3 ft. Poorly Graded Sand (SP):** About 95% predominantly fine sand, 5% nonplastic fines and a trace of fine, rounded gravel. Low dry strength, rapid dilatancy and low toughness. Max. size, 5 mm.. No reaction with HCl. In-place condition: soft, homogenous, dry, light brown material with weak cementation. Lab test data from 0.0-3.3 ft.: 91% sand, 9% fines, 0% gravel; LL and PI not tested, Field Moisture = 1.2%. pH = 8.64, Resistivity = 7,424 ohm/cm, Sulfates = 1 ppm, Sulfides = < 1 ppm, Chlorides = 1 ppm. Lab classification is Poorly Graded Sand with Silt (SP-SM). **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
(Ss) Visual Class. **5.5 ft.**	**3.3 - 5.5 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand moderately cemented with silica; crossbedded, beds are 1/8 to 3 in. thick. Moderately hard, edges of hand-size fragment break with manual pressure; thicker portions require moderate hammer blow to break. No reaction with HCl. Color is light gray to yellowish gray (due to limonite staining). Upon excavation with a backhoe, the sandstone breaks up into platy fragments 1-3 in. in size and smaller. **Geologic Interpretation:** Navajo Sandstone Formation			

REMARKS: Surface: flat; scattered grass and Mormon Tea; sandstone outcrops in roadway located about 70 ft. east. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

LAB RESULTS

TABULATION OF LABORATORY TEST DATA

TEST PIT NUMBER	SAMPLE INTERVAL (ft)	NATURAL WATER CONTENT (Percent of Dry Weight)	PARTICLE SIZE DISTRIBUTION (Percent Finer)					ATTERBERG LIMITS			UNIFIED SOIL CLASSIFICATION SYMBOL	UNIFIED SOIL CLASSIFICATION	pH	RESISTIVITY (Ohm-Centimeters)	SULFATES (SO_4) (ppm)	SULFIDE (ppm)	CHLORIDE (CL) (ppm)	FIELD DENSITY (sand cone method)		EXPANSION INDEX (measured) (EIM)		% FINES	% SAND	% GRAVEL	DEPTH TO ROCK	REFUSAL DEPTH	REASON FOR TERMINATION	Material
			#200 SIEVE	#40 SIEVE	#10 SIEVE	#4 SIEVE	3 INCH SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX								DEPTH (ft)	lb/ft3	DEPTH (ft)								
TP-01	0.0 - 8.0	2.3	15	84	95	97	100	NT	NT	NT	SM	SILTY SAND *	8.82	6,218	14	2	17	NT	NT	NT	NT	15	82	3	NE	12.0	Reach	Qal
TP-02	0.0 - 12.0	4.0	37	73	81	84	100	NP	NP	NP	(SM)g	SILTY SAND with GRAVEL	8.48	473	1,400	< 1	120	3.5	98.4	NT	NT	37	47	16	NE	13.0	Reach	Qal
TP-03	4.0 - 13.0	1.6	8	48	66	73	100	NT	NT	NT	(SP-SM)g	POORLY GRADED SAND with SILT and GRAVEL	9.00	3,712	25	< 1	62	NT	NT	NT	NT	8	65	27	NE	13.0	Reach	Qal
TP-04	4.0 - 13.0	2.6	15	33	42	53	100	22	18	4	(GC-GM)s	SILTY CLAYEY GRAVEL with SAND	8.10	483	530	< 1	170	3.8	91.4	NT	NT	15	38	47	NE	13.0	Reach	Qal
TP-05	2.0 - 12.0	2.0	72	99	100	100	100	28	15	13	(CL)s	LEAN CLAY with SAND	8.45	1,021	30	< 1	92	NT	NT	NT	NT	72	28	0	NE	12.0	Reach	Qal
TP-06	4.0 - 10.4	1.3	15	68	80	87	100	NT	NT	NT	SM	SILTY SAND	8.88	2,784	34	3	24	NT	NT	NT	NT	15	72	13	10.0	13.5	Reach	Ls
TP-07	0.0 - 14.0	3.0	42	70	86	91	100	20	15	5	SC-SM	SILTY, CLAYEY SAND	8.68	1,021	160	2	100	3.5	104.0	NT	NT	42	49	9	NE	14.0	Reach	Qal
TP-08	2.0 - 6.0	3.9	42	57	66	75	100	26	15	11	(SC)g	CLAYEY SAND with GRAVEL	8.70	1,856	110	6	55	NT	NT	NT	NT	42	33	25	6.0	7.5	Refusal	Clst
TP-09	6.0 - 10.0	3.9	21	36	57	71	100	21	15	6	(SC-SM)g	SILTY, CLAYEY SAND with GRAVEL	8.22	659	1,500	< 1	160	NT	NT	NT	NT	21	50	29	10.0	12.0	Refusal	Ss
TP-10	0.0 - 9.0	2.6	30	47	59	67	100	21	16	5	(SC-SM)g	SILTY, CLAYEY SAND with GRAVEL	8.48	2,042	400	< 1	140	NT	NT	NT	NT	30	37	33	9.4	13.0	Reach	Clst
TP-11	0.0 - 6.0	3.2	38	63	71	77	100	22	14	8	(SC)g	CLAYEY SAND with GRAVEL	7.26	854	1,700	< 1	72	4.2	97.6	NT	NT	38	39	23	7.5	11.5	Refusal	Ss
TP-12	3.8 - 11.5	4.8	30	58	82	91	100	22	14	8	SC	CLAYEY SAND	7.66	1,856	51	< 1	57	NT	NT	NT	NT	30	61	9	NE	11.5	Reach	Qal
TP-13	0.0 - 4.5	4.9	39	70	95	98	100	21	14	7	SC-SM	SILTY, CLAYEY SAND	8.50	1,949	22	2	60	NT	NT	NT	NT	39	59	2	4.0	11.0	Refusal	Clst
TP-14	0.0 - 10.0	1.9	15	68	85	91	100	NT	NT	NT	SM	SILTY SAND	8.32	1,949	18	2	24	NT	NT	NT	NT	15	76	9	10.0	11.0	Refusal	Ss
TP-15	0.9 - 5.5	3.4	23	52	77	85	100	20	15	5	SC-SM	SILTY, CLAYEY SAND	8.80	2,042	30	< 1	23	NT	NT	NT	NT	23	62	15	5.5	7.0	Refusal	Ss
TP-16	0.0 - 3.5	5.4	51	72	81	87	100	NT	NT	NT	s(CL)	SANDY LEAN CLAY)	8.48	2,227	11	4	22	NT	NT	NT	NT	51	36	13	3.5	6.0	Refusal	Ss
TP-18	2.5 - 9.0	16.0	94	98	100	100	100	NT	NT	NT	CL	CLAYSTONE - (LEAN CLAY)	7.25	752	73	3	74	NT	NT	2.5-9.0	49	94	6	0	2.5	9.5	Refusal	Clst
TP-19	0.0 - 8.0	6.0	19	41	64	74	100	22	13	9	(SC)g	CLAYEY SAND with GRAVEL	8.54	928	210	2	420	NT	NT	NT	NT	19	55	26	10.0	14.0	Reach	Clst
TP-20	0.0 - 8.5	3.8	28	61	86	94	100	23	18	5	SC-SM	SILTY, CLAYEY SAND	8.41	1,856	29	< 1	66	5.0	106.2	NT	NT	28	66	6	9.5	12.0	Reach	Clst
TP-21	3.0 - 5.0	2.0	5	17	45	62	100	NT	NT	NT	(SW-SC)g	WELL-GRADED SAND with CLAY and GRAVEL *	9.70	3,526	96	3	67	3.0	127.2	NT	NT	5	57	38				
TP-21	8.5 - 14.0	13.6	68	97	100	100	100	42	24	18	s(CL)	CLAYSTONE - (SANDY LEAN CLAY)	8.83	2,877	14	< 1	46	NT	NT	NT	NT	68	32	0	8.5	14.0	Reach	Clst
TP-22	7.0 - 14.0	12.2	12	25	43	57	100	NT	NT	NT	(SW-SC)g	WELL-GRADED SAND with CLAY and GRAVEL *	10.16	780	NT	NT	NT	4.0	120.9	NT	NT	12	45	43	NE	14.0	Reach	Qal
TP-23	0.0 - 4.0	2.6	31	89	98	99	100	NP	NP	NP	SM	SILTY SAND	9.29	2,227	22	2	26	4.0	100.1	NT	NT	31	68	1				
TP-23	6.0 - 8.0	9.0	18	45	75	85	100	22	13	9	(SC)g	CLAYEY SAND with GRAVEL	9.83	1,949	12	3	17	NT	NT	NT	NT	18	67	15	NE	14.0	Reach	Qal
TP-24	4.0-10.0	2.4	7	27	49	58	100	NT	NT	NT	(SP-SM)g	POORLY GRADED SAND with SILT and GRAVEL	9.11	1,578	80	2	34	3.5	123.7	NT	NT	7	51	42	NE	15.0	Reach	Qal
TP-25	8.0 - 12.0	2.8	12	66	85	89	100	NT	NT	NT	SC-SM	SILTY, CLAYEY SAND	7.31	4,640	7	< 1	17	NT	NT	NT	NT	12	77	11	NE	12.0	Reach	Qal
TP-26	3.5 - 10.5	8.9	12	57	97	98	100	NT	NT	NT	SC-SM	SILTY, CLAYEY SAND	8.80	1,578	7	5	22	NT	NT	NT	NT	12	86	2	3.5	10.5	Refusal	Ss
TP-27	0.0 - 5.0	11.5	10	54	83	92	100	NT	NT	NT	SP-SM	POORLY GRADED SAND with SILT *	9.70	2,042	33	< 1	33	NT	NT	NT	NT	10	82	8	NE	6.0	Water	Qal
TP-28	0.0 - 14.0	5.5	15	42	66	75	100	NT	NT	NT	(SM)g	SILTY SAND with GRAVEL *	8.71	510	28	2	28	NT	NT	NT	NT	15	60	25	NE	13.5	Reach	Qal
TP-29	0.5 - 10.0	8.9	73	90	94	95	100	38	18	20	(CL)s	CLAYSTONE - (LEAN CLAY with SAND)	8.85	2,970	210	< 1	2,400	3.0	115.5	NT	NT	73	22	5	0.5	10.0	Refusal	Clst
TP-30	2.3 - 14.0	24.2	78	92	99	100	100	22	14	8	(CL)s	LEAN CLAY with SAND	7.84	408	86	< 1	180	NT	NT	2.3-14.0	129	78	22	0	2.3	14.0	Reach	Clst
TP-31	1.8 - 3.0	4.5	29	73	95	97	100	35	19	16	SC	CLAYEY SAND	8.90	371	1,800	4	268	4.0	116.8	NT	NT	29	68	3	1.0	5.0	Refusal	Ss
TP-32	0.0 - 13.5	3.2	13	33	70	81	100	NT	NT	NT	(SM)g	SILTY SAND with GRAVEL *	8.91	1,670	NT	NT	NT	NT	NT	NT	NT	13	68	19	NE	14.0	Reach	Qal
TP-33	0.0 - 3.0	2.8	23	58	87	93	100	24	19	5	SC-SM	SILTY, CLAYEY SAND	8.91	1,021	180	6	49	NT	NT	NT	NT	23	70	7	3.0	5.5	Refusal	Ss
TP-34	1.5 - 13.0	11.9	76	92	98	99	100	42	23	19	(CL)s	CLAYSTONE - (LEAN CLAY with SAND)	7.40	436	3,500	< 1	53	NT	NT	NT	NT	76	23	1	1.5	13.0	Reach	Clst
TP-35	0.0 - 4.5	4.3	35	64	84	92	100	28	11	17	SC	CLAYEY SAND	8.86	780	450	6	17	4.5	113.1	NT	NT	35	57	8	6.0	9.5	Refusal	Clst

TABULATION OF LABORATORY TEST DATA

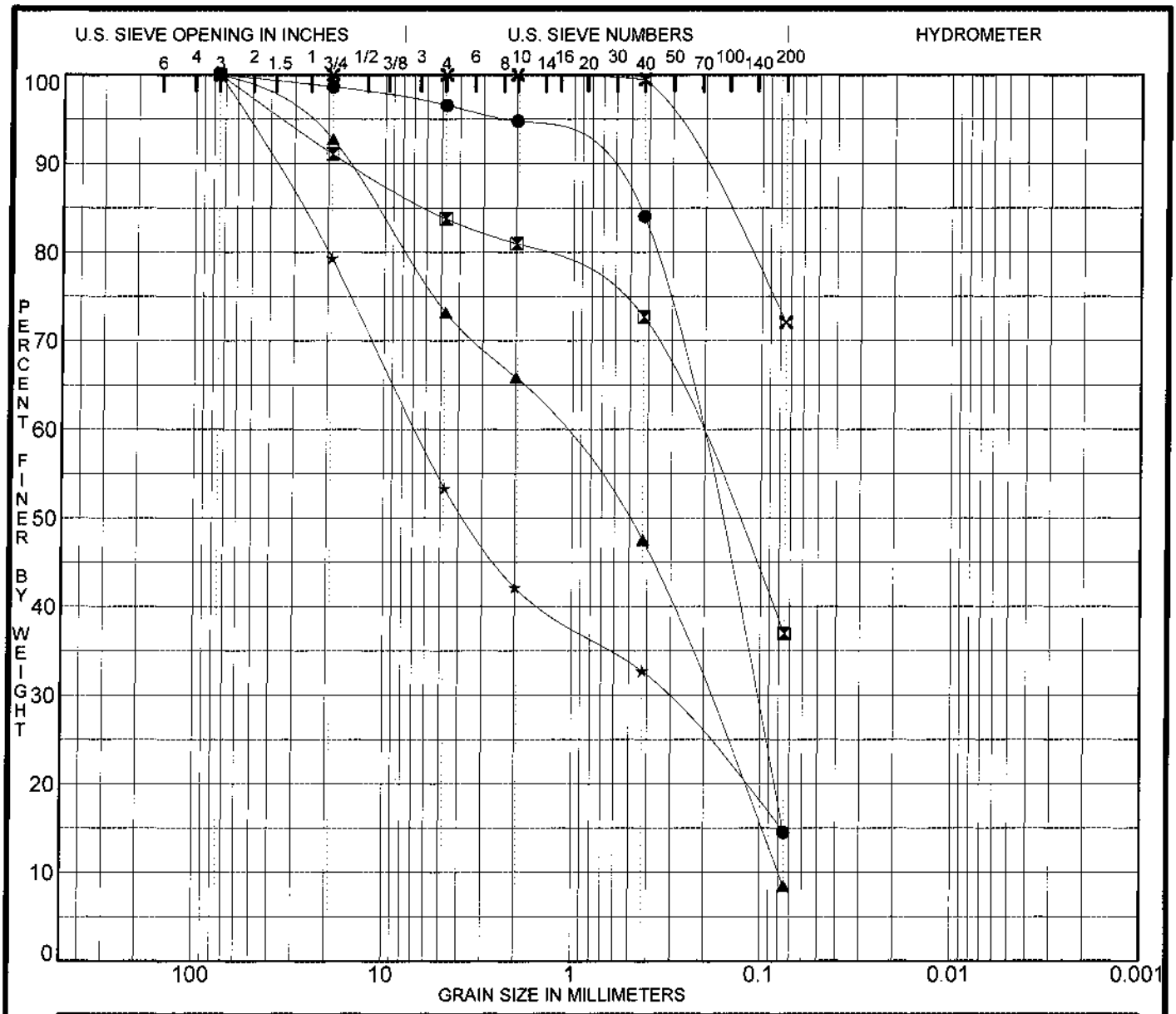
TEST PIT NUMBER	SAMPLE INTERVAL (ft)	NATURAL WATER CONTENT (Percent of Dry Weight)	PARTICLE SIZE DISTRIBUTION (Percent Finer)					ATTERBERG LIMITS			UNIFIED SOIL CLASSIFICATION SYMBOL	UNIFIED SOIL CLASSIFICATION	pH	RESISTIVITY (Ohm-Centimeters)	SULFATES (SO_4) (ppm)	SULFIDE (ppm)	CHLORIDE (CL) (ppm)	FIELD DENSITY (sand cone method)		EXPANSION INDEX (measured) (EIM)		% FINES	% SAND	% GRAVEL	DEPTH TO ROCK	REFUSAL DEPTH	REASON FOR TERMINATION	Material
			#200 SIEVE	#40 SIEVE	#10 SIEVE	#4 SIEVE	3 INCH SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX								DEPTH (ft)	lb/ft3	DEPTH (ft)								
TP-36	7.0 - 13.5	6.1	28	64	86	93	100	33	14	19	SC	CLAYEY SAND	8.48	742	2,100	< 1	37	NT	NT	NT	NT	28	65	7	NE	13.5	Reach	Qal
TP-37	1.0 - 4.5	3.6	23	75	94	98	100	33	25	8	SM	SILTY SAND	8.00	742	1,300	< 1	28	4.5	113.2	NT	NT	23	75	2	4.5	10.5	Refusal	Ss
TP-38	1.0 - 4.0	8.2	28	85	99	99	100	NP	NP	NP	SM	SILTY SAND	7.73	1,485	2,100	2	240	NT	NT	NT	NT	28	71	1	1.0	4.0	Refusal	Ss
TP-39	0.0 - 3.5	4.3	25	65	88	94	100	27	16	11	SC	CLAYEY SAND	7.89	195	450	< 1	260	NT	NT	NT	NT	25	69	6	3.5	7.5	Refusal	Ss
TP-40	0.0 - 5.0	18.6	74	89	97	98	100	59	19	40	(CH)s	FAT CLAY with SAND	8.85	436	3,800	< 1	2,300	4.0	72.9	0.0-5.0	137	74	24	2	5.5	13.0	Refusal	Clst
TP-41	3.0 - 8.0	14.7	91	98	100	100	100	NT	NT	NT	CH	CLAYSTONE - (FAT CLAY)	7.09	752	3,900	< 1	720	NT	NT	3.0-8.0	117	91	9	0	8.0	12.0	Refusal	Clst
TP-42	7.0 - 14.5	5.9	47	87	93	96	100	28	18	10	SC	CLAYEY SAND	9.11	1,392	36	9	38	5.0	93.5	NT	NT	47	49	4	NE	14.5	Reach	Qal
TP-43	0.0 - 6.0	5.0	42	92	98	99	100	25	18	7	SC-SM	SILTY, CLAYEY SAND	8.95	566	97	2	200	NT	NT	NT	NT	42	57	1	6.0	13.0	Refusal	Clst
TP-44	0.8 - 8.5	7.2	42	89	98	99	100	24	19	5	SC-SM	CLAYSTONE - (SILTY, CLAYEY SAND)	9.44	742	110	2	700	NT	NT	NT	NT	42	57	1	0.8	8.5	Refusal	Clst
TP-45	4.5 - 13.4	12.2	72	96	100	100	100	NT	NT	NT	(CL)s	CLAYSTONE - (LEAN CLAY with SAND)	8.22	306	75	3	450	NT	NT	NT	NT	72	28	0	1.0	13.4	Reach	Clst
TP-46	0.0 - 8.0	7.9	54	74	78	82	100	41	26	15	s(ML)g	CLAYSTONE - (SANDY SILT with GRAVEL)	8.35	807	1,500	< 1	620	NT	NT	0.0-8.0	40	54	28	18	0.0	8.0	Refusal	Clst
TP-47	0.0 - 8.0	2.4	15	70	90	94	100	NT	NT	NT	SM	SILTY SAND *	9.42	733	300	< 1	83	NT	NT	NT	NT	15	79	6	8.0	13.5	Reach	Clst
TP-48	1.8 - 7.5	10.0	51	88	96	97	100	NT	NT	NT	s(CL)	CLAYSTONE - (SANDY LEAN CLAY)	8.15	1,021	2,100	< 1	390	NT	NT	1.8-7.5	20	51	46	3	1.8	7.5	Refusal	Clst
TP-49	0.0 - 3.2	1.1	9	97	100	100	100	NT	NT	NT	SP-SM	POORLY GRADED SAND with SILT *	8.90	6,125	3	< 1	7	NT	NT	NT	NT	9	91	0	3.2	7.0	Refusal	Ss
TP-50	0.0 - 5.0	1.4	13	94	100	100	100	NT	NT	NT	SM	SILTY SAND *	8.34	8,816	2	< 1	7	NT	NT	NT	NT	13	87	0	5.0	5.0	Refusal	Ss
TP-51	4.5 - 6.5	13.5	61	97	100	100	100	33	15	18	s(CL)	SANDY LEAN CLAY	8.84	817	100	< 1	143	NT	NT	NT	NT	61	39	0	10.4	13.0	Refusal	Ss
TP-52	2.0 - 8.0	0.6	4	97	99	100	100	NT	NT	NT	SP	POORLY GRADED SAND	8.82	9,187	6	< 1	8	NT	NT	NT	NT	4	96	0	3.8	7.0	Refusal	Ss
TP-53	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NOT TESTED	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	3.5	8.0	Refusal	Ss
TP-54	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NOT TESTED	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	2.4	6.5	Refusal	Ss
TP-55	5.0 - 14.5	1.1	3	90	94	96	100	NT	NT	NT	SP	POORLY GRADED SAND	9.09	2,877	23	< 1	36	NT	NT	NT	NT	3	93	4	NE	14.5	Reach	Qe
TP-56	2.7 - 15.0	1.1	7	92	100	100	100	NT	NT	NT	SP-SM	POORLY GRADED SAND with SILT *	8.39	2,320	38	< 1	55	NT	NT	NT	NT	7	93	0	NE	15.0	Reach	Qe
TP-57	0.0 - 10.0	1.4	6	92	100	100	100	NT	NT	NT	SP-SM	POORLY GRADED SAND with SILT *	8.84	13,920	1	< 1	7	NT	NT	NT	NT	6	94	0	10.0	10.0	Refusal	Ss
TP-58	0.0 - 13.0	0.5	4	89	100	100	100	NT	NT	NT	SP	POORLY GRADED SAND	9.20	16,704	4	< 1	11	4.5	101.6	NT	NT	4	96	0	NE	13.0	Reach	Qe
TP-59	0.0 - 5.5	0.7	12	79	100	100	100	NT	NT	NT	SM	SILTY SAND *	8.00	12,992	1	< 1	7	NT	NT	NT	NT	12	88	0	5.5	5.5	Refusal	Ss
TP-60	0.0 - 6.5	0.4	4	86	100	100	100	NT	NT	NT	SP	POORLY GRADED SAND	9.13	16,704	3	< 1	7	NT	NT	NT	NT	4	96	0	6.5	6.5	Refusal	Ss
TP-61	0.0 - 3.5	0.6	7	53	98	98	100	NT	NT	NT	SP-SM	POORLY GRADED SAND with SILT *	8.92	13,920	3	< 1	7	NT	NT	NT	NT	7	91	2	3.5	7.0	Refusal	Ss
TP-62	0.0 - 5.5	0.4	6	81	100	100	100	NT	NT	NT	SP-SM	POORLY GRADED SAND with SILT *	7.88	12,992	1	2	14	5.5	112.0	NT	NT	6	94	0	5.5	6.5	Refusal	Ss
TP-63	0.0 - 5.0	0.8	7	86	99	100	100	NT	NT	NT	SP-SM	POORLY GRADED SAND with SILT *	8.57	8,909	5	2	14	4.5	104.3	NT	NT	7	93	0	5.0	10.0	Refusal	Ss
TP-67	0.0 - 7.0	0.5	6	79	100	100	100	NT	NT	NT	SP-SM	POORLY GRADED SAND with SILT *	8.00	9,094	4	< 1	8	NT	NT	NT	NT	6	94	0	7.0	9.0	Refusal	Ss
TP-68	0.0 - 3.3	1.2	9	91	99	100	100	NT	NT	NT	SP-SM	POORLY GRADED SAND with SILT *	8.64	7,424	1	< 1	7	NT	NT	NT	NT	9	91	0	3.3	5.5	Refusal	Ss

*Descriptor based on plasticity of field specimen.

NT = Not Tested

NP = Nonplastic

NE = Not Encountered



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	TP-01	0.0	SILTY, CLAYEY SAND SC-SM		NT	NT	NT		
⊠	TP-02	0.0	SILTY SAND with GRAVEL SM		NP	NP	NP		
▲	TP-03	4.0	POORLY GRADED SAND with SILT, CLAY, and GRAVEL SP-SM-SC		NT	NT	NT	0.39	15.2
★	TP-04	4.0	SILTY, CLAYEY GRAVEL with SAND GC-GM		22	18	4		
✕	TP-05	2.0	LEAN CLAY with SAND CL		28	15	13		

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	TP-01	0.0	75.00	0.23	0.110		3.4	82.0	14.5	
⊠	TP-02	0.0	75.00	0.23			16.2	46.8	36.9	
▲	TP-03	4.0	75.00	1.22	0.195	0.0803	26.8	64.7	8.5	
★	TP-04	4.0	75.00	6.77	0.327		46.6	38.7	14.6	
✕	TP-05	2.0	75.00				0.0	27.9	72.1	

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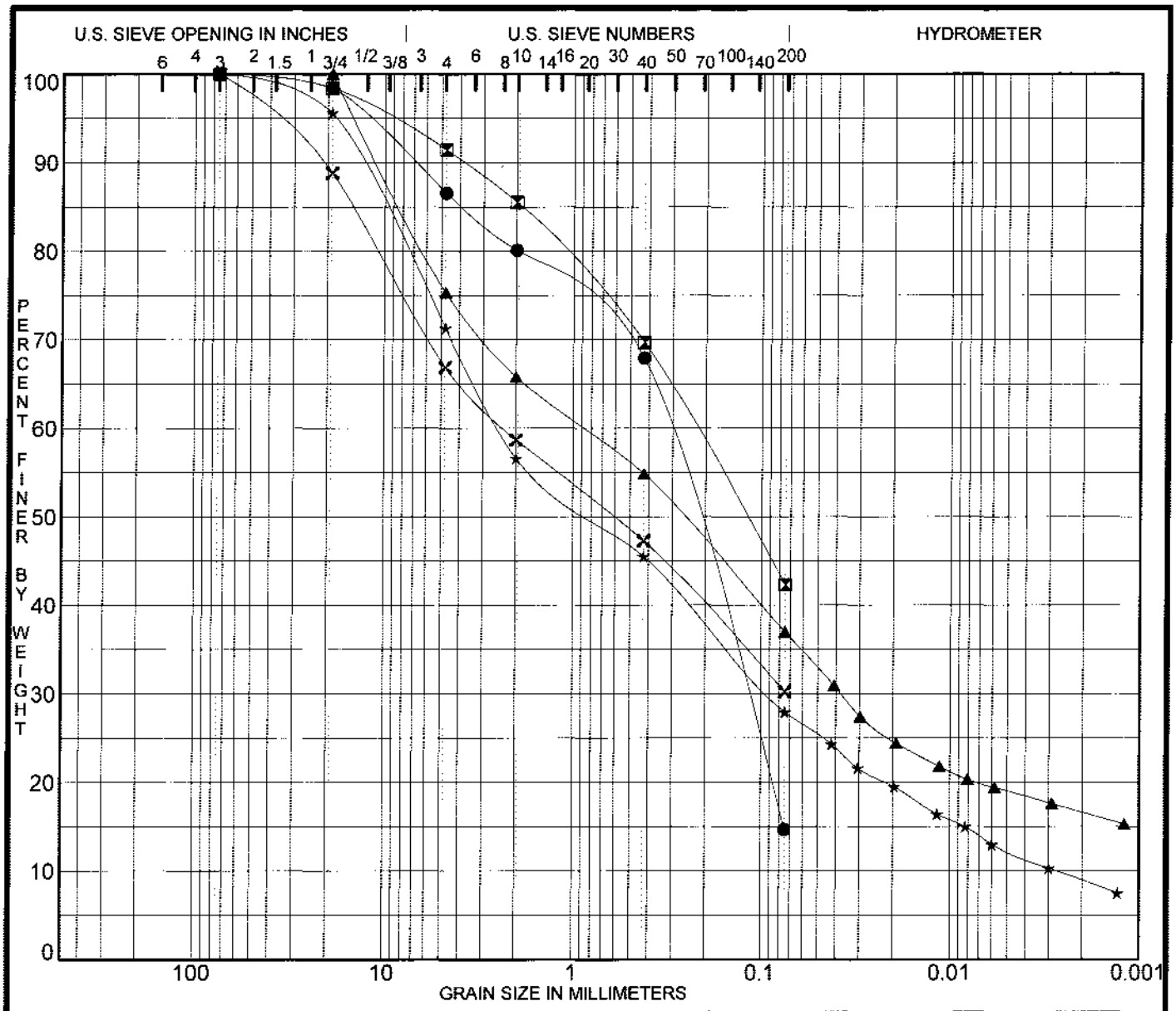
JOB NO. 120751TF

DATE 6/14/12

GRADATION CURVES

SPEEDIE AND ASSOCIATES

{GRSZLSZ 120751TF.GPJ 7/19/12



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	TP-06	4.0	SILTY, CLAYEY SAND SC-SM		NT	NT	NT		
⧓	TP-07	0.0	SILTY, CLAYEY SAND SC-SM		20	15	5		
▲	TP-08	2.0	CLAYEY SAND with GRAVEL SC		26	15	11		
★	TP-09	6.0	SILTY, CLAYEY SAND with GRAVEL SC-SM		21	15	6	1.26	891.2
✕	TP-10	0.0	SILTY, CLAYEY SAND with GRAVEL SC-SM		21	16	6		

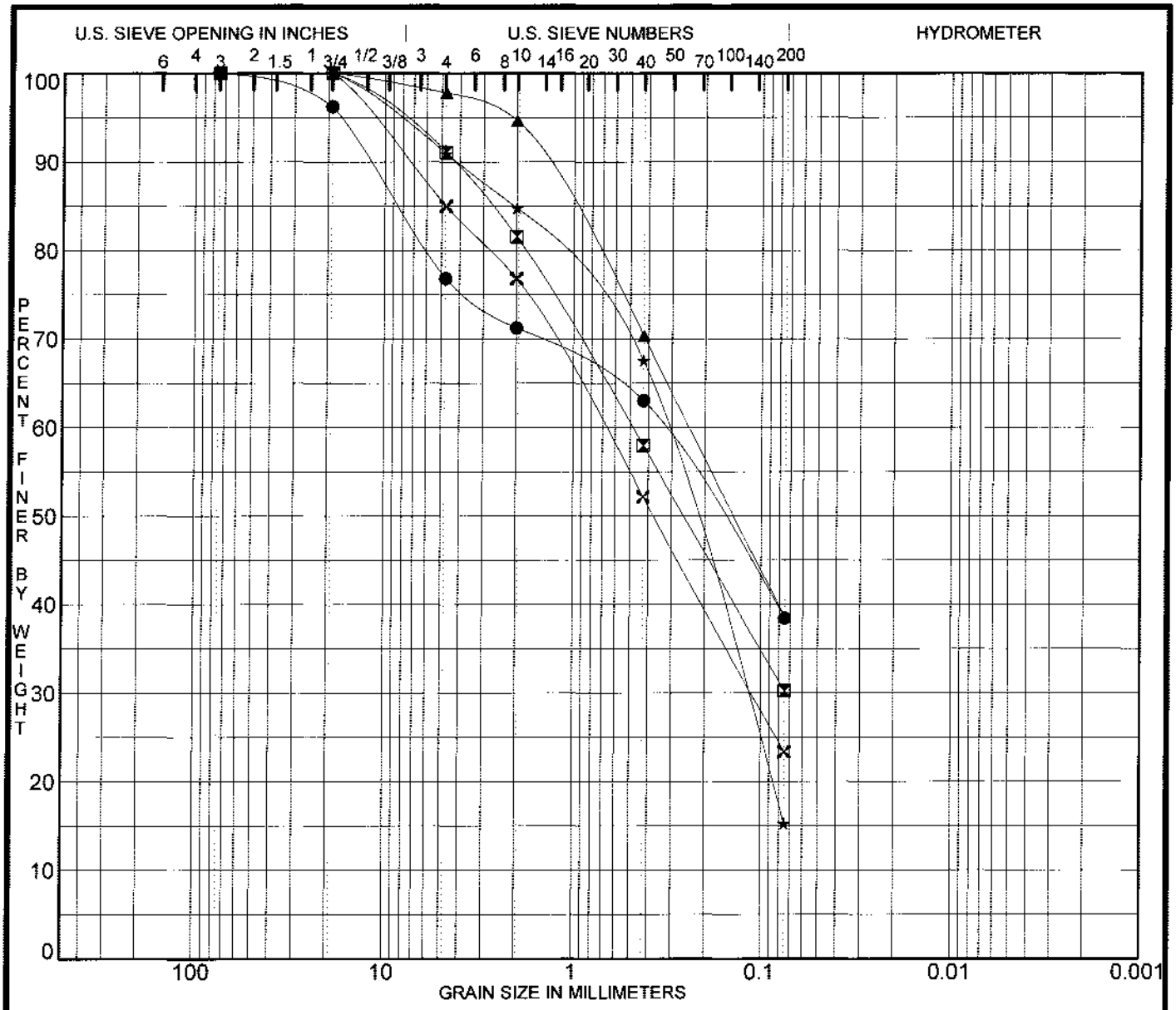
Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	TP-06	4.0	75.00	0.33	0.124		13.5	71.9	14.7	
⧓	TP-07	0.0	75.00	0.23			8.6	49.1	42.3	
▲	TP-08	2.0	75.00	0.88	0.038		24.7	38.3	18.0	19.0
★	TP-09	6.0	75.00	2.44	0.092	0.0027	28.7	43.4	15.7	12.3
✕	TP-10	0.0	75.00	2.30			33.1	36.7	30.2	

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GRADATION CURVES

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COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	TP-11	0.0	CLAYEY SAND with GRAVEL SC		22	14	8		
⊠	TP-12	3.8	CLAYEY SAND SC		22	14	8		
▲	TP-13	0.0	SILTY, CLAYEY SAND SC-SM		21	14	7		
★	TP-14	0.0	SILTY SAND SM		NP	NP	NP		
✕	TP-15	0.0	SILTY, CLAYEY SAND SC-SM		20	15	5		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	TP-11	0.0	75.00	0.34			23.1	38.4	38.5	
⊠	TP-12	3.8	75.00	0.49			8.9	60.9	30.2	
▲	TP-13	0.0	75.00	0.24			2.2	59.2	38.6	
★	TP-14	0.0	75.00	0.33	0.122		9.1	75.7	15.3	
✕	TP-15	0.0	75.00	0.70	0.112		15.0	61.6	23.4	

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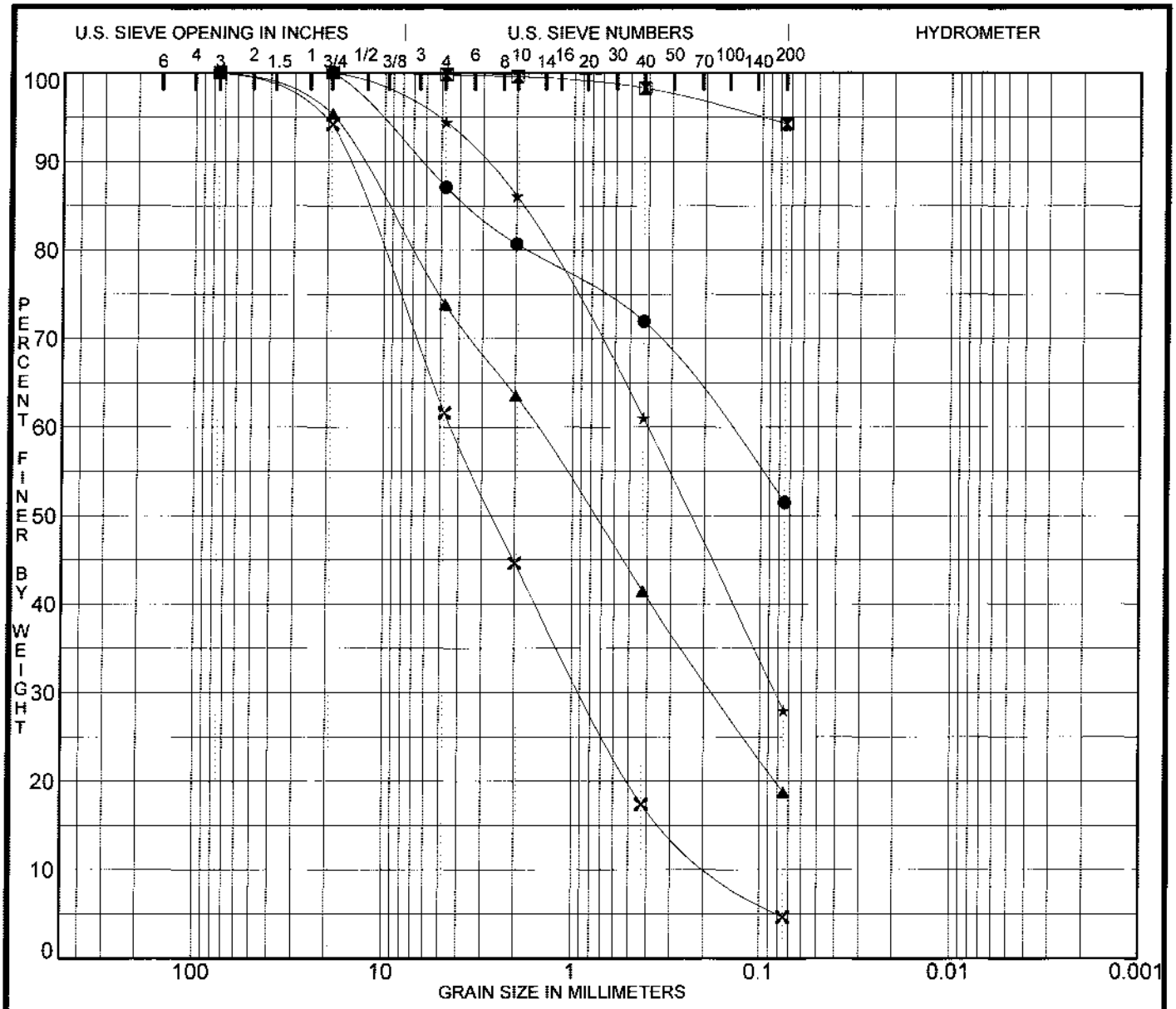
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DATE **6/11/12**

GRADATION CURVES

SPEEDIE AND ASSOCIATES

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COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	TP-16	0.0	CLAYSTONE (SANDY LEAN CLAY CL)		NT	NT	NT		
⊠	TP-18	2.5	CLAYSTONE (LEAN CLAY CL)		NT	NT	NT		
▲	TP-19	0.0	CLAYEY SAND with GRAVEL SC		22	13	9		
★	TP-20	0.0	SILTY, CLAYEY SAND SC-SM		23	18	5		
✕	TP-21	3.0	WELL-GRADED SAND with SILT, CLAY, and GRAVEL SW-SM-SC		NT	NT	NT	1.11	28.1

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	TP-16	0.0	75.00	0.15			12.9	35.6	51.5	
⊠	TP-18	2.5	75.00				0.2	5.6	94.2	
▲	TP-19	0.0	75.00	1.56	0.177		26.1	55.1	18.7	
★	TP-20	0.0	75.00	0.40	0.083		5.5	66.5	28.0	
✕	TP-21	3.0	75.00	4.37	0.871	0.1556	38.4	57.0	4.6	

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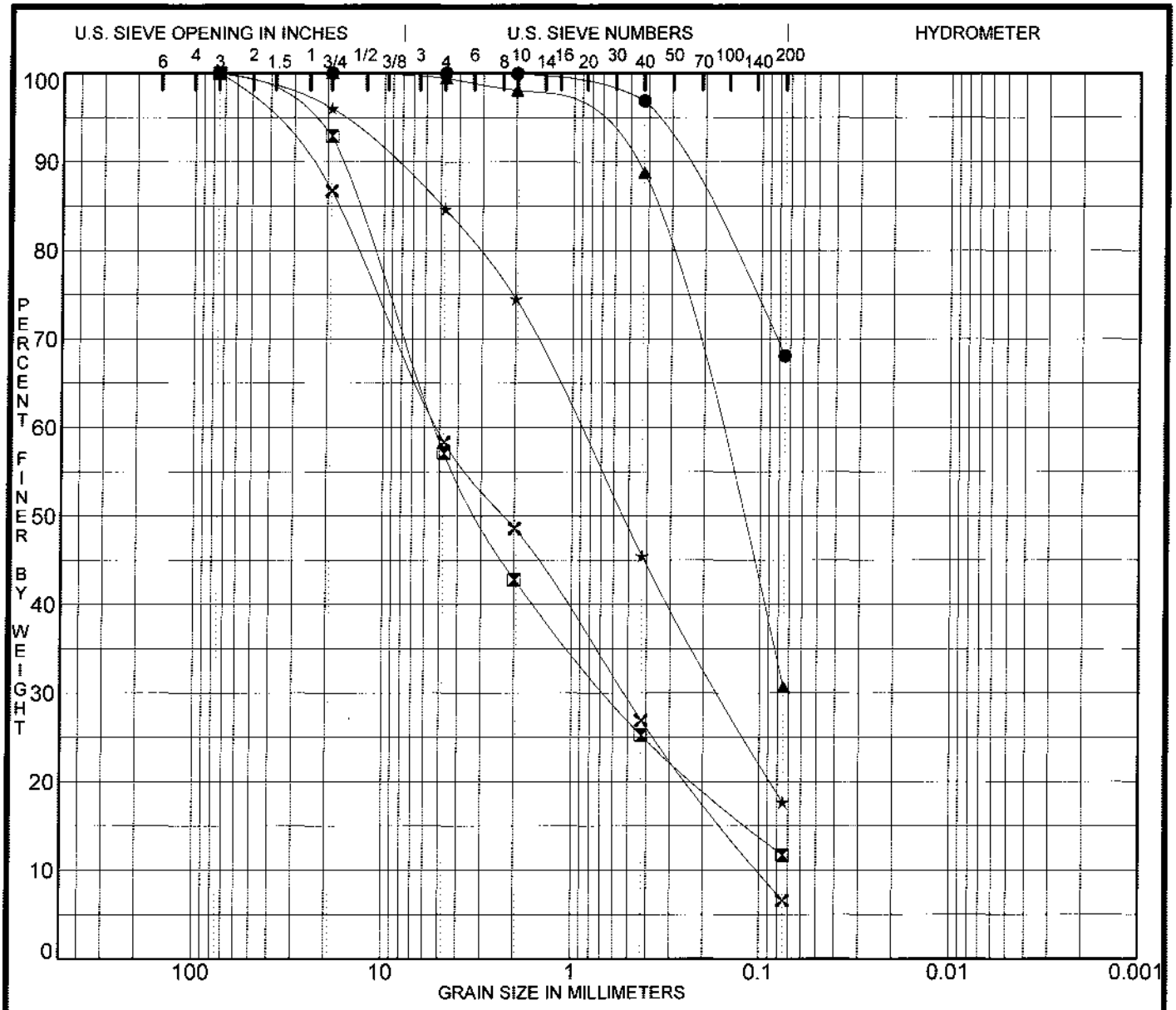
JOB NO. **120751TF**

DATE **6/13/12**

GRADATION CURVES

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COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	TP-21	8.0	CLAYSTONE (SANDY LEAN CLAY CL)		42	24	19		
⊠	TP-22	6.0	WELL-GRADED SAND with SILT, CLAY, and GRAVEL SW-SM-SC		NT	NT	NT	1.31	88.3
▲	TP-23	0.0	SILTY SAND SM		NP	NP	NP		
★	TP-23	6.0	CLAYEY SAND with GRAVEL SC		22	13	9		
✕	TP-24	5.0	POORLY GRADED SAND with SILT, CLAY, and GRAVEL SP-SM-SC		NT	NT	NT	0.54	51.3

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	TP-21	8.0	75.00				0.0	31.9	68.1	
⊠	TP-22	6.0	75.00	5.32	0.647		42.9	45.4	11.7	
▲	TP-23	0.0	75.00	0.18			0.6	68.7	30.7	
★	TP-23	6.0	75.00	0.92	0.162		15.4	67.0	17.6	
✕	TP-24	5.0	75.00	5.15	0.530	0.1004	41.6	51.8	6.6	

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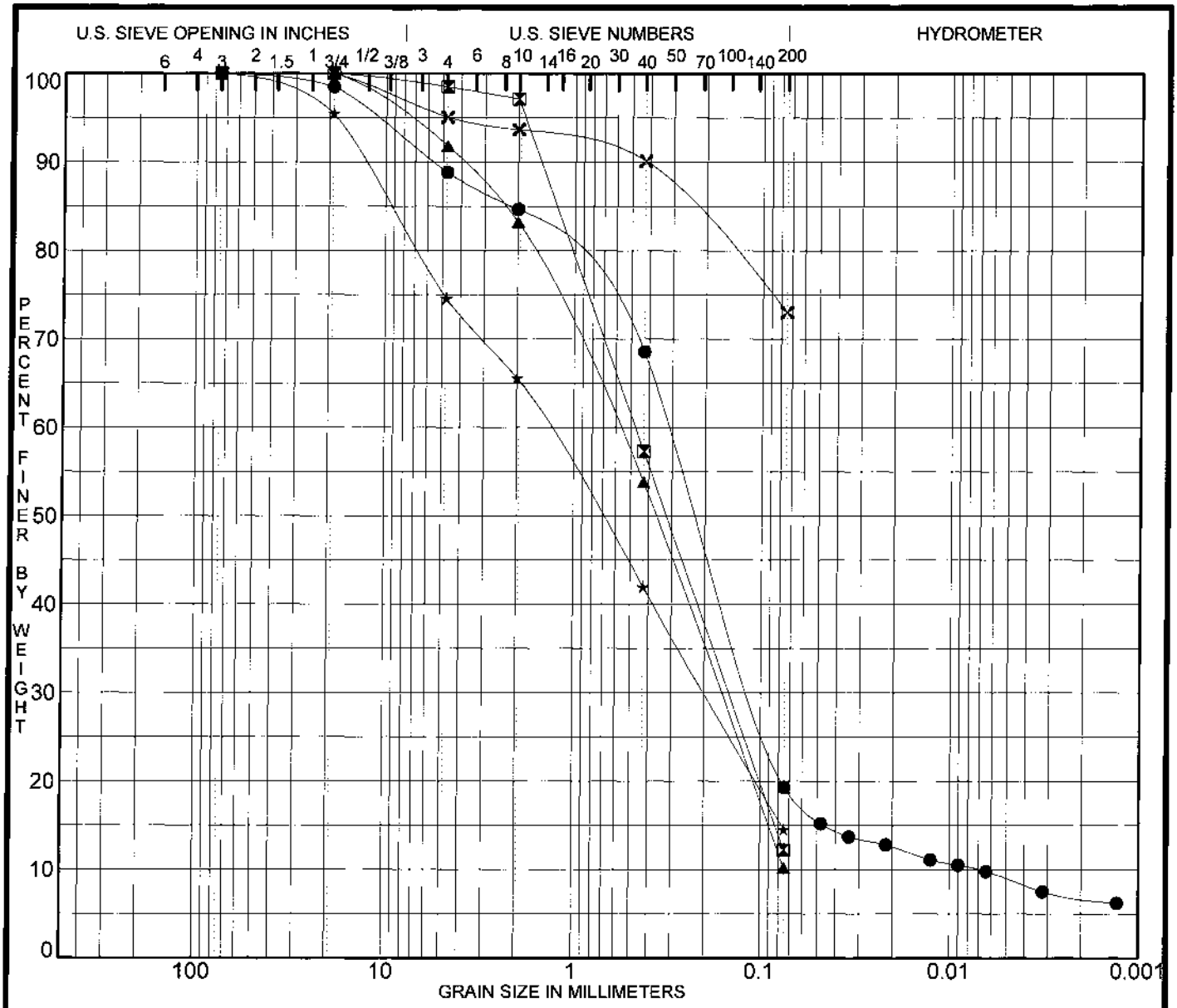
JOB NO. **120751TF**

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GRADATION CURVES

SPEEDIE AND ASSOCIATES

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COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	TP-25	8.0	SILTY SAND SM		17	NP	NP	5.38	44.5
⧓	TP-26	3.5	SILTY, CLAYEY SAND SC-SM		NT	NT	NT	0.68	6.9
▲	TP-27	0.0	POORLY GRADED SAND with SILT and CLAY SP-SM-SC		NT	NT	NT	0.62	7.9
★	TP-28	0.0	SILTY, CLAYEY SAND with GRAVEL SC-SM		NT	NT	NT		
✕	TP-29	0.5	CLAYSTONE (LEAN CLAY with SAND CL)		38	18	20		

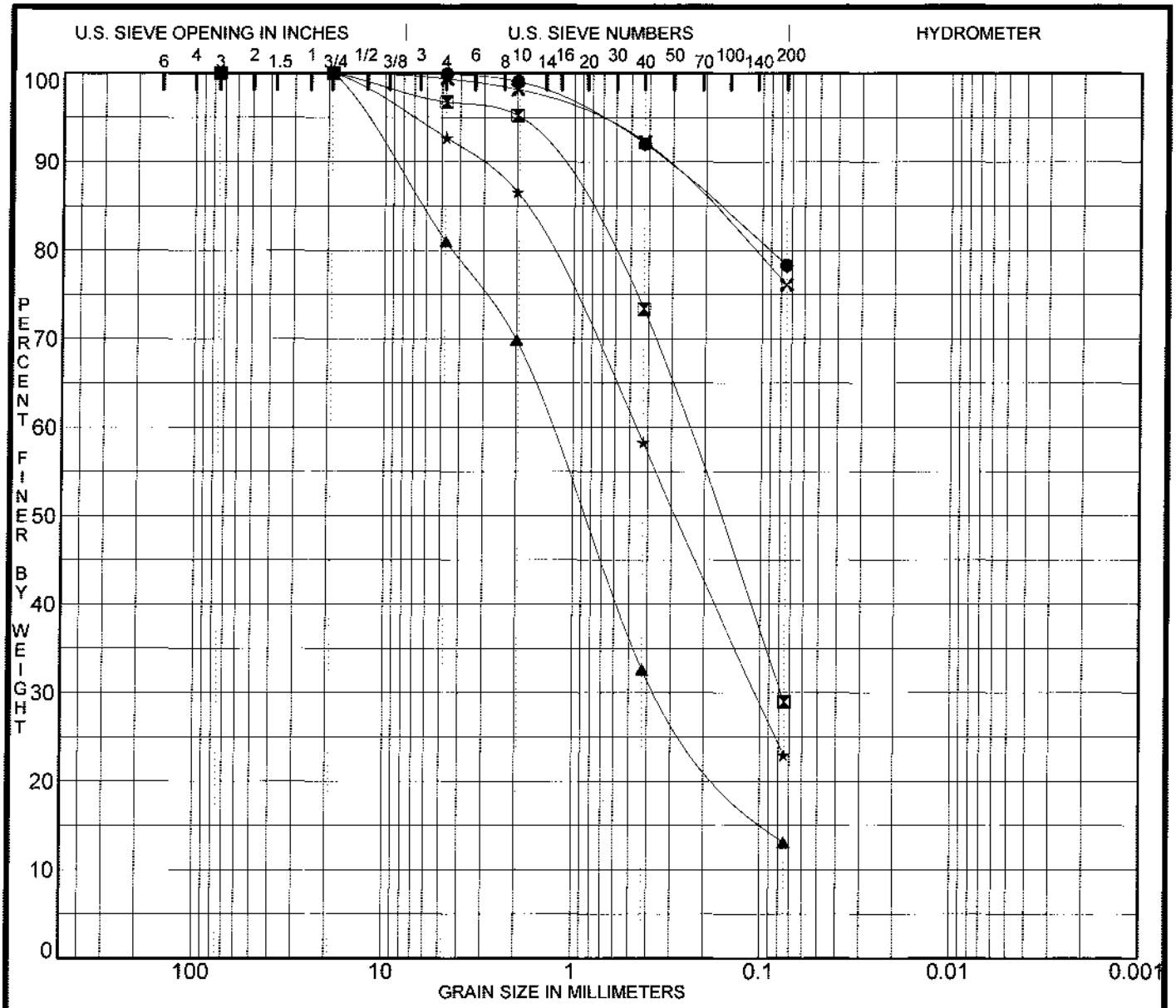
	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	TP-25	8.0	75.00	0.31	0.109	0.0071	11.2	69.5	10.3	9.0
⧓	TP-26	3.5	75.00	0.47	0.149		1.5	86.3	12.2	
▲	TP-27	0.0	75.00	0.59	0.165		8.2	81.6	10.2	
★	TP-28	0.0	75.00	1.39	0.199		25.4	60.0	14.6	
✕	TP-29	0.5	75.00				4.9	22.0	73.0	

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GRADATION CURVES

SPEEDIE AND ASSOCIATES

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COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	TP-30	2.0	LEAN CLAY with SAND CL		22	14	8		
⊠	TP-31	0.0	CLAYEY SAND SC		35	19	15		
▲	TP-32	0.0	SILTY, CLAYEY SAND with GRAVEL SC-SM		NT	NT	NT		
★	TP-33	0.0	SILTY, CLAYEY SAND SC-SM		24	19	5		
✕	TP-34	1.5	CLAYSTONE (LEAN CLAY with SAND CL)		42	23	19		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	TP-30	2.0	75.00				0.1	21.6	78.3	
⊠	TP-31	0.0	75.00	0.25	0.078		3.3	67.7	29.0	
▲	TP-32	0.0	75.00	1.33	0.337		19.0	67.9	13.1	
★	TP-33	0.0	75.00	0.47	0.106		7.3	69.7	22.9	
✕	TP-34	1.5	75.00				0.7	23.3	76.1	

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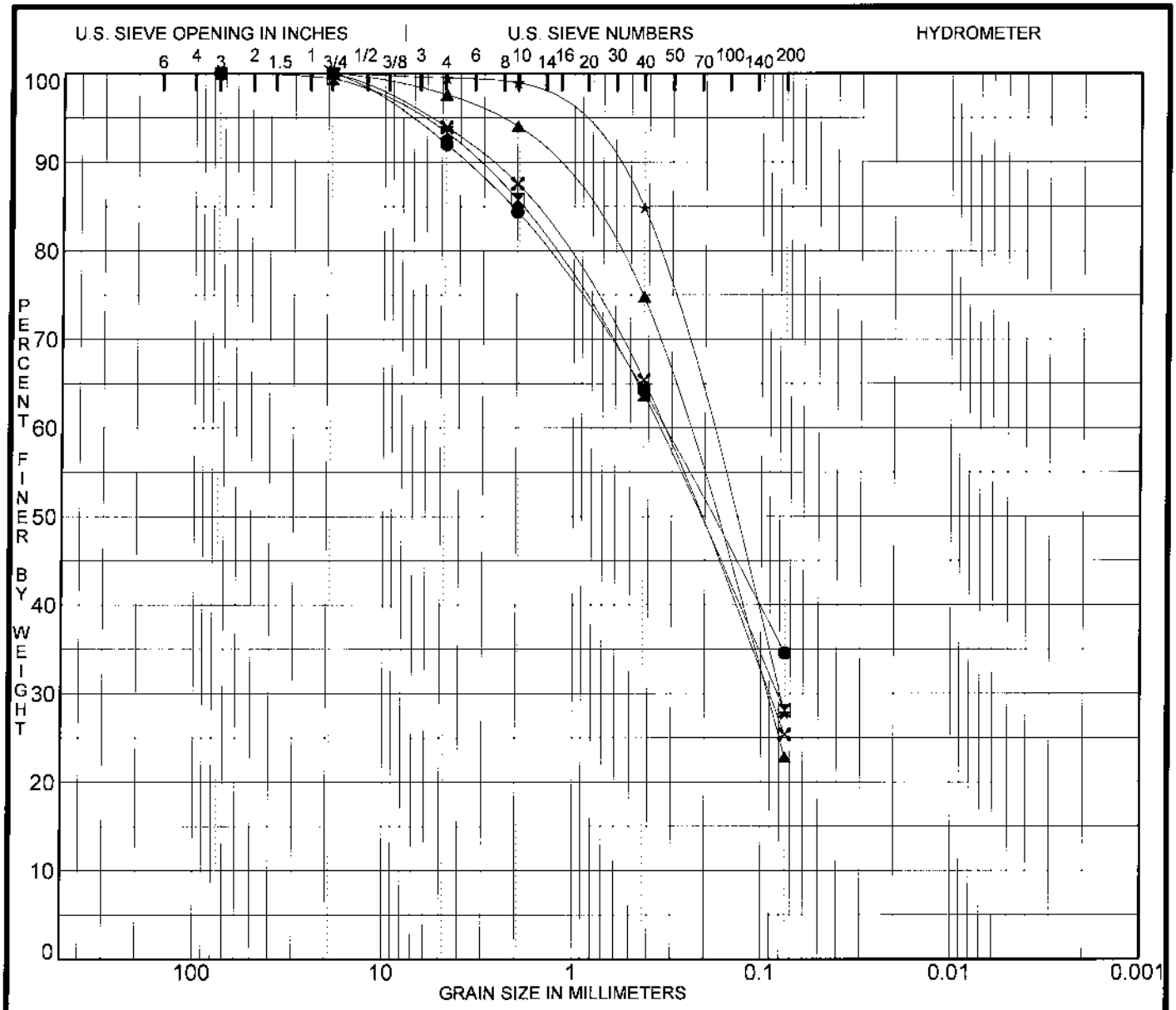
JOB NO. **120751TF**

DATE **6/7/12**

GRADATION CURVES

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COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	TP-35	0.0	CLAYEY SAND SC		28	11	17		
⧗	TP-36	7.0	CLAYEY SAND SC		33	14	18		
▲	TP-37	1.0	SILTY SAND SM		33	25	8		
★	TP-38	1.0	SILTY SAND SM		NP	NP	NP		
✕	TP-39	0.0	CLAYEY SAND SC		27	16	11		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	TP-35	0.0	75.00	0.33			8.0	57.4	34.6	
⧗	TP-36	7.0	75.00	0.35	0.082		6.7	65.3	28.1	
▲	TP-37	1.0	75.00	0.26	0.095		2.4	74.8	22.8	
★	TP-38	1.0	75.00	0.20	0.080		0.5	71.7	27.8	
✕	TP-39	0.0	75.00	0.34	0.092		6.1	68.6	25.4	

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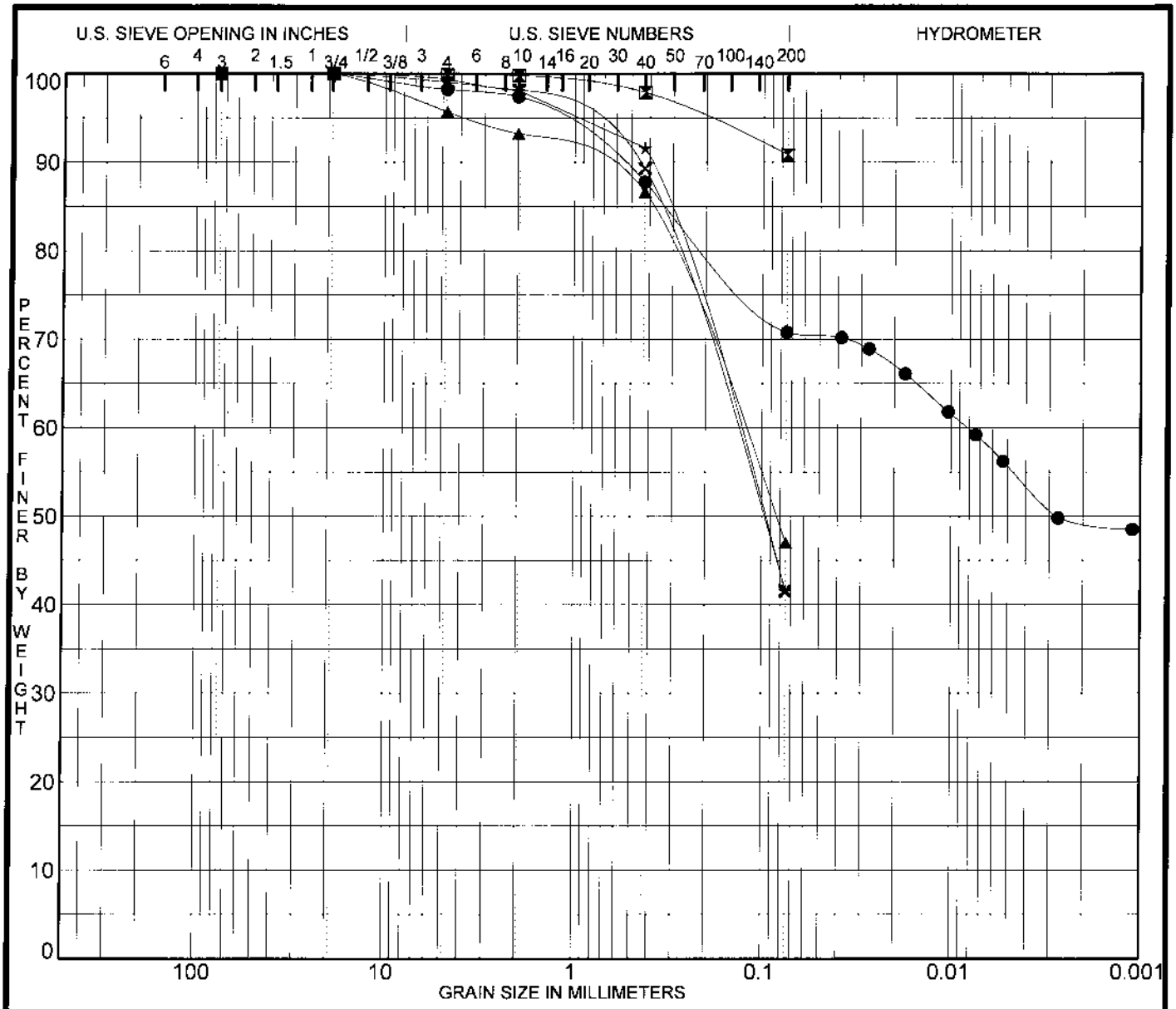
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DATE **6/6/12**

GRADATION CURVES

SPEEDIE AND ASSOCIATES

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COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	TP-40	0.0	FAT CLAY with SAND CH		59	19	40		
⧗	TP-41	3.0	CLAYSTONE (FAT CLAY CH)		NT	NT	NT		
▲	TP-42	7.0	CLAYEY SAND SC		28	18	10		
★	TP-43	0.0	SILTY, CLAYEY SAND SC-SM		25	18	8		
✕	TP-44	0.8	SILTY, CLAYEY SAND SC-SM		24	19	5		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	TP-40	0.0	75.00	0.01			1.8	27.4	15.1	55.6
⧗	TP-41	3.0	75.00				0.1	9.0	90.8	
▲	TP-42	7.0	75.00	0.13			4.3	48.7	47.0	
★	TP-43	0.0	75.00	0.14			0.7	57.8	41.6	
✕	TP-44	0.8	75.00	0.15			1.0	57.5	41.5	

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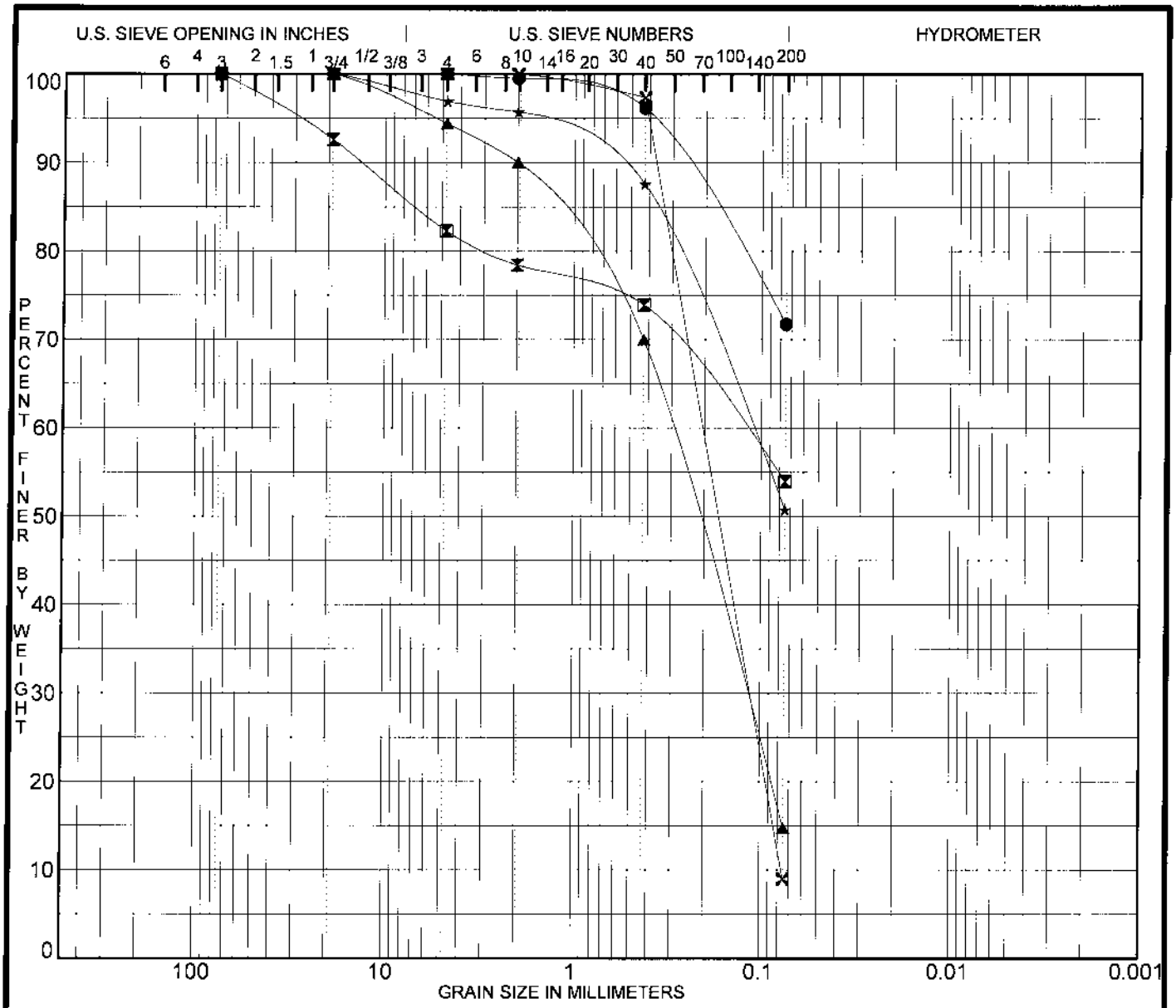
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GRADATION CURVES

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COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	TP-45	0.0	CLAYSTONE (LEAN CLAY with SAND CL)		NT	NT	NT		
⧗	TP-46	0.0	CLAYSTONE (SANDY SILT with GRAVEL ML)		41	26	15		
▲	TP-47	0.0	SILTY, CLAYEY SAND SC-SM		NT	NT	NT		
★	TP-48	1.8	CLAYSTONE (SANDY LEAN CLAY CL)		NT	NT	NT		
✕	TP-49	0.0	POORLY GRADED SAND with SILT and CLAY SP-SM-SC		NT	NT	NT	0.82	2.7

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	TP-45	0.0	75.00				0.0	28.3	71.7	
⧗	TP-46	0.0	75.00	0.13			17.7	28.3	53.9	
▲	TP-47	0.0	75.00	0.31	0.121		5.6	79.6	14.8	
★	TP-48	1.8	75.00	0.12			3.1	46.2	50.8	
✕	TP-49	0.0	75.00	0.20	0.113	0.0765	0.0	91.0	9.0	

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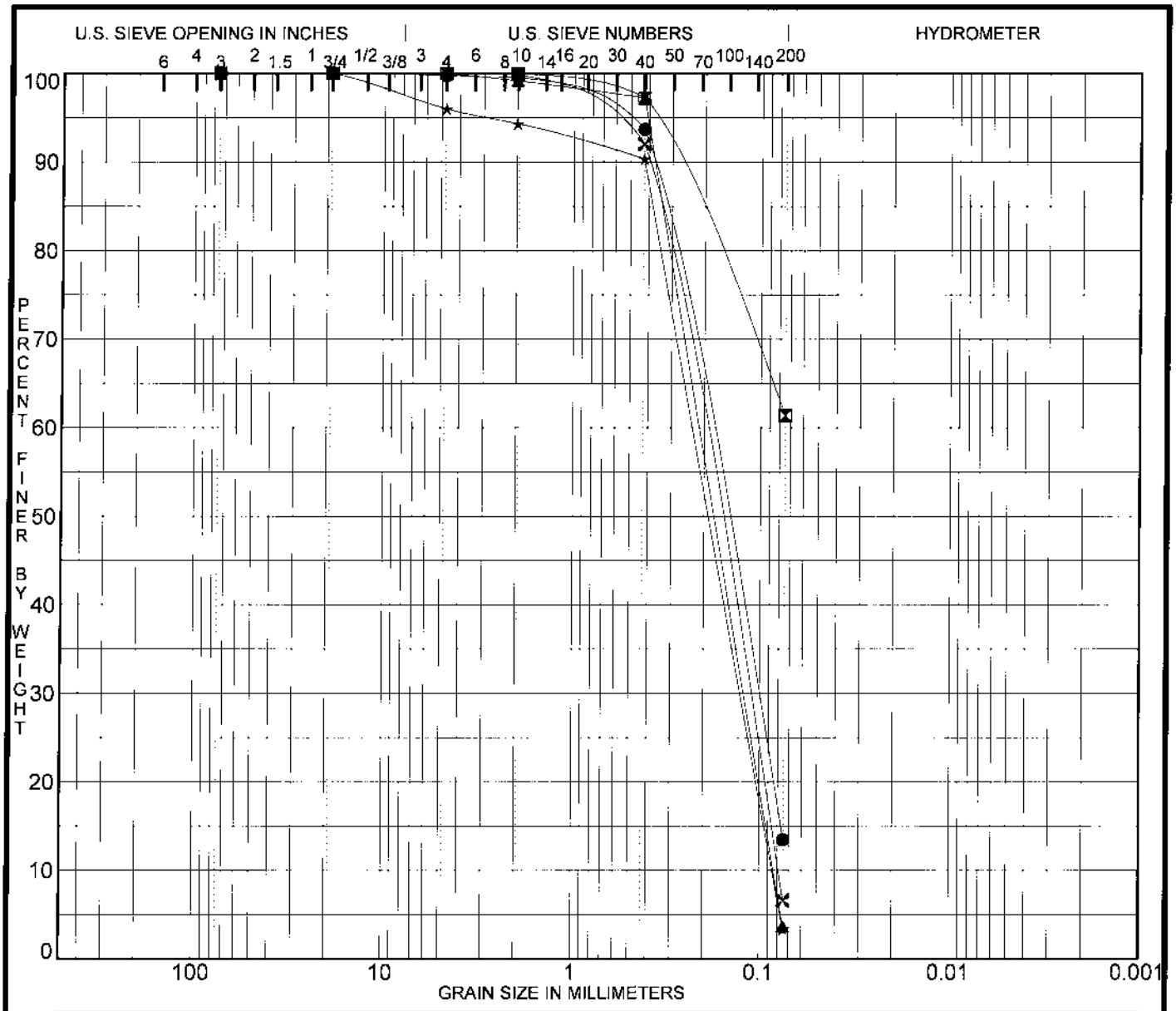
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DATE **6/18/12**

GRADATION CURVES

SPEEDIE AND ASSOCIATES

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COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	TP-50	0.0	SILTY, CLAYEY SAND SC-SM		NT	NT	NT		
⊠	TP-51	4.5	SANDY LEAN CLAY CL		33	15	18		
▲	TP-52	2.0	POORLY GRADED SAND SP		NT	NT	NT	0.83	2.5
★	TP-55	5.0	POORLY GRADED SAND SP		NT	NT	NT	0.82	2.7
✕	TP-56	2.0	POORLY GRADED SAND with SILT and CLAY SP-SM-SC		NT	NT	NT	0.82	2.8

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	TP-50	0.0	75.00	0.21	0.107		0.2	86.3	13.5	
⊠	TP-51	4.5	75.00				0.0	38.6	61.4	
▲	TP-52	2.0	75.00	0.21	0.122	0.0843	0.1	96.2	3.7	
★	TP-55	5.0	75.00	0.23	0.127	0.0856	4.0	92.6	3.4	
✕	TP-56	2.0	75.00	0.22	0.121	0.0804	0.0	93.4	6.6	

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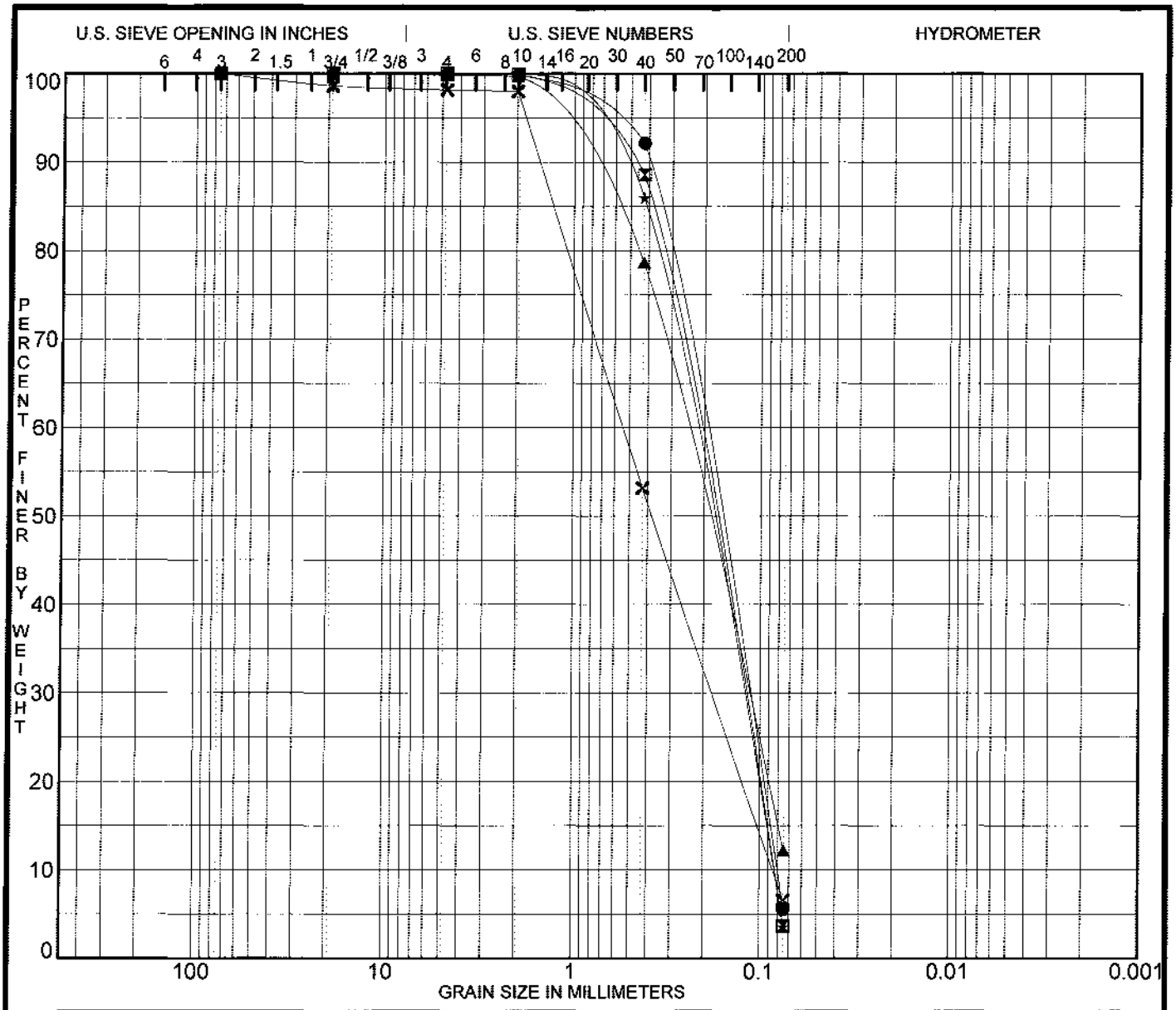
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GRADATION CURVES

SPEEDIE AND ASSOCIATES

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COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	TP-57	0.0	POORLY GRADED SAND with SILT and CLAY SP-SM-SC		NT	NT	NT	0.82	2.7
⧗	TP-58	0.0	POORLY GRADED SAND SP		NT	NT	NT	0.82	2.8
▲	TP-59	0.0	SILTY, CLAYEY SAND SC-SM		NT	NT	NT	0.77	3.7
★	TP-60	0.0	POORLY GRADED SAND SP		NT	NT	NT	0.81	2.9
✕	TP-61	0.0	POORLY GRADED SAND with SILT and CLAY SP-SM-SC		NT	NT	NT	0.70	6.3

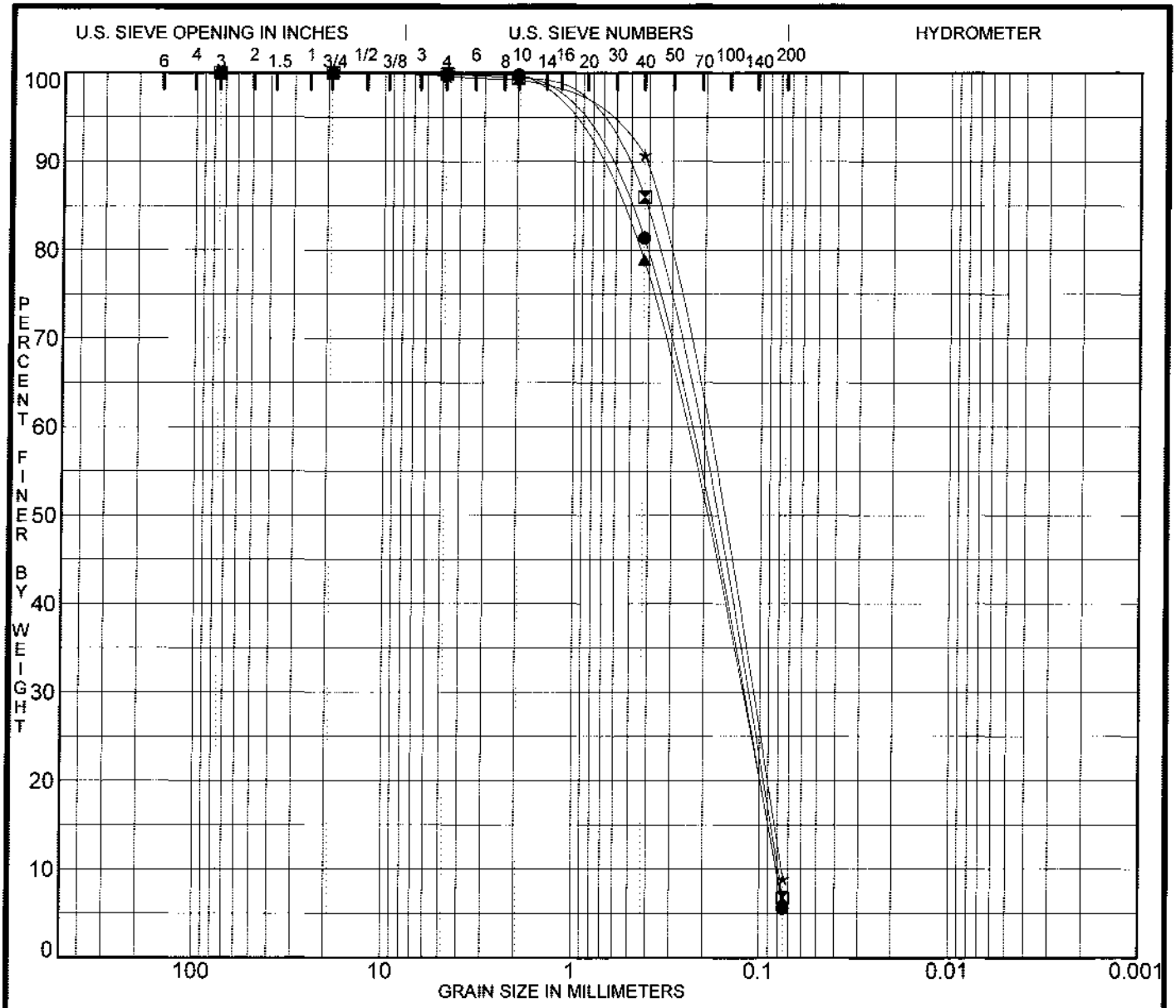
Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	TP-57	0.0	75.00	0.22	0.122	0.0820	0.0	94.5	5.5	
⧗	TP-58	0.0	75.00	0.24	0.129	0.0854	0.0	96.4	3.6	
▲	TP-59	0.0	75.00	0.26	0.119		0.2	87.7	12.2	
★	TP-60	0.0	75.00	0.25	0.131	0.0858	0.0	96.4	3.6	
✕	TP-61	0.0	75.00	0.54	0.179	0.0852	1.8	91.6	6.6	

PROJECT **Cameron Water Line - Page to Cameron** JOB NO. **120751TF**
DATE **6/19/12**

GRADATION CURVES

SPEEDIE AND ASSOCIATES

{GRSZLSZ 120751TF.GPJ 7/19/12}



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	TP-62	0.0	POORLY GRADED SAND with SILT and CLAY SP-SM-SC		NT	NT	NT	0.80	3.1
⊠	TP-63	0.0	POORLY GRADED SAND with SILT and CLAY SP-SM-SC		NT	NT	NT	0.80	3.0
▲	TP-67	0.0	POORLY GRADED SAND with SILT and CLAY SP-SM-SC		NT	NT	NT	0.79	3.3
★	TP-68	0.0	POORLY GRADED SAND with SILT and CLAY SP-SM-SC		NT	NT	NT	0.81	2.9

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	TP-62	0.0	75.00	0.26	0.131	0.0830	0.2	94.2	5.6	
⊠	TP-63	0.0	75.00	0.24	0.125	0.0805	0.1	93.1	6.8	
▲	TP-67	0.0	75.00	0.27	0.132	0.0821	0.1	93.7	6.2	
★	TP-68	0.0	75.00	0.22	0.117	0.0768	0.4	90.7	8.9	

PROJECT **Cameron Water Line - Page to Cameron**

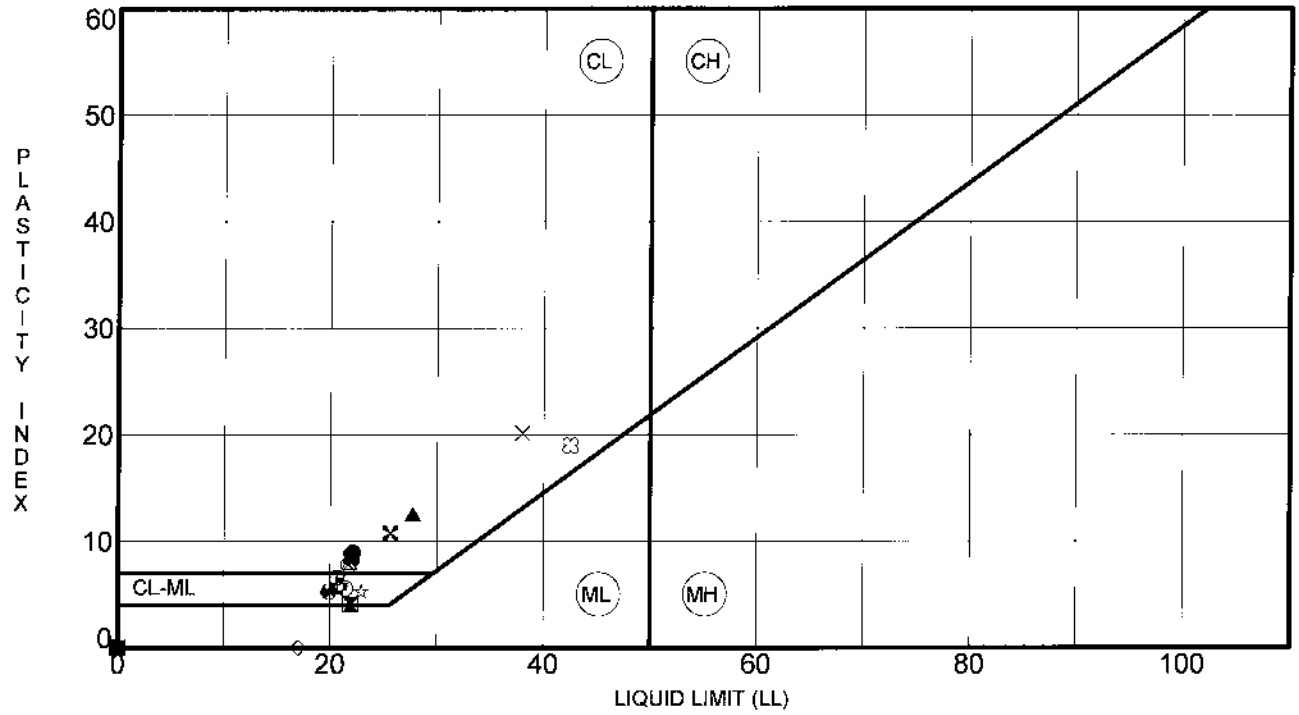
JOB NO. **120751TF**

DATE **6/18/12**

GRADATION CURVES

SPEEDIE AND ASSOCIATES

{GRSZLSZ 120751TF.GPJ 7/19/12}



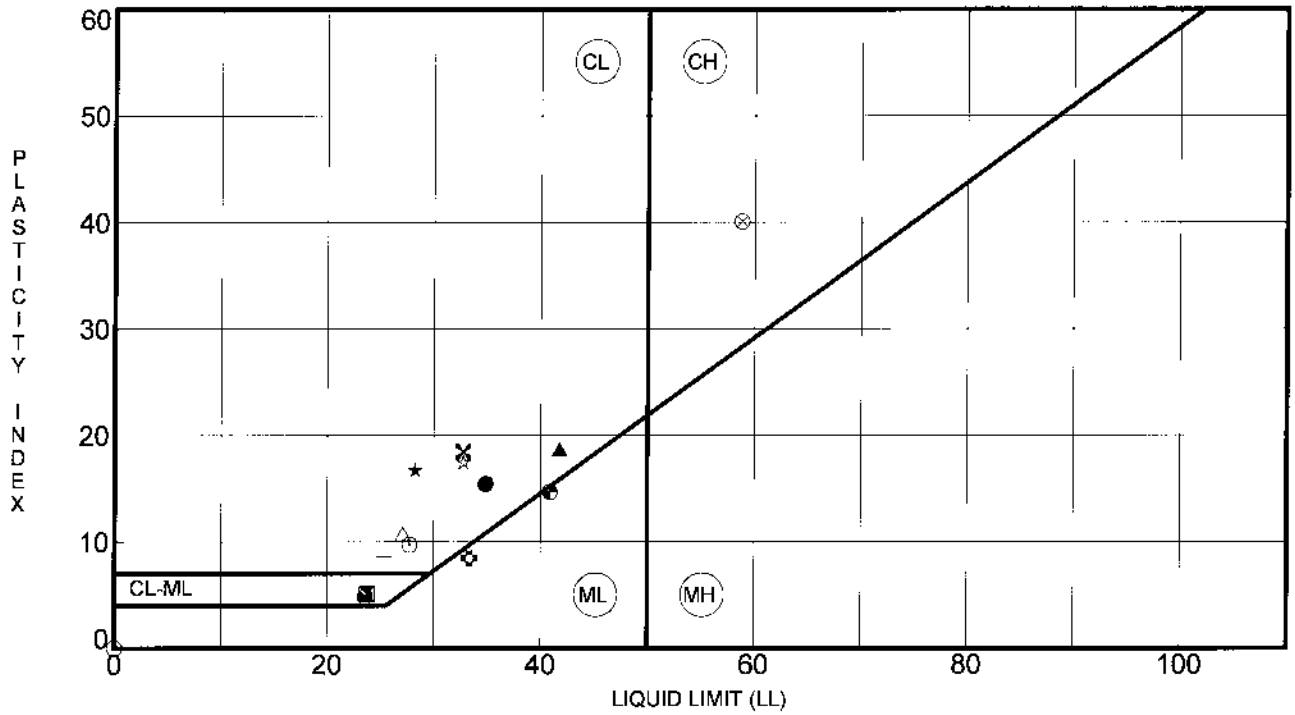
Specimen Identification		LL	PL	PI	Fines	Classification
●	TP-02 0.0	NP	NP	NP	36.9	SILTY SAND with GRAVEL SM
⊠	TP-04 4.0	22	18	4	14.6	SILTY, CLAYEY GRAVEL with SAND GC-GM
▲	TP-05 2.0	28	15	13	72.1	LEAN CLAY with SAND CL
★	TP-07 0.0	20	15	5	42.3	SILTY, CLAYEY SAND SC-SM
×	TP-08 2.0	26	15	11	37.0	CLAYEY SAND with GRAVEL SC
✿	TP-09 6.0	21	15	6	27.9	SILTY, CLAYEY SAND with GRAVEL SC-SM
○	TP-10 0.0	21	16	6	30.2	SILTY, CLAYEY SAND with GRAVEL SC-SM
△	TP-11 0.0	22	14	8	38.5	CLAYEY SAND with GRAVEL SC
⊗	TP-12 3.8	22	14	8	30.2	CLAYEY SAND SC
◐	TP-13 0.0	21	14	7	38.6	SILTY, CLAYEY SAND SC-SM
▭	TP-14 0.0	NP	NP	NP	15.3	SILTY SAND SM
⊖	TP-15 0.0	20	15	5	23.4	SILTY, CLAYEY SAND SC-SM
◕	TP-19 0.0	22	13	9	18.7	CLAYEY SAND with GRAVEL SC
☆	TP-20 0.0	23	18	5	28.0	SILTY, CLAYEY SAND SC-SM
⊠	TP-21 8.0	42	24	19	68.1	CLAYSTONE (SANDY LEAN CLAY CL)
■	TP-23 0.0	NP	NP	NP	30.7	SILTY SAND SM
◆	TP-23 6.0	22	13	9	17.6	CLAYEY SAND with GRAVEL SC
◇	TP-25 8.0	17	NP	NP	19.3	SILTY SAND SM
⊠	TP-29 3.0	38	18	20	73.0	CLAYSTONE (LEAN CLAY with SAND CL)
✱	TP-30 2.0	22	14	8	78.3	LEAN CLAY with SAND CL

PROJECT Cameron Water Line - Page to Cameron
JOB NO. 120751TF
DATE 6/7/12

ATTERBERG LIMITS' RESULTS

SPEEDIE AND ASSOCIATES

{ATTBLSZ 120751TF.GPJ 7/19/12



Specimen Identification			LL	PL	PI	Fines	Classification
●	TP-31	0.0	35	19	15	29.0	CLAYEY SAND SC
⊠	TP-33	0.0	24	19	5	22.9	SILTY, CLAYEY SAND SC-SM
▲	TP-34	1.5	42	23	19	76.1	CLAYSTONE (LEAN CLAY with SAND CL)
★	TP-35	0.0	28	11	17	34.6	CLAYEY SAND SC
×	TP-36	0.0	33	14	18	28.1	CLAYEY SAND SC
✡	TP-37	1.0	33	25	8	22.8	SILTY SAND SM
○	TP-38	1.0	NP	NP	NP	27.8	SILTY SAND SM
△	TP-39	0.0	27	16	11	25.4	CLAYEY SAND SC
⊗	TP-40	0.0	59	19	40	70.8	FAT CLAY with SAND CH
⊕	TP-42	7.0	28	18	10	47.0	CLAYEY SAND SC
❐	TP-43	0.0	25	18	8	41.6	SILTY, CLAYEY SAND SC-SM
⊖	TP-44	0.0	24	19	5	41.5	SILTY, CLAYEY SAND SC-SM
◒	TP-46	0.0	41	26	15	53.9	CLAYSTONE (SANDY SILT with GRAVEL ML)
☆	TP-51	4.5	33	15	18	61.4	SANDY LEAN CLAY CL

PROJECT **Cameron Water Line - Page to Cameron** JOB NO. **120751TF**
DATE **6/18/12**

ATTERBERG LIMITS' RESULTS

SPEEDIE AND ASSOCIATES

{ATTBLSZ 120751TF.GPJ 7/19/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line PROJECT NO.: 120751TF

LOCATION: Page to Cameron DATE: 6/14/12

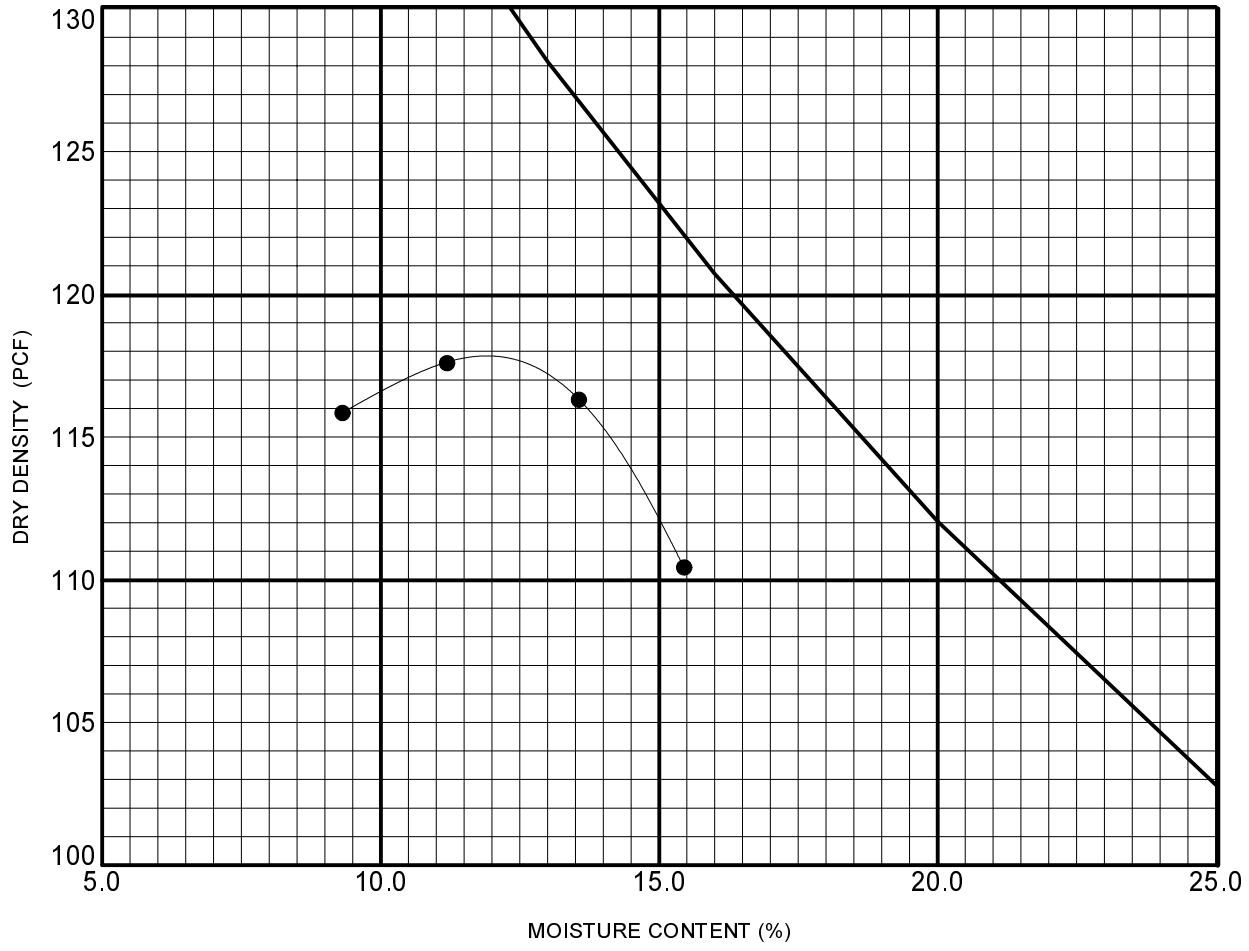
BORING NO.: TP-01 SAMPLE NO.: BS-1 SAMPLE DEPTH: 0 to 8 LABORATORY NO.: 373442

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT PLASTIC LIMIT: NT PLASTICITY INDEX: NT

CLASSIFICATION: SC-SM ASTM SOIL DESCRIPTION: SILTY, CLAYEY SAND

MAXIMUM DRY DENSITY: **117.9 PCF** OPTIMUM MOISTURE CONTENT: **11.8%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.:** 120751TF

LOCATION: Page to Cameron **DATE:** 6/14/12

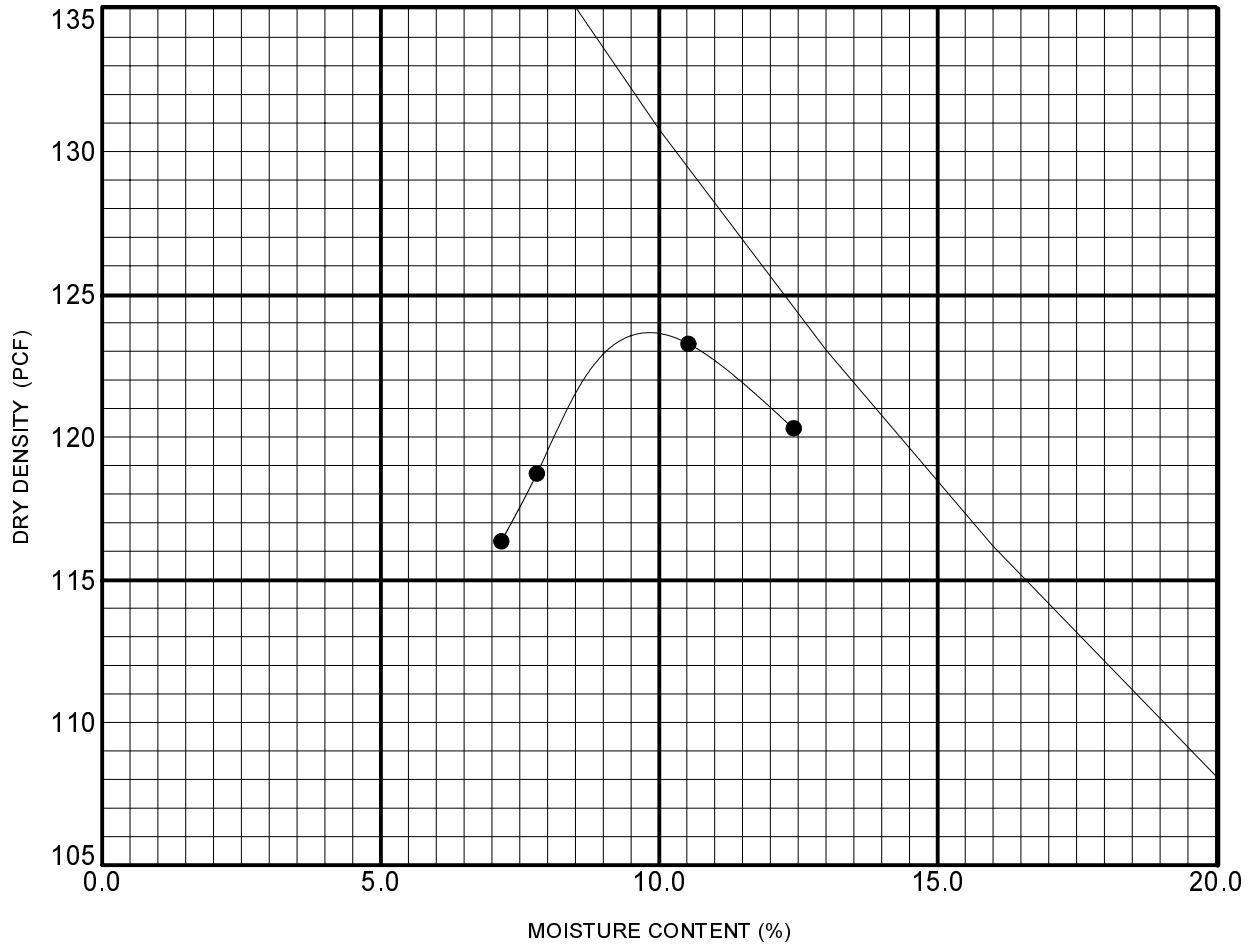
BORING NO.: TP-02 **SAMPLE NO.:** BS-1 **SAMPLE DEPTH:** 0 to 12 **LABORATORY NO.:** 373441

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NP **PLASTIC LIMIT:** NP **PLASTICITY INDEX:** NP

CLASSIFICATION: SM **ASTM SOIL DESCRIPTION:** SILTY SAND with GRAVEL

MAXIMUM DRY DENSITY: **123.7 PCF** OPTIMUM MOISTURE CONTENT: **9.8%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/6/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.:** 120751TF

LOCATION: Page to Cameron **DATE:** 6/14/12

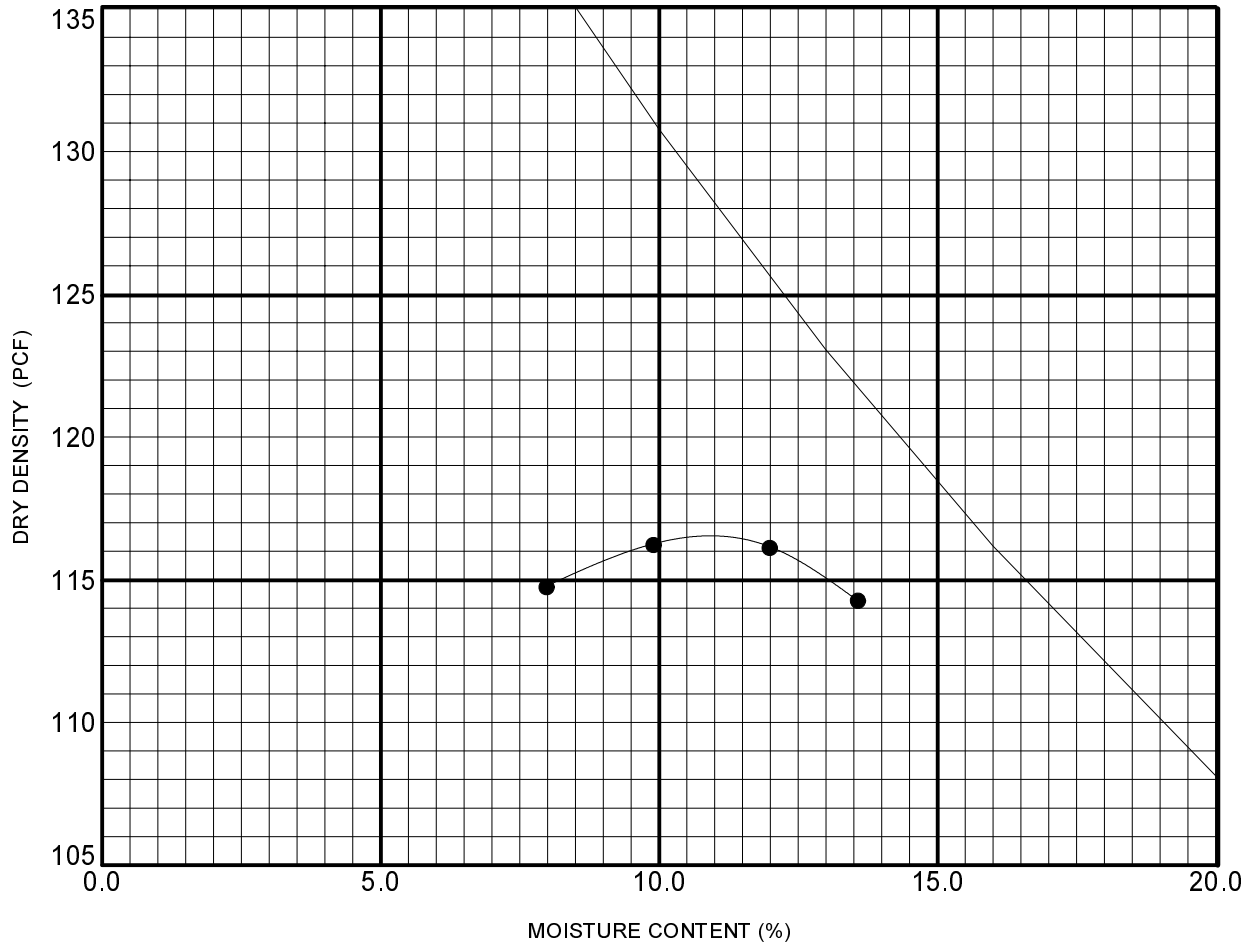
BORING NO.: TP-03 **SAMPLE NO.:** BS-1 **SAMPLE DEPTH:** 4 to 13 **LABORATORY NO.:** 373440

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT **PLASTIC LIMIT:** NT **PLASTICITY INDEX:** NT

CLASSIFICATION: SP-SM-SC **ASTM SOIL DESCRIPTION:** POORLY GRADED SAND with SILT, CLAY and GRAVEL

MAXIMUM DRY DENSITY: **116.5 PCF** OPTIMUM MOISTURE CONTENT: **10.8%**



SPEEDIE AND ASSOCIATES

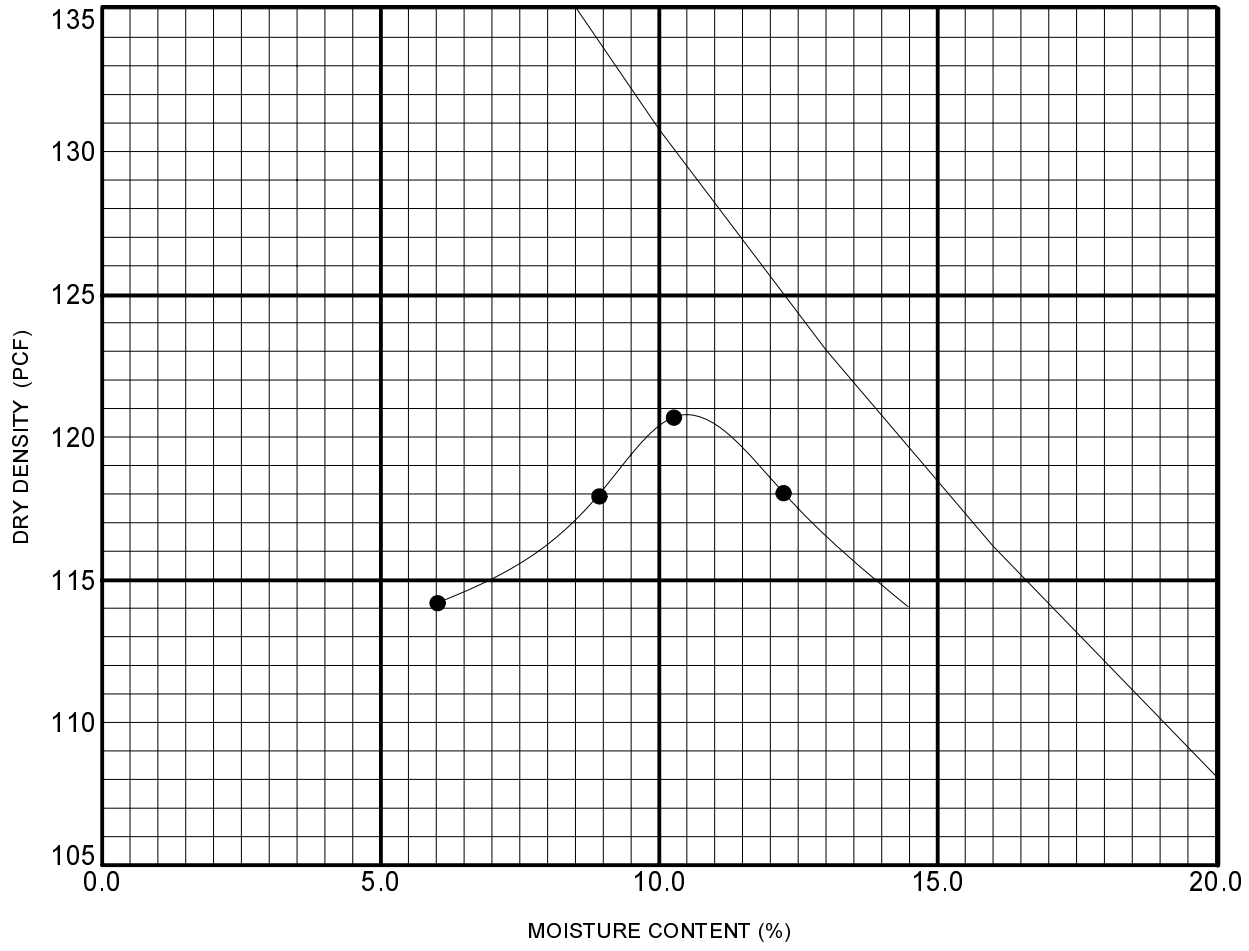
GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT:	**Cameron Water Line**				**PROJECT NO.: 120751TF**
LOCATION:	**Page to Cameron**				**DATE: 6/14/12**
BORING NO.: TP-04	**SAMPLE NO.: BS-1**	**SAMPLE DEPTH: 4 to 13**			**LABORATORY NO.: 373439**
METHOD OF COMPACTION:	**D698A**				
LIQUID LIMIT:	**22**	**PLASTIC LIMIT:**	**18**	**PLASTICITY INDEX:**	**4**
CLASSIFICATION:	**GC-GM**	**ASTM SOIL DESCRIPTION:**		**SILTY, CLAYEY GRAVEL with SAND**	

MAXIMUM DRY DENSITY: **120.9 PCF**

OPTIMUM MOISTURE CONTENT: **10.5%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/6/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.:** 120751TF

LOCATION: Page to Cameron **DATE:** 6/14/12

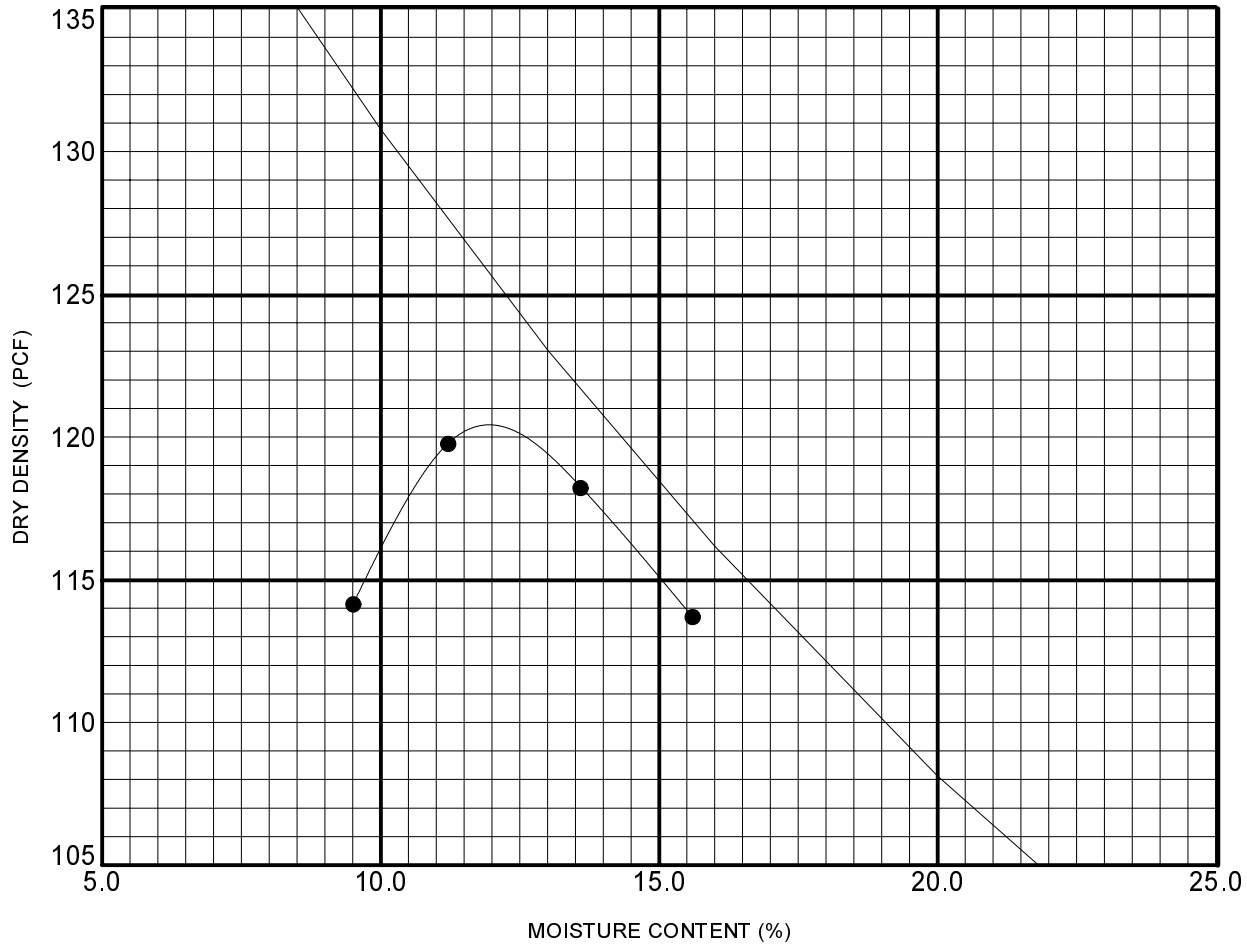
BORING NO.: TP-05 **SAMPLE NO.:** BS-1 **SAMPLE DEPTH:** 2 to 12 **LABORATORY NO.:** 373443

METHOD OF COMPACTION: D698A

LIQUID LIMIT: 28 **PLASTIC LIMIT:** 15 **PLASTICITY INDEX:** 13

CLASSIFICATION: CL **ASTM SOIL DESCRIPTION:** LEAN CLAY with SAND

MAXIMUM DRY DENSITY: **120.4 PCF** OPTIMUM MOISTURE CONTENT: **11.9 %**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/6/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.:** 120751TF

LOCATION: Page to Cameron **DATE:** 6/14/12

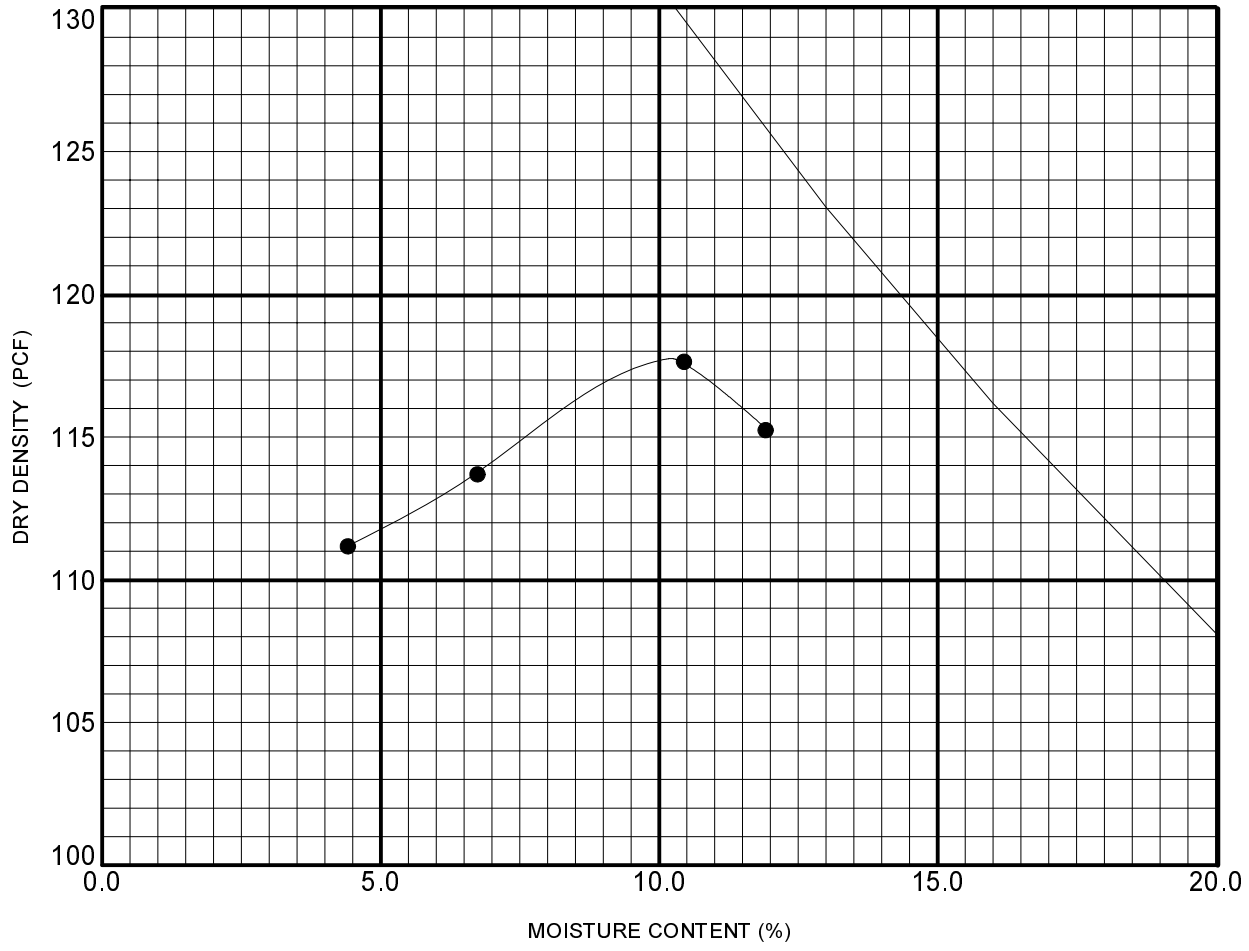
BORING NO.: TP-06 **SAMPLE NO.:** BS-1 **SAMPLE DEPTH:** 4 to 10.4 **LABORATORY NO.:** 373444

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT **PLASTIC LIMIT:** NT **PLASTICITY INDEX:** NT

CLASSIFICATION: SC-SM **ASTM SOIL DESCRIPTION:** SILTY, CLAYEY SAND

MAXIMUM DRY DENSITY: **117.8 PCF** OPTIMUM MOISTURE CONTENT: **10.3%**



SPEEDIE AND ASSOCIATES

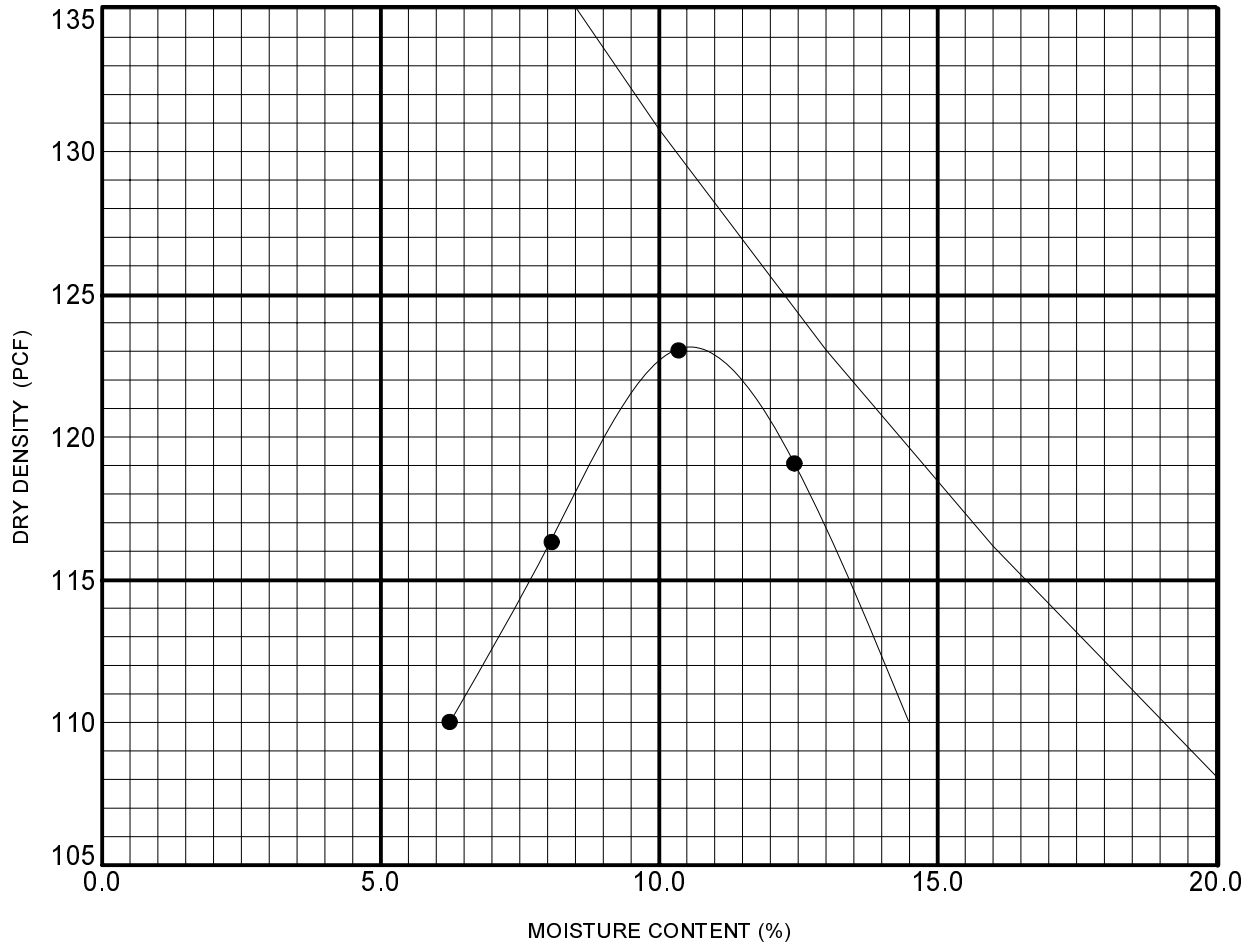
GEOTECH PROCTOR 120751TF.GPJ 7/6/12

MOISTURE-DENSITY RELATIONS

PROJECT:	**Cameron Water Line**		**PROJECT NO.: 120751TF**
LOCATION:	**Page to Cameron**		**DATE: 6/14/12**
BORING NO.: TP-07	**SAMPLE NO.: BS-1**	**SAMPLE DEPTH: 0 to 14**	**LABORATORY NO.: 373445**
METHOD OF COMPACTION:	**D698A**		
LIQUID LIMIT:	**20**	**PLASTIC LIMIT: 15**	**PLASTICITY INDEX: 5**
CLASSIFICATION:	**SC-SM**	**ASTM SOIL DESCRIPTION:**	**SILTY, CLAYEY SAND**

MAXIMUM DRY DENSITY: **123.1 PCF**

OPTIMUM MOISTURE CONTENT: **10.6 %**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/6/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line PROJECT NO.: 120751TF

LOCATION: Page to Cameron DATE:

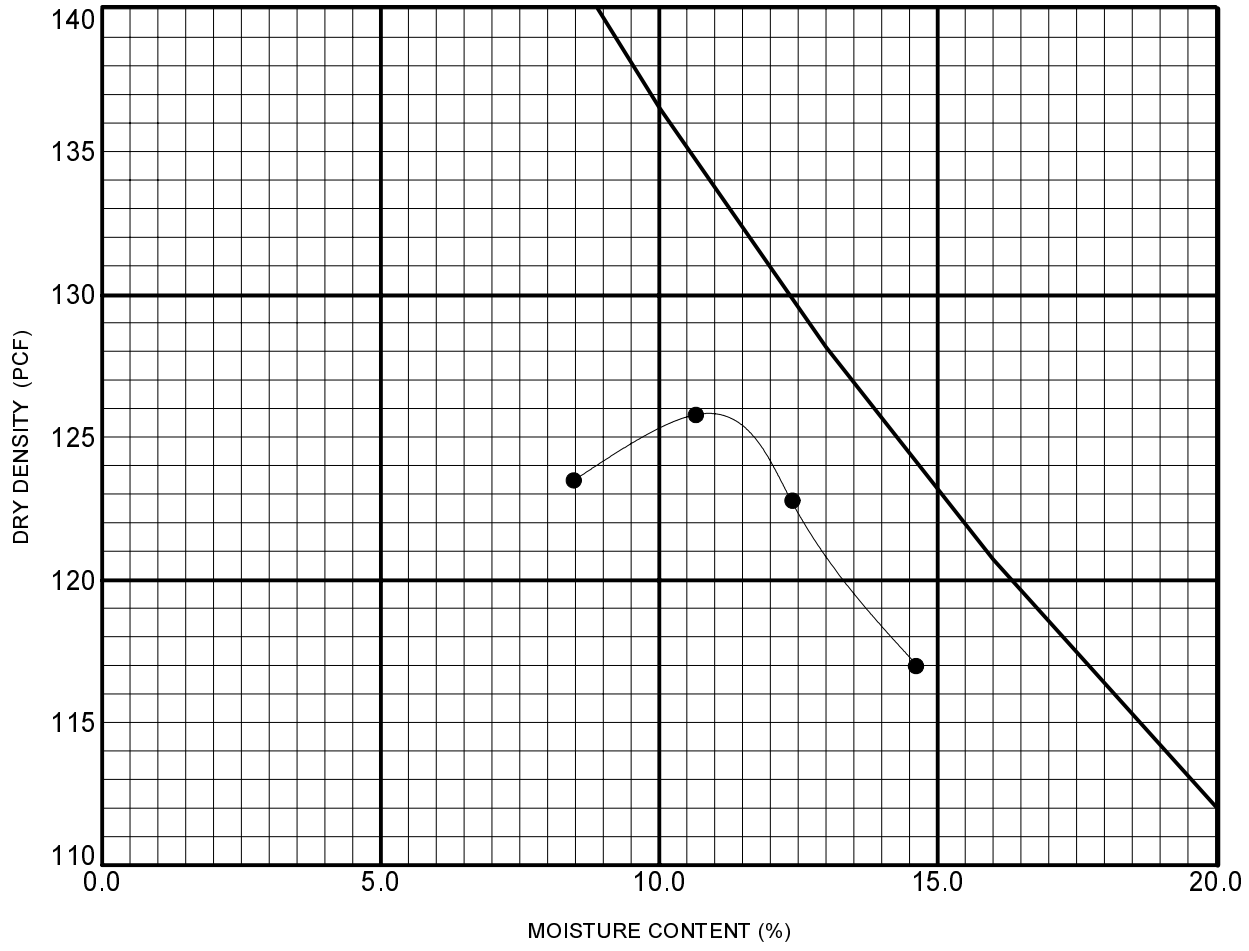
BORING NO.: TP-08 SAMPLE NO.: BS-1 SAMPLE DEPTH: 2 to 7 LABORATORY NO.: 373284

METHOD OF COMPACTION: D698A

LIQUID LIMIT: 26 PLASTIC LIMIT: 15 PLASTICITY INDEX: 11

CLASSIFICATION: SC ASTM SOIL DESCRIPTION: CLAYEY SAND with GRAVEL

MAXIMUM DRY DENSITY: **125.8 PCF** OPTIMUM MOISTURE CONTENT: **11.0%**



SPEEDIE AND ASSOCIATES

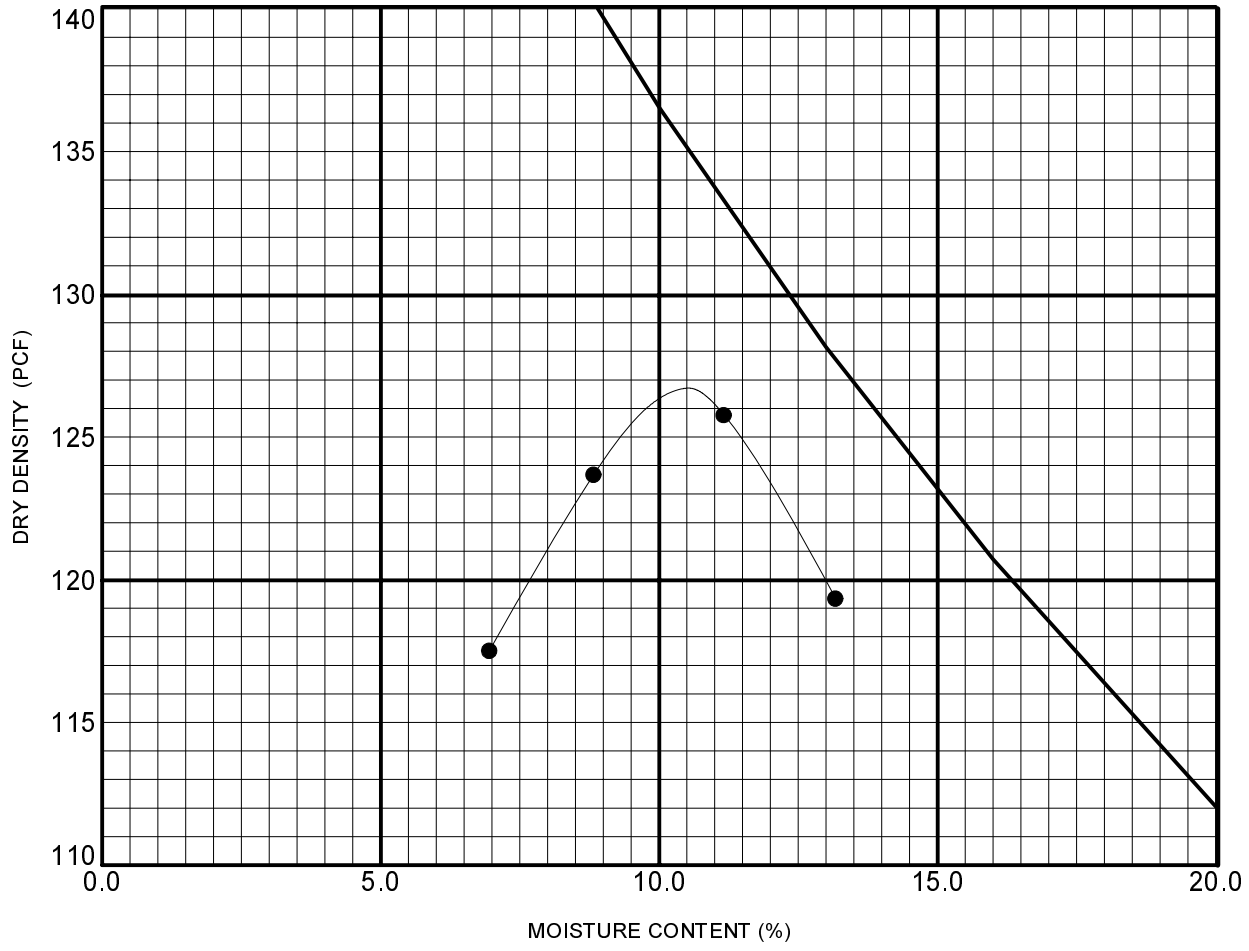
GEOTECH PROCTOR 120751TF.GPJ 7/6/12

MOISTURE-DENSITY RELATIONS

PROJECT:	**Cameron Water Line**				**PROJECT NO.: 120751TF**
LOCATION:	**Page to Cameron**				**DATE: 6/13/12**
BORING NO.: TP-09	**SAMPLE NO.: BS-1**	**SAMPLE DEPTH: 6 to 10**			**LABORATORY NO.: 373438**
METHOD OF COMPACTION:	**D698A**				
LIQUID LIMIT:	**21**	**PLASTIC LIMIT:**	**15**	**PLASTICITY INDEX:**	**6**
CLASSIFICATION:	**SC-SM**	**ASTM SOIL DESCRIPTION:**		**SILTY, CLAYEY SAND with GRAVEL**	

MAXIMUM DRY DENSITY: **126.8 PCF**

OPTIMUM MOISTURE CONTENT: **10.5%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/6/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.:** 120751TF

LOCATION: Page to Cameron **DATE:**

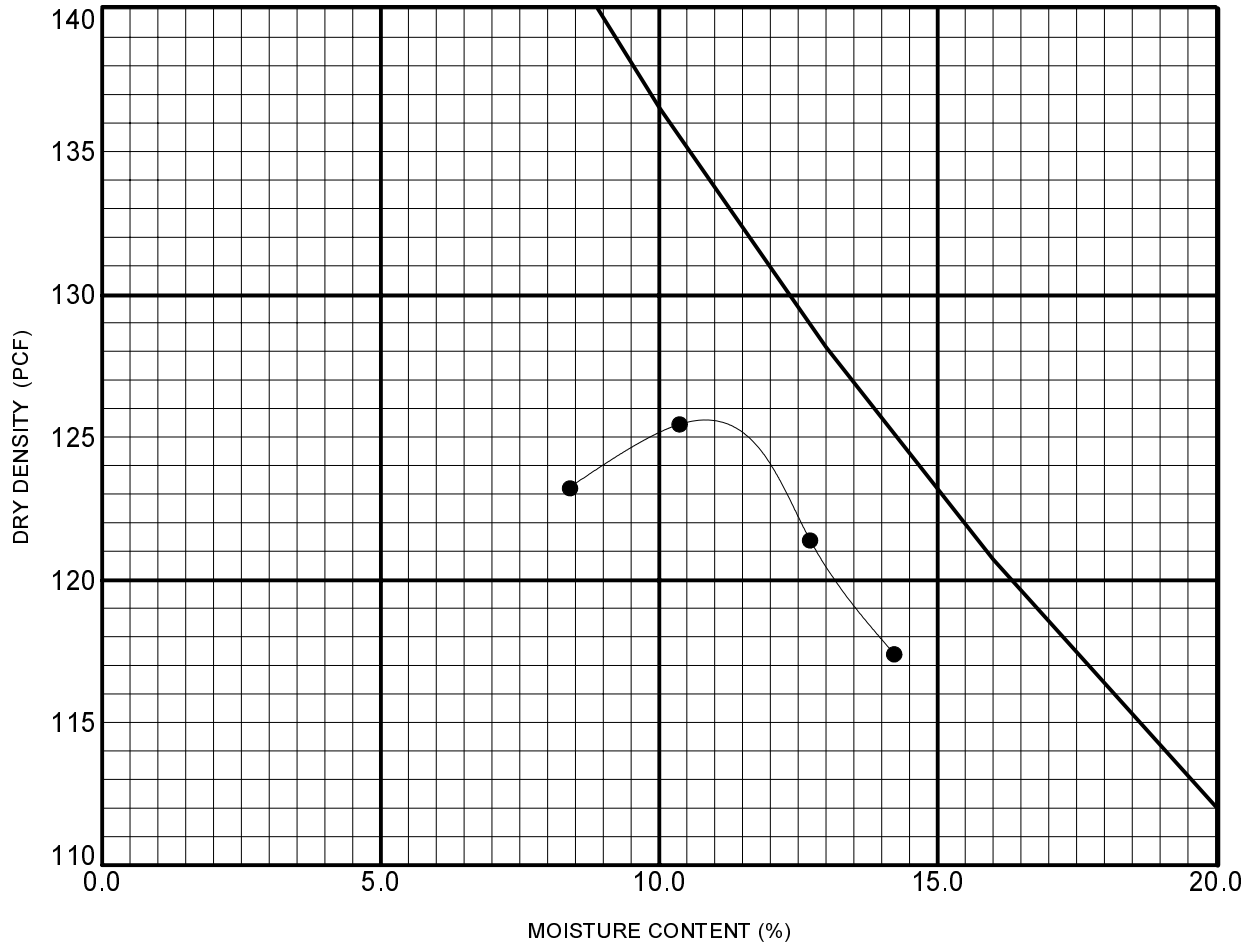
BORING NO.: TP-10 **SAMPLE NO.:** BS-1 **SAMPLE DEPTH:** 0 to 9 **LABORATORY NO.:** 373285

METHOD OF COMPACTION: D698A

LIQUID LIMIT: 21 **PLASTIC LIMIT:** 16 **PLASTICITY INDEX:** 6

CLASSIFICATION: SC-SM **ASTM SOIL DESCRIPTION:** SILTY, CLAYEY SAND with GRAVEL

MAXIMUM DRY DENSITY: **125.5 PCF** OPTIMUM MOISTURE CONTENT: **10.7%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line PROJECT NO.: 120751TF

LOCATION: Page to Cameron DATE: 6/13/12

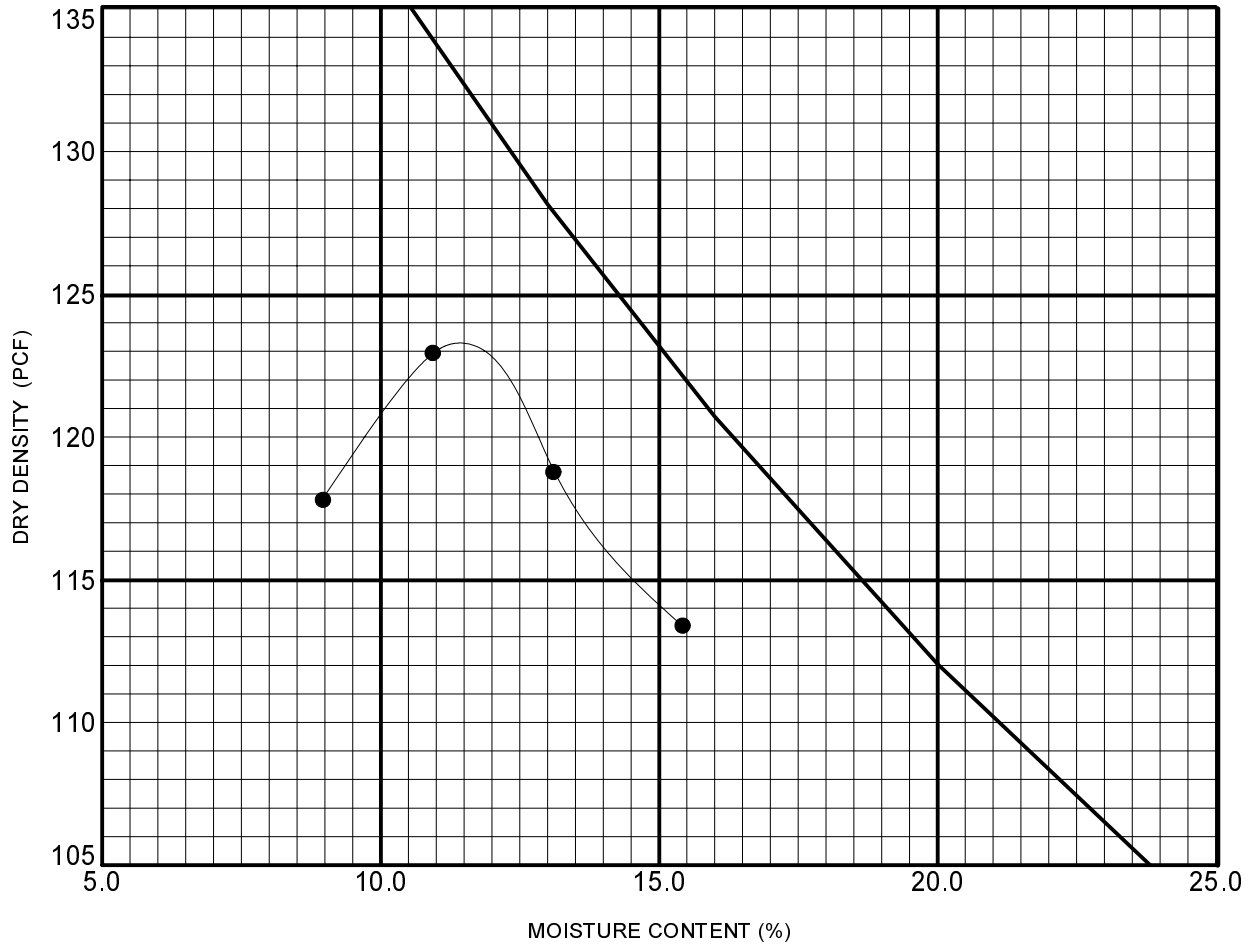
BORING NO.: TP-11 SAMPLE NO.: BS-1 SAMPLE DEPTH: 0 to 6.0 LABORATORY NO.: 373437

METHOD OF COMPACTION: D698A

LIQUID LIMIT: 22 PLASTIC LIMIT: 14 PLASTICITY INDEX: 8

CLASSIFICATION: SC ASTM SOIL DESCRIPTION: CLAYEY SAND with GRAVEL

MAXIMUM DRY DENSITY: **123.3 PCF** OPTIMUM MOISTURE CONTENT: **11.4%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line PROJECT NO.: 120751TF

LOCATION: Page to Cameron DATE: 6/11/12

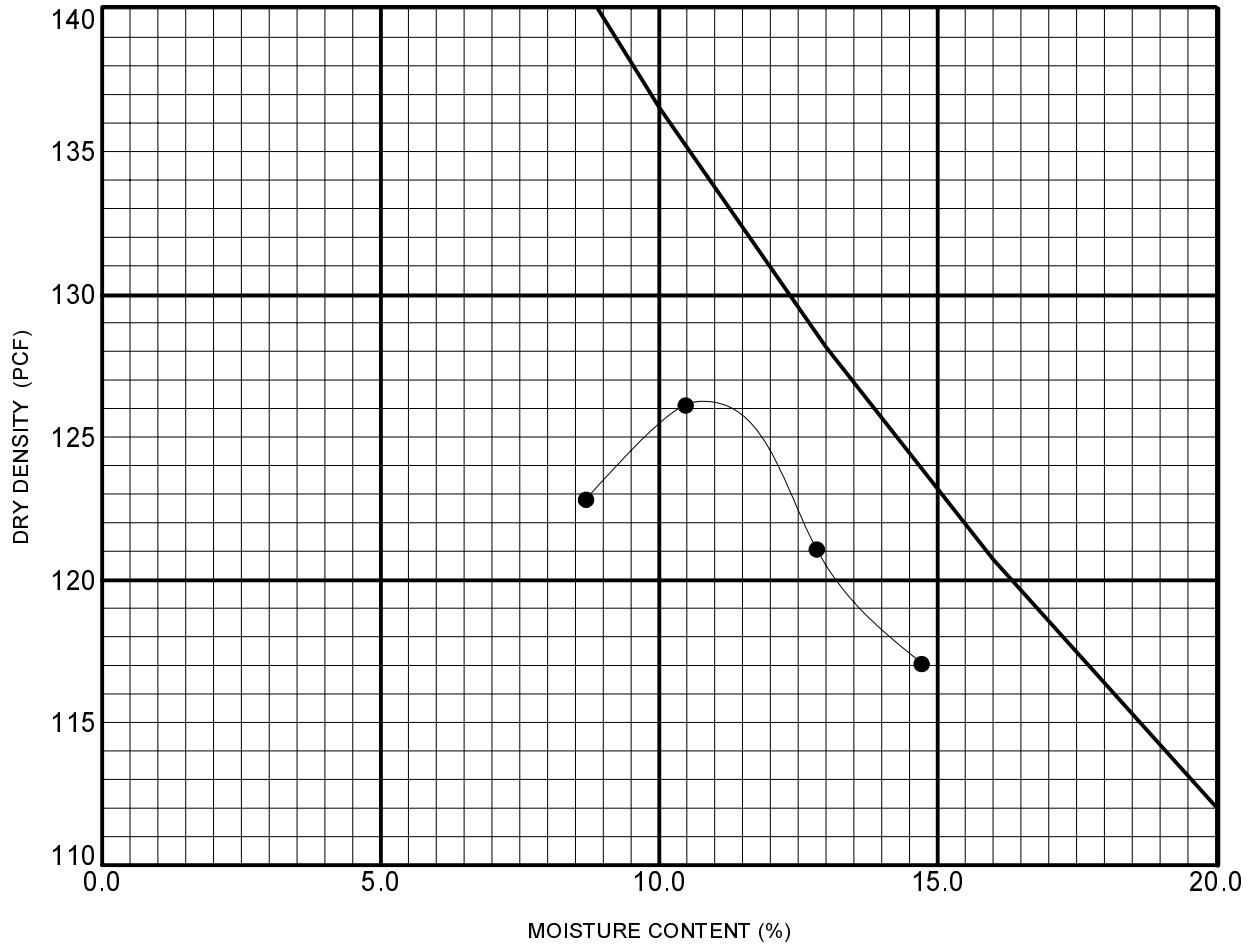
BORING NO.: TP-12 SAMPLE NO.: BS-1 SAMPLE DEPTH: 3.8 to 11.5 LABORATORY NO.: 373287

METHOD OF COMPACTION: D698A

LIQUID LIMIT: 22 PLASTIC LIMIT: 14 PLASTICITY INDEX: 8

CLASSIFICATION: SC ASTM SOIL DESCRIPTION: CLAYEY SAND

MAXIMUM DRY DENSITY: **126.2 PCF** OPTIMUM MOISTURE CONTENT: **10.8%**



SPEEDIE AND ASSOCIATES

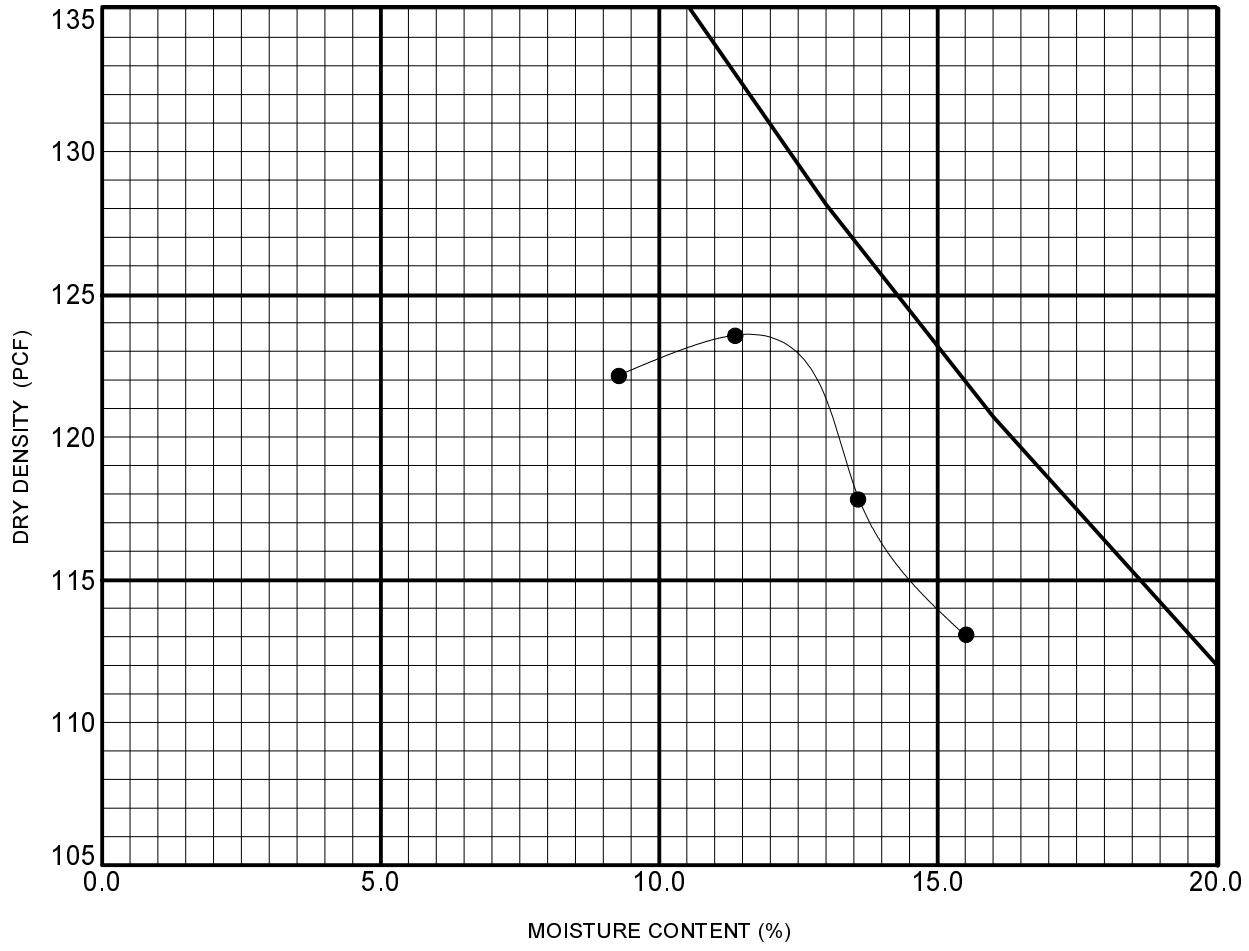
GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT:	**Cameron Water Line**		**PROJECT NO.: 120751TF**
LOCATION:	**Page to Cameron**		**DATE: 6/11/12**
BORING NO.: TP-13	**SAMPLE NO.: BS-1**	**SAMPLE DEPTH: 0 to 4.5**	**LABORATORY NO.: 373288**
METHOD OF COMPACTION:	**D698A**		
LIQUID LIMIT:	**21**	**PLASTIC LIMIT: 14**	**PLASTICITY INDEX: 7**
CLASSIFICATION:	**SC-SM**	**ASTM SOIL DESCRIPTION:**	**SILTY, CLAYEY SAND**

MAXIMUM DRY DENSITY: **123.7 PCF**

OPTIMUM MOISTURE CONTENT: **11.7 %**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/11/12**

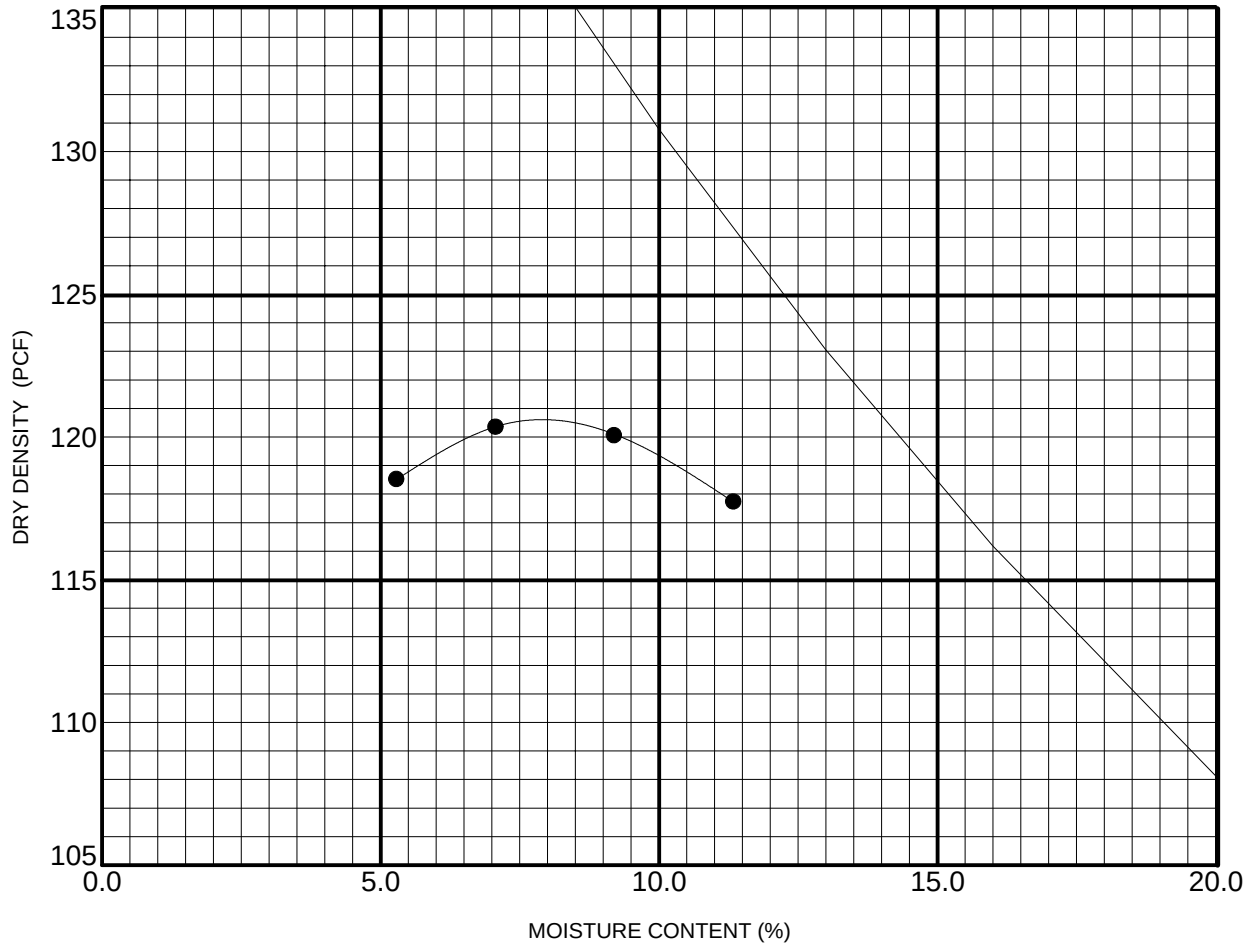
BORING NO.: TP-14 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 0 to 10** **LABORATORY NO.: 373289**

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT **PLASTIC LIMIT:** NT **PLASTICITY INDEX:** NT

CLASSIFICATION: SC-SM **ASTM SOIL DESCRIPTION:** SILTY, CLAYEY SAND

MAXIMUM DRY DENSITY: **120.7 PCF** OPTIMUM MOISTURE CONTENT: **7.8%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/11/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/11/12**

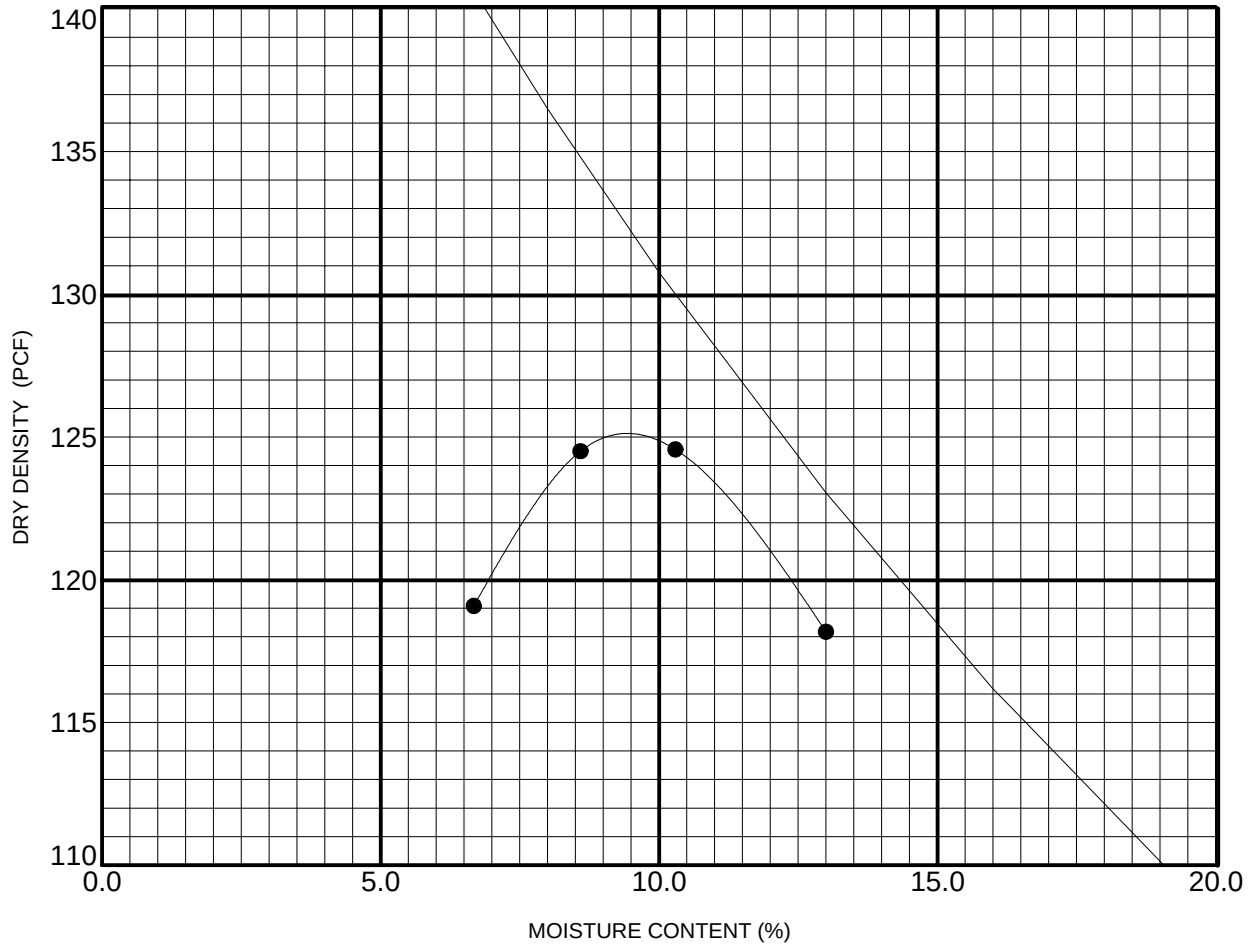
BORING NO.: TP-15 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 0 to 5.5** **LABORATORY NO.: 373290**

METHOD OF COMPACTION: D698A

LIQUID LIMIT: 20 **PLASTIC LIMIT:** 15 **PLASTICITY INDEX:** 5

CLASSIFICATION: SC-SM **ASTM SOIL DESCRIPTION:** SILTY, CLAYEY SAND

MAXIMUM DRY DENSITY: **125.1 PCF** OPTIMUM MOISTURE CONTENT: **9.4 %**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE:**

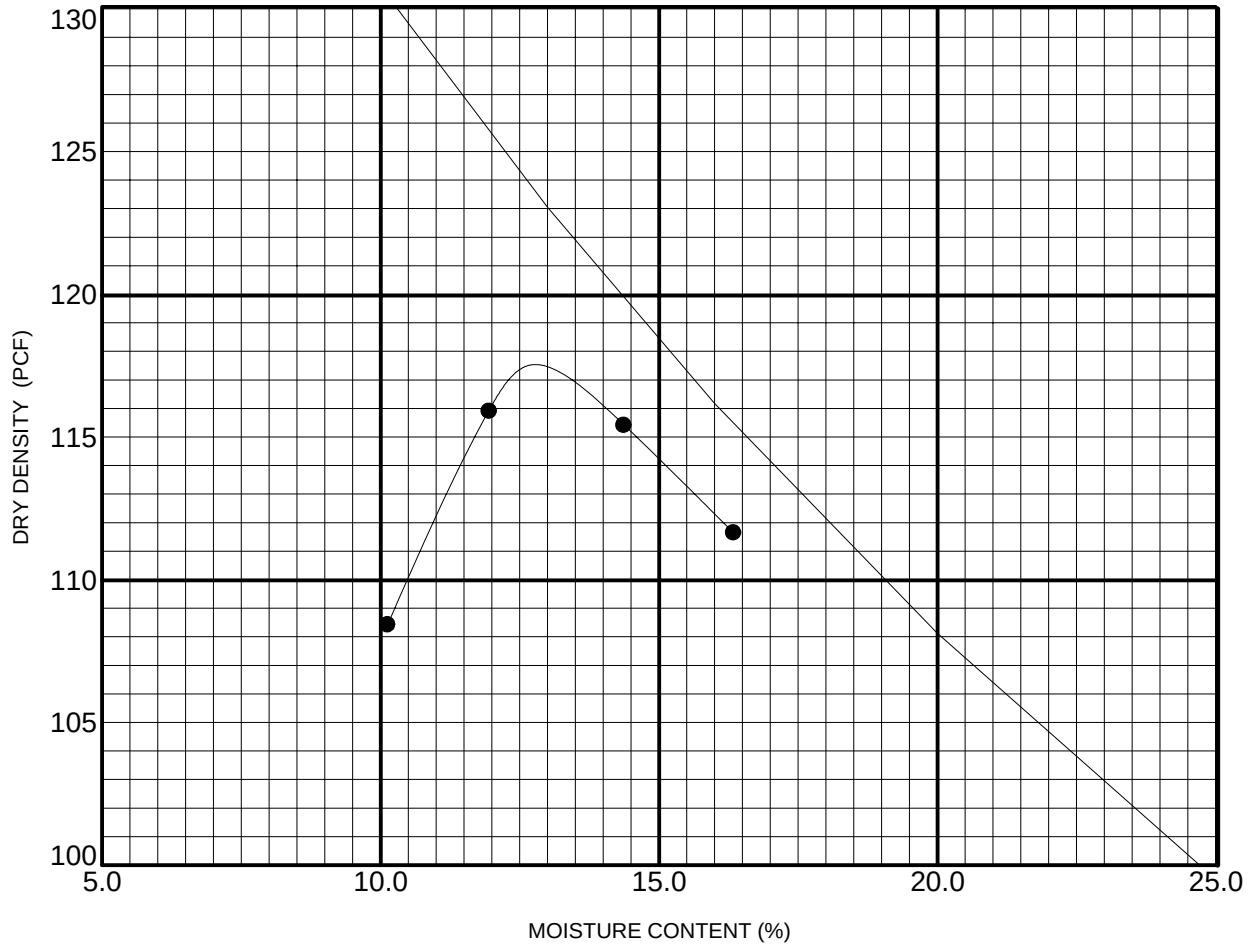
BORING NO.: TP-16 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 0 to 3.5** **LABORATORY NO.: 373291**

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT **PLASTIC LIMIT:** NT **PLASTICITY INDEX:** NT

CLASSIFICATION: CL **ASTM SOIL DESCRIPTION:** CLAYSTONE (SANDY LEAN CLAY)

MAXIMUM DRY DENSITY: **117.6 PCF** OPTIMUM MOISTURE CONTENT: **12.7%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE:**

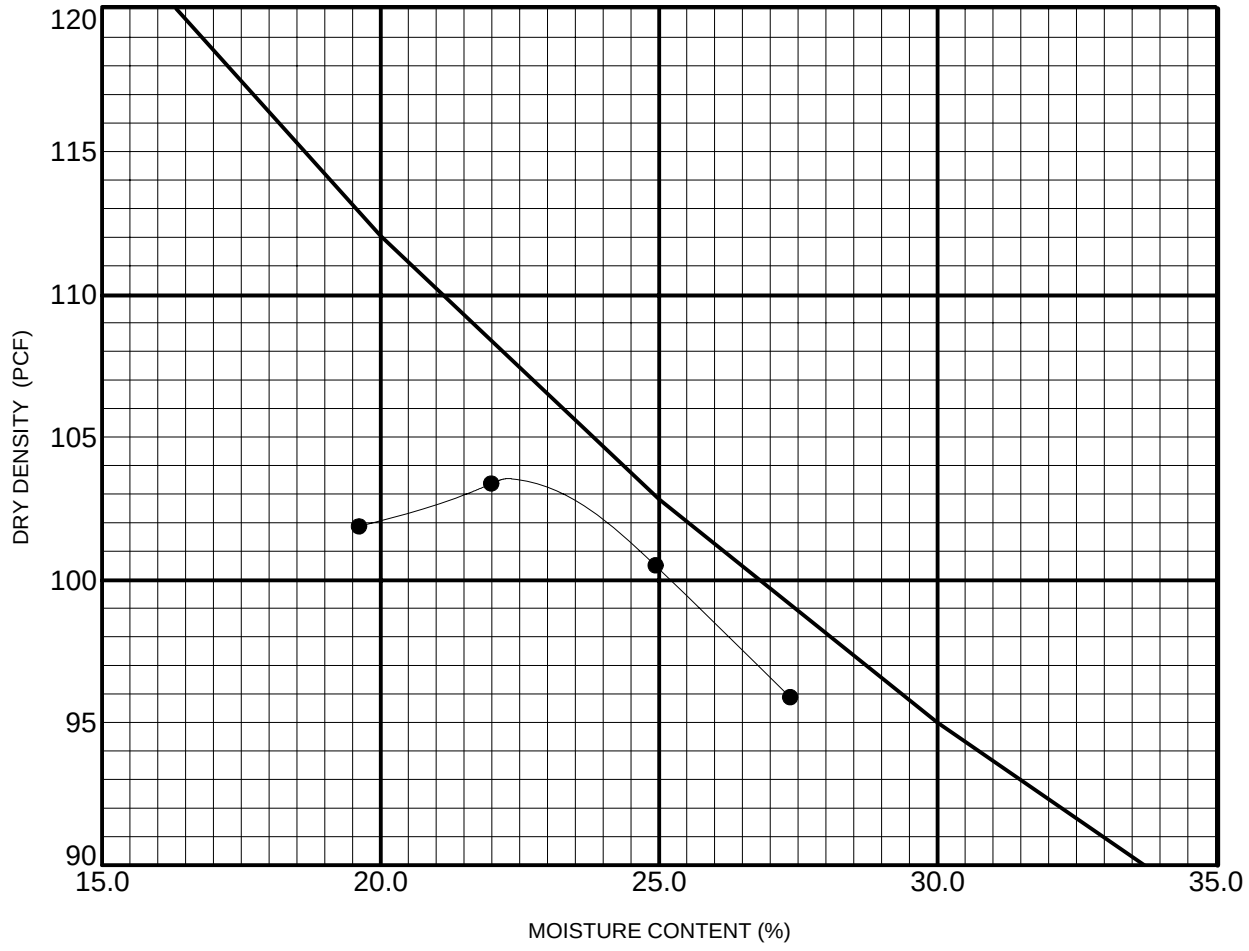
BORING NO.: TP-18 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 2.5 to 9** **LABORATORY NO.: 373309**

METHOD OF COMPACTION: **D698A**

LIQUID LIMIT: **NT** **PLASTIC LIMIT:** **NT** **PLASTICITY INDEX:** **NT**

CLASSIFICATION: **CL** **ASTM SOIL DESCRIPTION:** **CLAYSTONE (LEAN CLAY)**

MAXIMUM DRY DENSITY: **103.6 PCF** OPTIMUM MOISTURE CONTENT: **22.3%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/13/12**

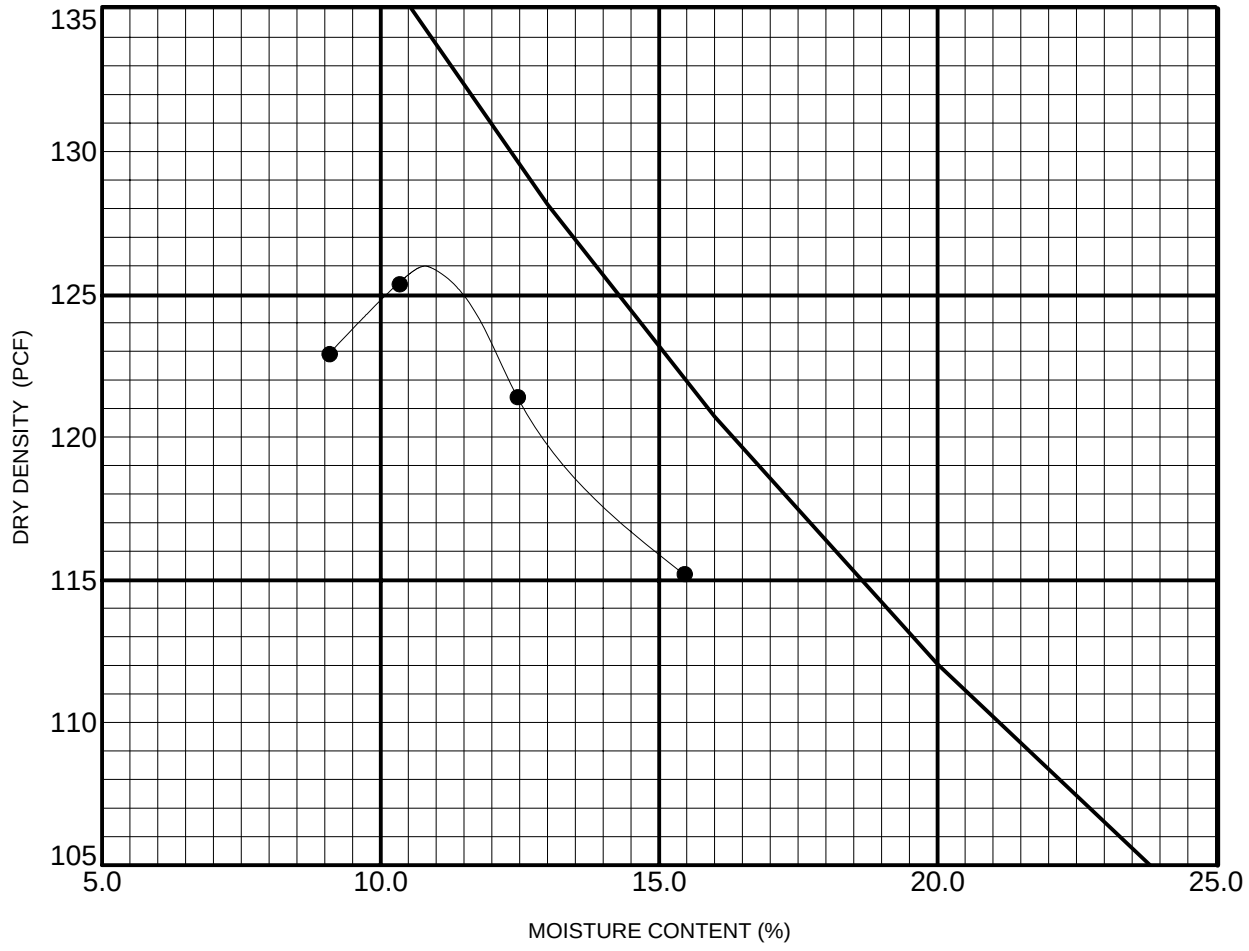
BORING NO.: TP-19 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 0 to 8** **LABORATORY NO.: 373436**

METHOD OF COMPACTION: D698A

LIQUID LIMIT: 22 **PLASTIC LIMIT:** 13 **PLASTICITY INDEX:** 9

CLASSIFICATION: SC **ASTM SOIL DESCRIPTION:** CLAYEY SAND with GRAVEL

MAXIMUM DRY DENSITY: **126.0 PCF** OPTIMUM MOISTURE CONTENT: **10.8%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/13/12**

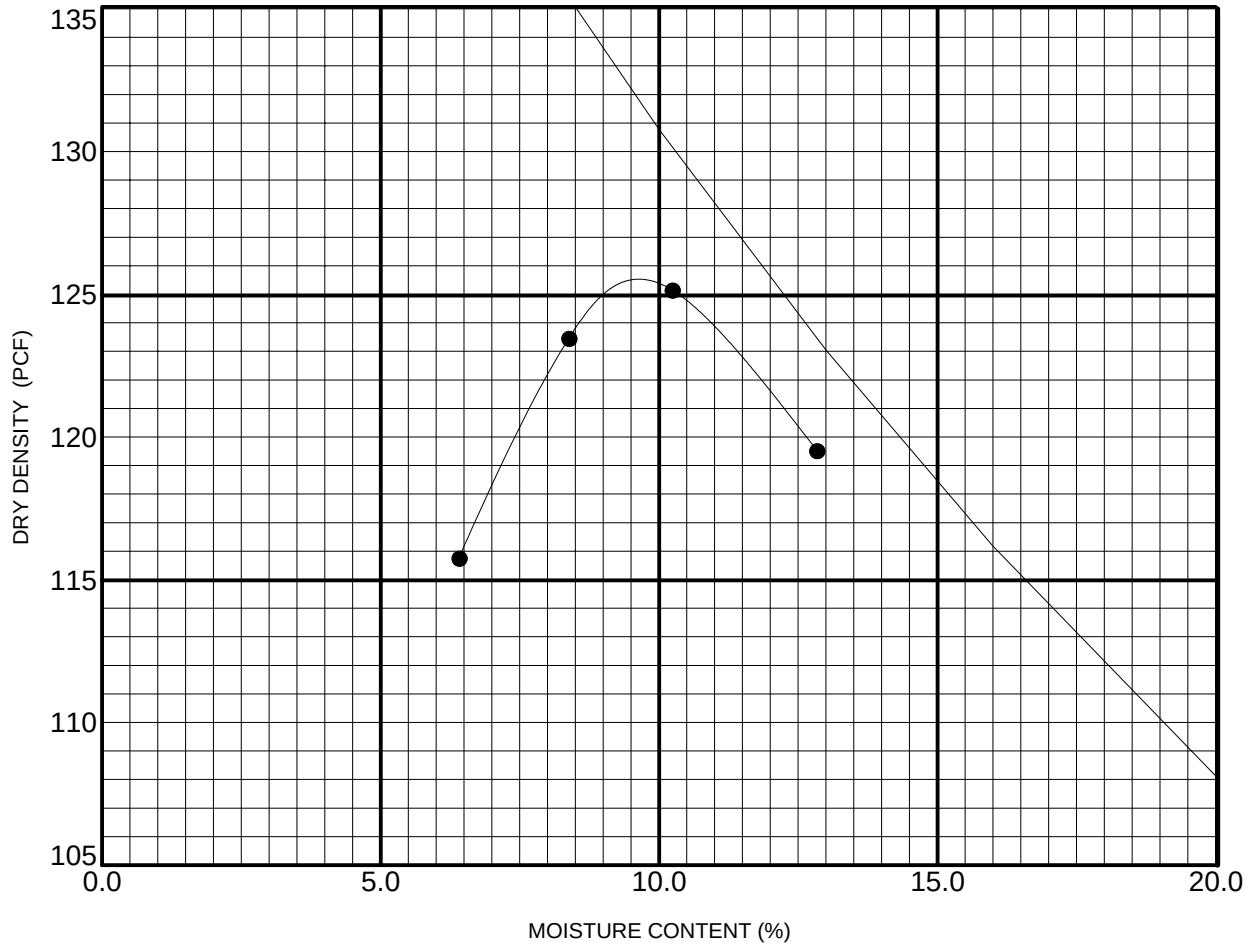
BORING NO.: TP-20 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 0 to 8.5** **LABORATORY NO.: 373435**

METHOD OF COMPACTION: D698A

LIQUID LIMIT: 23 **PLASTIC LIMIT:** 18 **PLASTICITY INDEX:** 5

CLASSIFICATION: SC-SM **ASTM SOIL DESCRIPTION:** SILTY, CLAYEY SAND

MAXIMUM DRY DENSITY: **125.6 PCF** OPTIMUM MOISTURE CONTENT: **9.6%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/13/12**

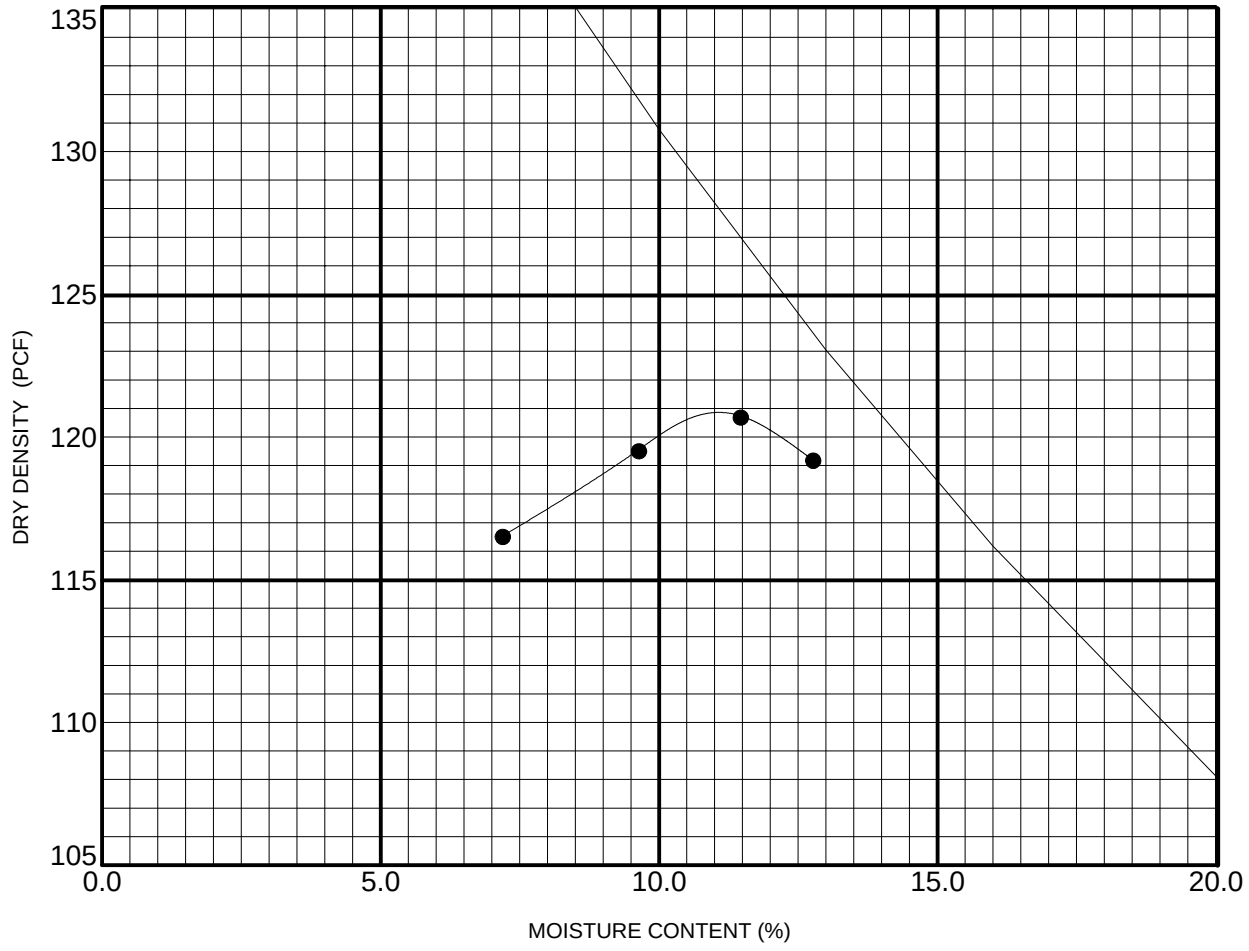
BORING NO.: TP-21 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 3 to 5** **LABORATORY NO.: 373433**

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT **PLASTIC LIMIT:** NT **PLASTICITY INDEX:** NT

CLASSIFICATION: SW-SM-SC **ASTM SOIL DESCRIPTION:** WELL-GRADED SAND with SILT, CLAY, and GRAVEL

MAXIMUM DRY DENSITY: **120.9 PCF** OPTIMUM MOISTURE CONTENT: **11.1%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/13/12**

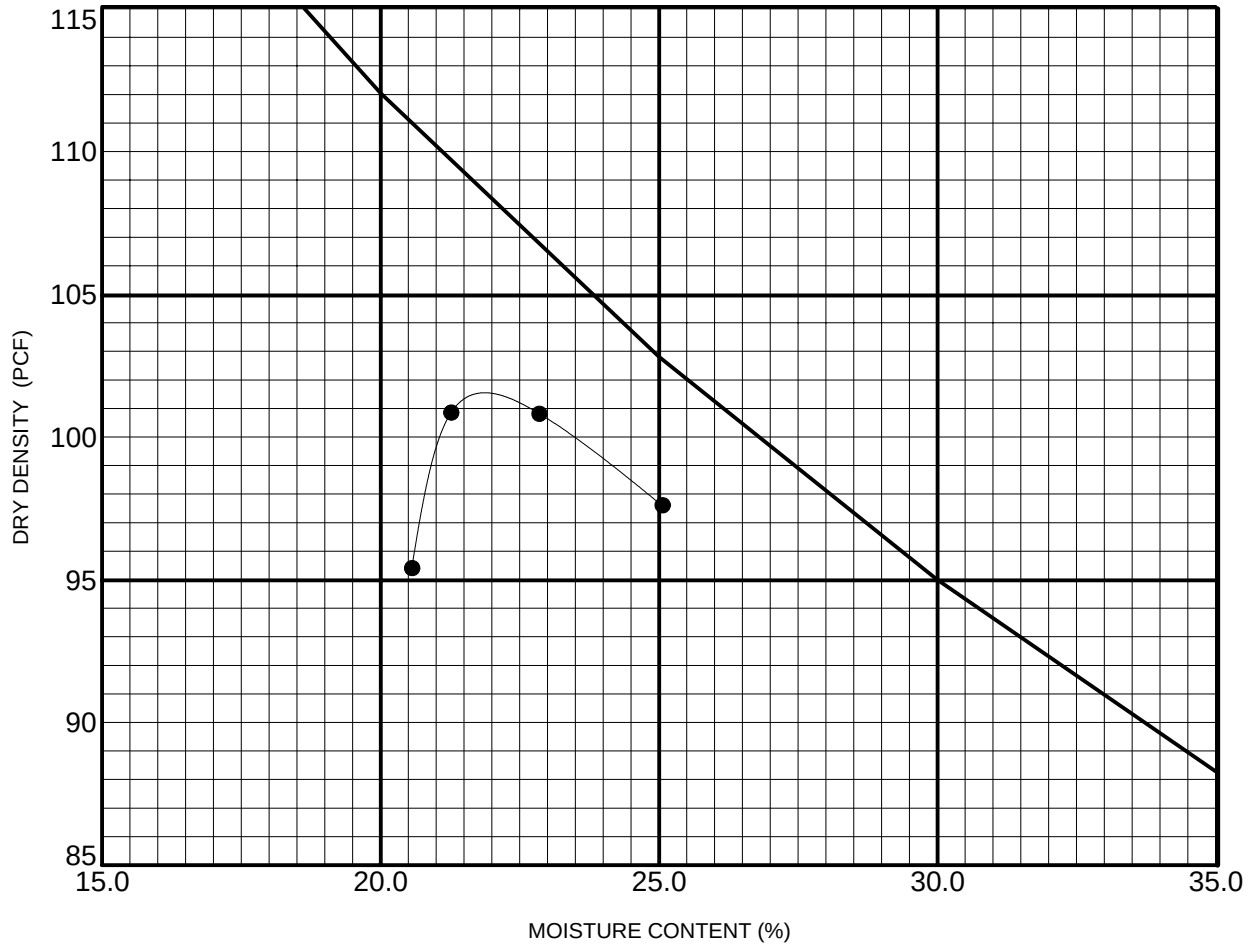
BORING NO.: TP-21 **SAMPLE NO.: BS-2** **SAMPLE DEPTH: 8 to 15** **LABORATORY NO.: 373434**

METHOD OF COMPACTION: D698A

LIQUID LIMIT: 42 **PLASTIC LIMIT:** 24 **PLASTICITY INDEX:** 19

CLASSIFICATION: CL **ASTM SOIL DESCRIPTION:** CLAYSTONE (SANDY LEAN CLAY)

MAXIMUM DRY DENSITY: **101.5 PCF** OPTIMUM MOISTURE CONTENT: **21.8 %**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/13/12**

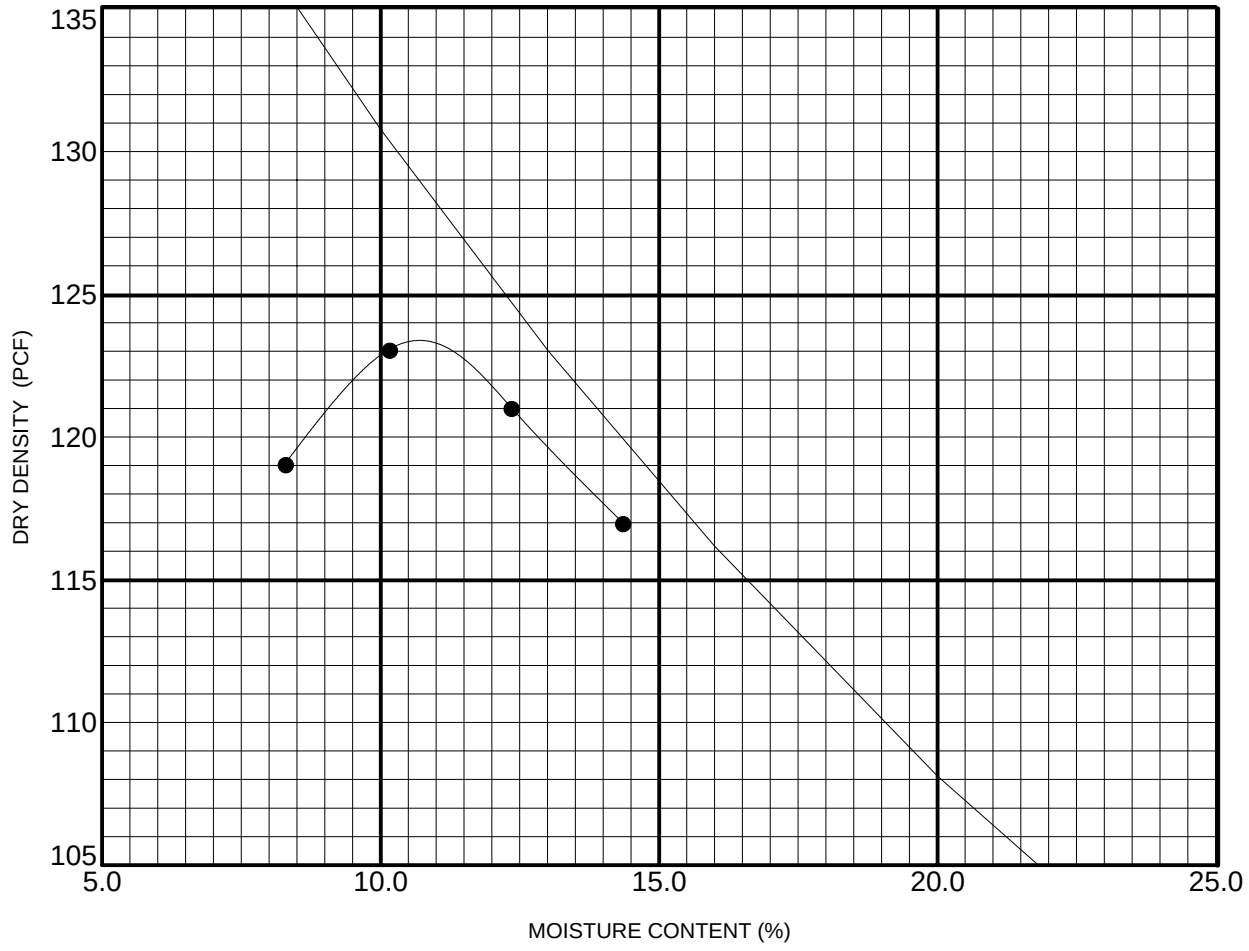
BORING NO.: TP-22 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 6 to 14** **LABORATORY NO.: 373432**

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT **PLASTIC LIMIT:** NT **PLASTICITY INDEX:** NT

CLASSIFICATION: SW-SM-SC **ASTM SOIL DESCRIPTION:** WELL-GRADED SAND with SILT, CLAY and GRAVEL

MAXIMUM DRY DENSITY: **123.3 PCF** OPTIMUM MOISTURE CONTENT: **10.7%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/13/12**

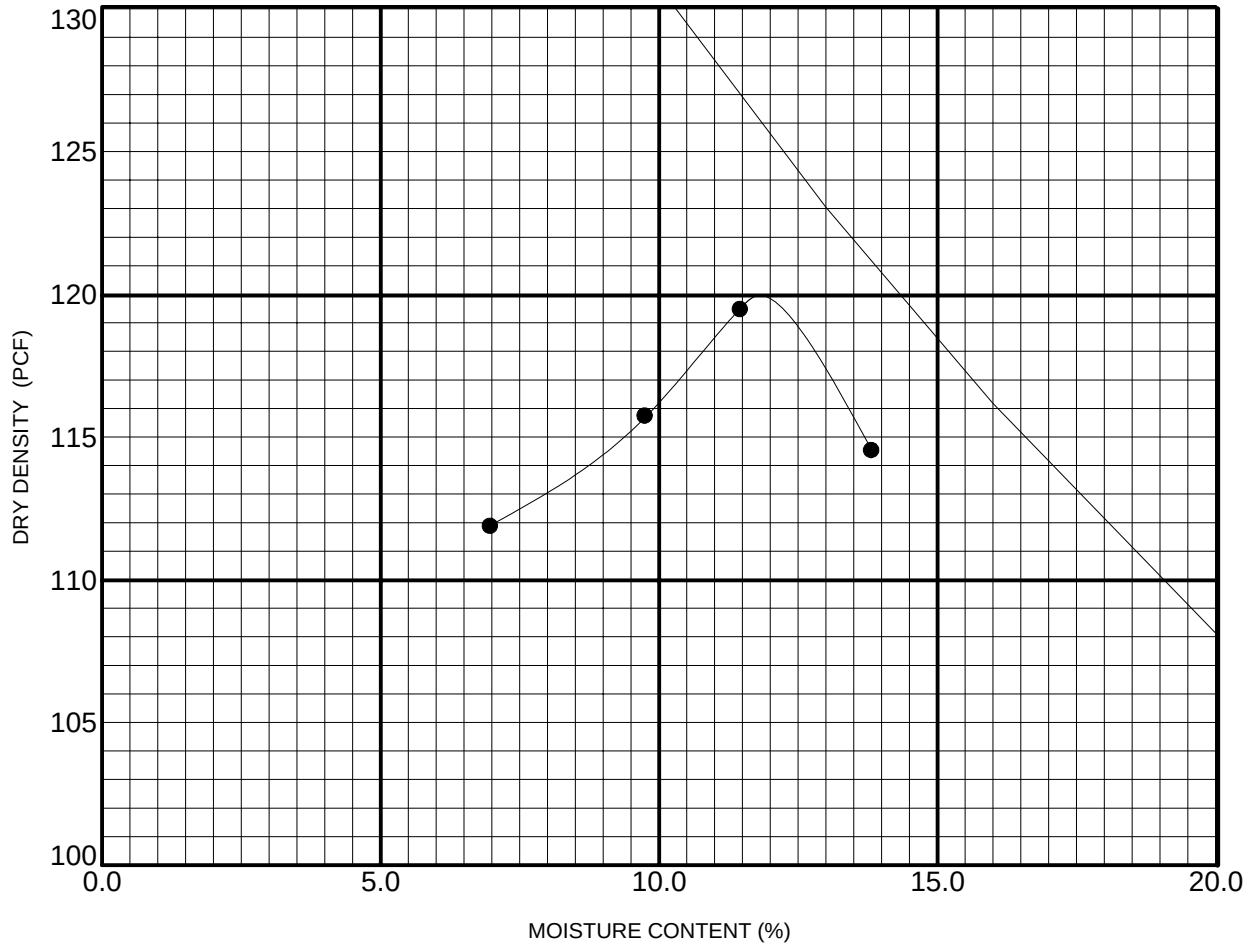
BORING NO.: TP-23 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 0 to 6** **LABORATORY NO.: 373430**

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NP **PLASTIC LIMIT:** NP **PLASTICITY INDEX:** NP

CLASSIFICATION: SM **ASTM SOIL DESCRIPTION:** SILTY SAND

MAXIMUM DRY DENSITY: **120.0 PCF** OPTIMUM MOISTURE CONTENT: **11.7%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/13/12**

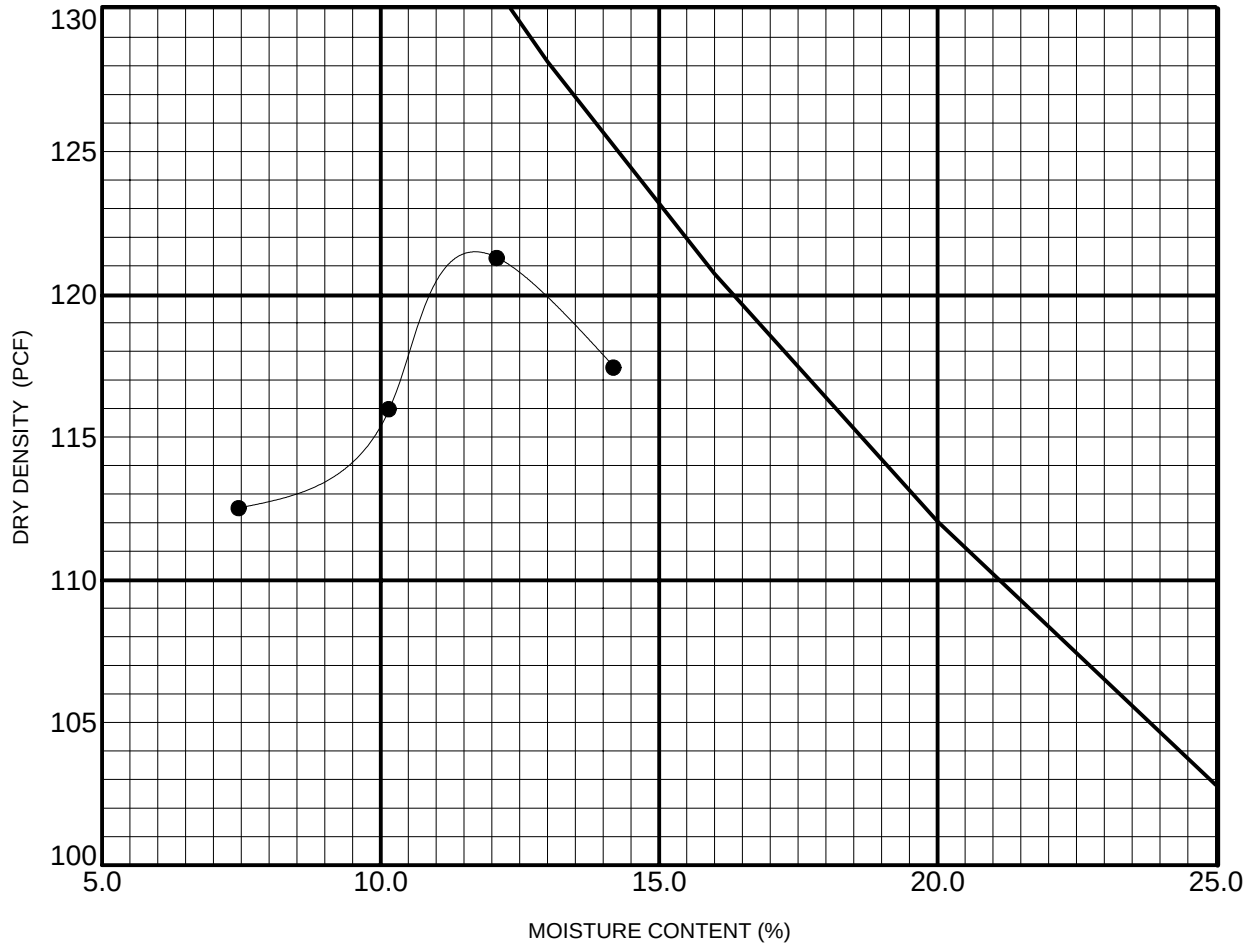
BORING NO.: TP-23 **SAMPLE NO.: BS-2** **SAMPLE DEPTH: 6 to 8** **LABORATORY NO.: 373431**

METHOD OF COMPACTION: D698A

LIQUID LIMIT: 22 **PLASTIC LIMIT:** 13 **PLASTICITY INDEX:** 9

CLASSIFICATION: SC **ASTM SOIL DESCRIPTION:** CLAYEY SAND with GRAVEL

MAXIMUM DRY DENSITY: **121.5 PCF** OPTIMUM MOISTURE CONTENT: **11.7%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/12/12**

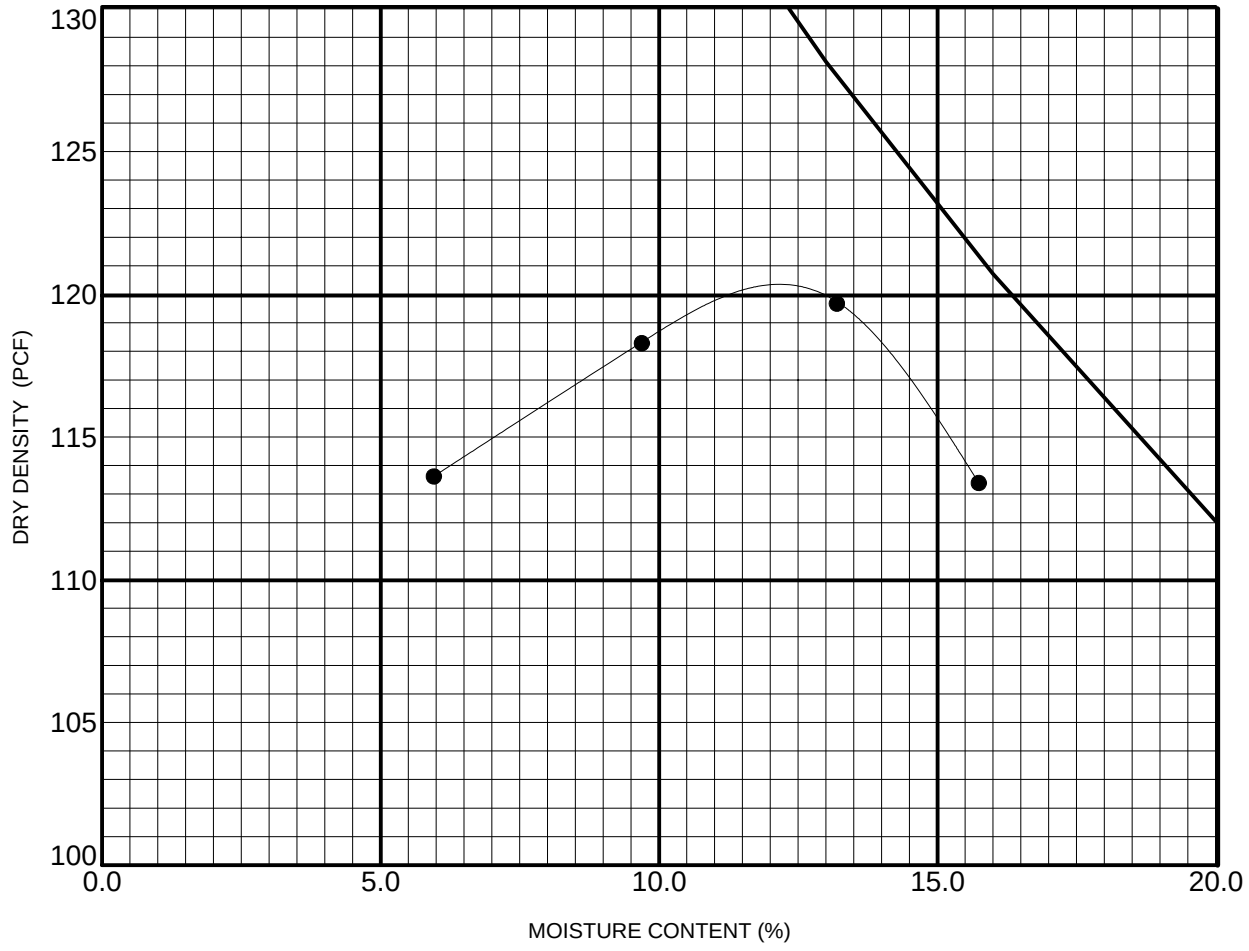
BORING NO.: TP-24 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 5 to 15.0** **LABORATORY NO.: 373429**

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT **PLASTIC LIMIT:** NT **PLASTICITY INDEX:** NT

CLASSIFICATION: SP-SM-SC **ASTM SOIL DESCRIPTION:** POORLY GRADED SAND with SILT, CLAY and GRAVEL

MAXIMUM DRY DENSITY: **120.2 PCF** OPTIMUM MOISTURE CONTENT: **12.2%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/7/12**

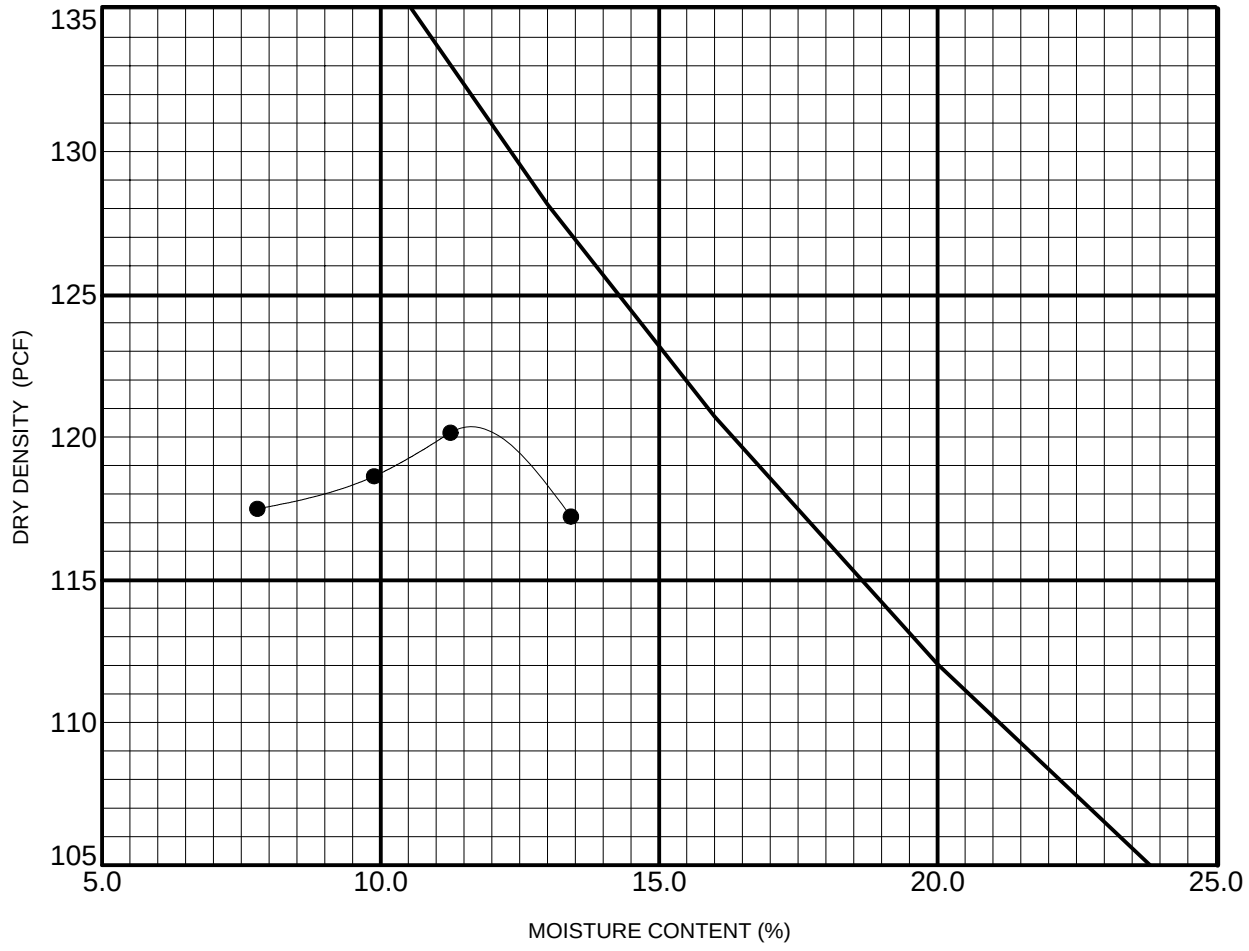
BORING NO.: TP-25 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 8 to 12** **LABORATORY NO.: 373111**

METHOD OF COMPACTION: **D698A**

LIQUID LIMIT: **NT** **PLASTIC LIMIT:** **NT** **PLASTICITY INDEX:** **NT**

CLASSIFICATION: **SC-SM** **ASTM SOIL DESCRIPTION:** **SILTY, CLAYEY SAND**

MAXIMUM DRY DENSITY: **120.3 PCF** OPTIMUM MOISTURE CONTENT: **11.7%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/7/12**

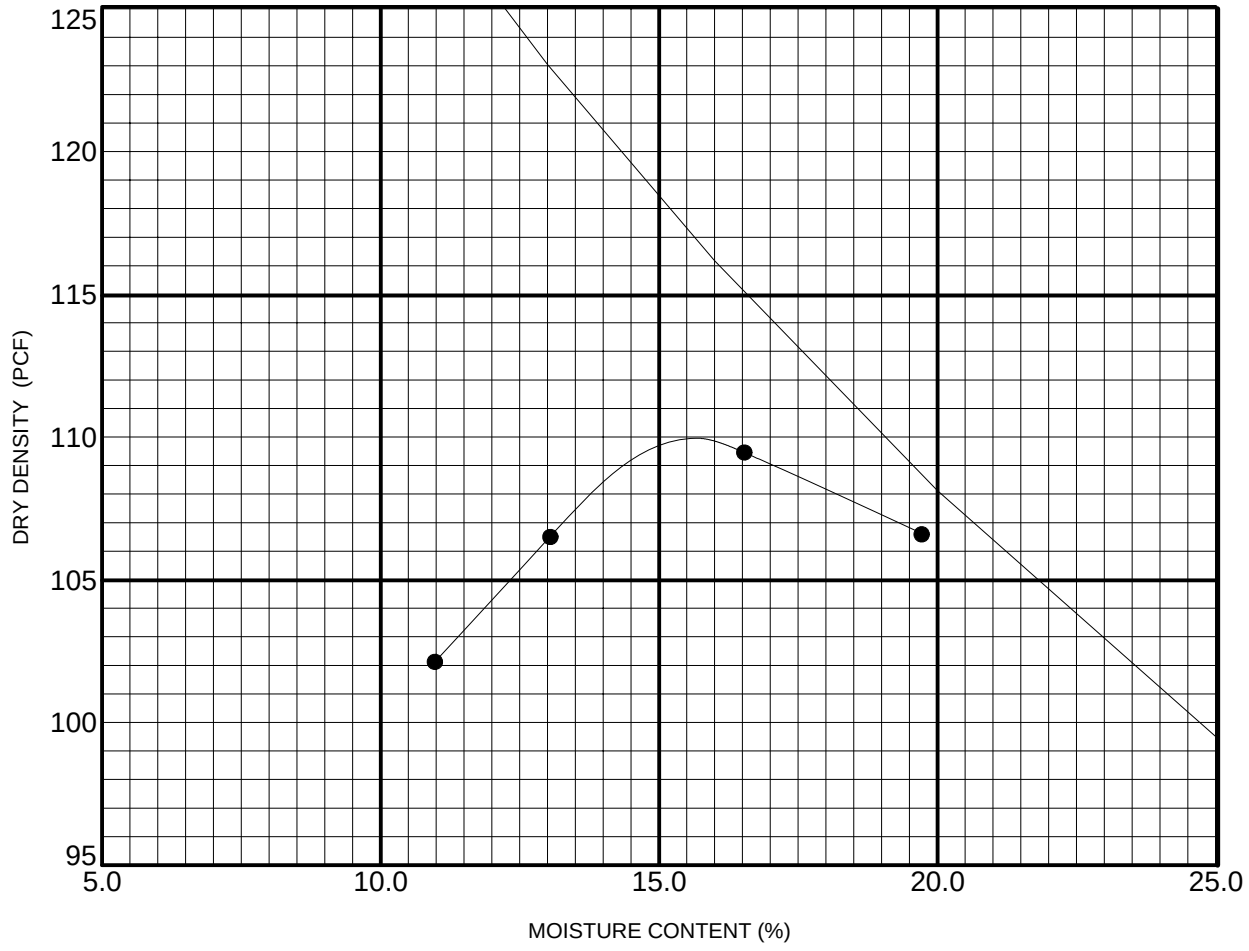
BORING NO.: TP-26 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 3.5 to 10.5** **LABORATORY NO.: 373114**

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT **PLASTIC LIMIT:** NT **PLASTICITY INDEX:** NT

CLASSIFICATION: SC-SM **ASTM SOIL DESCRIPTION:** SILTY, CLAYEY SAND

MAXIMUM DRY DENSITY: **110.0 PCF** OPTIMUM MOISTURE CONTENT: **15.6%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/7/12**

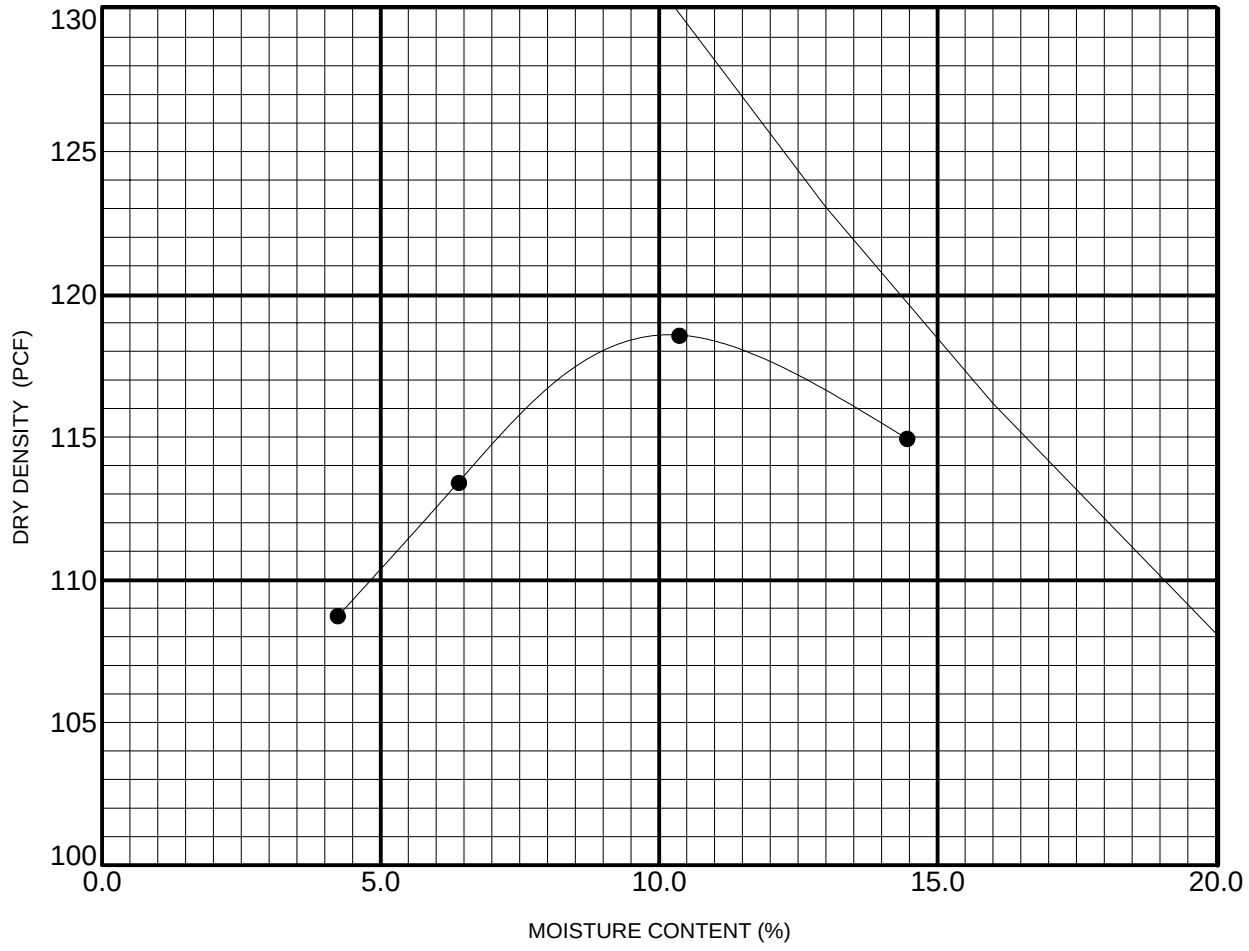
BORING NO.: TP-27 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 0 to 5** **LABORATORY NO.: 373117**

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT **PLASTIC LIMIT:** NT **PLASTICITY INDEX:** NT

CLASSIFICATION: SP-SM-SC **ASTM SOIL DESCRIPTION:** POORLY GRADED SAND with SILT and CLAY

MAXIMUM DRY DENSITY: **118.5 PCF** OPTIMUM MOISTURE CONTENT: **10.3%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/7/12**

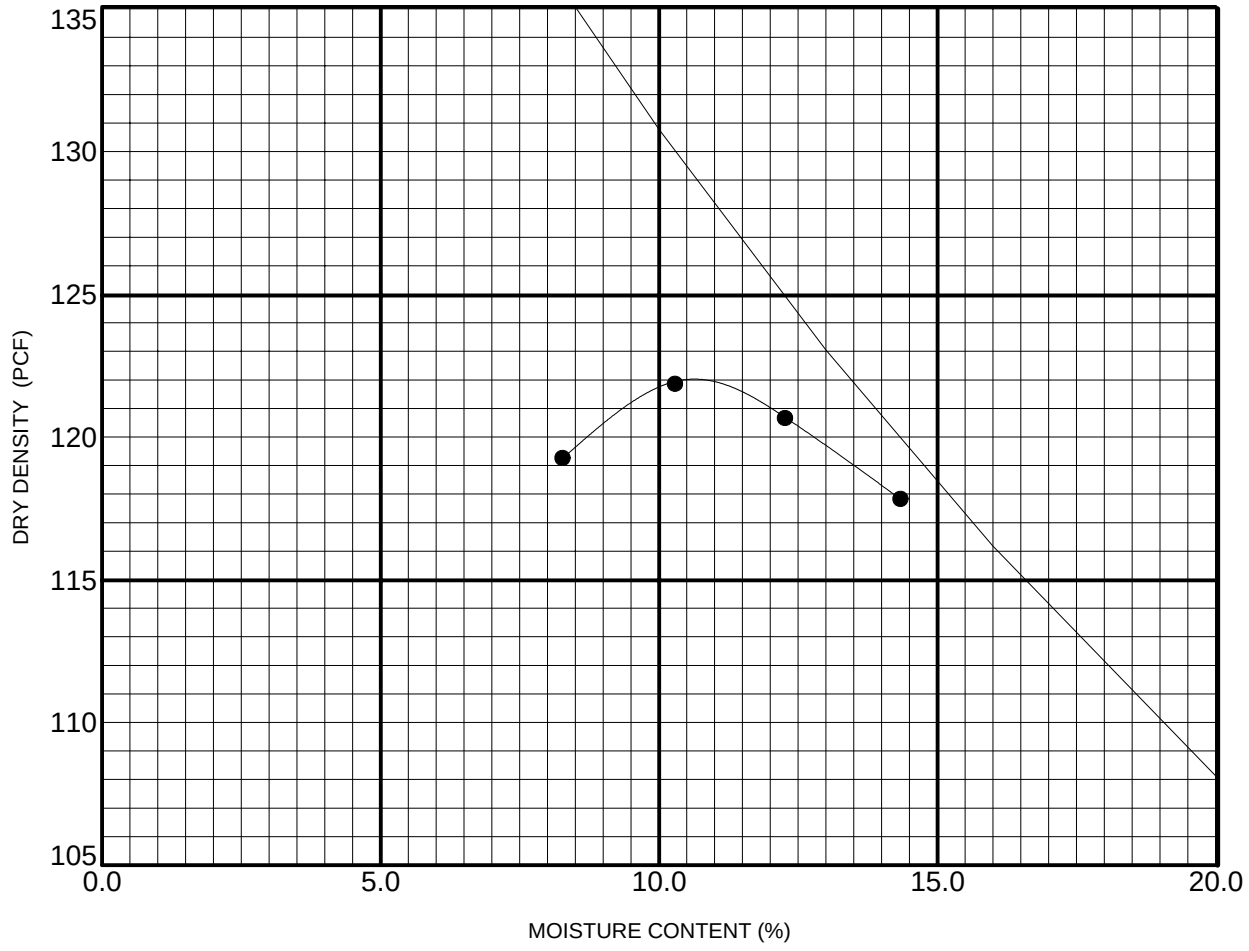
BORING NO.: TP-28 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 0 to 14** **LABORATORY NO.: 373120**

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT **PLASTIC LIMIT:** NT **PLASTICITY INDEX:** NT

CLASSIFICATION: SC-SM **ASTM SOIL DESCRIPTION:** SILTY, CLAYEY SAND with GRAVEL

MAXIMUM DRY DENSITY: **122.0 PCF** OPTIMUM MOISTURE CONTENT: **10.6%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/12/12**

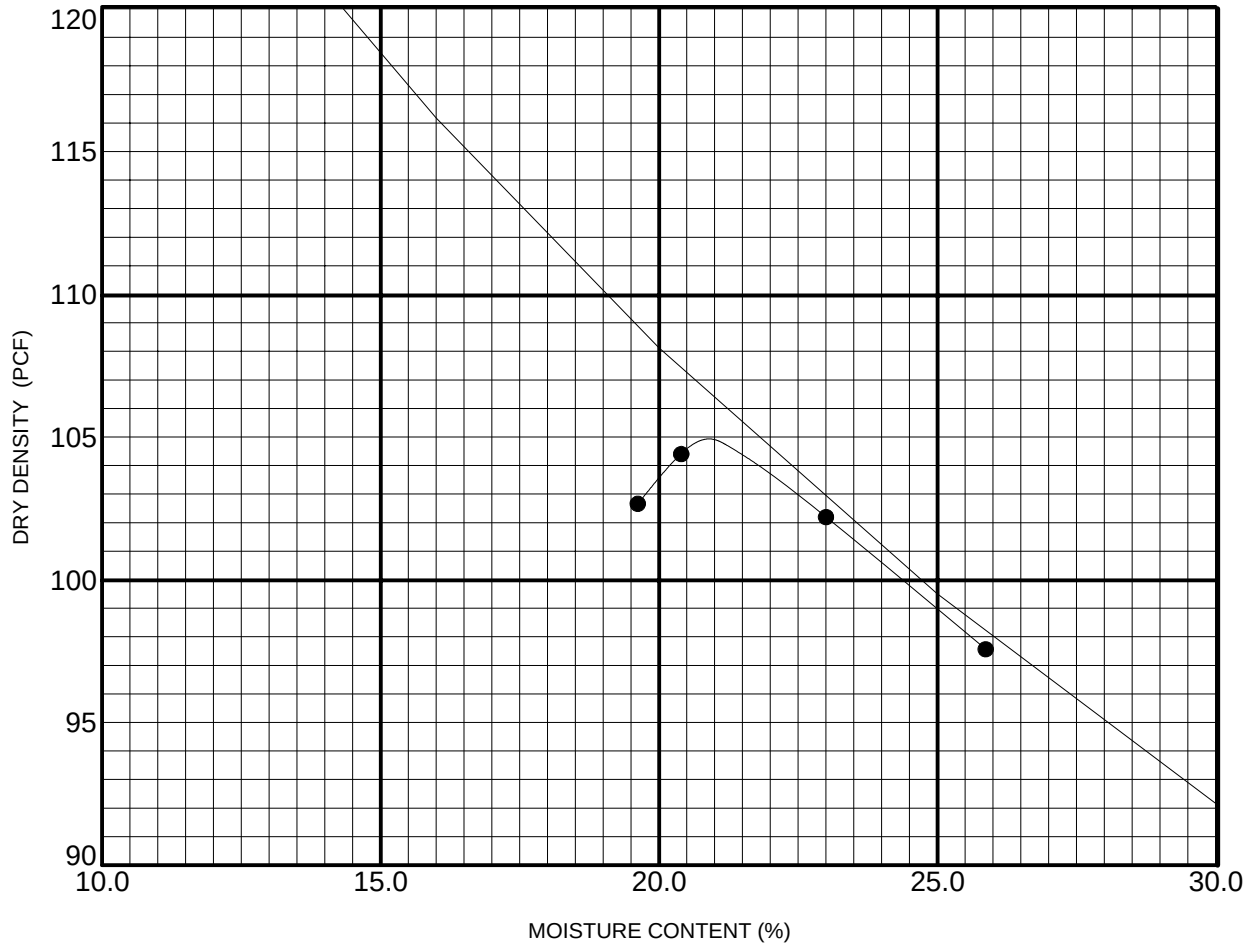
BORING NO.: TP-29 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 0.5 to 10.0** **LABORATORY NO.: 373428**

METHOD OF COMPACTION: D698A

LIQUID LIMIT: 38 **PLASTIC LIMIT:** 18 **PLASTICITY INDEX:** 20

CLASSIFICATION: CL **ASTM SOIL DESCRIPTION:** CLAYSTONE (LEAN CLAY with SAND)

MAXIMUM DRY DENSITY: **104.9 PCF** OPTIMUM MOISTURE CONTENT: **20.9%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/11/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/7/12**

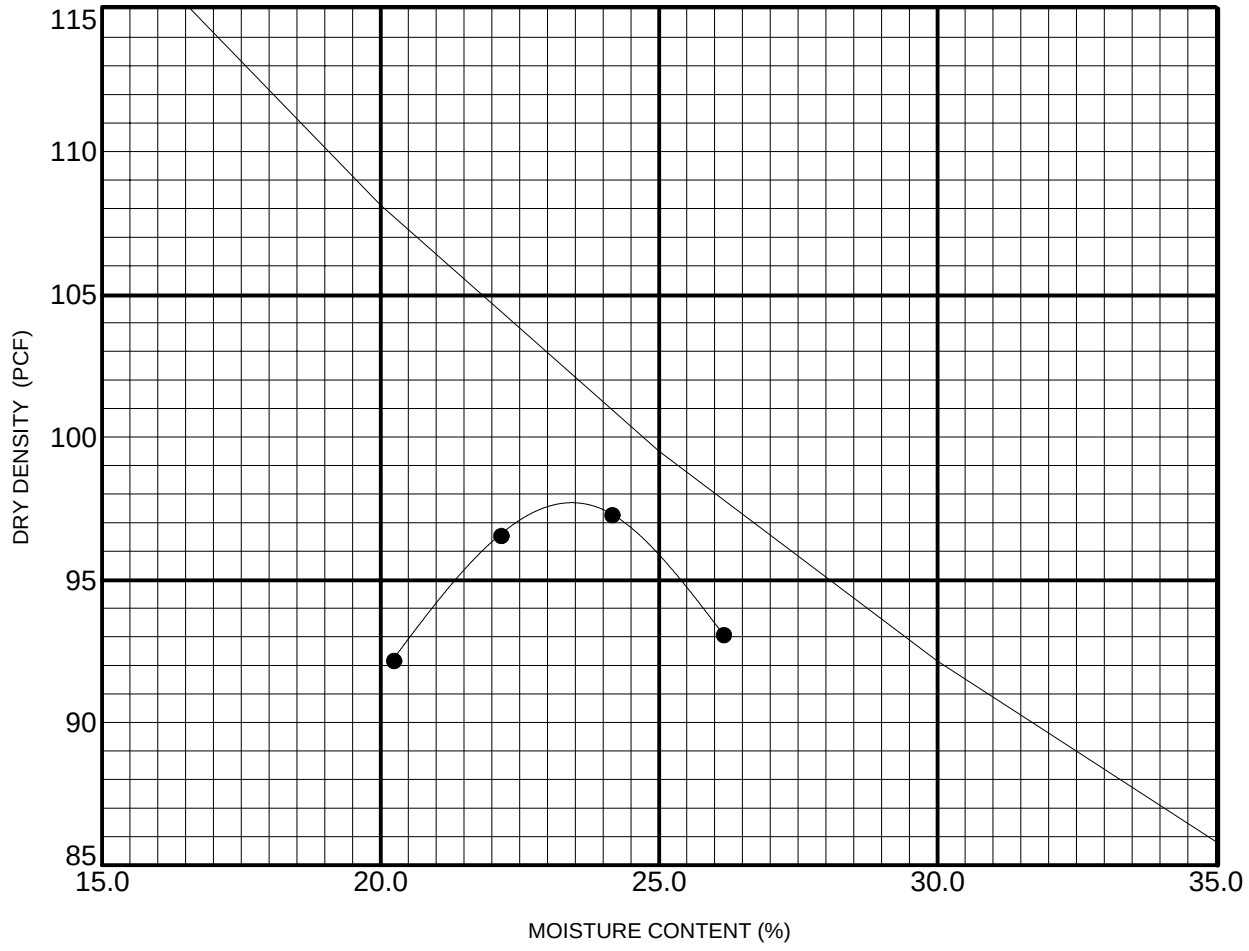
BORING NO.: TP-30 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 2 to 14** **LABORATORY NO.: 373122**

METHOD OF COMPACTION: D698A

LIQUID LIMIT: 22 **PLASTIC LIMIT:** 14 **PLASTICITY INDEX:** 8

CLASSIFICATION: CL **ASTM SOIL DESCRIPTION:** LEAN CLAY with SAND

MAXIMUM DRY DENSITY: **97.8 PCF** OPTIMUM MOISTURE CONTENT: **23.4%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/12/12**

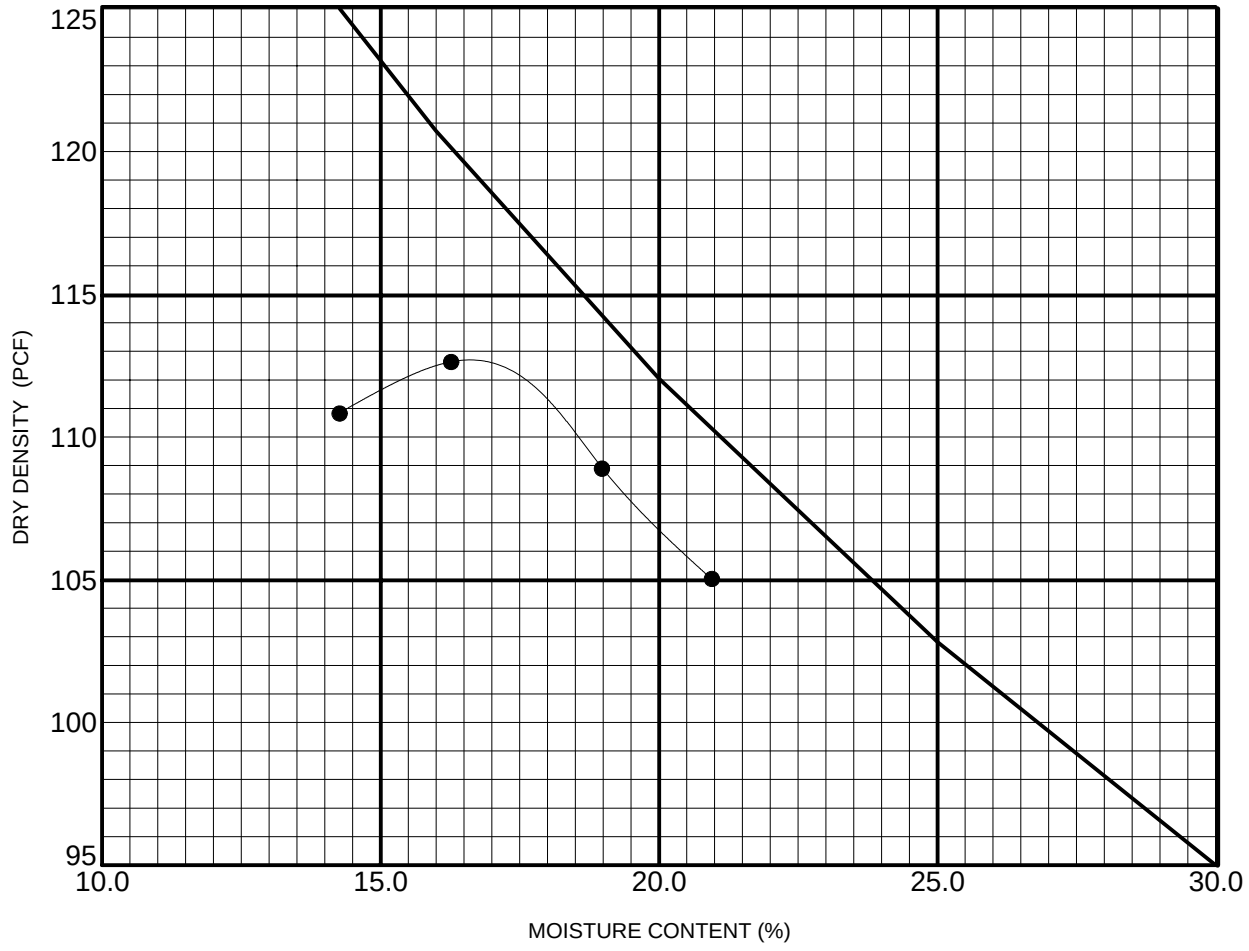
BORING NO.: TP-31 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 0 to 3.0** **LABORATORY NO.: 373427**

METHOD OF COMPACTION: D698A

LIQUID LIMIT: 35 **PLASTIC LIMIT:** 19 **PLASTICITY INDEX:** 15

CLASSIFICATION: SC **ASTM SOIL DESCRIPTION:** CLAYEY SAND

MAXIMUM DRY DENSITY: **112.8 PCF** OPTIMUM MOISTURE CONTENT: **16.6%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/7/12**

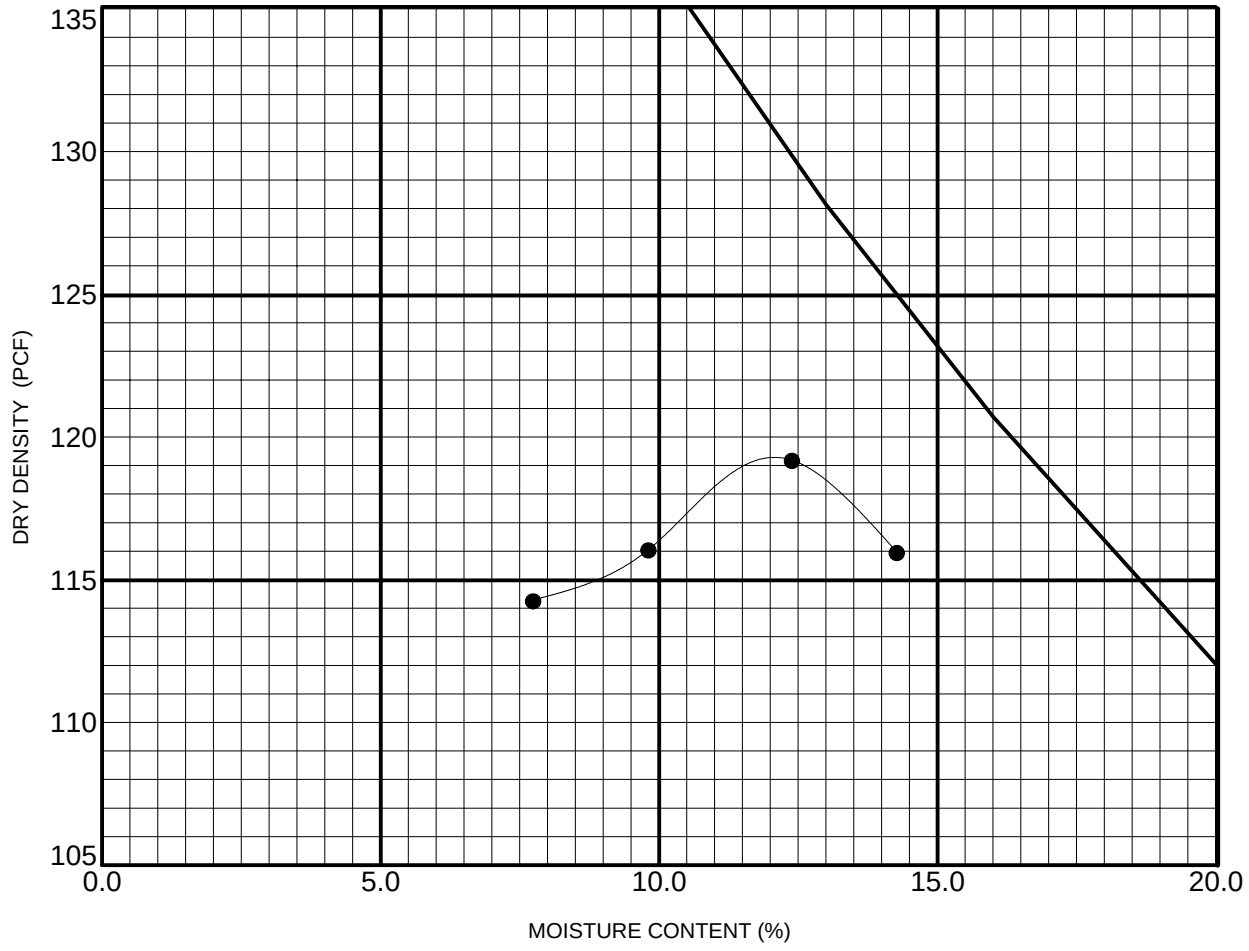
BORING NO.: TP-32 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 0 to 14** **LABORATORY NO.: 373124**

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT **PLASTIC LIMIT:** NT **PLASTICITY INDEX:** NT

CLASSIFICATION: SC-SM **ASTM SOIL DESCRIPTION:** SILTY, CLAYEY SAND with GRAVEL

MAXIMUM DRY DENSITY: **119.2 PCF** OPTIMUM MOISTURE CONTENT: **12.1%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/12/12**

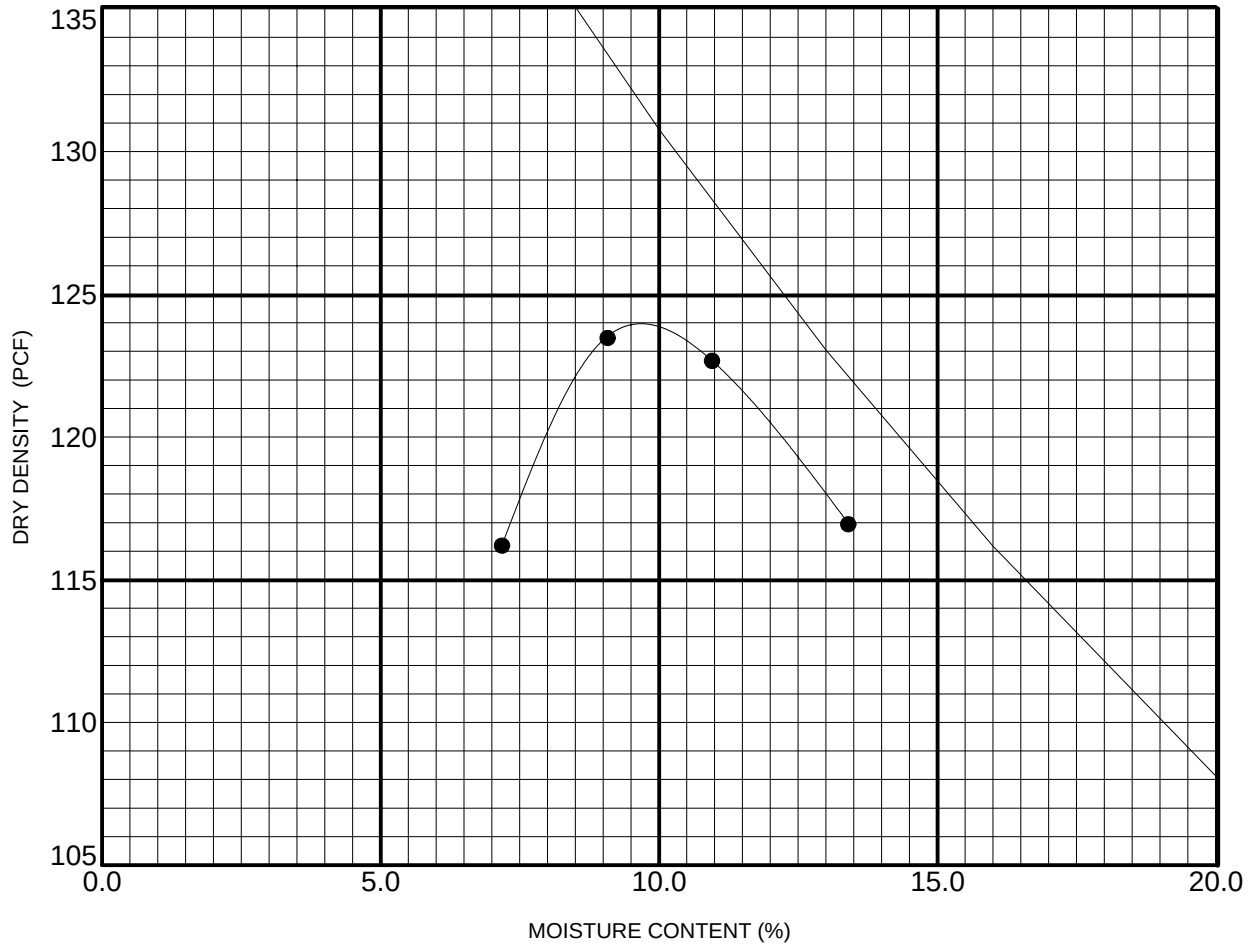
BORING NO.: TP-33 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 0 to 2** **LABORATORY NO.: 373426**

METHOD OF COMPACTION: D698A

LIQUID LIMIT: 24 **PLASTIC LIMIT:** 19 **PLASTICITY INDEX:** 5

CLASSIFICATION: SC-SM **ASTM SOIL DESCRIPTION:** SILTY, CLAYEY SAND

MAXIMUM DRY DENSITY: **124.0 PCF** OPTIMUM MOISTURE CONTENT: **9.7%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/11/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/7/12**

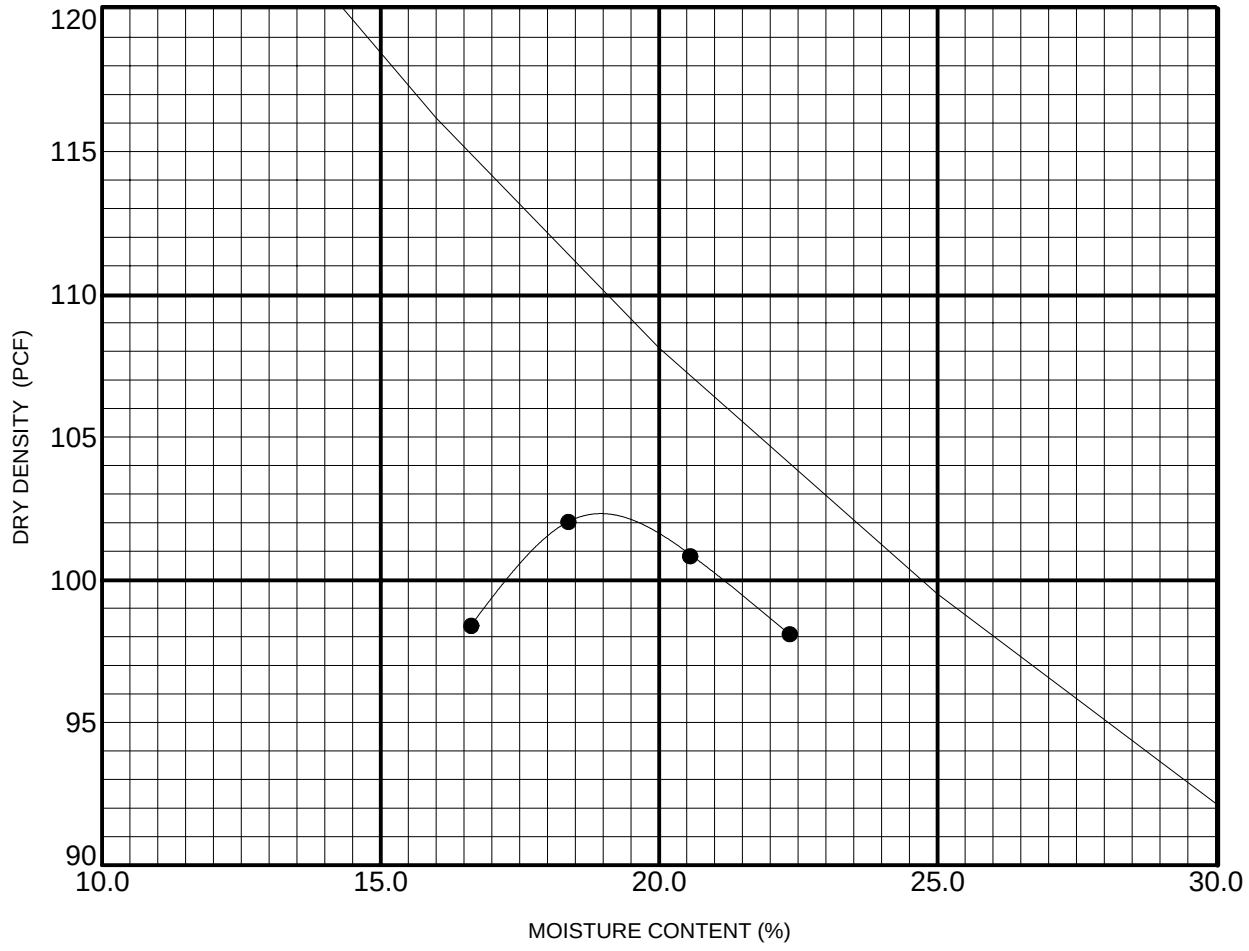
BORING NO.: TP-34 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 1.5 to 13** **LABORATORY NO.: 373126**

METHOD OF COMPACTION: **D698A**

LIQUID LIMIT: **42** **PLASTIC LIMIT:** **23** **PLASTICITY INDEX:** **19**

CLASSIFICATION: **CL** **ASTM SOIL DESCRIPTION:** **CLAYSTONE (LEAN CLAY with SAND)**

MAXIMUM DRY DENSITY: **102.3 PCF** OPTIMUM MOISTURE CONTENT: **19.0%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line PROJECT NO.: 120751TF

LOCATION: Page to Cameron DATE: 6/12/12

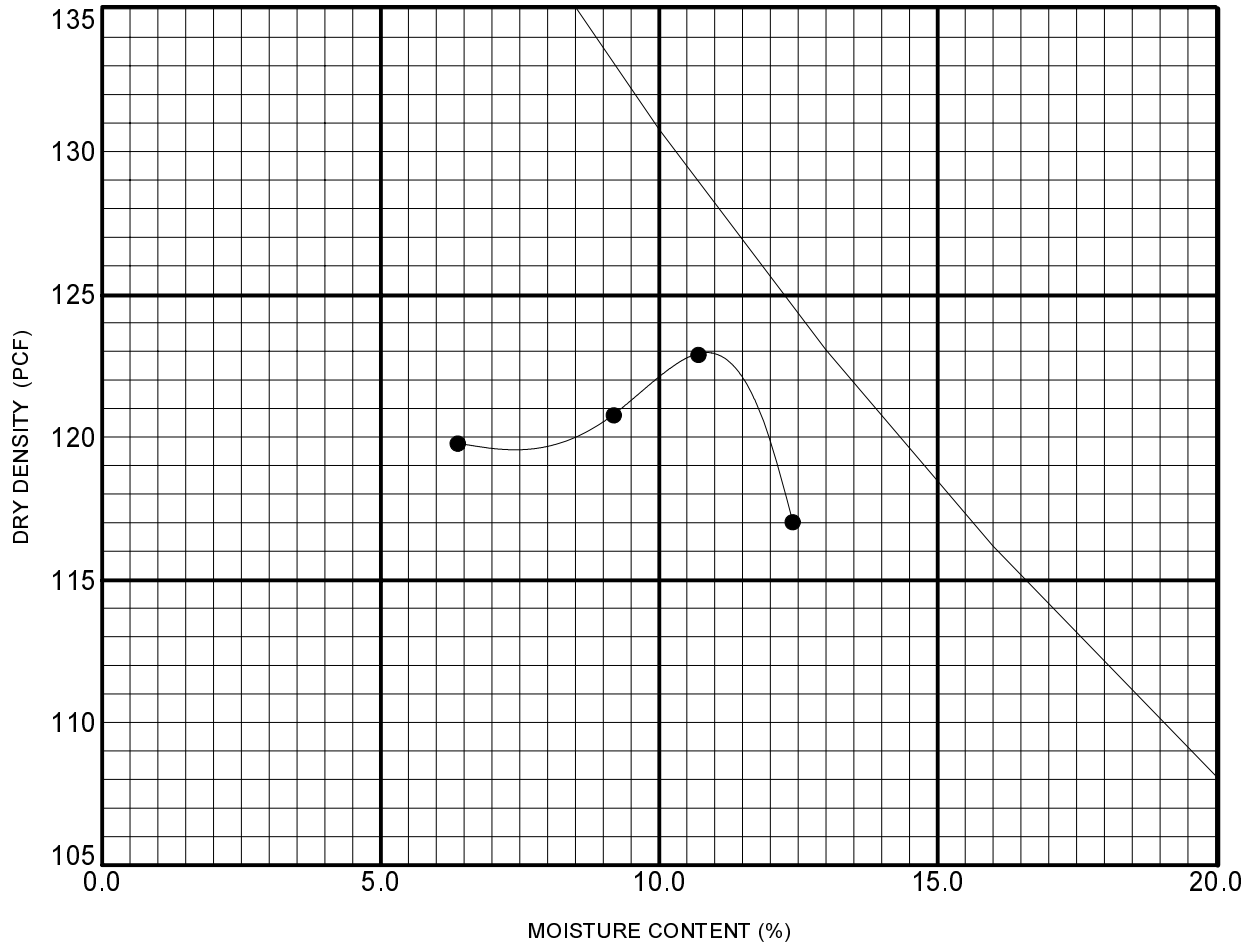
BORING NO.: TP-35 SAMPLE NO.: BS-1 SAMPLE DEPTH: 0 to 4.5 LABORATORY NO.: 373425

METHOD OF COMPACTION: D698A

LIQUID LIMIT: 28 PLASTIC LIMIT: 11 PLASTICITY INDEX: 17

CLASSIFICATION: SC ASTM SOIL DESCRIPTION: CLAYEY SAND

MAXIMUM DRY DENSITY: **123.0 PCF** OPTIMUM MOISTURE CONTENT: **10.8%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/11/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/7/12**

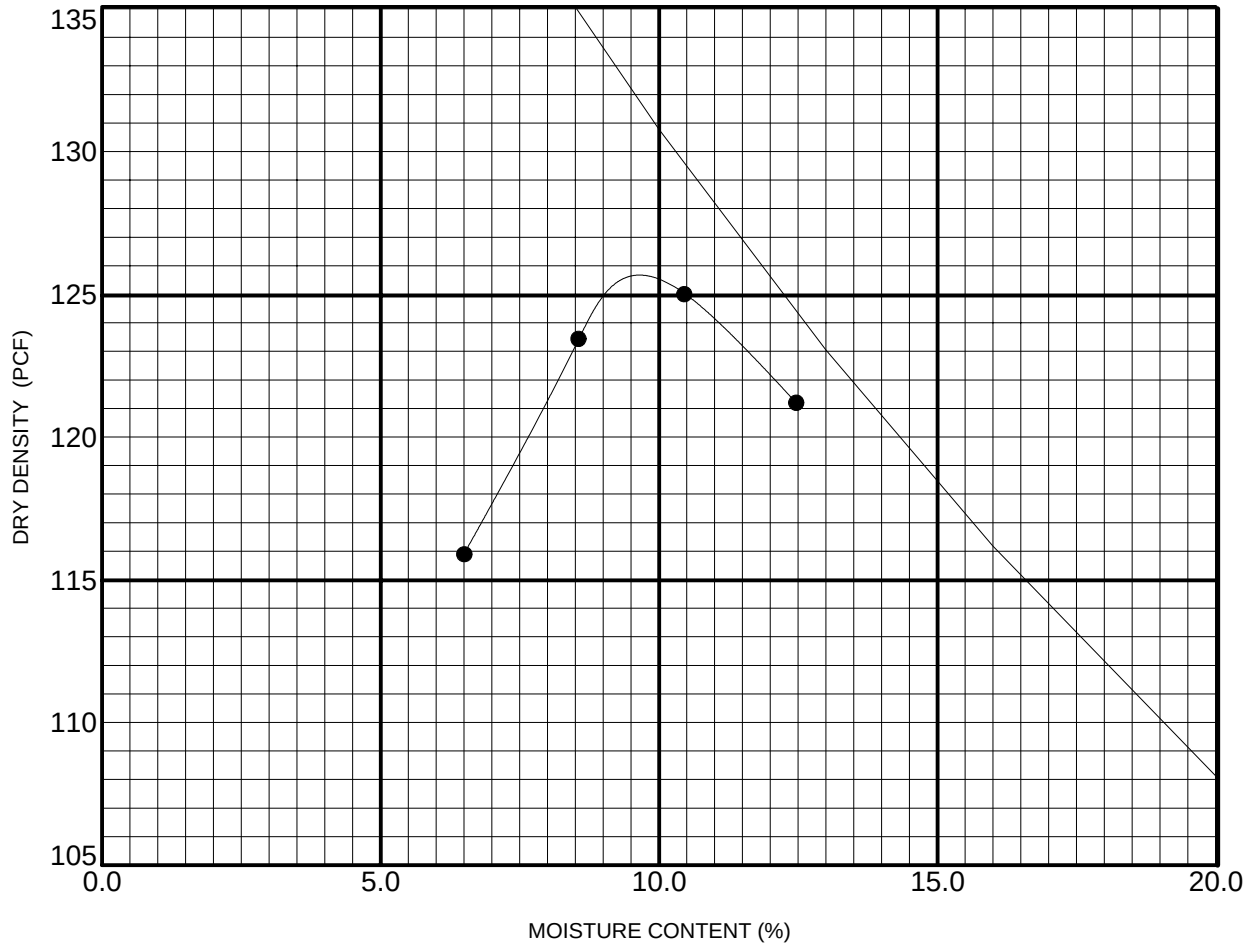
BORING NO.: TP-36 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 7 to 13.5** **LABORATORY NO.: 373127**

METHOD OF COMPACTION: D698A

LIQUID LIMIT: 33 **PLASTIC LIMIT:** 14 **PLASTICITY INDEX:** 18

CLASSIFICATION: SC **ASTM SOIL DESCRIPTION:** CLAYEY SAND

MAXIMUM DRY DENSITY: **125.8 PCF** OPTIMUM MOISTURE CONTENT: **9.7%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/6/12**

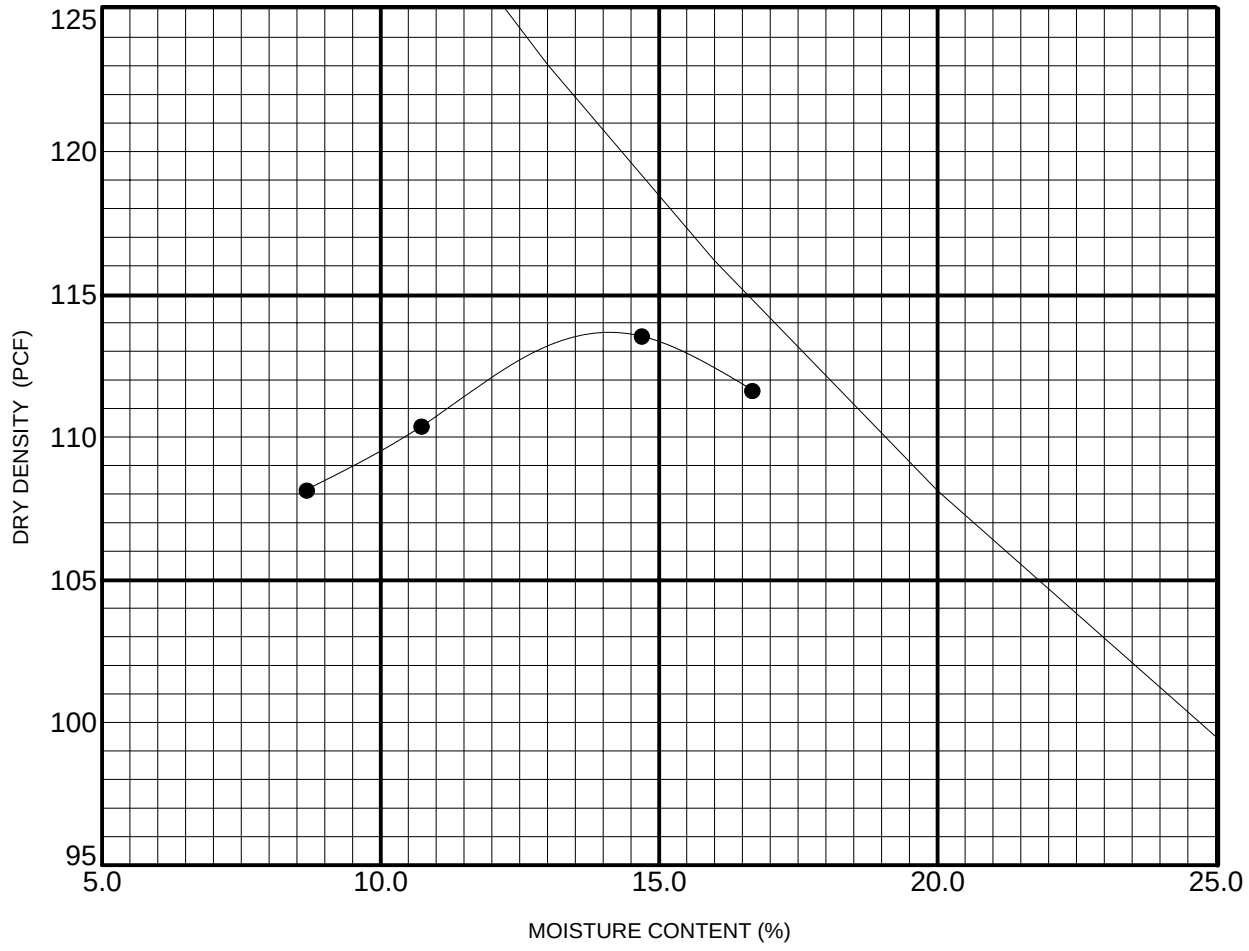
BORING NO.: TP-37 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 1 to 4.5** **LABORATORY NO.: 373351**

METHOD OF COMPACTION: **D698A**

LIQUID LIMIT: **33** **PLASTIC LIMIT:** **25** **PLASTICITY INDEX:** **8**

CLASSIFICATION: **SM** **ASTM SOIL DESCRIPTION:** **SILTY SAND**

MAXIMUM DRY DENSITY: **113.8 PCF** OPTIMUM MOISTURE CONTENT: **14.1%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/6/12**

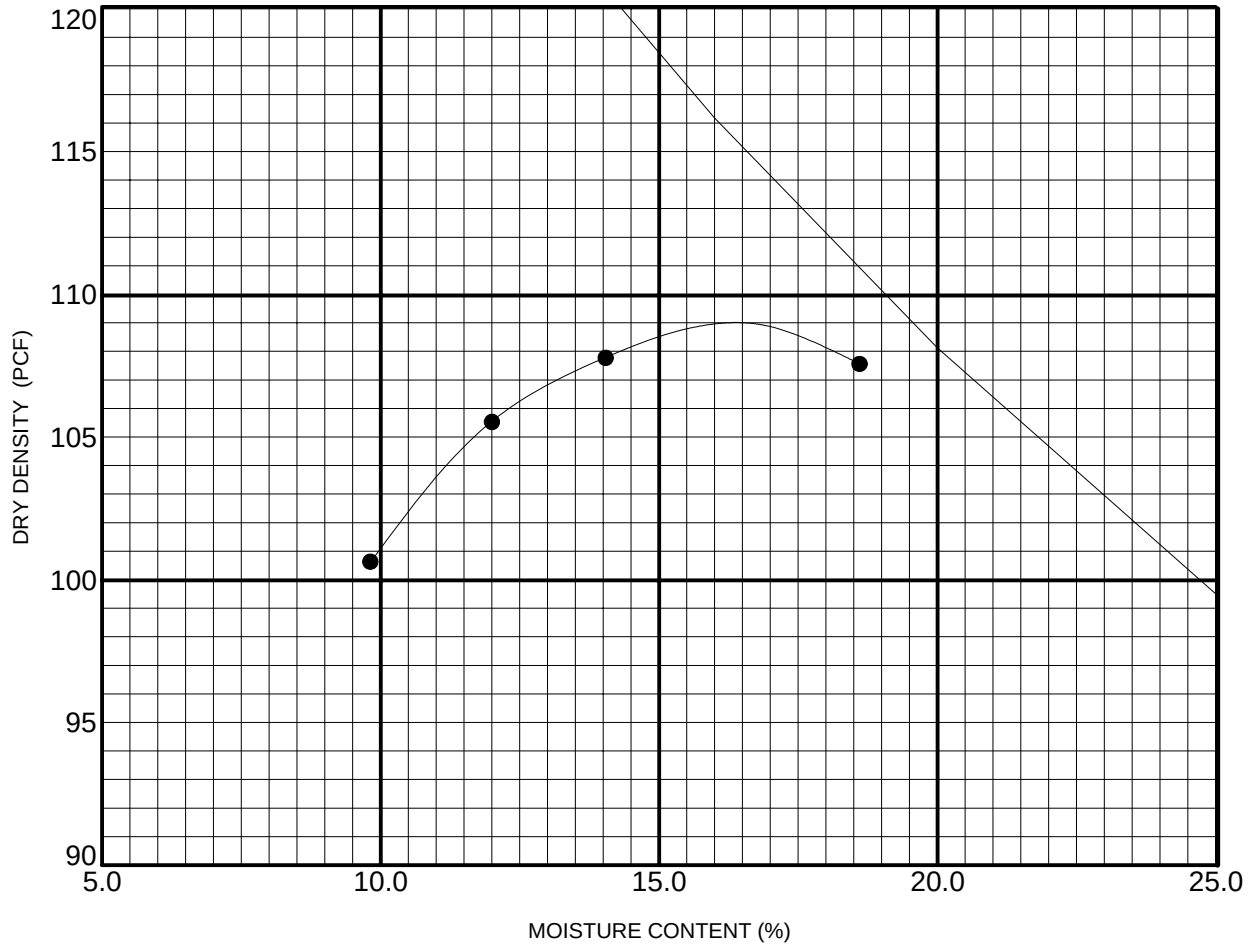
BORING NO.: TP-38 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 1 to 4** **LABORATORY NO.: 373070**

METHOD OF COMPACTION: **D698A**

LIQUID LIMIT: **NP** **PLASTIC LIMIT:** **NP** **PLASTICITY INDEX:** **NP**

CLASSIFICATION: **SM** **ASTM SOIL DESCRIPTION:** **SILTY SAND**

MAXIMUM DRY DENSITY: **109.0 PCF** OPTIMUM MOISTURE CONTENT: **16.4%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line — PROJECT NO.: 120751TF

LOCATION: Page to Cameron — DATE: 6/6/12

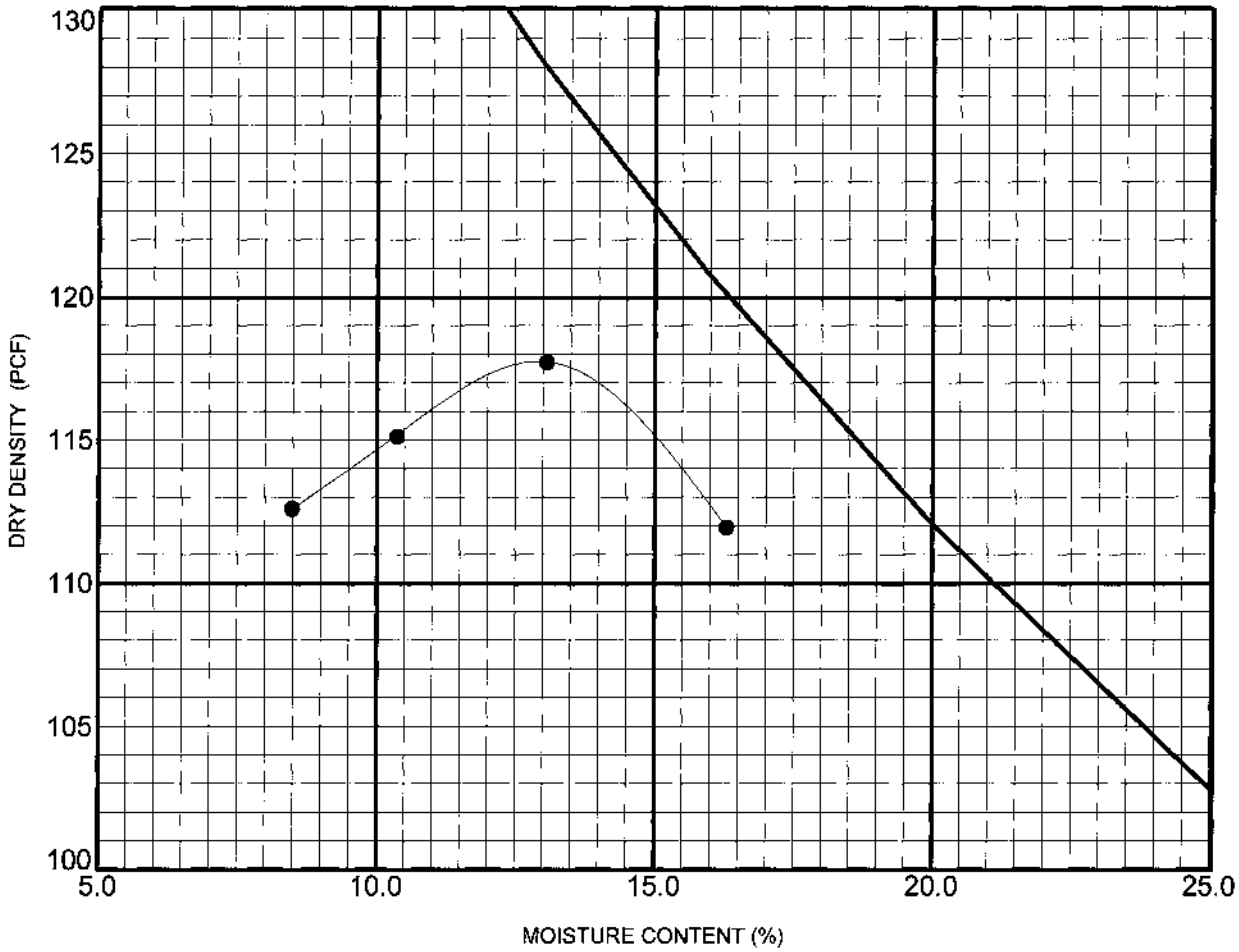
BORING NO.: TP-39 SAMPLE NO.: BS-1 SAMPLE DEPTH: 0 to 3.5 LABORATORY NO.: 373071

METHOD OF COMPACTION: D698A

LIQUID LIMIT: 27 PLASTIC LIMIT: 16 PLASTICITY INDEX: 11

CLASSIFICATION: SC ASTM SOIL DESCRIPTION: CLAYEY SAND

MAXIMUM DRY DENSITY: **117.8 PCF** OPTIMUM MOISTURE CONTENT: **12.9%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line — PROJECT NO.: 120751TF

LOCATION: Page to Cameron — DATE: 6/6/12

BORING NO.: TP-40 SAMPLE NO.: BS-1 SAMPLE DEPTH: 0 to 5 LABORATORY NO.: 373072

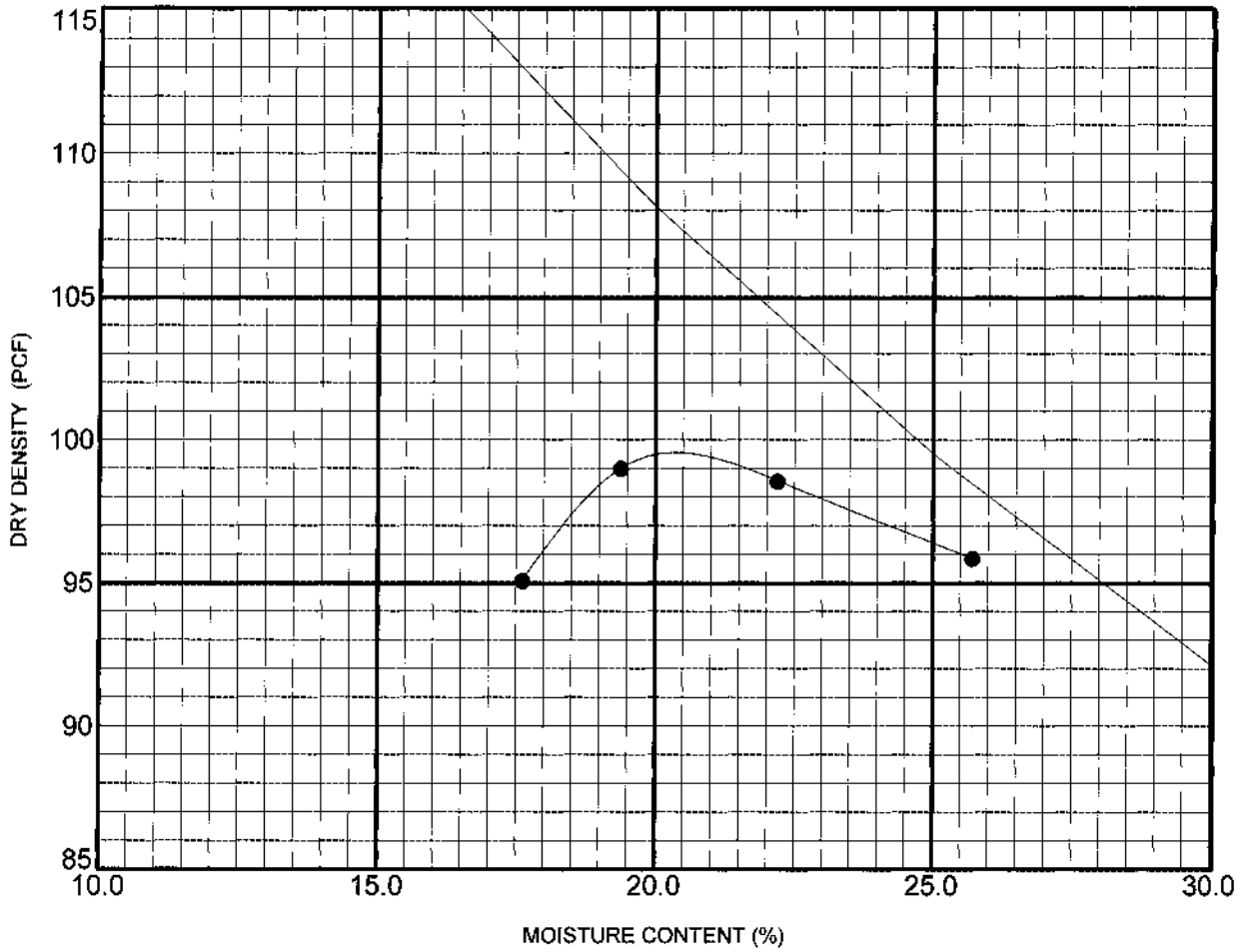
METHOD OF COMPACTION: D698A

LIQUID LIMIT: 59 PLASTIC LIMIT: 19 PLASTICITY INDEX: 40

CLASSIFICATION: CH ASTM SOIL DESCRIPTION: FAT CLAY with SAND

MAXIMUM DRY DENSITY: 99.5 PCF

OPTIMUM MOISTURE CONTENT: 20.4%



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line — PROJECT NO.: 120751TF

LOCATION: Page to Cameron — DATE: 6/6/12

BORING NO.: TP-41 SAMPLE NO.: BS-1 SAMPLE DEPTH: 3 to 8 LABORATORY NO.: 373073

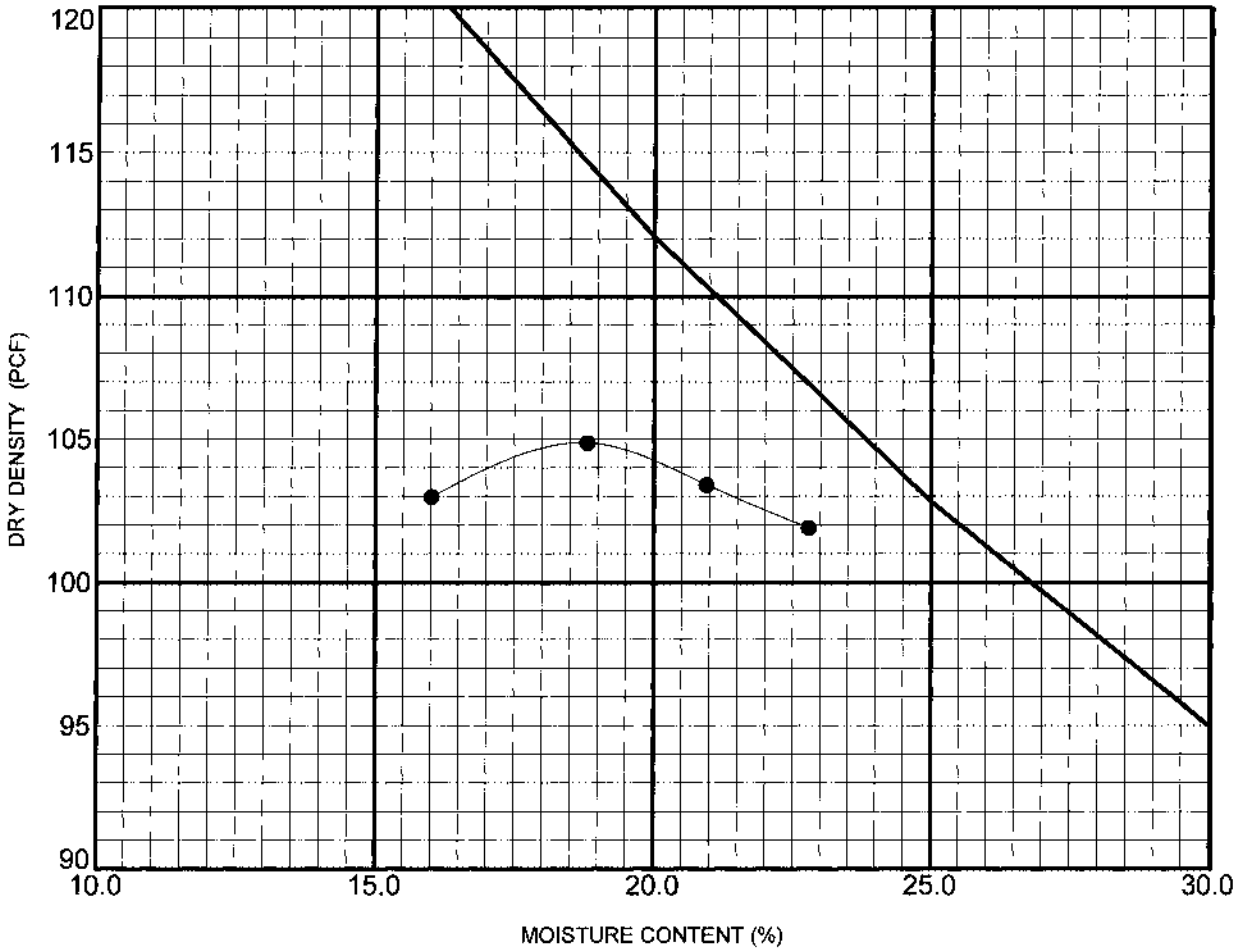
METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT PLASTIC LIMIT: NT PLASTICITY INDEX: NT

CLASSIFICATION: CH ASTM SOIL DESCRIPTION: CLAYSTONE (FAT CLAY)

MAXIMUM DRY DENSITY: 104.9 PCF

OPTIMUM MOISTURE CONTENT: 18.7%



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line — PROJECT NO.: 120751TF

LOCATION: Page to Cameron — DATE: 6/6/12

BORING NO.: TP-42 SAMPLE NO.: BS-1 SAMPLE DEPTH: 7 to 14.5 LABORATORY NO.: 373074

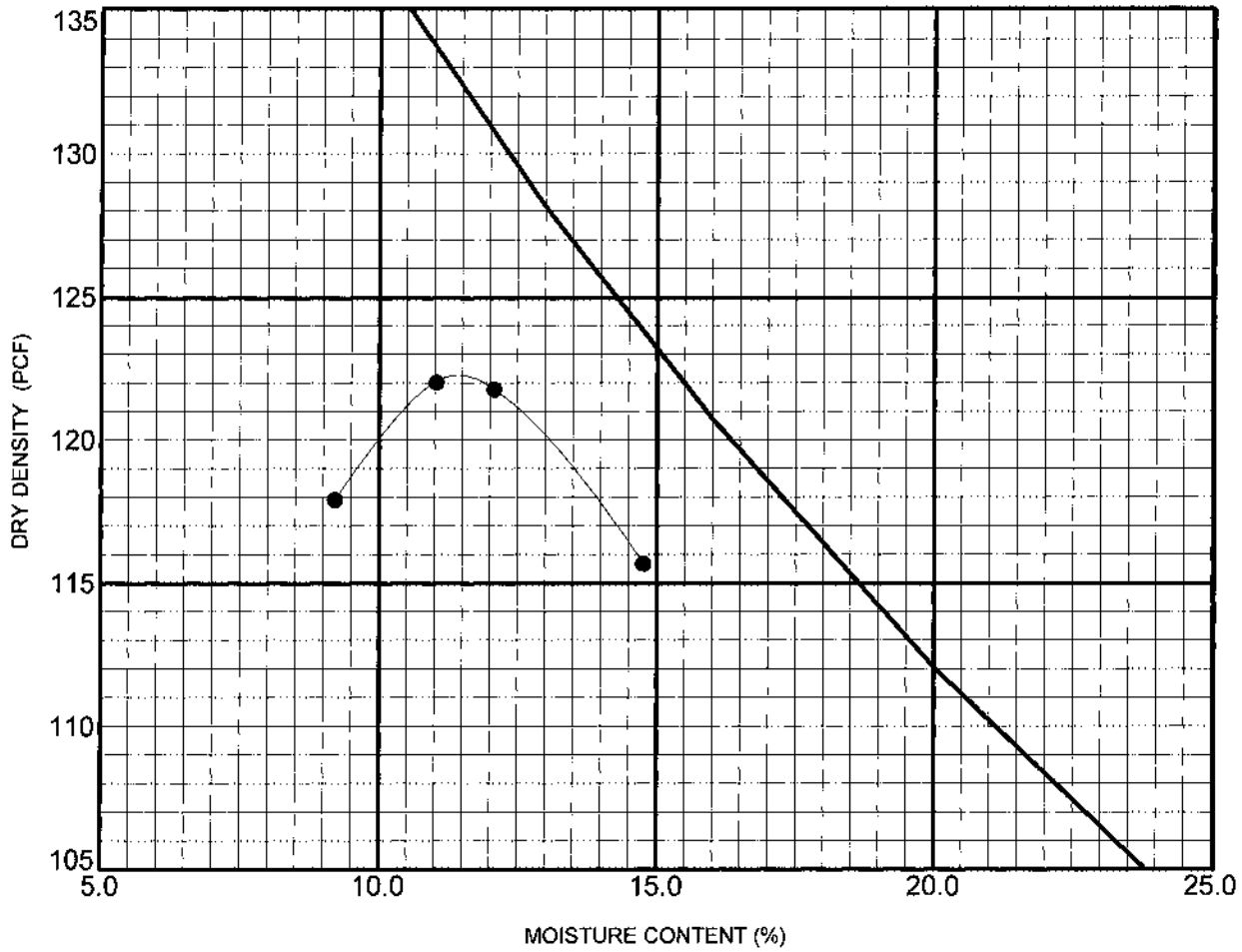
METHOD OF COMPACTION: D698A

LIQUID LIMIT: 28 PLASTIC LIMIT: 18 PLASTICITY INDEX: 10

CLASSIFICATION: SC ASTM SOIL DESCRIPTION: CLAYEY SAND

MAXIMUM DRY DENSITY: 122.2 PCF

OPTIMUM MOISTURE CONTENT: 11.4%



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line — PROJECT NO.: 120751TF

LOCATION: Page to Cameron — DATE: 6/6/12

BORING NO.: TP-43 SAMPLE NO.: BS-1 SAMPLE DEPTH: 0 to 6 LABORATORY NO.: 373075

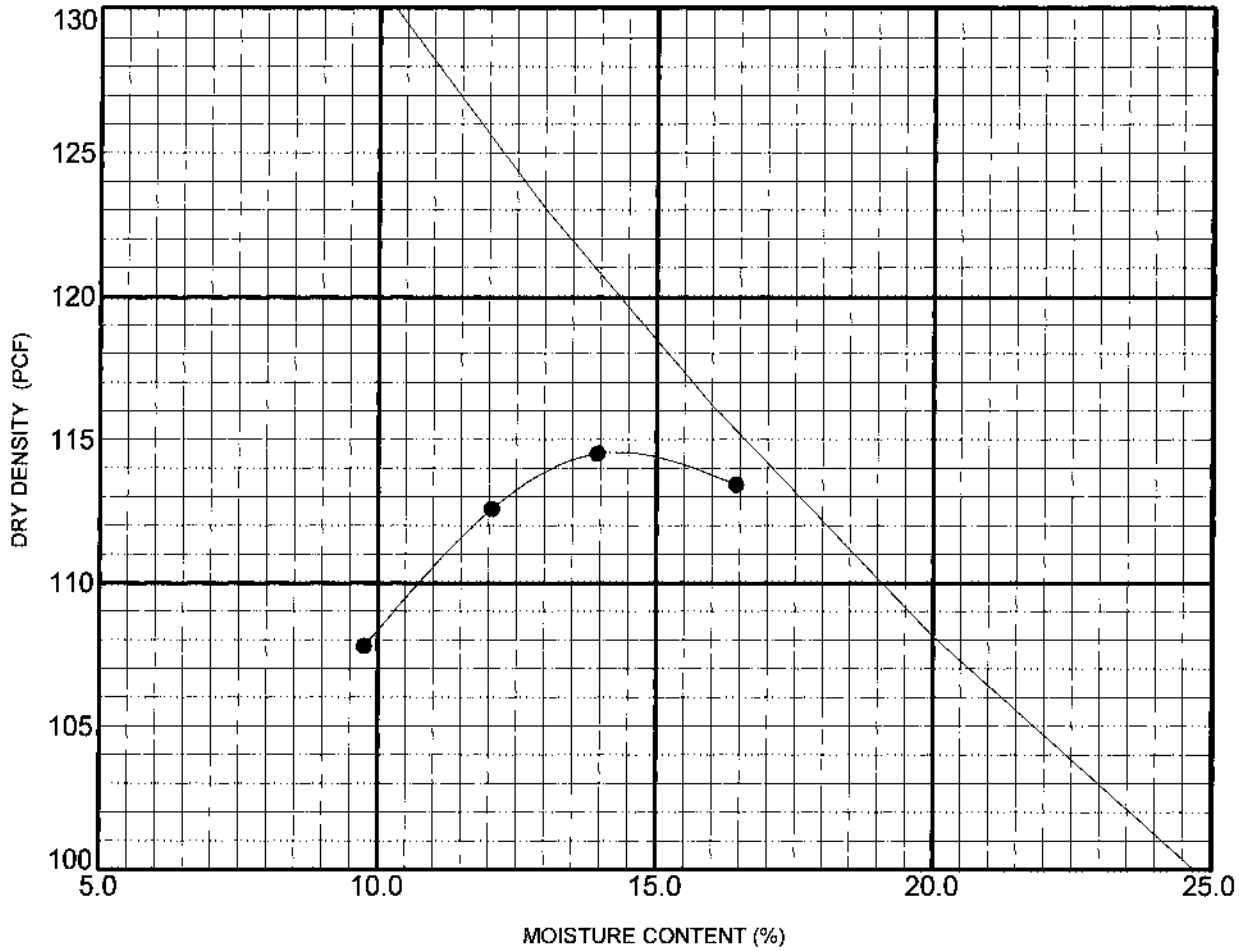
METHOD OF COMPACTION: D698A

LIQUID LIMIT: 25 PLASTIC LIMIT: 18 PLASTICITY INDEX: 8

CLASSIFICATION: SC-SM ASTM SOIL DESCRIPTION: SILTY, CLAYEY SAND

MAXIMUM DRY DENSITY: 114.5 PCF

OPTIMUM MOISTURE CONTENT: 14.3%



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line PROJECT NO.: 120751TF

LOCATION: Page to Cameron DATE: 6/5/12

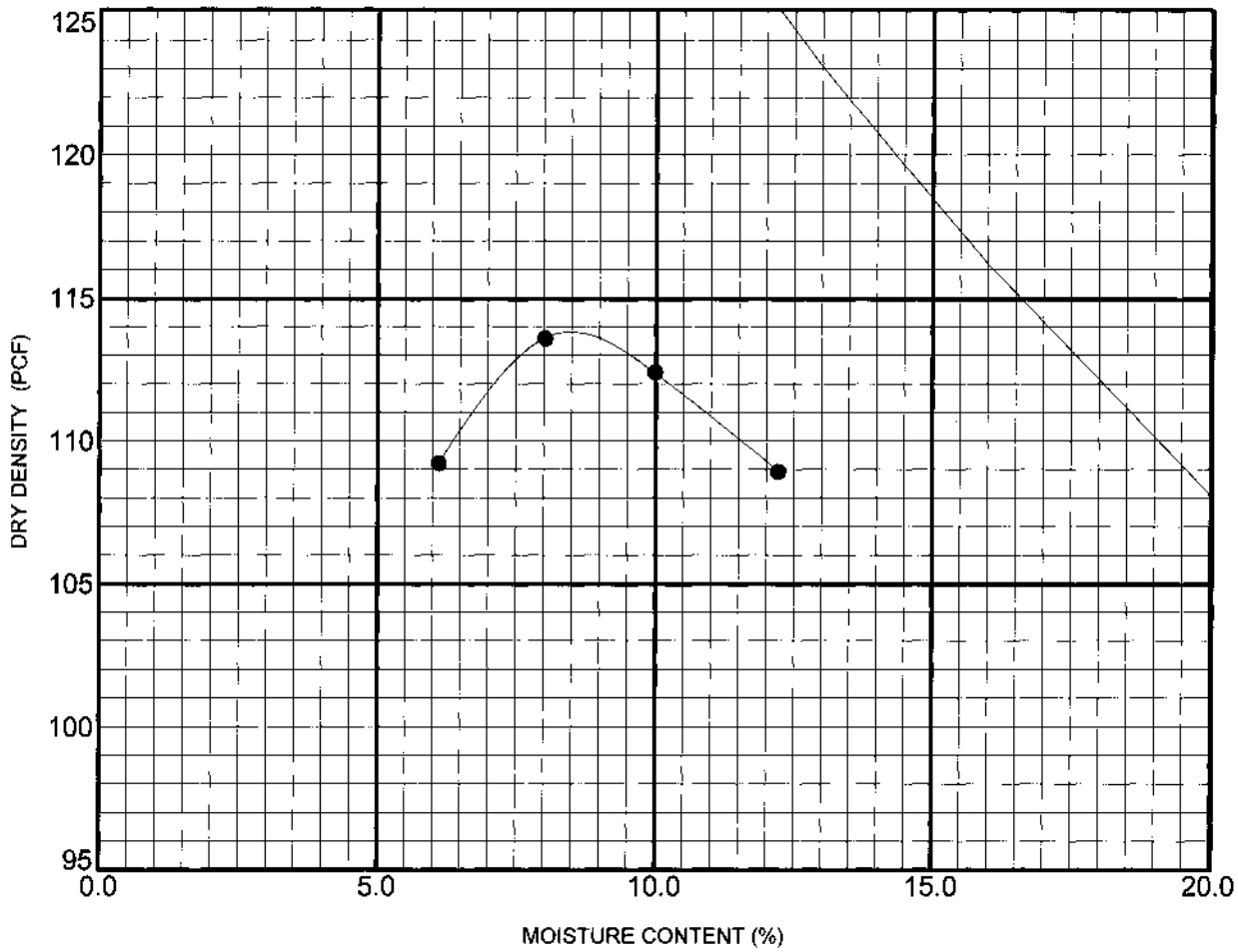
BORING NO.: TP-44 SAMPLE NO.: BS-1 SAMPLE DEPTH: 0.8 to 8.5 LABORATORY NO.: 372912

METHOD OF COMPACTION: D698A

LIQUID LIMIT: 24 PLASTIC LIMIT: 19 PLASTICITY INDEX: 5

CLASSIFICATION: SC-SM ASTM SOIL DESCRIPTION: SILTY, CLAYEY SAND

MAXIMUM DRY DENSITY: 113.9 PCF OPTIMUM MOISTURE CONTENT: 9.5%



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line — PROJECT NO.: 120751TF

LOCATION: Page to Cameron — DATE: 6/5/12

BORING NO.: TP-45 SAMPLE NO.: BS-1 SAMPLE DEPTH: 0 to 14 LABORATORY NO.: 372908

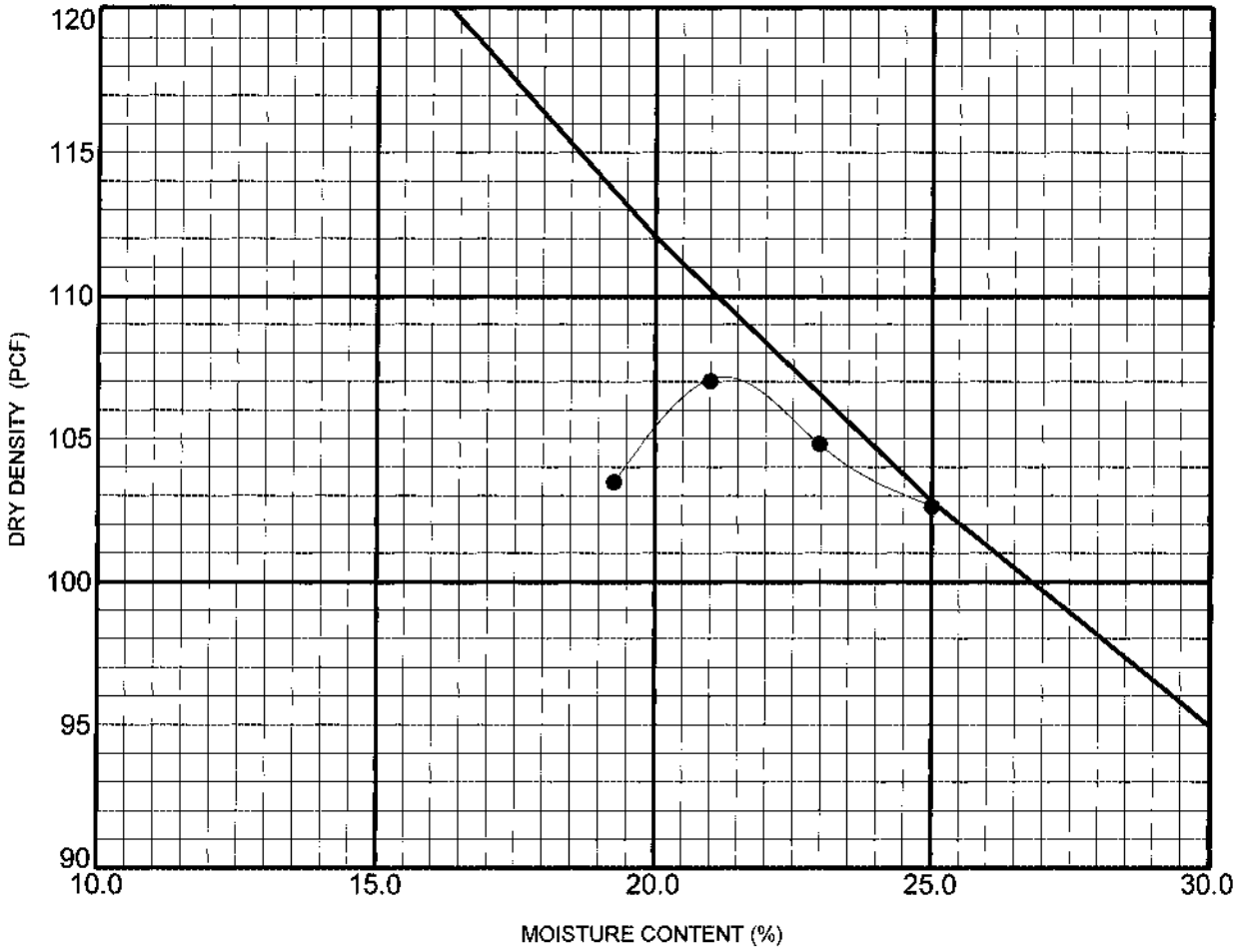
METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT PLASTIC LIMIT: NT PLASTICITY INDEX: NT

CLASSIFICATION: CL ASTM SOIL DESCRIPTION: CLAYSTONE (LEAN CLAY with SAND)

MAXIMUM DRY DENSITY: 107.1 PCF

OPTIMUM MOISTURE CONTENT: 21.2%



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/11/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line — PROJECT NO.: 120751TF

LOCATION: Page to Cameron — DATE: 6/5/12

BORING NO.: TP-46 SAMPLE NO.: BS-1 SAMPLE DEPTH: 0 to 8 — LABORATORY NO.: 372907

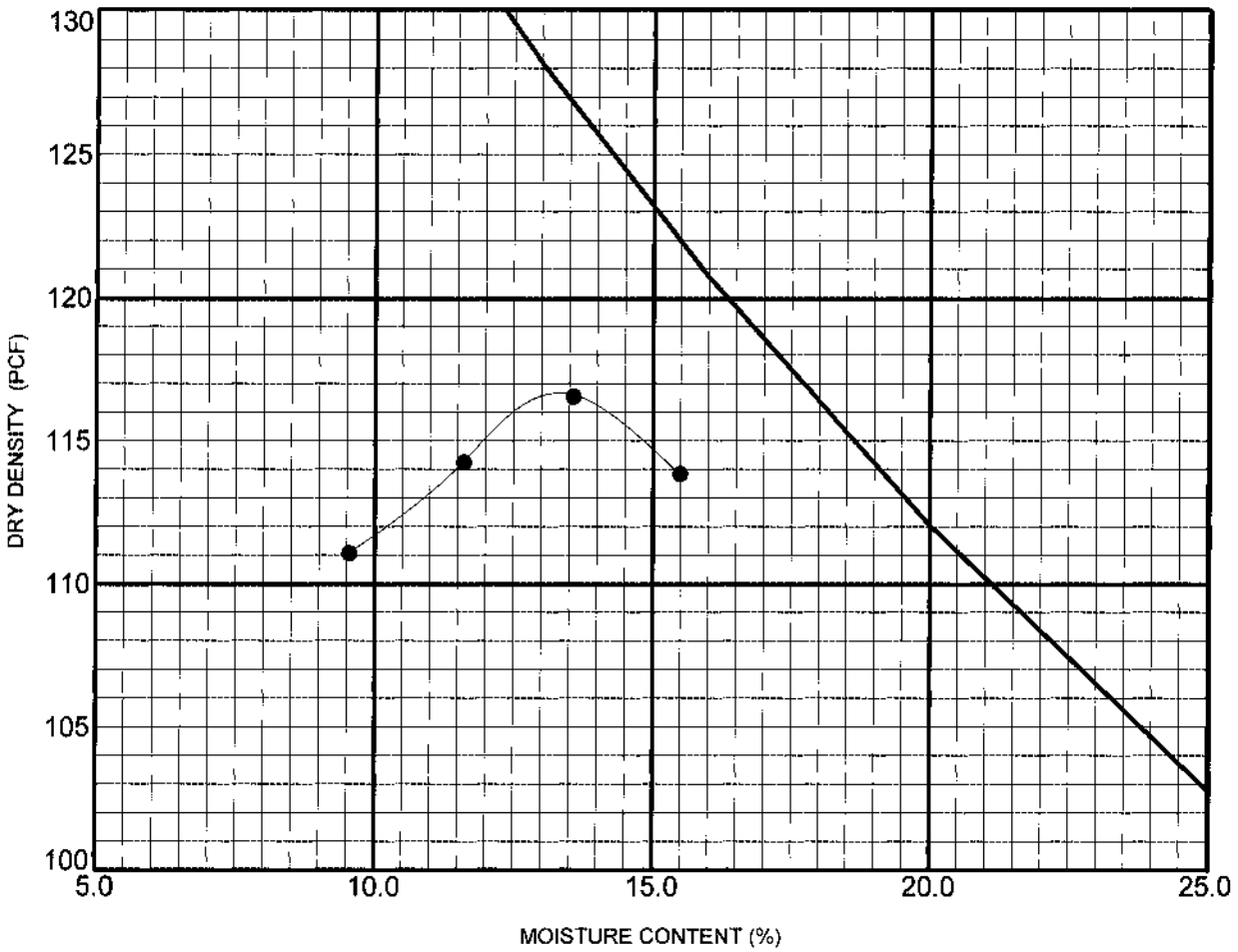
METHOD OF COMPACTION: D698A

LIQUID LIMIT: 41 PLASTIC LIMIT: 26 PLASTICITY INDEX: 15

CLASSIFICATION: ML ASTM SOIL DESCRIPTION: CLAYSTONE (SANDY SILT with GRAVEL)

MAXIMUM DRY DENSITY: **116.7 PCF**

OPTIMUM MOISTURE CONTENT: **13.4%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line — PROJECT NO.: 120751TF

LOCATION: Page to Cameron — DATE: 6/5/12

BORING NO.: TP-47 SAMPLE NO.: BS-1 SAMPLE DEPTH: 0 to 8 — LABORATORY NO.: 372906

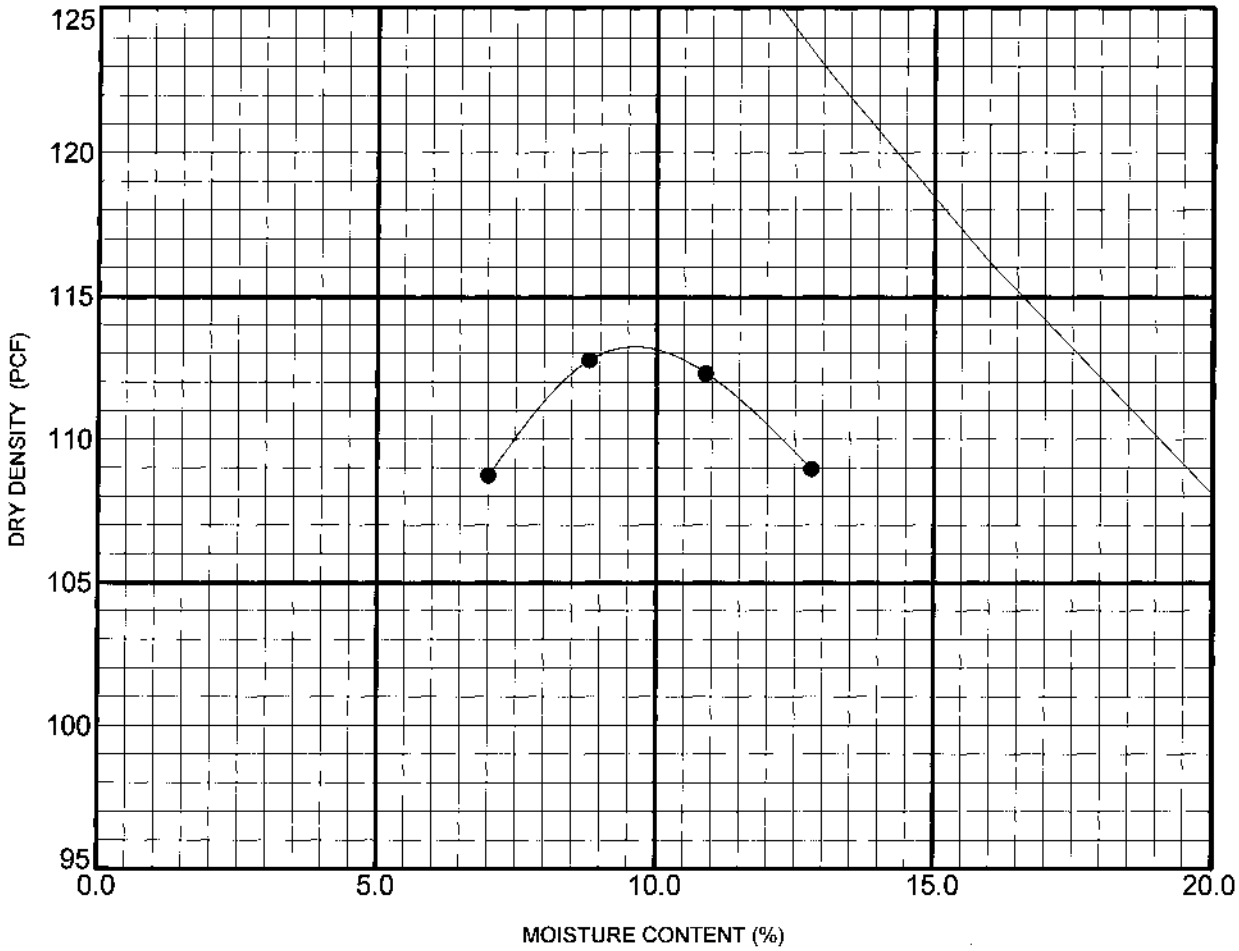
METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT PLASTIC LIMIT: NT PLASTICITY INDEX: NT

CLASSIFICATION: SC-SM ASTM SOIL DESCRIPTION: SILTY, CLAYEY SAND

MAXIMUM DRY DENSITY: 113.2 PCF

OPTIMUM MOISTURE CONTENT: 9.6%



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line PROJECT NO.: 120751TF

LOCATION: Page to Cameron DATE: 6/5/12

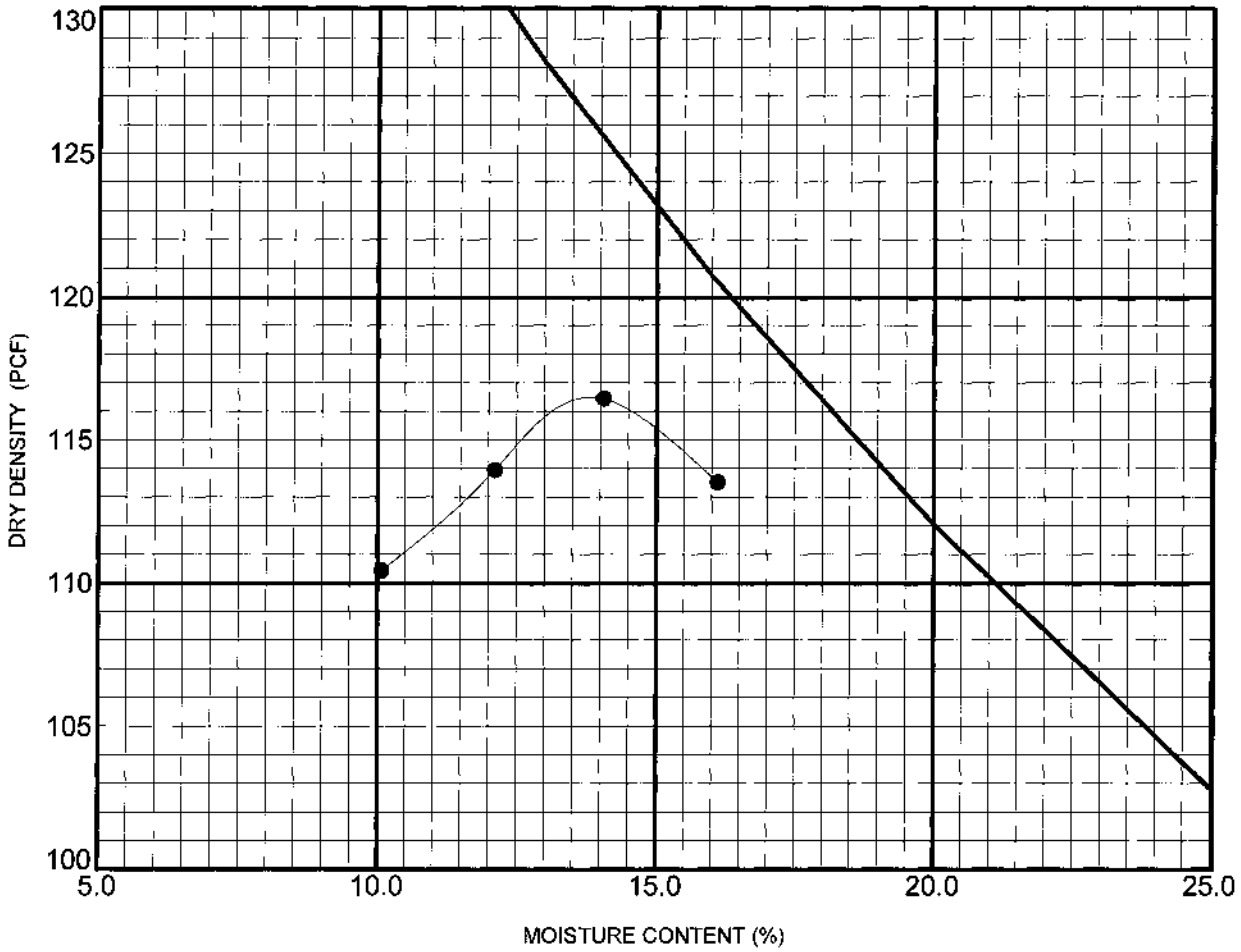
BORING NO.: TP-48 SAMPLE NO.: BS-1 SAMPLE DEPTH: 1.8 to 7.5 LABORATORY NO.: 372905

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT PLASTIC LIMIT: NT PLASTICITY INDEX: NT

CLASSIFICATION: CL ASTM SOIL DESCRIPTION: CLAYSTONE (SANDY LEAN CLAY)

MAXIMUM DRY DENSITY: 116.5 PCF OPTIMUM MOISTURE CONTENT: 13.8%



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line — PROJECT NO.: 120751TF

LOCATION: Page to Cameron — DATE: 6/18/12

BORING NO.: TP-49 SAMPLE NO.: 373697 SAMPLE DEPTH: 0 to 3.2 — LABORATORY NO.: 373697

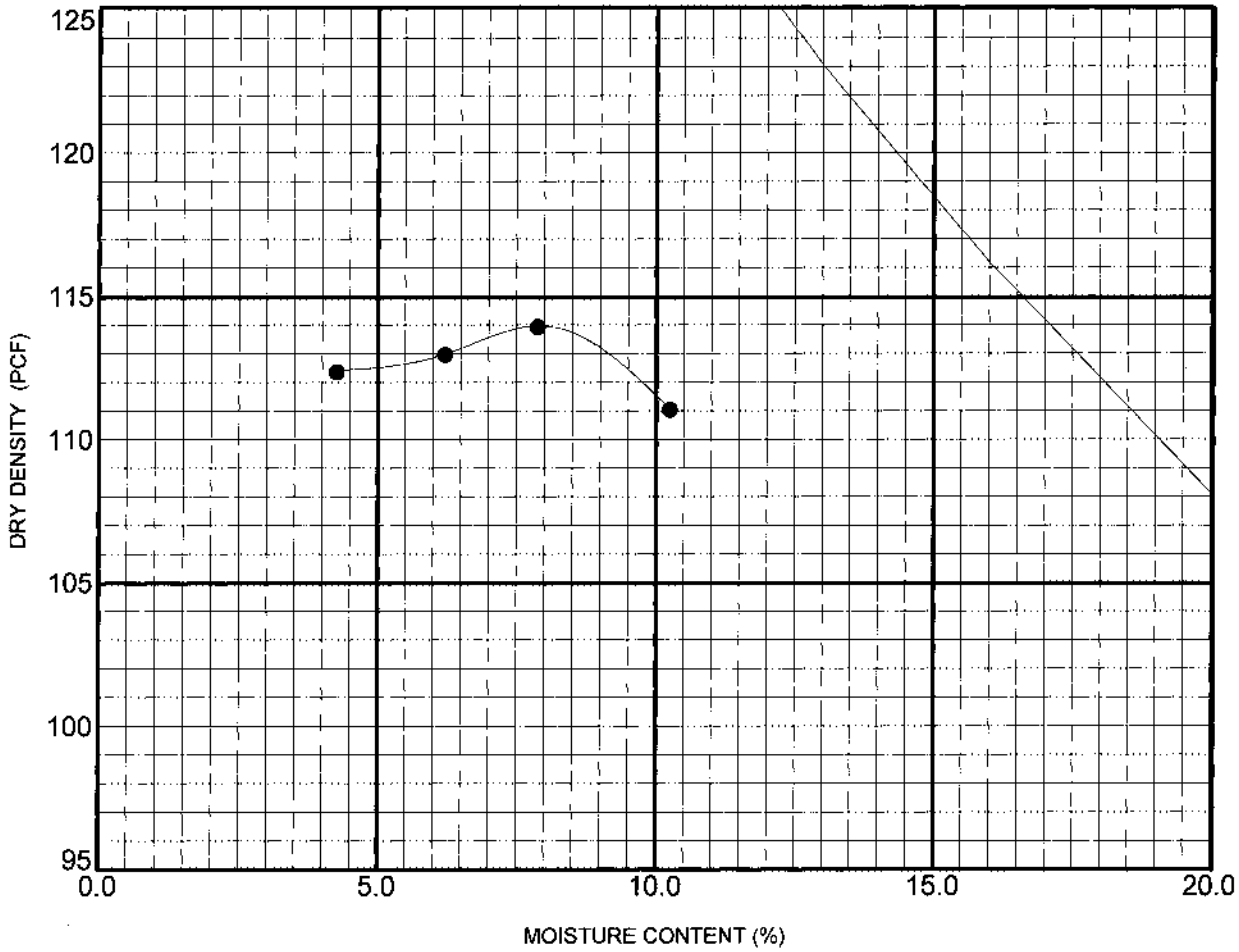
METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT PLASTIC LIMIT: NT PLASTICITY INDEX: NT

CLASSIFICATION: SP-SM-SC ASTM SOIL DESCRIPTION: POORLY GRADED SAND with SILT and CLAY

MAXIMUM DRY DENSITY: 113.9 PCF

OPTIMUM MOISTURE CONTENT: 7.9%



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line — PROJECT NO.: 120751TF

LOCATION: Page to Cameron — DATE: 6/18/12

BORING NO.: TP-50 SAMPLE NO.: BS-1 SAMPLE DEPTH: 0 to 5 — LABORATORY NO.: 373698

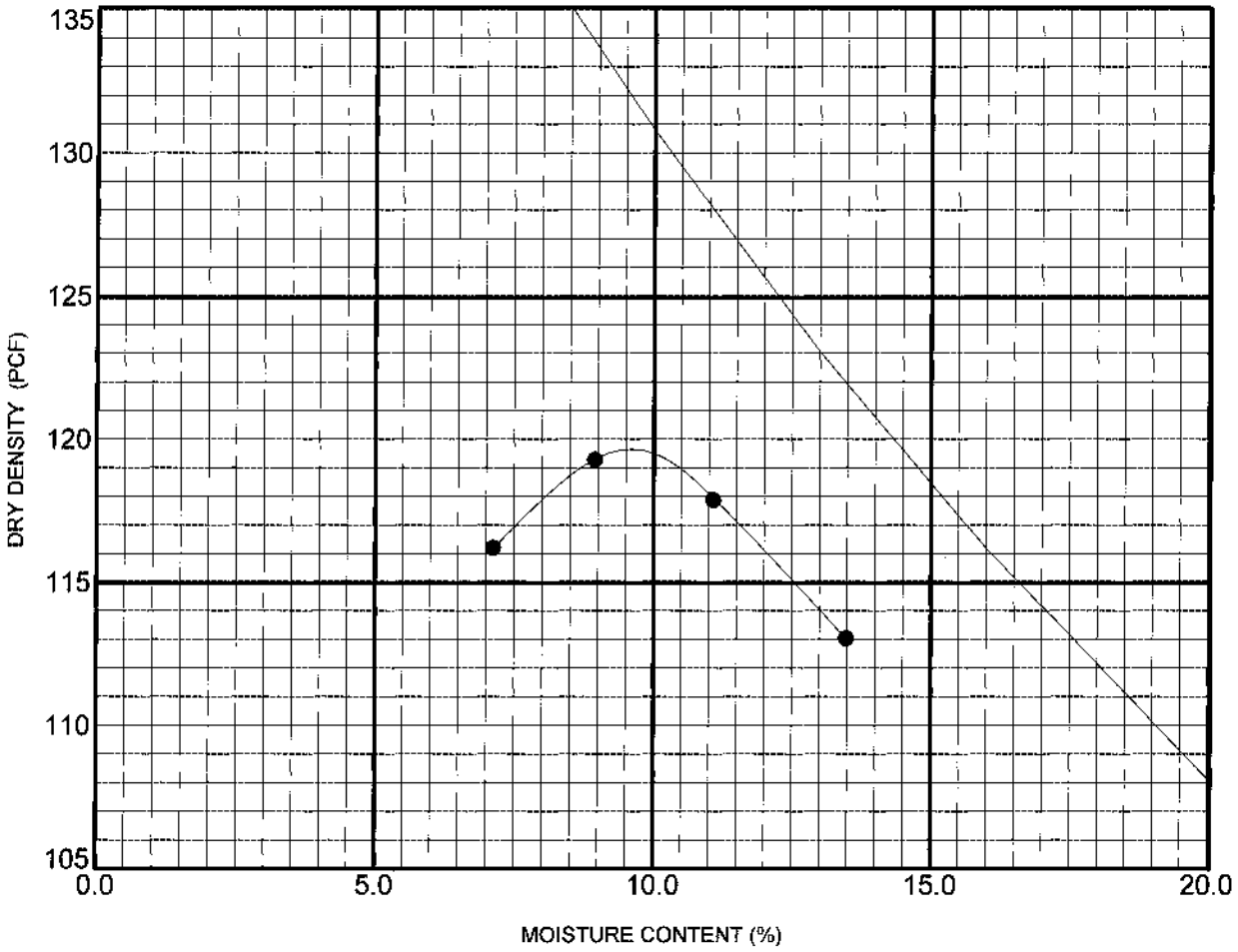
METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT PLASTIC LIMIT: NT PLASTICITY INDEX: NT

CLASSIFICATION: SC-SM ASTM SOIL DESCRIPTION: SILTY, CLAYEY SAND

MAXIMUM DRY DENSITY: 119.6 PCF

OPTIMUM MOISTURE CONTENT: 9.6%



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line — PROJECT NO.: 120751TF

LOCATION: Page to Cameron — DATE: 6/18/12

BORING NO.: TP-51 SAMPLE NO.: BS-1 SAMPLE DEPTH: 4.5 to 6.5 LABORATORY NO.: 373703

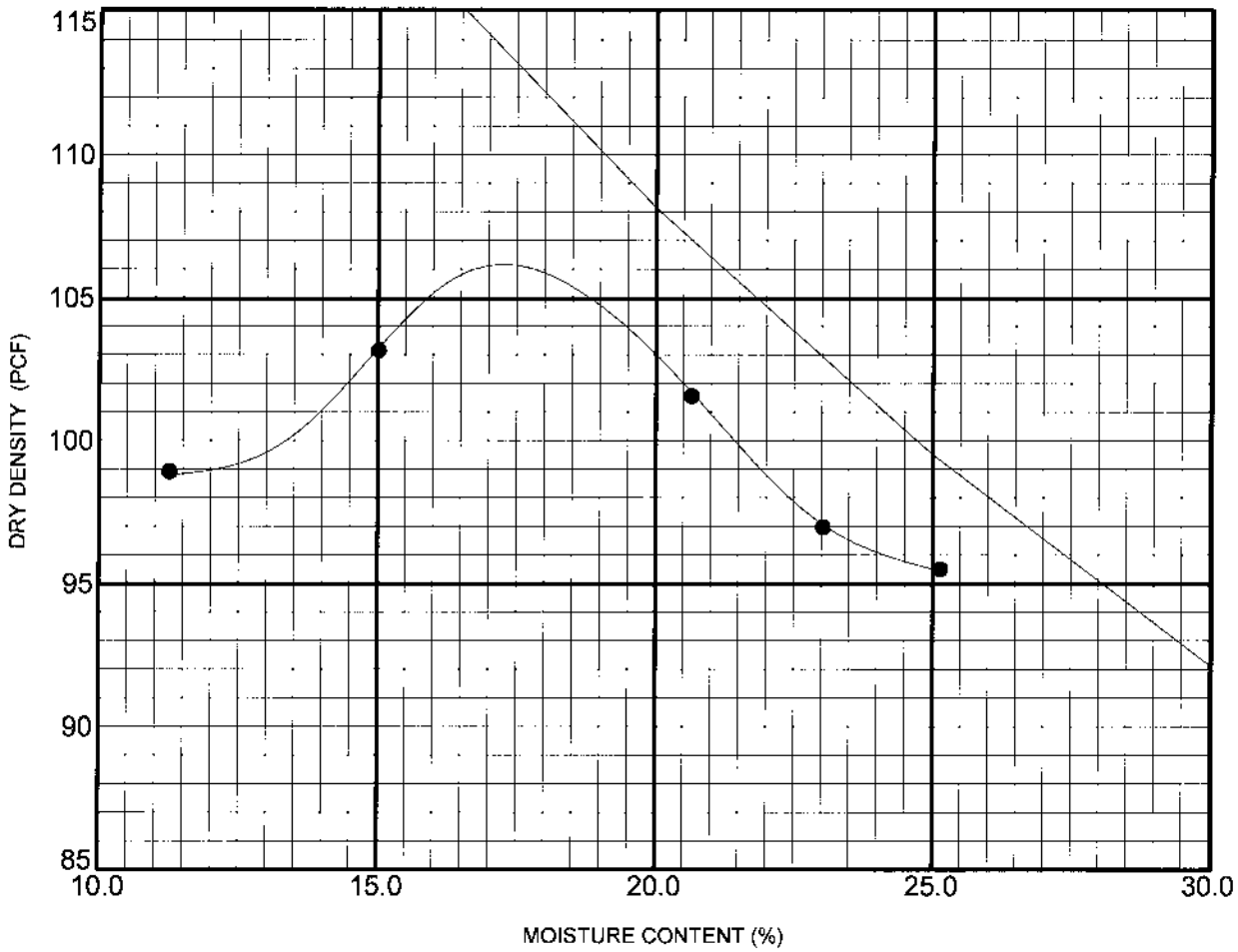
METHOD OF COMPACTION: D698A

LIQUID LIMIT: 33 PLASTIC LIMIT: 15 PLASTICITY INDEX: 18

CLASSIFICATION: CL ASTM SOIL DESCRIPTION: SANDY LEAN CLAY

MAXIMUM DRY DENSITY: 106.1 PCF

OPTIMUM MOISTURE CONTENT: 17.3%



SPEEDIE AND ASSOCIATES

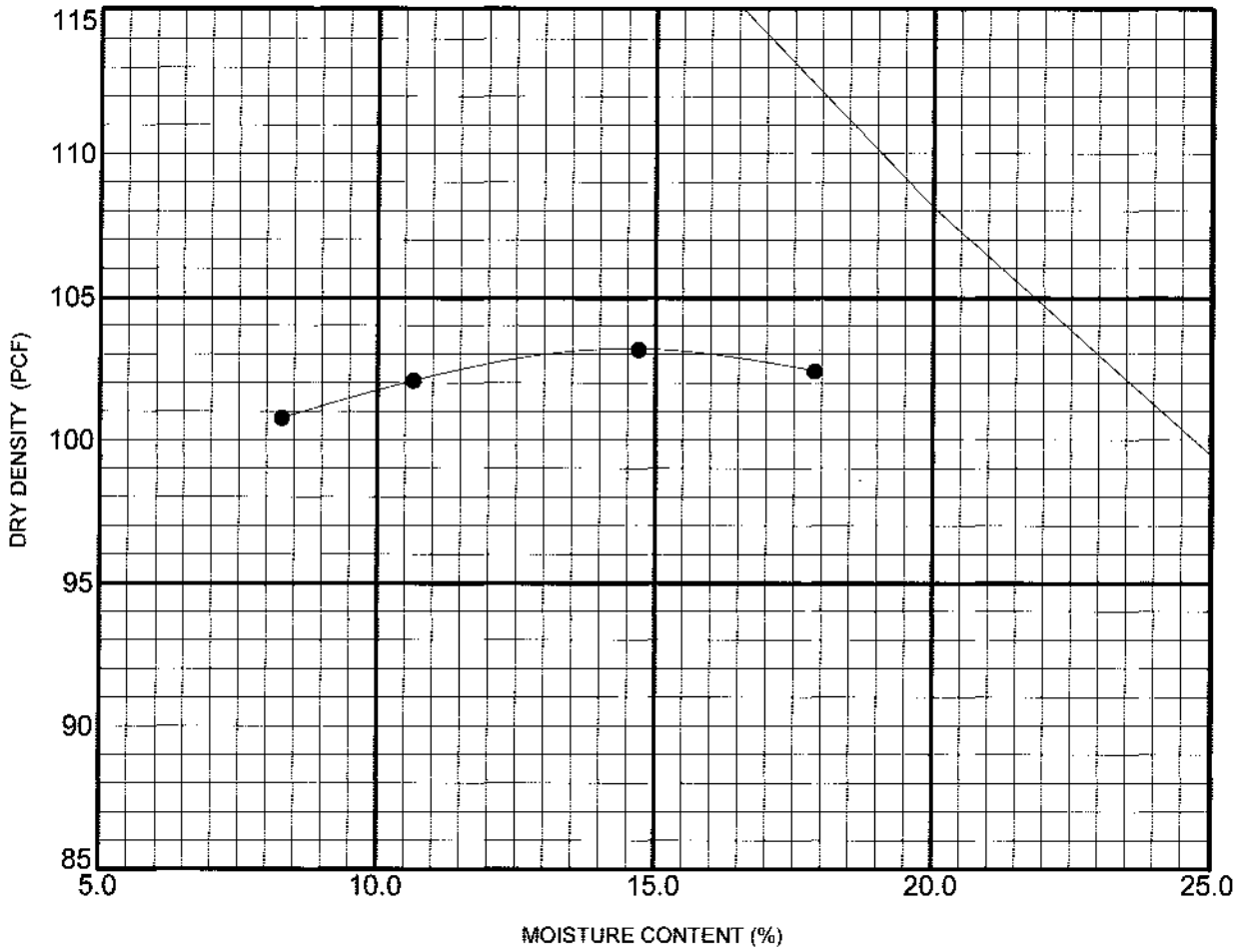
GEOTECH PROCTOR 120751TF.GPJ 7/11/12

MOISTURE-DENSITY RELATIONS

PROJECT:	Cameron Water Line		**PROJECT NO.: 120751TF**
LOCATION:	Page to Cameron		**DATE: 6/18/12**
BORING NO.: TP-52	**SAMPLE NO.: BS-1**	**SAMPLE DEPTH: 2 to 8**	**LABORATORY NO.: 373699**
METHOD OF COMPACTION:	**D698A**		
LIQUID LIMIT:	**NT**	**PLASTIC LIMIT: NT**	**PLASTICITY INDEX: NT**
CLASSIFICATION:	**SP**	**ASTM SOIL DESCRIPTION:**	**POORLY GRADED SAND**

MAXIMUM DRY DENSITY: **103.2 PCF**

OPTIMUM MOISTURE CONTENT: **14.4%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line — PROJECT NO.: 120751TF

LOCATION: Page to Cameron — DATE: 6/18/12

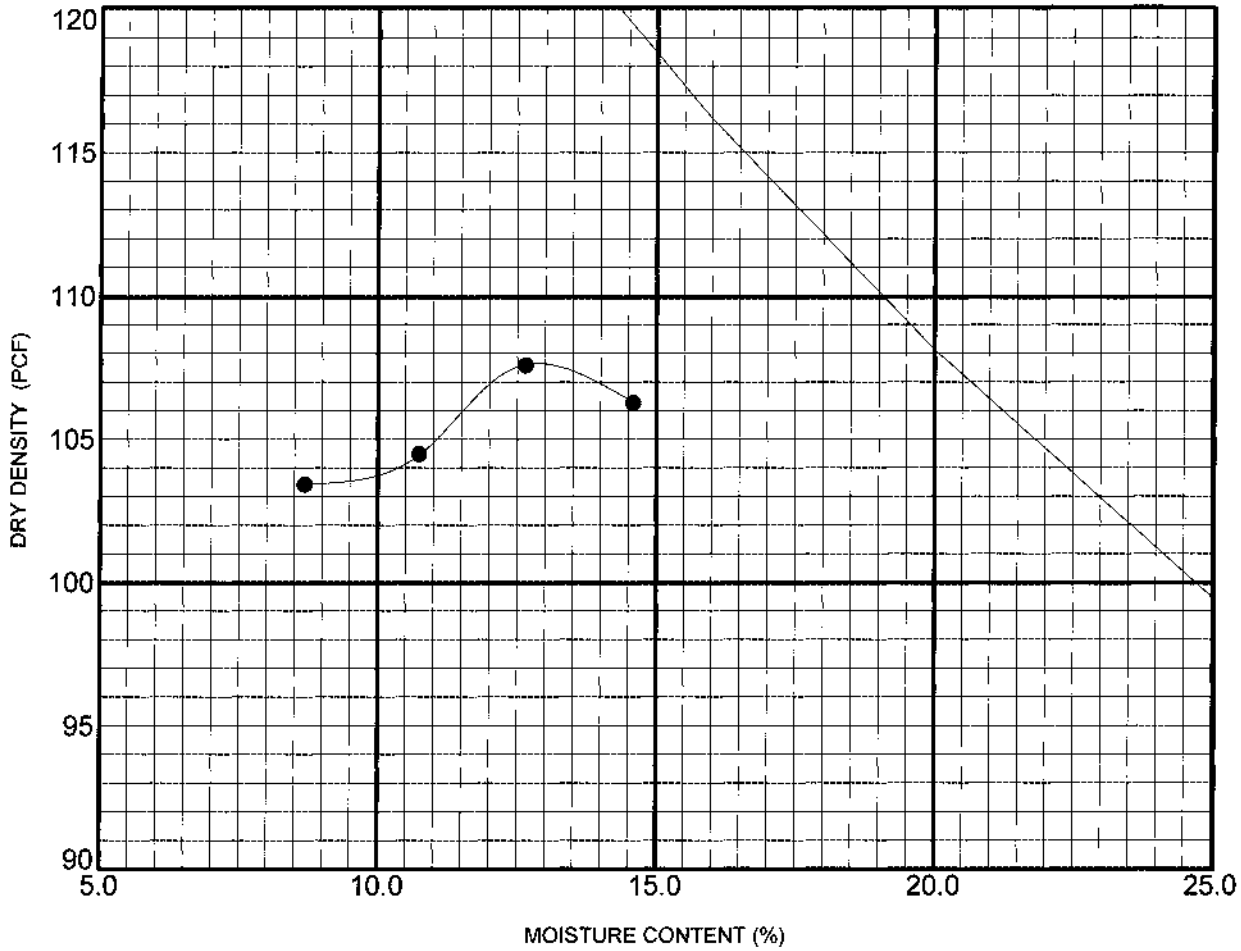
BORING NO.: TP-55 SAMPLE NO.: BS-1 SAMPLE DEPTH: 5 to 14.5 LABORATORY NO.: 373701

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT PLASTIC LIMIT: NT PLASTICITY INDEX: NT

CLASSIFICATION: SP ASTM SOIL DESCRIPTION: POORLY GRADED SAND

MAXIMUM DRY DENSITY: **107.7 PCF** OPTIMUM MOISTURE CONTENT: **12.8%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line PROJECT NO.: 120751TF

LOCATION: Page to Cameron DATE: 6/18/12

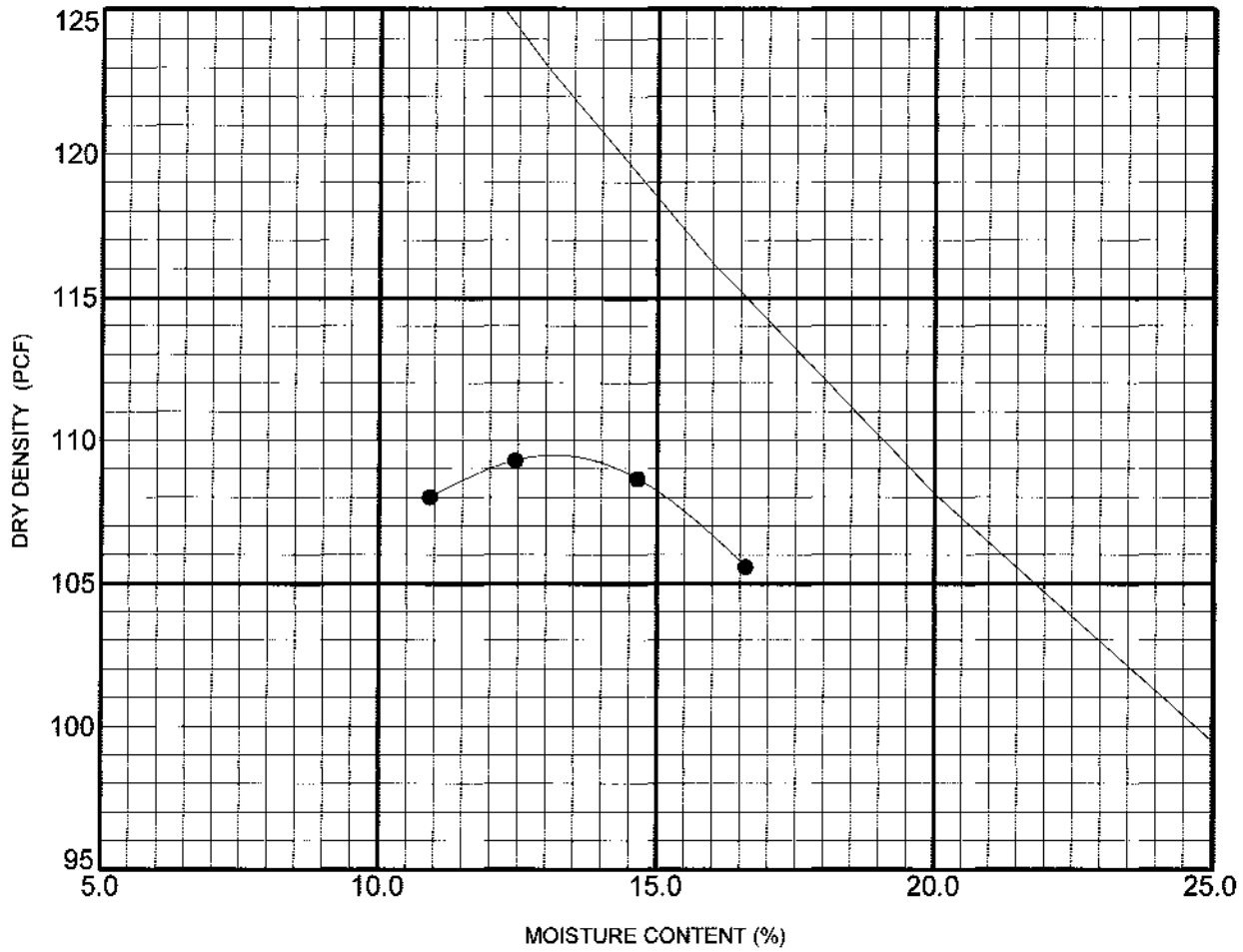
BORING NO.: TP-56 SAMPLE NO.: BS-1 SAMPLE DEPTH: 2 to 15 LABORATORY NO.: 347087

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT PLASTIC LIMIT: NT PLASTICITY INDEX: NT

CLASSIFICATION: SP-SM-SC ASTM SOIL DESCRIPTION: POORLY GRADED SAND with SILT and CLAY

MAXIMUM DRY DENSITY: 109.5 PCF OPTIMUM MOISTURE CONTENT: 13.2%



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line — PROJECT NO.: 120751TF

LOCATION: Page to Cameron — DATE: 6/19/12

BORING NO.: TP-57 SAMPLE NO.: BS-1 SAMPLE DEPTH: 0 to 10 LABORATORY NO.: 373696

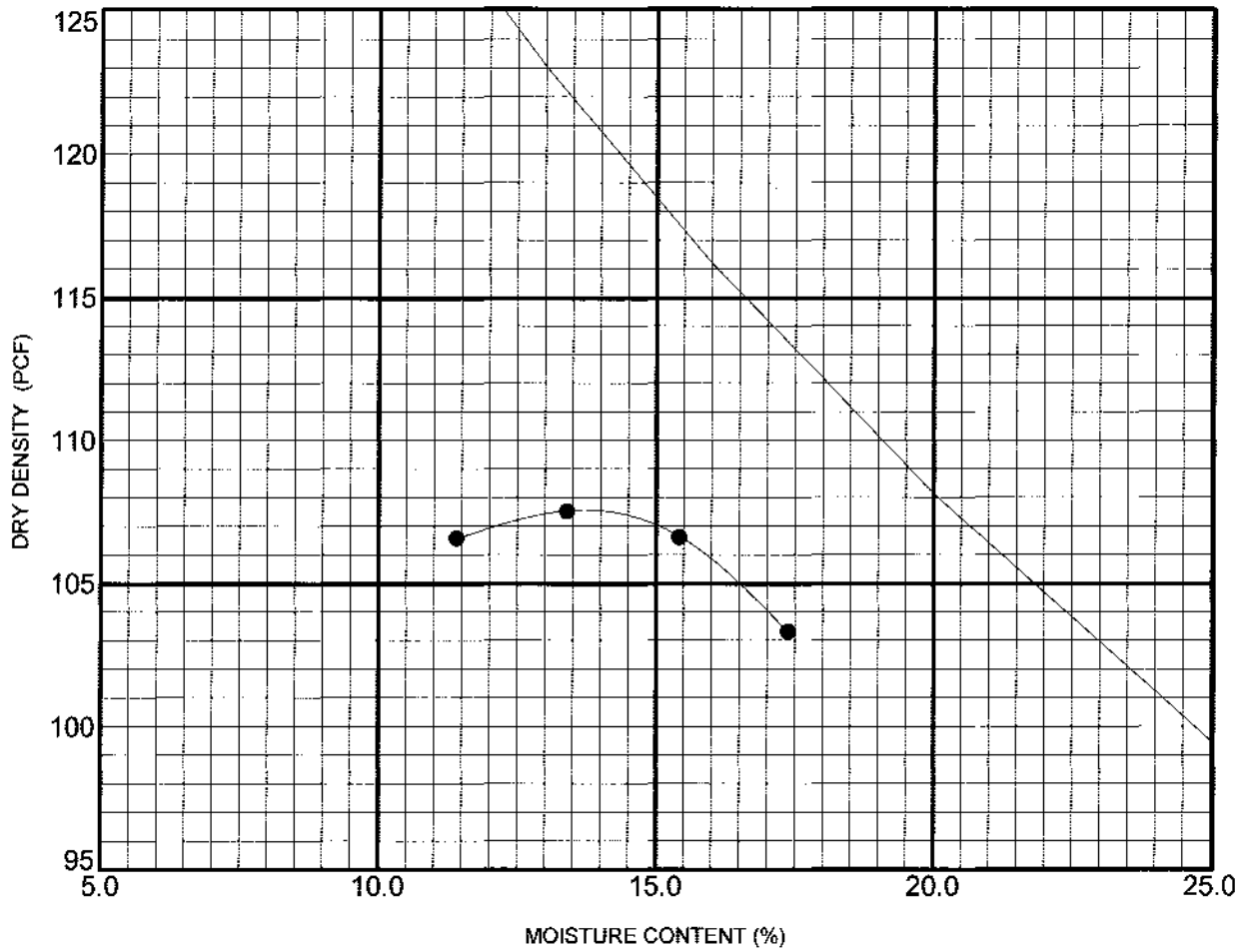
METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT PLASTIC LIMIT: NT PLASTICITY INDEX: NT

CLASSIFICATION: SP-SM-SC ASTM SOIL DESCRIPTION: POORLY GRADED SAND with SILT and CLAY

MAXIMUM DRY DENSITY: **107.5** PCF

OPTIMUM MOISTURE CONTENT: **13.7%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line — PROJECT NO.: 120751TF

LOCATION: Page to Cameron — DATE: 6/19/12

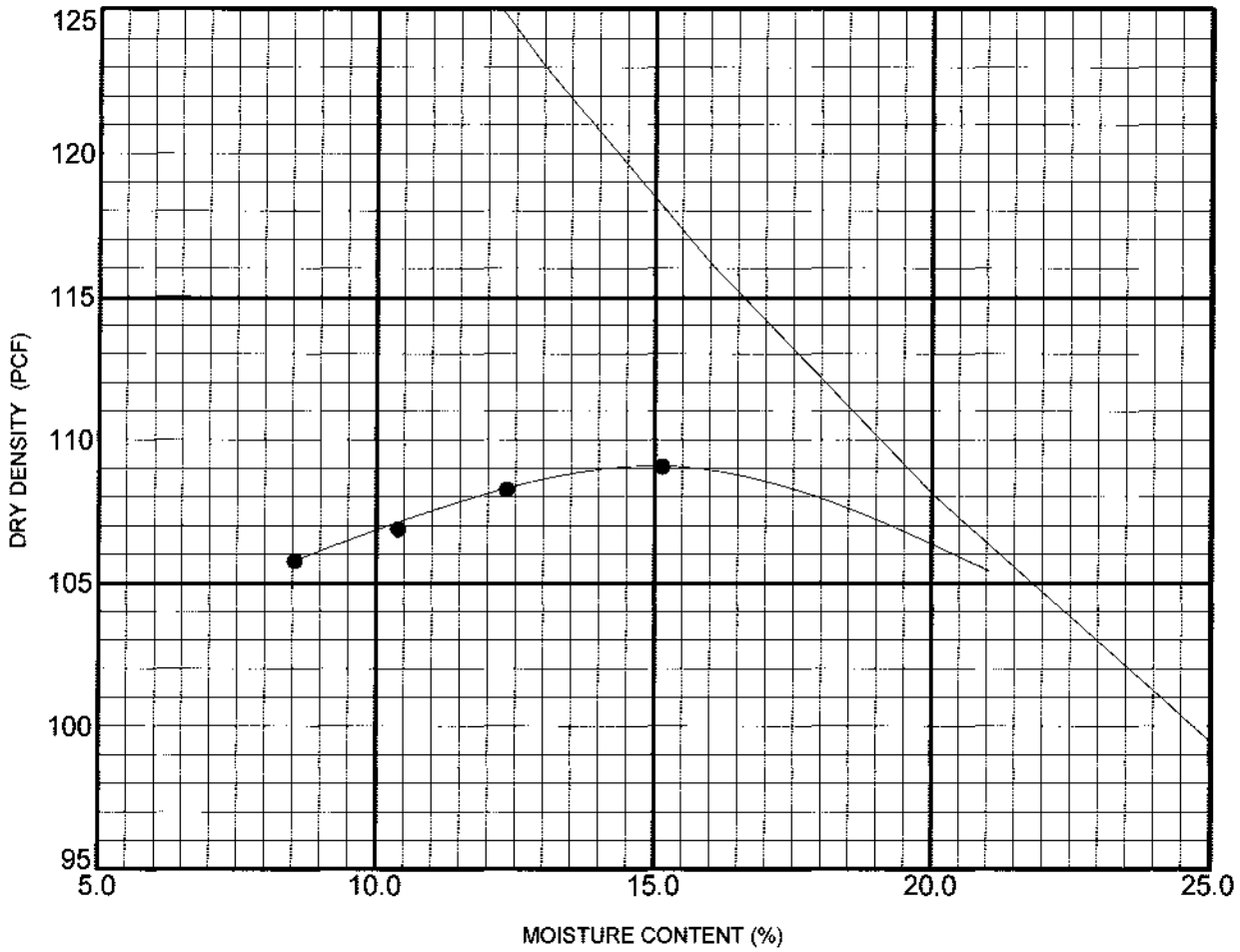
BORING NO.: TP-58 SAMPLE NO.: BS-1 SAMPLE DEPTH: 0 to 13 LABORATORY NO.: 373695

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT PLASTIC LIMIT: NT PLASTICITY INDEX: NT

CLASSIFICATION: SP ASTM SOIL DESCRIPTION: POORLY GRADED SAND

MAXIMUM DRY DENSITY: **109.1 PCF** OPTIMUM MOISTURE CONTENT: **15.1%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line PROJECT NO.: 120751TF

LOCATION: Page to Cameron DATE: 6/19/12

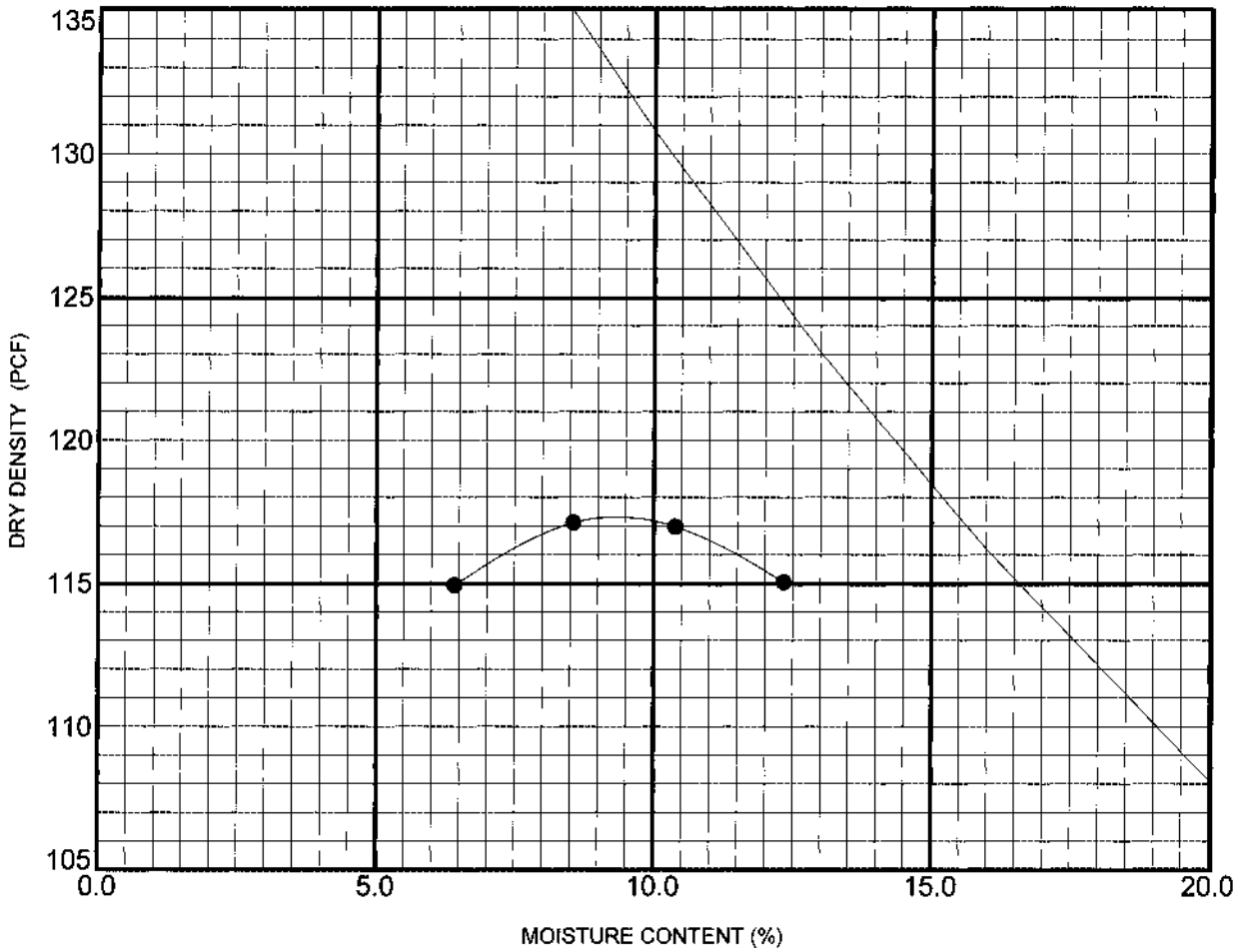
BORING NO.: TP-59 SAMPLE NO.: BS-1 SAMPLE DEPTH: 0 to 5.5 LABORATORY NO.: 373694

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT PLASTIC LIMIT: NT PLASTICITY INDEX: NT

CLASSIFICATION: SC-SM ASTM SOIL DESCRIPTION: SILTY, CLAYEY SAND

MAXIMUM DRY DENSITY: 117.3 PCF OPTIMUM MOISTURE CONTENT: 9.3%



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line — PROJECT NO.: 120751TF

LOCATION: Page to Cameron — DATE: 6/19/12

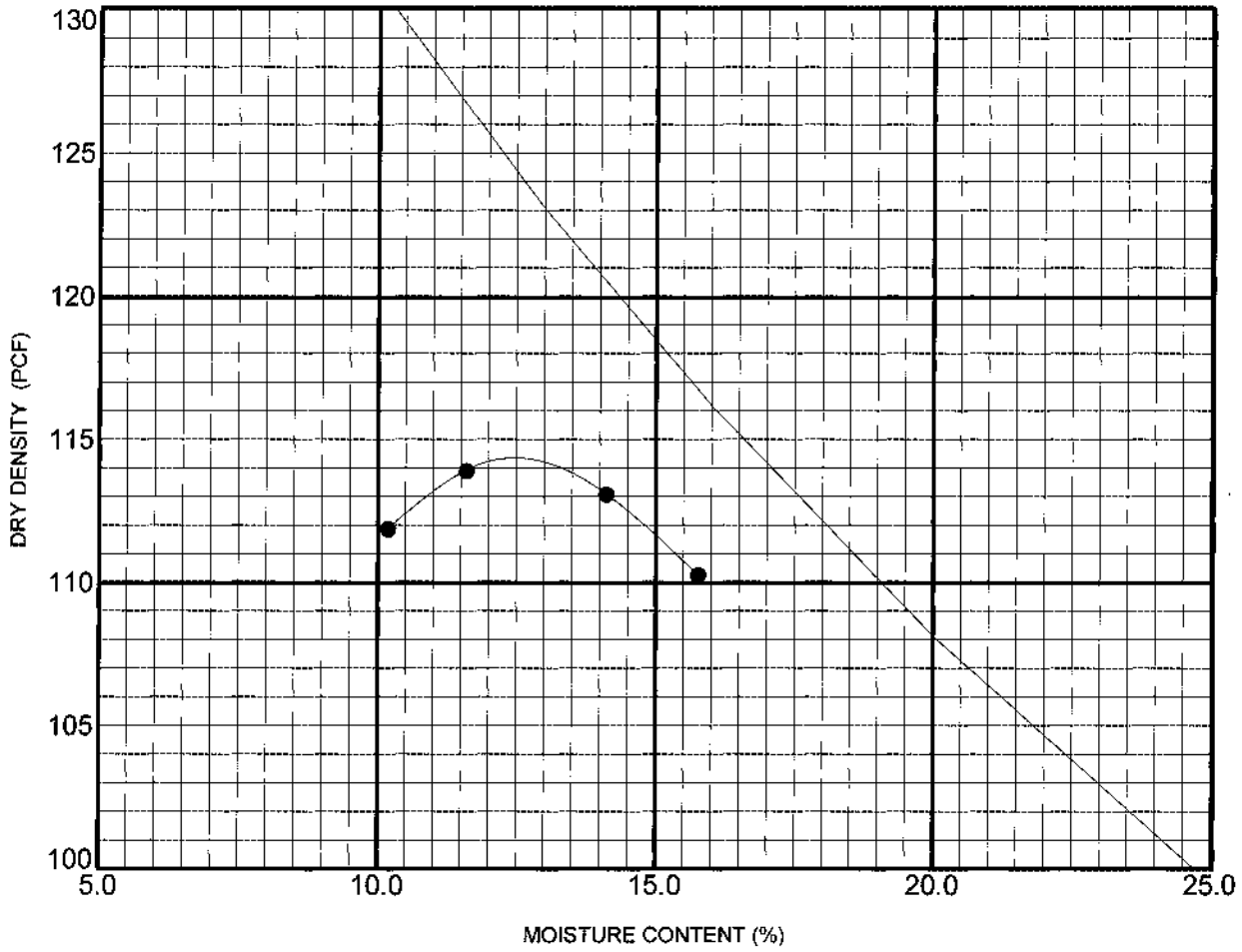
BORING NO.: TP-60 SAMPLE NO.: BS-1 SAMPLE DEPTH: 0 to 6.5 LABORATORY NO.: 373693

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT PLASTIC LIMIT: NT PLASTICITY INDEX: NT

CLASSIFICATION: SP ASTM SOIL DESCRIPTION: POORLY GRADED SAND

MAXIMUM DRY DENSITY: 114.3 PCF OPTIMUM MOISTURE CONTENT: 12.4%



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line — PROJECT NO.: 120751TF

LOCATION: Page to Cameron — DATE: 6/19/12

BORING NO.: TP-61 SAMPLE NO.: BS-1 SAMPLE DEPTH: 0 to 3.5 LABORATORY NO.: 373692

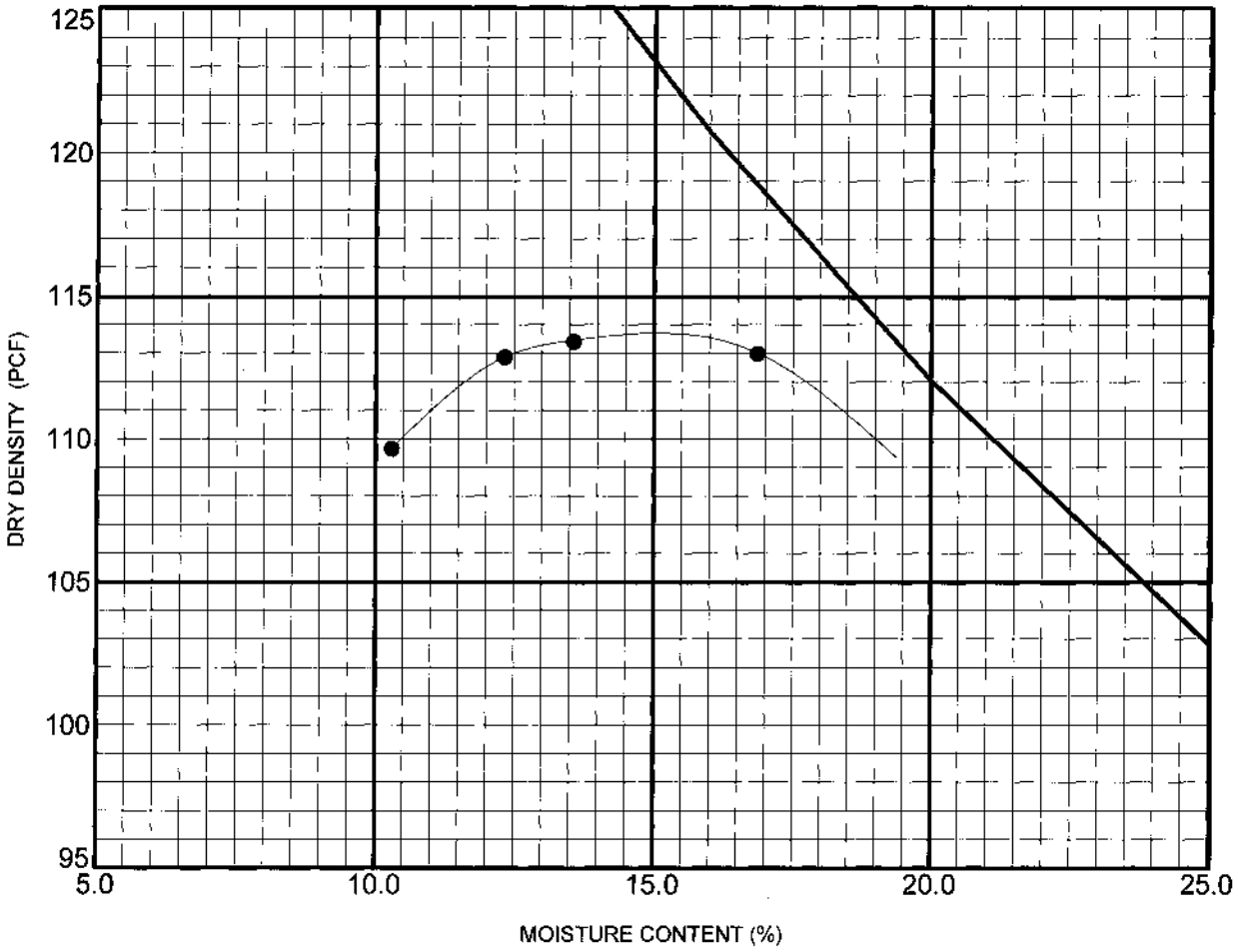
METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT PLASTIC LIMIT: NT PLASTICITY INDEX: NT

CLASSIFICATION: SP-SM-SC ASTM SOIL DESCRIPTION: POORLY GRADED SAND with SILT and CLAY

MAXIMUM DRY DENSITY: 113.8 PCF

OPTIMUM MOISTURE CONTENT: 15.1%



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line — PROJECT NO.: 120751TF

LOCATION: Page to Cameron — DATE: 6/19/12

BORING NO.: TP-62 SAMPLE NO.: BS-1 SAMPLE DEPTH: 0 to 5.5 LABORATORY NO.: 373691

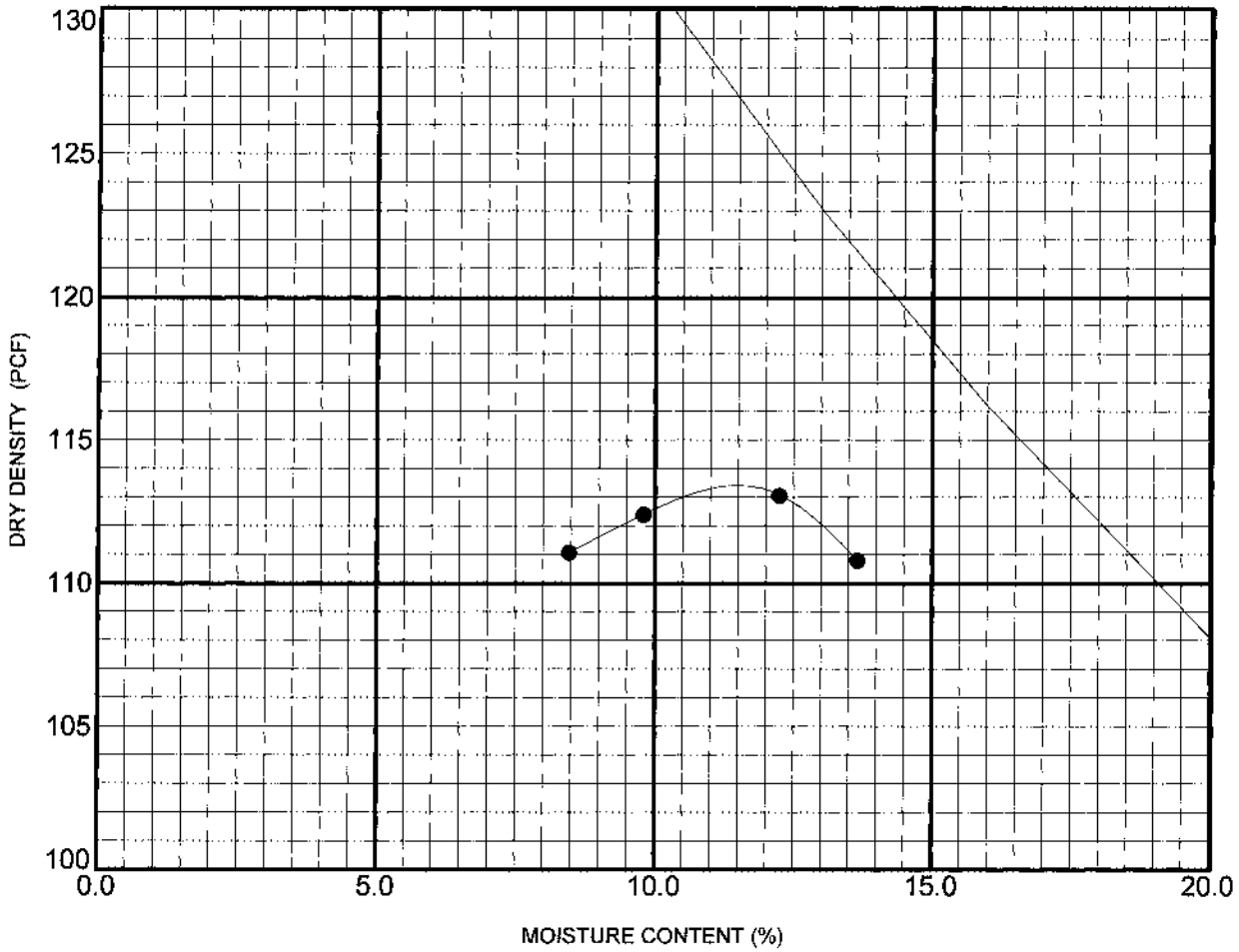
METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT PLASTIC LIMIT: NT PLASTICITY INDEX: NT

CLASSIFICATION: SP-SM-SC ASTM SOIL DESCRIPTION: POORLY GRADED SAND with SILT and CLAY

MAXIMUM DRY DENSITY: 113.4 PCF

OPTIMUM MOISTURE CONTENT: 11.5%



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.:** 120751TF

LOCATION: Page to Cameron **DATE:** 6/19/12

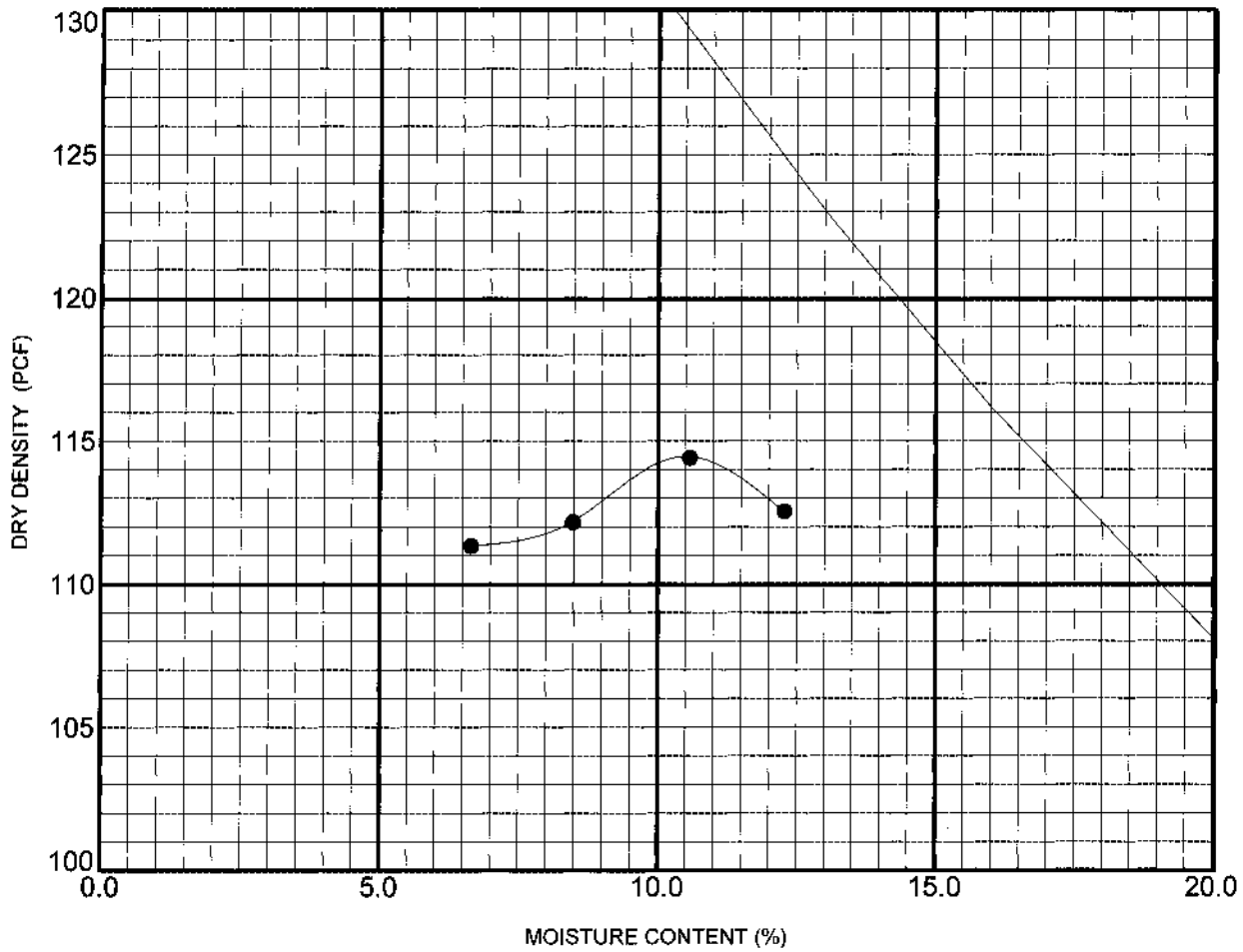
BORING NO.: TP-63 **SAMPLE NO.:** BS-1 **SAMPLE DEPTH:** 0 to 5 **LABORATORY NO.:** 373690

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT **PLASTIC LIMIT:** NT **PLASTICITY INDEX:** NT

CLASSIFICATION: SP-SM-SC **ASTM SOIL DESCRIPTION:** POORLY GRADED SAND with SILT and CLAY

MAXIMUM DRY DENSITY: **114.4 PCF** OPTIMUM MOISTURE CONTENT: **10.6%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line — PROJECT NO.: 120751TF

LOCATION: Page to Cameron — DATE: 6/18/12

BORING NO.: TP-67 SAMPLE NO.: BS-1 SAMPLE DEPTH: 0 to 7 — LABORATORY NO.: 373702

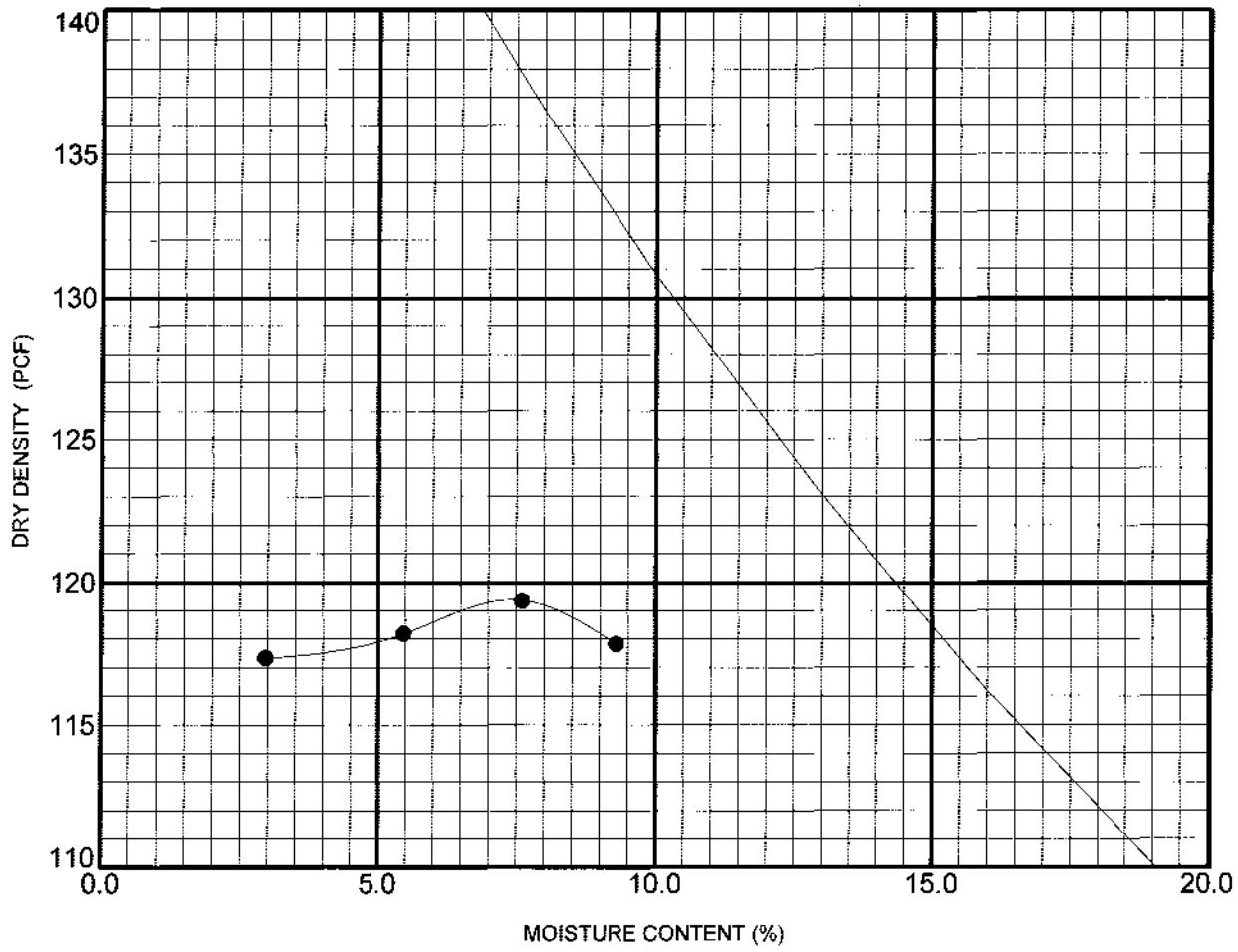
METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT PLASTIC LIMIT: NT PLASTICITY INDEX: NT

CLASSIFICATION: SP-SM-SC ASTM SOIL DESCRIPTION: POORLY GRADED SAND with SILT and CLAY

MAXIMUM DRY DENSITY: 119.4 PCF

OPTIMUM MOISTURE CONTENT: 7.4%



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/11/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line PROJECT NO.: 120751TF

LOCATION: Page to Cameron DATE: 6/18/12

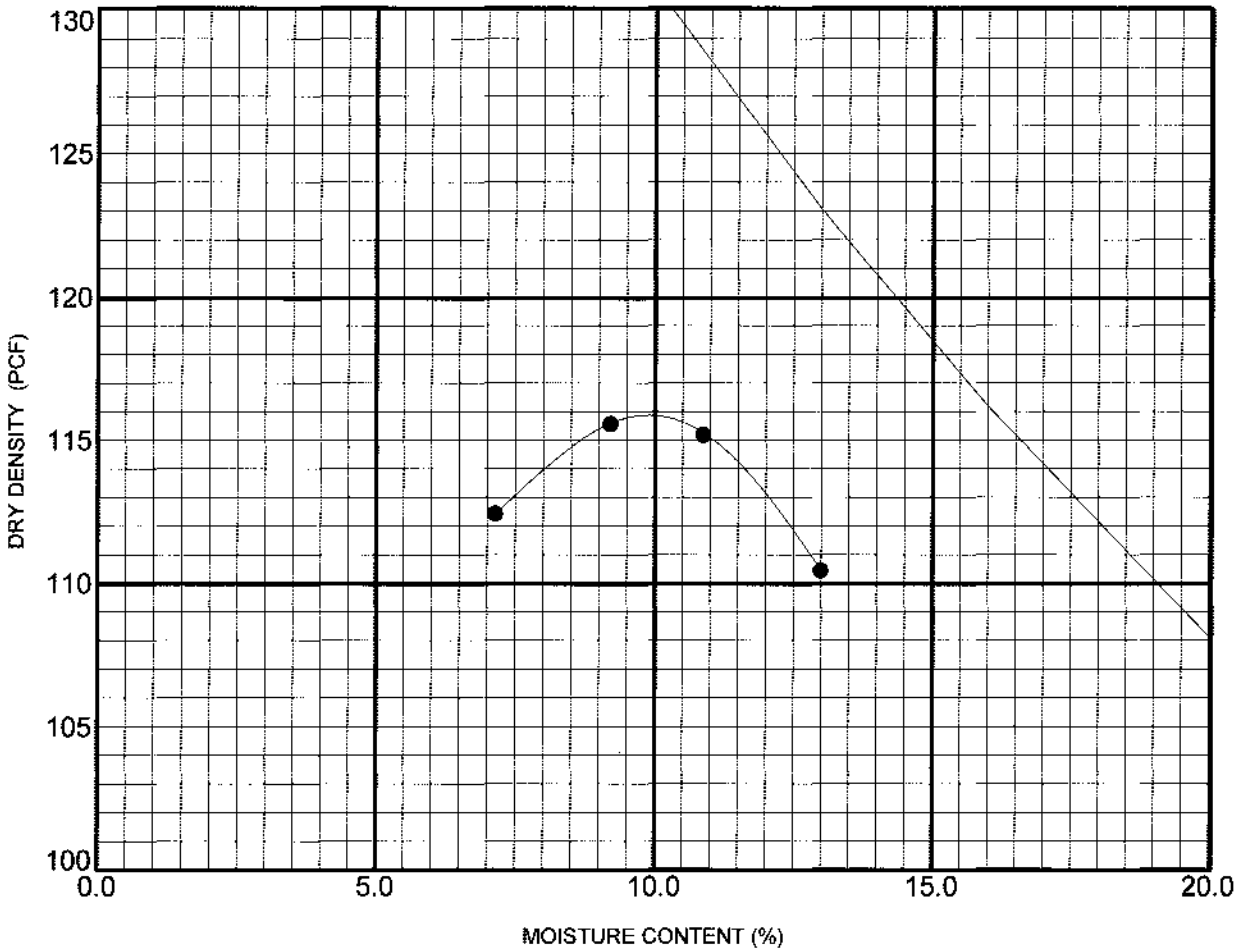
BORING NO.: TP-68 SAMPLE NO.: BS-1 SAMPLE DEPTH: 0 to 3.3 LABORATORY NO.: 373700

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT PLASTIC LIMIT: NT PLASTICITY INDEX: NT

CLASSIFICATION: SP-SM-SC ASTM SOIL DESCRIPTION: POORLY GRADED SAND with SILT and CLAY

MAXIMUM DRY DENSITY: 115.9 PCF OPTIMUM MOISTURE CONTENT: 9.8%



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

SPEEDIE AND ASSOCIATES
Geotechnical ▪ Environmental ▪ Materials Engineers
4025 E. HUNTINGTON DR., STE.140, FLAGSTAFF, AZ 86004 ▪ O: 928-526-6681 F: 928-526-6695

S&A PROJECT NO. 120751TF

CLIENT PROJECT NO.

SHEET 1 of 1

DAILY FIELD REPORT

PROJECT:	Cameron Water Line	**DATE:**	June 5, 2012
LOCATION:	Hwy 89, Page to Cameron Cameron, AZ	**WEATHER CONDITIONS:**	Clear/Windy
CLIENT:	Apache Underground & Excavating	**REPRESENTATIVE:**	Mark Gardner
CONTRACTOR:	Apache Underground & Excavating	**REPRESENTATIVE:**	James Gillespie

Summary for: A. Arp-Romero **Number of Trips:** 1

- ☐ Soil Density Testing
- ☐ AC Density Testing
- ☐ Concrete Testing
- ☐ Pick Up Concrete
- ☒ Pick Up Soil Sample
- ☒ Other: Test Pit Obs./Sampling 7.0

Progress of Work:

The writer arrived on site at request of the client to obtain samples from test pits. The contractor excavated test pits 44, 45, 46, 47 and 48 today. Bulk samples from each test pit were obtained and transported to Speedie and Associates laboratory for testing. Refer to the Tabulation of Test Data and Physical Properties of Soils and Aggregates Reports for testing results. In addition, the writer met with the project geologist throughout the day and discussed the testing to be performed. Field density testing is scheduled to be performed on selected test pits on June 6th.

SPEEDIE AND ASSOCIATES
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S&A PROJECT NO. 120751TF

CLIENT PROJECT NO.

SHEET 1 of 1

DAILY FIELD REPORT

PROJECT:	Cameron Water Line	**DATE:**	June 6, 2012
LOCATION:	Hwy 89, Page to Cameron Cameron, AZ	**WEATHER CONDITIONS:**	Clear/Windy
CLIENT:	Apache Underground & Excavating	**REPRESENTATIVE:**	Mark Gardner
CONTRACTOR:	Apache Underground & Excavating	**REPRESENTATIVE:**	James Gillespie

Summary for: A. Arp-Romero **Number of Trips:** 1

☒	Soil Density Testing	☐	Concrete Testing	☒	Pick Up Soil Sample
☐	AC Density Testing	☐	Pick Up Concrete	9.0 ☒	Other: Test Pit Obs./Sampling

Progress of Work:

The writer arrived on site at request of the client to obtain samples from test pits and to perform field density testing. The contractor excavated test pits 37, 38, 39, 40, 41, 42, and 43 today. Bulk samples from each test pit were obtained and transported to Speedie and Associates laboratory for testing. Refer to the Tabulation of Test Data and Physical Properties of Soils and Aggregates Reports for testing results. While on site, the writer performed field density testing at test pits 37, 40, and 42. Density testing was performed by the sand cone method and nuclear guage method. Refer to Sand Cone Field Density Test Daily Report and Field Density Test Daily Report for test results.

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S&A PROJECT NO. 120751TF

CLIENT PROJECT NO.

SHEET 1 of 1

DAILY FIELD REPORT

PROJECT:	Cameron Water Line	**DATE:**	June 12, 2012
LOCATION:	Hwy 89, Page to Cameron Cameron, AZ	**WEATHER CONDITIONS:**	Clear/Windy
CLIENT:	Apache Underground & Excavating	**REPRESENTATIVE:**	Mark Gardner
CONTRACTOR:	Apache Underground & Excavating	**REPRESENTATIVE:**	James Gillespie

Summary for: A. Griffiths **Number of Trips:** 1

5.0	☒	Soil Density Testing	☐	Concrete Testing		☒	Pick Up Soil Sample
	☐	AC Density Testing	☐	Pick Up Concrete	4.5	☒	Other: Test Pit Obs./Sampling

Progress of Work:

The writer arrived on site at request of the client to obtain samples from test pits and to perform field density testing. The contractor excavated test pits 35, 33, 31, 29A, and 24 today. Bulk samples from each test pit were obtained and transported to Speedie and Associates laboratory for testing. Refer to the Tabulation of Test Data and Physical Properties of Soils and Aggregates Reports for testing results. While on site, the writer performed field density testing at test pits 35, 31, 29A, and 24 by the sand cone method. Refer to Sand Cone Field Density Test Daily Report for specific testing locations and results.

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S&A PROJECT NO. 120751TF

CLIENT PROJECT NO.

SHEET 1 of 1

DAILY FIELD REPORT

PROJECT:	Cameron Water Line	**DATE:**	June 13, 2012
LOCATION:	Hwy 89, Page to Cameron Cameron, AZ	**WEATHER CONDITIONS:**	Clear/Windy
CLIENT:	Apache Underground & Excavating	**REPRESENTATIVE:**	Mark Gardner
CONTRACTOR:	Apache Underground & Excavating	**REPRESENTATIVE:**	James Gillespie

Summary for: A. Griffiths **Number of Trips:** 1

6.0	☒	Soil Density Testing	☐	Concrete Testing		☒	Pick Up Soil Sample
	☐	AC Density Testing	☐	Pick Up Concrete	5.5	☒	Other: Test Pit Obs./Sampling

Progress of Work:

The writer arrived on site at request of the client to obtain samples from test pits and to perform field density testing. The contractor excavated test pits 23, 22, 21, 20, 19, 11, and 9 today. Bulk samples from each test pit were obtained and transported to Speedie and Associates laboratory for testing. Refer to the Tabulation of Test Data and Physical Properties of Soils and Aggregates Reports for testing results. While on site, the writer performed field density testing at test pits 23, 22, 21, 20, and 11 by the sand cone method. Refer to Sand Cone Field Density Test Daily Report for specific testing locations and results.

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S&A PROJECT NO. 120751TF

CLIENT PROJECT NO.

SHEET 1 of 1

DAILY FIELD REPORT

PROJECT:	Cameron Water Line	**DATE:**	June 14, 2012
LOCATION:	Hwy 89, Page to Cameron Cameron, AZ	**WEATHER CONDITIONS:**	Clear/Windy
CLIENT:	Apache Underground & Excavating	**REPRESENTATIVE:**	Mark Gardner
CONTRACTOR:	Apache Underground & Excavating	**REPRESENTATIVE:**	James Gillespie

Summary for: A. Griffiths **Number of Trips:** 1

3.0	☒ Soil Density Testing	☐ Concrete Testing		☒ Pick Up Soil Sample	
	☐ AC Density Testing	☐ Pick Up Concrete	7.5	☒ Other: Test Pit Obs./Sampling	

Progress of Work:

The writer arrived on site at request of the client to obtain samples from test pits and to perform field density testing. The contractor excavated test pits 4, 3, 2, 1, 5, 6, and 7 today. Bulk samples from each test pit were obtained and transported to Speedie and Associates laboratory for testing. Refer to the Tabulation of Test Data and Physical Properties of Soils and Aggregates Reports for testing results. While on site, the writer performed field density testing at test pits 4, 2, and 7 by the sand cone method. Refer to Sand Cone Field Density Test Daily Report for specific testing locations and results.

SPEEDIE AND ASSOCIATES
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S&A PROJECT NO. 120751TF

CLIENT PROJECT NO.

SHEET 1 of 1

DAILY FIELD REPORT

PROJECT:	Cameron Water Line	**DATE:**	June 19, 2012
LOCATION:	Hwy 89, Page to Cameron Cameron, AZ	**WEATHER CONDITIONS:**	Clear/Windy
CLIENT:	Apache Underground & Excavating	**REPRESENTATIVE:**	Mark Gardner
CONTRACTOR:	Apache Underground & Excavating	**REPRESENTATIVE:**	James Gillespie

Summary for: A. Griffiths **Number of Trips:** 1

3.5	☒ Soil Density Testing	☐ Concrete Testing	☒ Pick Up Soil Sample		
	☐ AC Density Testing	☐ Pick Up Concrete	8.0	☒ Other: Test Pit Obs./Sampling	

Progress of Work:

The writer arrived on site at request of the client to obtain samples from test pits and to perform field density testing. The contractor excavated test pits 57, 58, 59, 60, 61, 62, and 63 today. Bulk samples were obtained from each test pit. The writer also retrieved samples obtained by the contractor from excavations performed the previous day at test pits 49, 50, 51, 52, 55, 67, and 68. All samples were transported tot eh Speedie & Associates laboratory in Flagstaff for testing. Refer to the Tabulation of Test Data report and Physical Properties of Soils and Aggregates Reports for testing results.

While on site, the writer performed field density testing at test pits 58, 62, and 63 by the sand cone method. Refer to Sand Cone Field Density Test Daily Report for specific testing locations and results.

CORROSIVE TEST DATA

SOIL BORING or TEST PIT NUMBER	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE INTERVAL (ft)	PERCENT FINER #200 SIEVE	pH	RESISTIVITY (Ohm-Centimeters)	SULFATE (SO4) (ppm)	CHLORIDE (CL) (ppm)	REDOX (millivolts)	SULFIDE (ppm)	UNIFIED SOIL CLASSIFICATION	SPECIMEN DESCRIPTION
TP-01	BS-1	BULK	0.0 - 8.0	14.5	8.82	6217.6	14	17	NT	2	SC-SM	SILTY, CLAYEY SAND
TP-02	BS-1	BULK	0.0 - 12.0	36.9	8.48	473.3	1400	120	NT	<1	SM	SILTY SAND with GRAVEL
TP-03	BS-1	BULK	4.0 - 13.0	8.5	9	3712	25	62	NT	<1	SP-SM-SC	POORLY GRADED SAND with SILT, CLAY, and GRAVEL
TP-04	BS-1	BULK	4.0 - 13.0	14.6	8.1	482.6	530	170	NT	<1	GC-GM	SILTY, CLAYEY GRAVEL with SAND
TP-05	BS-1	BULK	2.0 - 12.0	72.1	8.45	1020.8	30	92	NT	<1	CL	LEAN CLAY with SAND
TP-06	BS-1	BULK	4.0 - 10.4	14.7	8.88	2784	34	24	NT	3	SC-SM	SILTY, CLAYEY SAND
TP-07	BS-1	BULK	0.0 - 14.0	42.3	8.68	1020.8	160	100	NT	2	SC-SM	SILTY, CLAYEY SAND
TP-08	BS-1	BULK	2.0 - 7.0	37.0	8.7	1856	110	55	NT	6	SC	CLAYEY SAND with GRAVEL
TP-09	BS-1	BULK	6.0 - 10.0	27.9	8.22	658.9	1500	160	NT	<1	SC-SM	SILTY, CLAYEY SAND with GRAVEL
TP-10	BS-1	BULK	0.0 - 9.0	30.2	8.48	2041.6	400	140	NT	<1	SC-SM	SILTY, CLAYEY SAND with GRAVEL
TP-11	BS-1	BULK	0.0 - 6.0	38.5	7.26	853.8	1700	72	NT	<1	SC	CLAYEY SAND with GRAVEL
TP-12	BS-1	BULK	3.8 - 11.5	30.2	7.66	1856	51	57	NT	<1	SC	CLAYEY SAND
TP-13	BS-1	BULK	0.0 - 4.5	38.6	8.5	1948.8	22	60	NT	2	SC-SM	SILTY, CLAYEY SAND
TP-14	BS-1	BULK	0.0 - 10.0	15.3	8.32	1948.8	18	24	NT	2	SM	SILTY SAND
TP-15	BS-1	BULK	0.0 - 5.5	23.4	8.8	2041.6	30	23	NT	<1	SC-SM	SILTY, CLAYEY SAND

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SPEEDIE AND ASSOCIATES

TABOFLAB REDOX-SULFIDE 120751TF.GPJ GENGEO.GDT 7/18/12

CORROSIVE TEST DATA

SOIL BORING or TEST PIT NUMBER	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE INTERVAL (ft)	PERCENT FINER #200 SIEVE	pH	RESISTIVITY (Ohm-Centimeters)	SULFATE (SO4) (ppm)	CHLORIDE (CL) (ppm)	REDOX (millivolts)	SULFIDE (ppm)	UNIFIED SOIL CLASSIFICATION	SPECIMEN DESCRIPTION
TP-16	BS-1	BULK	0.0 - 3.5	51.5	8.48	2227.2	11	22	NT	4	CL	CLAYSTONE (SANDY LEAN CLAY)
TP-18	BS-1	BULK	2.5 - 9.0	94.2	7.25	751.7	73	74	NT	3	CL	CLAYSTONE (LEAN CLAY)
TP-19	BS-1	BULK	0.0 - 8.0	18.7	8.54	928	210	420	NT	2	SC	CLAYEY SAND with GRAVEL
TP-20	BS-1	BULK	0.0 - 8.5	28.0	8.41	1856	29	66	NT	<1	SC-SM	SILTY, CLAYEY SAND
TP-21	BS-1	BULK	3.0 - 5.0	4.6	9.7	3526.4	96	67	NT	3	SW-SM-SC	WELL-GRADED SAND with SILT, CLAY, and GRAVEL
TP-21	BS-2	BULK	8.0 - 15.0	68.1	8.83	2876.8	14	46	NT	<1	CL	(CLAYSTONE) SANDY LEAN CLAY
TP-22	BS-1	BULK	6.0 - 14.0	11.7	10.16	779.5	NT	NT	NT	NT	SW-SM-SC	WELL-GRADED SAND with SILT, CLAY, and GRAVEL
TP-23	BS-1	BULK	0.0 - 6.0	30.7	9.29	2227.2	22	26	NT	2	SM	SILTY SAND
TP-23	BS-2	BULK	6.0 - 8.0	17.6	9.83	1948.8	12	17	NT	3	SC	CLAYEY SAND with GRAVEL
TP-24	BS-1	BULK	5.0 - 15.0	6.6	9.11	1577.6	80	34	NT	2	SP-SM-SC	POORLY GRADED SAND with SILT, CLAY, and GRAVEL
TP-25	BS-1	BULK	8.0 - 12.0	19.3	7.31	4640	7	17	NT	<1	SM	SILTY SAND
TP-26	BS-1	BULK	3.5 - 10.5	12.2	8.8	1577.6	7	22	NT	5	SC-SM	SILTY, CLAYEY SAND
TP-27	BS-1	BULK	0.0 - 5.0	10.2	9.7	2041.6	33	33	NT	<1	SP-SM-SC	POORLY GRADED SAND with SILT and CLAY
TP-28	BS-1	BULK	0.0 - 14.0	14.6	8.71	510.4	28	28	NT	2	SC-SM	SILTY, CLAYEY SAND with GRAVEL
TP-29	BS-1	BULK	0.5 - 10.0	73.0	8.85	2969.6	210	2400	NT	<1	CL	CLAYSTONE (LEAN CLAY with SAND)

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SPEEDIE AND ASSOCIATES

TABOFLAB REDOX-SULFIDE 120751TF.GPJ GENGEO.GDT 7/18/12

CORROSIVE TEST DATA

SOIL BORING or TEST PIT NUMBER	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE INTERVAL (ft)	PERCENT FINER #200 SIEVE	pH	RESISTIVITY (Ohm-Centimeters)	SULFATE (SO4) (ppm)	CHLORIDE (CL) (ppm)	REDOX (millivolts)	SULFIDE (ppm)	UNIFIED SOIL CLASSIFICATION	SPECIMEN DESCRIPTION
TP-30	BS-1	BULK	2.0 - 14.0	78.3	7.84	408.3	86	180	NT	<1	CL	LEAN CLAY with SAND
TP-31	BS-1	BULK	0.0 - 3.0	29.0	8.9	371.2	1800	268	NT	4	SC	CLAYEY SAND
TP-32	BS-1	BULK	0.0 - 14.0	13.1	8.91	1670.4	NT	NT	NT	NT	SC-SM	SILTY, CLAYEY SAND with GRAVEL
TP-33	BS-1	BULK	0.0 - 2.0	22.9	8.91	1020.8	180	49	NT	6	SC-SM	SILTY, CLAYEY SAND
TP-34	BS-1	BULK	1.5 - 13.0	76.1	7.4	436.2	3500	53	NT	<1	CL	CLAYSTONE (LEAN CLAY with SAND)
TP-35	BS-1	BULK	0.0 - 4.5	34.6	8.86	779.5	450	17	NT	6	SC	CLAYEY SAND
TP-36	BS-1	BULK	7.0 - 13.5	28.1	8.48	742.4	2100	37	NT	<1	SC	CLAYEY SAND
TP-37	BS-1	BULK	1.0 - 4.5	22.8	8	742.4	1300	28	NT	<1	SM	SILTY SAND
TP-38	BS-1	BULK	1.0 - 4.0	27.8	7.73	1484.8	2100	240	NT	2	SM	SILTY SAND
TP-39	BS-1	BULK	0.0 - 3.5	25.4	7.89	194.9	450	260	NT	<1	SC	CLAYEY SAND
TP-40	BS-1	BULK	0.0 - 5.0	70.8	8.85	436.2	3800	2300	NT	<1	CH	FAT CLAY with SAND
TP-41	BS-1	BULK	3.0 - 8.0	90.8	7.09	751.7	3900	720	NT	<1	CH	CLAYSTONE (FAT CLAY)
TP-42	BS-1	BULK	7.0 - 14.5	47.0	9.11	1392	36	38	NT	9	SC	CLAYEY SAND
TP-43	BS-1	BULK	0.0 - 6.0	41.6	8.95	566.1	97	200	NT	2	SC-SM	SILTY, CLAYEY SAND
TP-44	BS-1	BULK	0.8 - 8.5	41.5	9.44	742.4	110	700	NT	2	SC-SM	SILTY, CLAYEY SAND
TP-45	BS-1	BULK	0.0 - 14.0	71.7	8.22	306.2	75	450	NT	3	CL	CLAYSTONE (LEAN CLAY with SAND)

Cameron Water Line
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SPEEDIE AND ASSOCIATES

TABOFLAB REDOX-SULFIDE 120751TF.GPJ GENGEO.GDT 7/18/12

CORROSIVE TEST DATA

SOIL BORING or TEST PIT NUMBER	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE INTERVAL (ft)	PERCENT FINER #200 SIEVE	pH	RESISTIVITY (Ohm-Centimeters)	SULFATE (SO4) (ppm)	CHLORIDE (CL) (ppm)	REDOX (millivolts)	SULFIDE (ppm)	UNIFIED SOIL CLASSIFICATION	SPECIMEN DESCRIPTION
TP-46	BS-1	BULK	0.0 - 8.0	53.9	8.35	807.4	1500	620	NT	<1	ML	CLAYSTONE (SANDY SILT with GRAVEL)
TP-47	BS-1	BULK	0.0 - 8.0	14.8	9.42	733.1	300	83	NT	<1	SC-SM	SILTY, CLAYEY SAND
TP-48	BS-1	BULK	1.8 - 7.5	50.8	8.15	1020.8	2100	390	NT	<1	CL	CLAYSTONE (SANDY LEAN CLAY)
TP-49	373697	BULK	0.0 - 3.2	9.0	8.9	6124.8	3	7	NT	<1	SP-SM-SC	POORLY GRADED SAND with SILT and CLAY
TP-50	BS-1	BULK	0.0 - 5.0	13.5	8.34	8816	2	7	NT	<1	SC-SM	SILTY, CLAYEY SAND
TP-51	BS-1	BULK	4.5 - 6.5	61.4	8.84	816.6	100	143	NT	<1	CL	SANDY LEAN CLAY
TP-52	BS-1	BULK	2.0 - 8.0	3.7	8.82	9187.2	6	8	NT	<1	SP	POORLY GRADED SAND
TP-55	BS-1	BULK	5.0 - 14.5	3.4	9.09	2876.8	23	36	NT	<1	SP	POORLY GRADED SAND
TP-56	BS-1	BULK	2.0 - 15.0	6.6	8.39	2320	38	55	NT	<1	SP-SM-SC	POORLY GRADED SAND with SILT and CLAY
TP-57	BS-1	BULK	0.0 - 10.0	5.5	8.84	13920	1	7	NT	<1	SP-SM-SC	POORLY GRADED SAND with SILT and CLAY
TP-58	BS-1	BULK	0.0 - 13.0	3.6	9.2	16704	4	11	NT	<1	SP	POORLY GRADED SAND
TP-59	BS-1	BULK	0.0 - 5.5	12.2	8	12992	1	7	NT	<1	SC-SM	SILTY, CLAYEY SAND
TP-60	BS-1	BULK	0.0 - 6.5	3.6	9.13	16704	3	7	NT	<1	SP	POORLY GRADED SAND
TP-61	BS-1	BULK	0.0 - 3.5	6.6	8.92	13920	3	7	NT	<1	SP-SM-SC	POORLY GRADED SAND with SILT and CLAY
TP-62	BS-1	BULK	0.0 - 5.5	5.6	7.88	12992	1	14	NT	2	SP-SM-SC	POORLY GRADED SAND with SILT and CLAY
TP-63	BS-1	BULK	0.0 - 5.0	6.8	8.57	8908.8	5	14	NT	2	SP-SM-SC	POORLY GRADED SAND with SILT and CLAY

Cameron Water Line
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SPEEDIE AND ASSOCIATES

TABOFLAB REDOX-SULFIDE 120751TF.GPJ GENGEO.GDT 7/18/12

CORROSIVE TEST DATA

SOIL BORING or TEST PIT NUMBER	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE INTERVAL (ft)	PERCENT FINER #200 SIEVE	pH	RESISTIVITY (Ohm-Centimeters)	SULFATE (SO4) (ppm)	CHLORIDE (CL) (ppm)	REDOX (millivolts)	SULFIDE (ppm)	UNIFIED SOIL CLASSIFICATION	SPECIMEN DESCRIPTION
TP-67	BS-1	BULK	0.0 - 7.0	6.2	8	9094.4	4	8	NT	<1	SP-SM-SC	POORLY GRADED SAND with SILT and CLAY
TP-68	BS-1	BULK	0.0 - 3.3	8.9	8.64	7424	1	7	NT	<1	SP-SM-SC	POORLY GRADED SAND with SILT and CLAY

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SPEEDIE AND ASSOCIATES

TABOFLAB REDOX-SULFIDE 120751TF.GPJ GENGEO.GDT 7/18/12

SPEEDIE AND ASSOCIATES

LABORATORY REPORT

Physical Properties of Soils and Aggregates

Client: Apache Underground & Excavating, LLC
Attention: Mark Gardner
6141 Crimson Oak Dr.
Lakeside, AZ 85929

Project No. 120751TF
Lab No. 373309
Report Date: 07-16-12

Project: Cameron Water Line
Location: Hwy 89 Page to Cameron
Material: Claystone (Lean Clay) Sampled By: Client Date: 06-11-12
Source: TP-18 Submitted By: C. Jones Date: 06-11-12
Supplier: Native Authorized By: Client Date: 06-11-12
Sample Location: 2.5' to 9.0'

Expansion Index (ASTM D4829)

Sample Properties

Before Test		After Test	
Wet Density (pcf)	110.2	Wet Density (pcf)	120.9
Dry Density (pcf)	97.4	Dry Density (pcf)	92.8
Moisture Content	13.2%	Moisture Content	30.2%
Degree of Saturation	48.8%	Degree of Saturation	100.2%

Measured Expansion Index (EI_M) = 49

Calculated Expansion Index @ 50% Saturation (EI_{50}) = 48

Expansion Index Classification:

E.I.	Potential Expansion
0-20	Very Low
21-50	Low
51-90	Medium
91-130	High
>130	Very High

Laboratory test results reported herein apply only to the specific sample on which the test was run. The above services and report were performed pursuant to the terms and conditions of the agreement or proposal, if any, between SA and client. SA warrants that this work was performed under the appropriate standard of care, including the skill and judgement that is reasonably expected from similarly situated professionals. No other warranty, guaranty, or representation, either express or implied is included or intended.

Reviewed by _____
Laboratory Manager

SPEEDIE AND ASSOCIATES

LABORATORY REPORT

Physical Properties of Soils and Aggregates

Client: Apache Underground & Excavating, LLC
Attention: Mark Gardner
6141 Crimson Oak Dr.
Lakeside, AZ 85929

Project No. 120751TF
Lab No. 373122
Report Date: 07-16-12

Project: Cameron Water Line
Location: Hwy 89 Page to Cameron
Material: Lean Clay with Sand — Sampled By: Client — Date: 06-07-12
Source: TP-30 — Submitted By: C. Jones — Date: 06-11-12
Supplier: Native — Authorized By: Client — Date: 06-07-12
Sample Location: 2.0' to 14.0'

Expansion Index (ASTM D4829)

Sample Properties

Before Test		After Test	
Wet Density (pcf)	110.1	Wet Density (pcf)	115.5
Dry Density (pcf)	94.1	Dry Density (pcf)	83.4
Moisture Content	17.0%	Moisture Content	38.6%
Degree of Saturation	58.1%	Degree of Saturation	102.0%

Measured Expansion Index (EI_M) = 129

Calculated Expansion Index @ 50% Saturation (EI_{50}) = 139

Expansion Index Classification:

E.I.	Potential Expansion
0-20	Very Low
21-50	Low
51-90	Medium
91-130	High
>130	Very High

Laboratory test results reported herein apply only to the specific sample on which the test was run. The above services and report were performed pursuant to the terms and conditions of the agreement or proposal, if any, between SA and client. SA warrants that this work was performed under the appropriate standard of care, including the skill and judgement that is reasonably expected from similarly situated professionals. No other warranty, guaranty, or representation, either express or implied is included or intended.

Reviewed by _____
Laboratory Manager

SPEEDIE AND ASSOCIATES

LABORATORY REPORT

Physical Properties of Soils and Aggregates

Client: Apache Underground & Excavating, LLC
Attention: Mark Gardner
6141 Crimson Oak Dr.
Lakeside, AZ 85929

Project No. 120751TF
Lab No. 373072
Report Date: 07-16-12

Project: Cameron Water Line
Location: Hwy 89 Page to Cameron
Material: Fat Clay with Sand — Sampled By: A. Arp-Romero — Date: 06-06-12
Source: TP-40 — Submitted By: C. Jones — Date: 06-11-12
Supplier: Native — Authorized By: Client — Date: 06-06-12
Sample Location: 0.0' to 5.0'

Expansion Index (ASTM D4829)

Sample Properties

Before Test		After Test	
Wet Density (pcf)	111.9	Wet Density (pcf)	115.2
Dry Density (pcf)	96.4	Dry Density (pcf)	84.8
Moisture Content	16.0%	Moisture Content	35.9%
Degree of Saturation	57.8%	Degree of Saturation	98.2%

Measured Expansion Index (EI_M) = 137

Calculated Expansion Index @ 50% Saturation (EI_{50}) = 147

Expansion Index Classification:

E.I.	Potential Expansion
0-20	Very Low
21-50	Low
51-90	Medium
91-130	High
>130	Very High

Laboratory test results reported herein apply only to the specific sample on which the test was run. The above services and report were performed pursuant to the terms and conditions of the agreement or proposal, if any, between SA and client. SA warrants that this work was performed under the appropriate standard of care, including the skill and judgement that is reasonably expected from similarly situated professionals. No other warranty, guaranty, or representation, either express or implied is included or intended.

Reviewed by _____
Laboratory Manager

SPEEDIE AND ASSOCIATES

LABORATORY REPORT

Physical Properties of Soils and Aggregates

Client: Apache Underground & Excavating, LLC
Attention: Mark Gardner
6141 Crimson Oak Dr.
Lakeside, AZ 85929

Project No. 120751TF
Lab No. 373073
Report Date: 07-16-12

Project: Cameron Water Line
Location: Hwy 89 Page to Cameron
Material: Claystone (Fat Clay) Sampled By: A. Arp-Romero Date: 06-06-12
Source: TP-41 Submitted By: C. Jones Date: 06-11-12
Supplier: Native Authorized By: Client Date: 06-06-12
Sample Location: 3.0' to 8.0'

Expansion Index (ASTM D4829)

Sample Properties

Before Test		After Test	
Wet Density (pcf)	112.4	Wet Density (pcf)	116.2
Dry Density (pcf)	97.1	Dry Density (pcf)	87.0
Moisture Content	15.7%	Moisture Content	33.6%
Degree of Saturation	57.7%	Degree of Saturation	96.8%

Measured Expansion Index (EI_M) = 117
Calculated Expansion Index @ 50% Saturation (EI_{50}) = 126

Comments: 43% rock in sample.

Expansion Index Classification:

E.I.	Potential Expansion
0-20	Very Low
21-50	Low
51-90	Medium
91-130	High
>130	Very High

Laboratory test results reported herein apply only to the specific sample on which the test was run. The above services and report were performed pursuant to the terms and conditions of the agreement or proposal, if any, between SA and client. SA warrants that this work was performed under the appropriate standard of care, including the skill and judgement that is reasonably expected from similarly situated professionals. No other warranty, guaranty, or representation, either express or implied is included or intended.

Reviewed by _____
Laboratory Manager

SPEEDIE AND ASSOCIATES

LABORATORY REPORT

Physical Properties of Soils and Aggregates

Client: Apache Underground & Excavating, LLC
Attention: Mark Gardner
6141 Crimson Oak Dr.
Lakeside, AZ 85929

Project No. 120751TF
Lab No. 372907
Report Date: 07-16-12

Project: Cameron Water Line
Location: Hwy 89 Page to Cameron
Material: Claystone (Sandy Silt with Gravel) Sampled By: A. Arp-Romero Date: 06-05-12
Source: TP-46 Submitted By: C. Jones Date: 06-11-12
Supplier: Native Authorized By: Client Date: 06-05-12
Sample Location: 0.0' to 0.8'

Expansion Index (ASTM D4829)

Sample Properties

Before Test		After Test	
Wet Density (pcf)	118.7	Wet Density (pcf)	126.8
Dry Density (pcf)	106.7	Dry Density (pcf)	102.6
Moisture Content	11.3%	Moisture Content	23.6%
Degree of Saturation	52.5%	Degree of Saturation	99.1%

Measured Expansion Index (EI_M) = 40

Calculated Expansion Index @ 50% Saturation (EI_{50}) = 42

Expansion Index Classification:

E.I.	Potential Expansion
0-20	Very Low
21-50	Low
51-90	Medium
91-130	High
>130	Very High

Laboratory test results reported herein apply only to the specific sample on which the test was run. The above services and report were performed pursuant to the terms and conditions of the agreement or proposal, if any, between SA and client. SA warrants that this work was performed under the appropriate standard of care, including the skill and judgement that is reasonably expected from similarly situated professionals. No other warranty, guaranty, or representation, either express or implied is included or intended.

Reviewed by _____
Laboratory Manager

SPEEDIE AND ASSOCIATES

LABORATORY REPORT

Physical Properties of Soils and Aggregates

Client: Apache Underground & Excavating, LLC
Attention: Mark Gardner
6141 Crimson Oak Dr.
Lakeside, AZ 85929

Project No. 120751TF
Lab No. 372905
Report Date: 07-16-12

Project: Cameron Water Line
Location: Hwy 89 Page to Cameron
Material: Claystone (Sandy Lean Clay) Sampled By: A. Arp-Romero Date: 06-05-12
Source: TP-48 Submitted By: C. Jones Date: 06-11-12
Supplier: Native Authorized By: Client Date: 06-05-12
Sample Location: 1.8' to 7.5'

Expansion Index (ASTM D4829)

Sample Properties

Before Test		After Test	
Wet Density (pcf)	120.6	Wet Density (pcf)	129.6
Dry Density (pcf)	108.4	Dry Density (pcf)	106.2
Moisture Content	11.3%	Moisture Content	22.0%
Degree of Saturation	55.0%	Degree of Saturation	101.5%

Measured Expansion Index (EI_M) = 20

Calculated Expansion Index @ 50% Saturation (EI_{50}) = 23

Expansion Index Classification:

E.I.	Potential Expansion
0-20	Very Low
21-50	Low
51-90	Medium
91-130	High
>130	Very High

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Reviewed by _____
Laboratory Manager

TABULATION OF TEST DATA

SOIL BORING or TEST PIT NUMBER	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE INTERVAL (ft)	NATURAL WATER CONTENT (Percent of Dry Weight)	IN-PLACE DRY DENSITY (Pounds Per Cubic Foot)	PARTICLE SIZE DISTRIBUTION (Percent Finer)					ATTERBERG LIMITS			pH	RESISTIVITY (Ohm-Centimeters)	UNIFIED SOIL CLASSIFICATION	SPECIMEN DESCRIPTION
						#200 SIEVE	#40 SIEVE	#10 SIEVE	#4 SIEVE	3" SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX				
TP-01	BS-1	BULK	0.0 - 8.0	2.3	NT	15	84	95	97	100	NT	NT	NT	8.82	6217.6	SM	SILTY, CLAYEY SAND
TP-02	BS-1	BULK	0.0 - 12.0	4.0	NT	37	73	81	84	100	NP	NP	NP	8.48	473.3	SM	SILTY SAND with GRAVEL
TP-03	BS-1	BULK	4.0 - 13.0	1.6	NT	8	48	66	73	100	NT	NT	NT	9	3712	SP-SM-SC	POORLY GRADED SAND with SILT, CLAY, and GRAVEL
TP-04	BS-1	BULK	4.0 - 13.0	2.6	NT	15	33	42	53	100	22	18	4	8.1	482.6	GC-GM	SILTY, CLAYEY GRAVEL with SAND
TP-05	BS-1	BULK	2.0 - 12.0	2.0	NT	72	99	100	100	100	28	15	13	8.45	1020.8	CL	LEAN CLAY with SAND
TP-06	BS-1	BULK	4.0 - 10.4	1.3	NT	15	68	80	87	100	NT	NT	NT	8.88	2784	SC-SM	SILTY, CLAYEY SAND
TP-07	BS-1	BULK	0.0 - 14.0	3.0	NT	42	70	86	91	100	20	15	5	8.68	1020.8	SC-SM	SILTY, CLAYEY SAND
TP-08	BS-1	BULK	2.0 - 7.0	3.9	NT	42	57	66	75	100	26	15	11	8.7	1856	SC	CLAYEY SAND with GRAVEL
TP-09	BS-1	BULK	6.0 - 10.0	3.9	NT	21	36	57	71	100	21	15	6	8.22	658.9	SC-SM	SILTY, CLAYEY SAND with GRAVEL
TP-10	BS-1	BULK	0.0 - 9.0	2.6	NT	30	47	59	67	100	21	16	5	8.48	2041.6	SC-SM	SILTY, CLAYEY SAND with GRAVEL
TP-11	BS-1	BULK	0.0 - 6.0	3.2	NT	38	63	71	77	100	22	14	8	7.26	853.8	SC	CLAYEY SAND with GRAVEL
TP-12	BS-1	BULK	3.8 - 11.5	4.8	NT	30	58	82	91	100	22	14	8	7.66	1856	SC	CLAYEY SAND

Sieve analysis results do not include material greater than 3". Refer to the actual boring logs for the possibility of cobble and boulder sized materials.

NT=Not Tested

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SPEEDIE AND ASSOCIATES

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TABULATION OF TEST DATA

SOIL BORING or TEST PIT NUMBER	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE INTERVAL (ft)	NATURAL WATER CONTENT (Percent of Dry Weight)	IN-PLACE DRY DENSITY (Pounds Per Cubic Foot)	PARTICLE SIZE DISTRIBUTION (Percent Finer)					ATTERBERG LIMITS			pH	RESISTIVITY (Ohm-Centimeters)	UNIFIED SOIL CLASSIFICATION	SPECIMEN DESCRIPTION
						#200 SIEVE	#40 SIEVE	#10 SIEVE	#4 SIEVE	3" SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX				
TP-13	BS-1	BULK	0.0 - 4.5	4.9	NT	39	70	95	98	100	21	14	7	8.5	1948.8	SC-SM	SILTY, CLAYEY SAND
TP-14	BS-1	BULK	0.0 - 10.0	1.9	NT	15	68	85	91	100	NT	NT	NT	8.32	1948.8	SC-SM	SILTY, CLAYEY SAND
TP-15	BS-1	BULK	0.0 - 5.5	3.4	NT	23	52	77	85	100	20	15	5	8.8	2041.6	SC-SM	SILTY, CLAYEY SAND
TP-16	BS-1	BULK	0.0 - 3.5	5.4	NT	51	72	81	87	100	NT	NT	NT	8.48	2227.2	CL	CLAYSTONE (SANDY LEAN CLAY)
TP-18	BS-1	BULK	2.5 - 9.0	16.0	NT	94	98	100	100	100	NT	NT	NT	7.25	751.7	CL	CLAYSTONE (LEAN CLAY)
TP-19	BS-1	BULK	0.0 - 8.0	6.0	NT	19	41	64	74	100	22	13	9	8.54	928	SC	CLAYEY SAND with GRAVEL
TP-20	BS-1	BULK	0.0 - 8.5	3.8	NT	28	61	86	94	100	23	18	5	8.41	1856	SC-SM	SILTY, CLAYEY SAND
TP-21	BS-1	BULK	3.0 - 5.0	2.0	NT	5	17	45	62	100	NT	NT	NT	9.7	3526.4	SW-SM-SC	WELL-GRADED SAND with SILT, CLAY, and GRAVEL
TP-21	BS-2	BULK	8.0 - 15.0	13.6	NT	68	97	100	100	100	42	24	18	8.83	2876.8	CL	CLAYSTONE (SANDY LEAN CLAY)
TP-22	BS-1	BULK	6.0 - 14.0	12.2	NT	12	25	43	57	100	NT	NT	NT	10.16	779.5	SW-SM-SC	WELL-GRADED SAND with SILT, CLAY, and GRAVEL
TP-23	BS-1	BULK	0.0 - 6.0	2.6	NT	31	89	98	99	100	NP	NP	NP	9.29	2227.2	SM	SILTY SAND
TP-23	BS-2	BULK	6.0 - 8.0	9.0	NT	18	45	75	85	100	22	13	9	9.83	1948.8	SC	CLAYEY SAND with GRAVEL
TP-24	BS-1	BULK	5.0 - 15.0	2.4	NT	7	27	49	58	100	NT	NT	NT	9.11	1577.6	SP-SM-SC	POORLY GRADED SAND with SILT, CLAY, and GRAVEL

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TABULATION OF TEST DATA

SOIL BORING or TEST PIT NUMBER	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE INTERVAL (ft)	NATURAL WATER CONTENT (Percent of Dry Weight)	IN-PLACE DRY DENSITY (Pounds Per Cubic Foot)	PARTICLE SIZE DISTRIBUTION (Percent Finer)					ATTERBERG LIMITS			pH	RESISTIVITY (Ohm-Centimeters)	UNIFIED SOIL CLASSIFICATION	SPECIMEN DESCRIPTION
						#200 SIEVE	#40 SIEVE	#10 SIEVE	#4 SIEVE	3" SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX				
TP-25	BS-1	BULK	8.0 - 12.0	2.8	NT	12	66	85	89	100	NT	NT	NT	7.31	4640	SC-SM	SILTY, CLAYEY SAND
TP-26	BS-1	BULK	3.5 - 10.5	8.9	NT	12	57	97	98	100	NT	NT	NT	8.8	1577.6	SC-SM	SILTY, CLAYEY SAND
TP-27	BS-1	BULK	0.0 - 5.0	11.5	NT	10	54	83	92	100	NT	NT	NT	9.7	2041.6	SP-SM-SC	POORLY GRADED SAND with SILT and CLAY
TP-28	BS-1	BULK	0.0 - 14.0	5.5	NT	15	42	66	75	100	NT	NT	NT	8.71	510.4	SC-SM	SILTY, CLAYEY SAND with GRAVEL
TP-29	BS-1	BULK	0.5 - 10.0	8.9	NT	73	90	94	95	100	38	18	20	8.85	2969.6	CL	CLAYSTONE (LEAN CLAY with SAND)
TP-30	BS-1	BULK	2.0 - 14.0	24.2	NT	78	92	99	100	100	22	14	8	7.84	408.3	CL	LEAN CLAY with SAND
TP-31	BS-1	BULK	0.0 - 3.0	4.5	NT	29	73	95	97	100	35	19	16	8.9	371.2	SC	CLAYEY SAND
TP-32	BS-1	BULK	0.0 - 14.0	3.2	NT	13	33	70	81	100	NT	NT	NT	8.91	1670.4	SC-SM	SILTY, CLAYEY SAND with GRAVEL
TP-33	BS-1	BULK	0.0 - 2.0	2.8	NT	23	58	87	93	100	24	19	5	8.91	1020.8	SC-SM	SILTY, CLAYEY SAND
TP-34	BS-1	BULK	1.5 - 13.0	11.9	NT	76	92	98	99	100	42	23	19	7.4	436.2	CL	CLAYSTONE (LEAN CLAY with SAND)
TP-35	BS-1	BULK	0.0 - 4.5	4.3	NT	35	64	84	92	100	28	11	17	8.86	779.5	SC	CLAYEY SAND
TP-36	BS-1	BULK	7.0 - 13.5	6.1	NT	28	64	86	93	100	33	14	19	8.48	742.4	SC	CLAYEY SAND
TP-37	BS-1	BULK	1.0 - 4.5	3.6	NT	23	75	94	98	100	33	25	8	8	742.4	SM	SILTY SAND
TP-38	BS-1	BULK	1.0 - 4.0	8.2	NT	28	85	99	99	100	NP	NP	NP	7.73	1484.8	SM	SILTY SAND
TP-39	BS-1	BULK	0.0 - 3.5	4.3	NT	25	65	88	94	100	27	16	11	7.89	194.9	SC	CLAYEY SAND

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SOIL BORING or TEST PIT NUMBER	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE INTERVAL (ft)	NATURAL WATER CONTENT (Percent of Dry Weight)	IN-PLACE DRY DENSITY (Pounds Per Cubic Foot)	PARTICLE SIZE DISTRIBUTION (Percent Finer)					ATTERBERG LIMITS			pH	RESISTIVITY (Ohm-Centimeters)	UNIFIED SOIL CLASSIFICATION	SPECIMEN DESCRIPTION
						#200 SIEVE	#40 SIEVE	#10 SIEVE	#4 SIEVE	3" SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX				
TP-40	BS-1	BULK	0.0 - 5.0	18.6	NT	74	89	97	98	100	59	19	40	8.85	436.2	CH	FAT CLAY with SAND
TP-41	BS-1	BULK	3.0 - 8.0	14.7	NT	91	98	100	100	100	NT	NT	NT	7.09	751.7	CH	CLAYSTONE (FAT CLAY)
TP-42	BS-1	BULK	7.0 - 14.5	5.9	NT	47	87	93	96	100	28	18	10	9.11	1392	SC	CLAYEY SAND
TP-43	BS-1	BULK	0.0 - 6.0	5.0	NT	42	92	98	99	100	25	18	7	8.95	566.1	SC-SM	SILTY, CLAYEY SAND
TP-44	BS-1	BULK	0.8 - 8.5	7.2	NT	42	89	98	99	100	24	19	5	9.44	742.4	SC-SM	SILTY, CLAYEY SAND
TP-45	BS-1	BULK	0.0 - 14.0	12.2	NT	72	96	100	100	100	NT	NT	NT	8.22	306.2	CL	CLAYSTONE (LEAN CLAY with SAND)
TP-46	BS-1	BULK	0.0 - 8.0	7.9	NT	54	74	78	82	100	41	26	15	8.35	807.4	ML	CLAYSTONE (SANDY SILT with GRAVEL)
TP-47	BS-1	BULK	0.0 - 8.0	2.4	NT	15	70	90	94	100	NT	NT	NT	9.42	733.1	SC-SM	SILTY, CLAYEY SAND
TP-48	BS-1	BULK	1.8 - 7.5	10.0	NT	51	88	96	97	100	NT	NT	NT	8.15	1020.8	CL	CLAYSTONE (SANDY LEAN CLAY)
TP-49	373697	BULK	0.0 - 3.2	1.1	NT	9	97	100	100	100	NT	NT	NT	8.9	6124.8	SP-SM-SC	POORLY GRADED SAND with SILT and CLAY
TP-50	BS-1	BULK	0.0 - 5.0	1.4	NT	13	94	100	100	100	NT	NT	NT	8.34	8816	SC-SM	SILTY, CLAYEY SAND
TP-51	BS-1	BULK	4.5 - 6.5	13.5	NT	61	97	100	100	100	33	15	18	8.84	816.6	CL	SANDY LEAN CLAY
TP-52	BS-1	BULK	2.0 - 8.0	0.6	NT	4	97	99	100	100	NT	NT	NT	8.82	9187.2	SP	POORLY GRADED SAND
TP-55	BS-1	BULK	5.0 - 14.5	1.1	NT	3	90	94	96	100	NT	NT	NT	9.09	2876.8	SP	POORLY GRADED SAND
TP-56	BS-1	BULK	2.0 - 15.0	1.1	NT	7	92	100	100	100	NT	NT	NT	8.39	2320	SP-SM-	POORLY GRADED SAND with

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TABULATION OF TEST DATA

SOIL BORING or TEST PIT NUMBER	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE INTERVAL (ft)	NATURAL WATER CONTENT (Percent of Dry Weight)	IN-PLACE DRY DENSITY (Pounds Per Cubic Foot)	PARTICLE SIZE DISTRIBUTION (Percent Finer)					ATTERBERG LIMITS			pH	RESISTIVITY (Ohm-Centimeters)	UNIFIED SOIL CLASSIFICATION	SPECIMEN DESCRIPTION
						#200 SIEVE	#40 SIEVE	#10 SIEVE	#4 SIEVE	3" SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX				
																SC	SILT and CLAY
TP-57	BS-1	BULK	0.0 - 10.0	1.4	NT	6	92	100	100	100	NT	NT	NT	8.84	13920	SP-SM-SC	POORLY GRADED SAND with SILT and CLAY
TP-58	BS-1	BULK	0.0 - 13.0	0.5	NT	4	89	100	100	100	NT	NT	NT	9.2	16704	SP	POORLY GRADED SAND
TP-59	BS-1	BULK	0.0 - 5.5	0.7	NT	12	79	100	100	100	NT	NT	NT	8	12992	SC-SM	SILTY, CLAYEY SAND
TP-60	BS-1	BULK	0.0 - 6.5	0.4	NT	4	86	100	100	100	NT	NT	NT	9.13	16704	SP	POORLY GRADED SAND
TP-61	BS-1	BULK	0.0 - 3.5	0.6	NT	7	53	98	98	100	NT	NT	NT	8.92	13920	SP-SM-SC	POORLY GRADED SAND with SILT and CLAY
TP-62	BS-1	BULK	0.0 - 5.5	0.4	NT	6	81	100	100	100	NT	NT	NT	7.88	12992	SP-SM-SC	POORLY GRADED SAND with SILT and CLAY
TP-63	BS-1	BULK	0.0 - 5.0	0.8	NT	7	86	99	100	100	NT	NT	NT	8.57	8908.8	SP-SM-SC	POORLY GRADED SAND with SILT and CLAY
TP-67	BS-1	BULK	0.0 - 7.0	0.5	NT	6	79	100	100	100	NT	NT	NT	8	9094.4	SP-SM-SC	POORLY GRADED SAND with SILT and CLAY
TP-68	BS-1	BULK	0.0 - 3.3	1.2	NT	9	91	99	100	100	NT	NT	NT	8.64	7424	SP-SM-SC	POORLY GRADED SAND with SILT and CLAY

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NT=Not Tested

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SPEEDIE AND ASSOCIATES

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North Central Arizona Water Supply Feasibility Study
Tuba City Spur Test Pit Investigations 2013

INTRODUCTION

The Bureau of Reclamation (Reclamation) is conducting a study to determine the feasibility of constructing the North Central Arizona Pipeline to deliver water from Lake Powell, south to Flagstaff, with laterals to Bitter Springs and Tuba City. The study is being funded under the Rural Water Act and is referred to as the North Central Arizona Water Supply Feasibility Study (NCAWSFS).

PREVIOUS INVESTIGATIONS

Reclamation performed eighty-nine seismic refraction surveys along portions of the proposed pipeline alignment in 2008, to determine the rippability of the material that would be encountered during construction. In order to calibrate the seismic refraction surveys with actual excavation conditions, seventeen test pits were excavated in specified areas that had already been surveyed. The proposed pipeline alignment was geologically mapped at a scale of 1 inch equals 10,000 feet. Rock types and their engineering characteristics were recorded at each seismic refraction survey site and at selected outcrops along the alignment. The report is titled "Proposed Western Navajo-Hopi Pipeline - Rippability of Materials Based on Seismic Wave Velocities". Drawings in the report give an indication of the rippability of the excavation based on the wave velocity and geologic mapping.

In June 2012, Reclamation excavated sixty-four test pits along portions of the proposed North Central Arizona Pipeline in order to determine the depth to bedrock and to obtain soil samples for materials testing. Test pits TP-1 through TP-48 were excavated along US Highway 89 or along the old US Highway 89, which runs parallel to US 89. Test pits TP-49 through TP-63 were excavated along Tribal Route 20 (Copper Mine Road) from The Gap to about 6 miles north of Coppermine Chapter. The test pits were approximately 20 feet long by 6 feet wide and 13 to 15 feet deep unless the backhoe met refusal. The pits were visually classified by a Reclamation geologist and representative samples taken and sent to a lab for gradation sieve analysis, testing for moisture content, Atterberg limits, Proctor compaction pH, conductivity, and sulfate, sulfide and chloride content,. Selected soils were tested for shrink/swell potential (expansion index) and in-place densities were measured using a sand cone apparatus in selected test pits at depths ranging from 3 to 5 feet. The report is titled "North Central Arizona Water Supply Feasibility Study - Test Pit Investigations 2012".

CURRENT INVESTIGATION

The Phoenix Area Office (PXAO) with the assistance of personnel from the Yuma Area Office excavated thirteen test pits along a 7-mile-long alignment extending from Moenave to Tuba City, Arizona, to determine the depth to bedrock and to obtain samples to conduct engineering soil tests.

The test pits were excavated from May 6 to May 8, 2013, in mostly wind deposited sand and ranged in depth from 2.4 to 13.0 feet deep. Test pits were approximately 20 feet long by 4 to 8 feet wide and 13 feet deep unless the backhoe met refusal. The materials encountered were visually classified by a Reclamation geologist and representative soil samples sent to the Yuma

Area Office's materials lab and tested for standard physical properties including gradations, moisture content, Atterberg limits and Proctor compaction in accordance with Reclamation Earth Manual laboratory standards. In-place density tests were conducted in selected pits at a depth of 5 feet utilizing a sand cone apparatus. The test pits are numbered TP-69 through TP-81 and are shown on Figure 1. Test pit logs, laboratory test results and photographs are provided following this text.

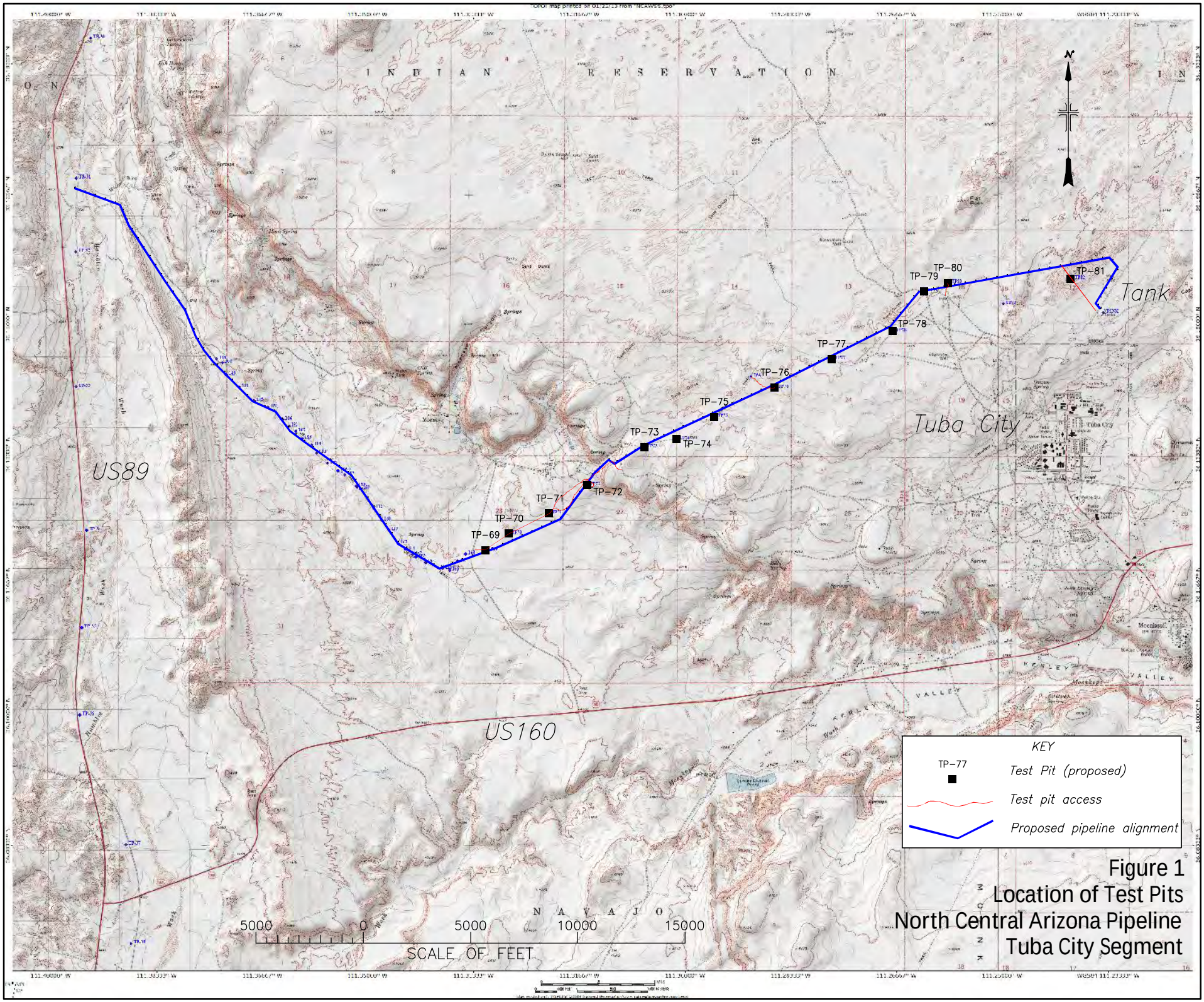


Figure 1
Location of Test Pits
North Central Arizona Pipeline
Tuba City Segment

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** **TP-69**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: TUBA CITY SPUR **METHOD OF EXPLORATION:** BACKHOE - DEERE 310J

COORDINATES (ARIZONA STATE PLANE): **N.** 1863869 **E.** 872798 **GROUND ELEVATION:** ~ 4626

APPROXIMATE DIMENSIONS: 20' x 4' x 4.5 DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 5/6/2013 **DATE LOGGED:** 5/6/2013

CLASSIFICATION GROUP SYMBOL (describe sample taken))	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(Mdst) Visual Class. Lab sample taken from 0.0-4.5 ft. (CL)s Lab Class . **4.5 ft.**	**0.0 - 4.5 ft. Mudstone (Mdst):** Mudstone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting of approximately 70% clay, and 30% fine sand. Moderately soft to moderately hard, fragments break with manual pressure, thicker portion requires moderate hammer blow to break, moderately weathered. Strong reaction with HCl. Color is medium reddish brown. Upon excavation with a backhoe, mudstone breaks up into angular, 1-2 inch-size and smaller chunks. Breaks down into sand and clay particles upon immersion in water. Lab test data from 0.0-4.5 ft.: Lab Classification is Lean Clay with Sand (CL)s derived from Claystone: 69% fines, 31% sand, 0% gravel. Liquid Limit (LL) = 31.0; Plasticity Index (PI) = 14.4. **Geologic Interpretation:** Glen Canyon Group, Kayenta Formation (silty facies)			

REMARKS: **S**urface: flat, no vegetation, scattered concentrations of polished, angular gravels up to 3 in. in diameter. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-70

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: TUBA CITY SPUR **METHOD OF EXPLORATION:** BACKHOE - DEERE 310J

COORDINATES (ARIZONA STATE PLANE): **N.** 1864644 **E.** 873906 **GROUND ELEVATION:** ~ 4680

APPROXIMATE DIMENSIONS: 20' x 4' x 13.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 5/7/2013 **DATE LOGGED:** 5/7/2013

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP-SM) Visual Class.	**0.0 - 13.0 ft. Poorly Graded Sand with Silt (SP-SM):** About 90% predominantly fine sand and 10% nonplastic fines with medium to high dry strength, rapid dilatancy and low toughness. Max. size, coarse sand.. Strong reaction with HCl.	0	0	0
Lab sample taken from 10.0-12.0 ft.	In-place condition: very soft consistency becoming firm with depth, homogenous, dry, light brown material with weak to moderate cementation.			
(SP-SM) Lab Class.	Lab test data from 10.0-12.0 ft.: Lab classification is Poorly Graded Sand with Silt (SP-SM): 91% sand, 9% fines, 0% gravel; Nonplastic; Field Moisture = 1.2%. Proctor Test (max. dry density) = 102.1 lbm/ft^3; Optimum Moisture = 15.3%.			
13.0 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			

REMARKS: **S**urface: top of sand dune; scattered scrub; outcrops of older, weakly cemented dunes located 100 ft. north. Coordinates and elevation obtained from GPS. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-71

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: TUBA CITY SPUR **METHOD OF EXPLORATION:** BACKHOE - DEERE 310J

COORDINATES (ARIZONA STATE PLANE): **N.** 1865606 **E.** 875773 **GROUND ELEVATION:** ~ 4714

APPROXIMATE DIMENSIONS: 20' x 8' x 9.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 5/7/2013 **DATE LOGGED:** 5/7/2013

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM) Visual Class.	**0.0 - 9.0 ft. Silty Sand (SM):** About 75% predominantly fine sand, 25% nonplastic fines with medium dry strength, rapid dilatancy and low toughness; trace of fine to coarse, angular gravel. Max. size, 40 mm. Strong reaction with HCl. 4.5 to 5.4 ft. gravelly layer composed of up to 30% fine to coarse, angular gravel.	0	0	0
Lab sample taken from 0.0-9.5 ft.	In-place condition: very soft consistency becoming firm with depth, homogenous, dry, light brown material with weak cementation.			
(SM) Lab Class.	Lab test data from 0.0-9.0 ft.: Lab classification is Silty Sand (SM): 69% sand, 22% fines, 9% gravel; Nonplastic; Field Moisture = 1.9%. Proctor Test (max. dry density) = 121.4 lbm/ft^3; Optimum Moisture = 10.8%. In-place density taken at 4.8 ft. with sand cone apparatus = 108.7 lbm/ft^3.			
9.0 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
(Mdst) Visual Class.	**9.0 - 9.5 ft. Mudstone (Mdst):** Mudstone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting of approximately 70% clay, and 30% fine sand. Moderately soft to moderately hard, fragments break with manual pressure, thicker portion requires moderate hammer blow to break, moderately weathered. Strong reaction with HCl. Color is medium gray. Upon excavation with a backhoe, mudstone breaks up into angular, 1-2 inch-size and smaller chunks; could not excavate beyond 9.5 ft.. Breaks down into sand and clay particles upon exposure to water. 9.3-9.4 ft. white, fine grained, intensely weathered, soft sandstone layer.			
9.5 ft.	**Geologic Interpretation:** Glen Canyon Group, Kayenta Formation (silty facies)			

REMARKS: **S**urface: loose sand; scattered scrub. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-72

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: TUBA CITY SPUR **METHOD OF EXPLORATION:** BACKHOE - DEERE 310J

COORDINATES (ARIZONA STATE PLANE): **N.** 1866916 **E.** 877543 **GROUND ELEVATION:** ~ 4821

APPROXIMATE DIMENSIONS: 20' x 8' x 12.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 5/7/2013 **DATE LOGGED:** 5/7/2013

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP-SM) Visual Class.	**0.0 - 12.0 ft. Poorly Graded Sand with Silt (SP-SM):** About 90% predominantly fine to coarse sand, 10% nonplastic fines with low to medium dry strength, rapid dilatancy and low toughness. Max. size, coarse sand. Strong reaction with HCl. 10.5-12.0 ft. scattered fragments of sandstone up to 2 inches in size. In-place condition: very soft consistency becoming firm with depth, homogenous, dry, tan material with weak cementation.	0	0	0
Lab sample taken from 0.0-12.0 ft. (SM) Lab Class.	Lab test data from 0.0-12.0 ft.: Lab classification is Silty Sand (SM): 87% sand, 13% fines, 0% gravel; Nonplastic; Field Moisture = 1.3%. Proctor Test (max. dry density) = 106.1 lbm/ft^3; Optimum Moisture = 13.5%. In-place density taken at 5.0 ft. with sand cone apparatus = 102.6 lbm/ft^3.			
12.0 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			

REMARKS: **S**urface: loose sand; scattered scrub. Coordinates and elevation obtained from GPS. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-73

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: TUBA CITY SPUR **METHOD OF EXPLORATION:** BACKHOE - DEERE 310J

COORDINATES (ARIZONA STATE PLANE): **N.** 1868709 **E.** 880201 **GROUND ELEVATION:** ~ 5026

APPROXIMATE DIMENSIONS: 20' x 4' x 3.8' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 5/7/2013 **DATE LOGGED:** 5/7/2013

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP-SM) Visual Class.	**0.0 - 2.5 ft. Poorly Graded Sand with Silt (SP-SM):** About 90% predominantly fine sand, 10% nonplastic fines with medium dry strength, rapid dilatancy and low toughness; trace of fine to coarse, angular gravel (sandstone fragments). Max. size, 30 mm. Strong reaction with HCl. In-place condition: firm consistency, homogenous, dry, light reddish brown material with weak cementation.	0	0	0
2.5 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
(Mdst & Ss) Visual Class.	**2.5 - 3.8 ft. Mudstone with Interbedded Sandstone (Mdst & Ss):** Mudstone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting of approximately 60% clay, and 40% fine sand. Moderately hard, fragments break with moderate hammer blow, moderately weathered. Unfractured. Strong reaction with HCl. Color is medium purplish gray with light gray bands. Upon excavation with a backhoe, mudstone breaks up into angular, 1-2 inch-size and smaller chunks.			
3.8 ft.	**Geologic Interpretation:** Glen Canyon Group, Navajo Sandstone Formation			

REMARKS: **S**urface: loose sand; scattered small scrub and grass. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-74

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: TUBA CITY SPUR **METHOD OF EXPLORATION:** BACKHOE - DEERE 310J

COORDINATES (ARIZONA STATE PLANE): **N.** 1869104 **E.** 881687 **GROUND ELEVATION:** ~ 5081

APPROXIMATE DIMENSIONS: 20' x 4' x 2.4' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 5/7/2013 **DATE LOGGED:** 5/7/2013

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP-SM) Visual Class.	**0.0 - 0.9 ft. Poorly Graded Sand with Silt (SP-SM):** About 90% predominantly fine sand, 10% nonplastic fines with medium dry strength, rapid dilatancy and low toughness; trace of fine to coarse, angular gravel (sandstone fragments). Max. size, 30 mm. Localized calcium carbonate concentrations present as white patches. Strong reaction with HCl. In-place condition: firm consistency, homogenous, dry, light reddish brown material with weak cementation.	0	0	0
0.9 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
(Ss) Visual Class.	**0.9 - 2.4 ft. Sandstone (Ss):** Sandstone is fine grained, intensely weathered becoming intensely to moderately weathered at 2.4 ft.; very soft, gouges easily with geologic pick, breaks with manual pressure. Strong reaction with HCl, color is light greenish gray. From 0.9 to 1.4 ft. an intensely fractured, very hard chert layer is present. Color is medium dark purple. Upon excavation with a backhoe, sandstone breaks up into angular, 1-2 inch-size and smaller chunks. Could not dig beyond 2.4 ft.			
2.4 ft.	**Geologic Interpretation:** Glen Canyon Group, Navajo Sandstone Formation			

REMARKS: **S**urface: loose sand; scattered small scrub and grass. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336
Bureau of Reclamation

LOG OF TEST PIT OR AUGER HOLE

HOLE NO. TP-75

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: TUBA CITY SPUR **METHOD OF EXPLORATION:** BACKHOE - DEERE 310J

COORDINATES (ARIZONA STATE PLANE): **N.** 1870153 **E.** 883455 **GROUND ELEVATION:** ~ 5107

APPROXIMATE DIMENSIONS: 20' x 4' x 8.7' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 5/7/2013 **DATE LOGGED:** 5/7/2013

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM) Visual Class.	**0.0 - 8.6 ft. Silty Sand (SM):** About 70% predominantly fine sand and 30% nonplastic fines. Low dry strength, rapid dilatancy and low toughness. Max. size, coarse sand.. No reaction with HCl.	0	0	0
Lab sample taken from 0.0-4.8 ft.	In-place condition: very hard consistency, homogenous, dry, light brown material with strong cementation.			
(SM) Lab Class.	Lab test data from 0.0-4.8 ft.: 68% sand, 32% fines, 0% gravel; Nonplastic; Field Moisture = 2.7%. Lab classification is Silty Sand (SM).			
8.6 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
(Ss) Visual Class.	**8.6 - 8.7 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand moderately cemented with silica; crossbedded, beds are 1/8 to 3 in. thick. Moderately hard, edges of hand-size fragment break with manual pressure; thicker portions require moderate hammer blow to break. Moist, no reaction with HCl. Color is light gray to yellowish gray (due to limonite staining). Upon excavation with a backhoe, the sandstone breaks up into platy fragments 1-3 in. in size and smaller.			
8.7 ft.	**Geologic Interpretation:** Glen Canyon Group, Navajo Sandstone Formation			

REMARKS: **S**urface: sand dunes; scattered grass; sandstone outcrops in trail located about 70 ft. east. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-76

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: TUBA CITY SPUR **METHOD OF EXPLORATION:** BACKHOE - DEERE 310J

COORDINATES (ARIZONA STATE PLANE): **N.** 1871536 **E.** 886275 **GROUND ELEVATION:** ~ 5186

APPROXIMATE DIMENSIONS: 20' x 4' x 6.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 5/7/2013 **DATE LOGGED:** 5/7/2013

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM) Visual Class. Lab sample taken from 0.0-6.0 ft. (SM) Lab Class. **6.0 ft.**	**0.0 - 6.0 ft. Silty Sand (SM):** About 70% predominantly fine sand and 30% nonplastic fines. Low dry strength, rapid dilatancy and low toughness. Max. size, coarse sand.. No reaction with HCl. In-place condition: very soft consistency, homogenous, dry, light brown material with no cementation. Lab test data from 0.0-6.0 ft.: Lab classification is Silty Sand (SM): 69% sand, 31% fines, 0% gravel; Nonplastic; Field Moisture = 3.1%. Proctor Test (max. dry density) = 114.1 lbm/ft^3; Optimum Moisture = 11.0%. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
(Ss) Visual Class. **6.5 ft.**	**6.0 - 6.5 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand cemented with calcium carbonate. Moderately weathered and moderately soft, fragment break with manual pressure. Moderate reaction with HCl. Color is white to tan with some limonite in matrix. Upon excavation with a backhoe, the sandstone breaks up into platy fragments 1-3 in. in size and smaller. Could not excavate below 6.5 ft. **Geologic Interpretation:** Glen Canyon Group, Navajo Sandstone Formation			

REMARKS: **S**urface: sand dunes with scattered grass. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-77

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: TUBA CITY SPUR **METHOD OF EXPLORATION:** BACKHOE - DEERE 310J

COORDINATES (ARIZONA STATE PLANE): **N.** 1872879 **E.** 888920 **GROUND ELEVATION:** ~ 5217

APPROXIMATE DIMENSIONS: 20' x 4' x 9.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 5/8/2013 **DATE LOGGED:** 5/8/2013

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM) Visual Class. Lab sample taken from 0.0-5.5 ft. (SM) Lab Class. **5.5 ft.**	**0.0 - 5.5 ft. Silty Sand (SM):** About 85% predominantly fine to coarse sand and 15% nonplastic fines. Rapid dilatancy and low toughness. Max. size, coarse sand.. Strong reaction with HCl. In-place condition: very hard consistency, homogenous, dry, tan material with strong cementation. Lab test data from 0.0-5.5 ft.: Lab classification is Silty Sand (SM): 85% sand, 15% fines, 0% gravel; Liquid Limit (LL) = 20.6; Plasticity Index (PI) = 2.3; Field Moisture = 2.2%. Proctor Test (max. dry density) = 118.5 lbm/ft^3; Optimum Moisture = 11.3%. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
(Ss) Visual Class. **9.0 ft.**	**5.5 - 9.0 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand cemented with silica. Moderately weathered and soft, fragments crumble with manual pressure. No reaction with HCl. Color is light brown grading to light gray and white at about 9.0 ft. Upon excavation with a backhoe, the sandstone breaks down into sand and fine gravel-size fragments. Could not excavate below 9.0 ft. **Geologic Interpretation:** Glen Canyon Group, Navajo Sandstone Formation			

REMARKS: **S**urface: flat sand dunes with scattered shrubs and grass. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-78**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: TUBA CITY SPUR **METHOD OF EXPLORATION:** BACKHOE - DEERE 310J

COORDINATES (ARIZONA STATE PLANE): **N.** 1874179 **E.** 891755 **GROUND ELEVATION:** ~ 5205

APPROXIMATE DIMENSIONS: 20' x 4' x 6.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 5/8/2013 **DATE LOGGED:** 5/8/2013

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM) Visual Class. Lab sample taken from 0.0-6.0 ft. (SM) Lab Class. **6.0 ft.**	**0.0 - 6.0 ft. Silty Sand (SM):** About 70% predominantly fine to coarse sand and 30% nonplastic fines. High dry strength, slow to rapid dilatancy and low toughness. Max. size, coarse sand.. Strong reaction with HCl. In-place condition: soft consistency, homogenous, dry, tan material with weak cementation. Lab test data from 0.0-6.0 ft.: Lab classification is Silty Sand (SM): 69% sand, 31% fines, 0% gravel; Liquid Limit (LL) = 18.4; Plasticity Index (PI) = 2.4; Field Moisture = 4.1%. Proctor Test (max. dry density) = 122.2 lbm/ft^3; Optimum Moisture = 10.0%. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
(Ss) Visual Class. **6.0 ft.**	**6.0 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand cemented with silica. Moderately weathered and soft, fragments crumble with manual pressure. No reaction with HCl. Color is light brown. Upon excavation with a backhoe, the sandstone breaks down into sand and fine gravel-size fragments. Backhoe could only scrape surface of sandstone, characteristics assumed similar to TP-77. **Geologic Interpretation:** Glen Canyon Group, Navajo Sandstone Formation			

REMARKS: **S**urface: flat area beside sand dune with scattered shrubs and grass. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-79

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: TUBA CITY SPUR **METHOD OF EXPLORATION:** BACKHOE - DEERE 310J

COORDINATES (ARIZONA STATE PLANE): **N.** 1876060 **E.** 893201 **GROUND ELEVATION:** ~ 5209

APPROXIMATE DIMENSIONS: 20' x 8' x 11.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 5/8/2013 **DATE LOGGED:** 5/8/2013

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM) Visual Class. Lab sample taken from 0.0-7.7 ft. (SM) Lab Class. **7.7 ft.**	**0.0 - 7.7 ft. Silty Sand (SM):** About 85% predominantly fine to coarse sand and 15% nonplastic fines. High dry strength, rapid dilatancy and low toughness. Max. size, coarse sand. Weak reaction with HCl. In-place condition: very soft consistency, homogenous, dry, light brown material with weak cementation. Lab test data from 0.0-7.7 ft.: Lab classification is Silty Sand (SM): 88% sand, 12% fines, 0% gravel; Nonplastic; Field Moisture = 1.5%. Proctor Test (max. dry density) = 107.2 lbm/ft^3; Optimum Moisture = 13.9%. In-place density taken at 5.0 ft. with sand cone apparatus = 107.8 lbm/ft^3. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
(Ss) Visual Class. **11.0 ft.**	**7.7 - 11.0 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand cemented with silica. Moderately weathered and soft, fragments crumble with manual pressure. No reaction with HCl. Color is light brown. Upon excavation with a backhoe, the sandstone breaks down into gravel-size fragments about 1 inch in diameter. **Geologic Interpretation:** Glen Canyon Group, Navajo Sandstone Formation			

REMARKS: **S**urface: active sand dune with scattered tumbleweeds. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** **TP-80**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: TUBA CITY SPUR **METHOD OF EXPLORATION:** BACKHOE - DEERE 310J

COORDINATES (ARIZONA STATE PLANE): **N.** 1876464 **E.** 894308 **GROUND ELEVATION:** ~ 5221

APPROXIMATE DIMENSIONS: 20' x 8' x 9.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 5/8/2013 **DATE LOGGED:** 5/8/2013

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM) Visual Class. Lab sample taken from 0.0-6.0 ft. (SM) Lab Class. **6.0 ft.**	**0.0 - 6.0 ft. Silty Sand (SM):** About 80% predominantly fine to coarse sand and 20% nonplastic fines. High dry strength, rapid dilatancy and low toughness. Max. size, coarse sand. Strong reaction with HCl. In-place condition: very hard consistency, homogenous, dry, tan material with strong cementation. Lab test data from 0.0-6.0 ft.: Lab classification is Silty Sand (SM): 78% sand, 22% fines, 0% gravel; Nonplastic; Field Moisture = 1.9%. Proctor Test (max. dry density) = 106.6 lbm/ft^3; Optimum Moisture = 13.2%. In-place density taken at 5.0 ft. with sand cone apparatus = 108.7 lbm/ft^3. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
(Ss) Visual Class. **9.0 ft.**	**6.0 - 9.0 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand cemented with calcium carbonate. Moderately weathered and soft, fragments crumble with manual pressure. Laminated to very thinly bedded, bedding planes range from ¼ to 1 in. apart; flaggy. Strong reaction with HCl; calcium carbonate concentrated along bedding surfaces. Color is light brown. Upon excavation with a backhoe, the sandstone breaks down into platy gravel-size fragments; although soft, backhoe could not excavate where the sandstone is not thinly bedded; refusal at 9.0 ft. **Geologic Interpretation:** Glen Canyon Group, Navajo Sandstone Formation			

REMARKS: **S**urface: sand dune with scattered shrubs. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-81**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: TUBA CITY SPUR **METHOD OF EXPLORATION:** BACKHOE - DEERE 310J

COORDINATES (ARIZONA STATE PLANE): **N.** 1876700 **E.** 900034 **GROUND ELEVATION:** ~ 5168

APPROXIMATE DIMENSIONS: 20' x 8' x 9.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 5/8/2013 **DATE LOGGED:** 5/8/2013

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP) Visual Class.	**0.0 - 9.5 ft. Poorly Graded Sand (SP):** About 95% predominantly fine to medium sand and 5% nonplastic fines. High dry strength, rapid dilatancy and low toughness. Max. size, medium sand. Strong reaction with HCl. In-place condition: very soft consistency, homogenous, dry becoming moist at about 6 ft, tan material with weak cementation.	0	0	0
Lab sample taken from 0.0-9.5 ft. (SP-SM) Lab Class.	Lab test data from 0.0-9.5 ft.: Lab classification is Poorly Graded Sand with Silt (SP-SM): 95% sand, 5% fines, 0% gravel; Nonplastic; Field Moisture = 1.0%. Proctor Test (max. dry density) = 105.4 lbm/ft^3; Optimum Moisture = 14.9%. In-place density taken at 5.0 ft. with sand cone apparatus = 99.4 lbm/ft^3.			
9.5 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
(Ss) Visual Class.	**9.5 ft. Sandstone (Ss):** Description based on sandstone outcrop located 70 ft. southwest in wind swept bowl not exposed 9 months earlier during initial site selection. Sandstone consists of predominately fine, subrounded sand cemented with calcium carbonate. Moderately weathered and very soft, fragments crumble with manual pressure. Laminated to very thinly bedded, bedding planes range from ¼ to 1 in. apart. Strong reaction with HCl. Color is light brown. Backhoe could not excavate below 9.5 ft.			
9.5 ft.	**Geologic Interpretation:** Glen Canyon Group, Navajo Sandstone Formation			

REMARKS: **S**urface: active sand dune with scattered grass and tumbleweeds. Coordinates and elevation obtained from GPS. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

Summary of Test Pits

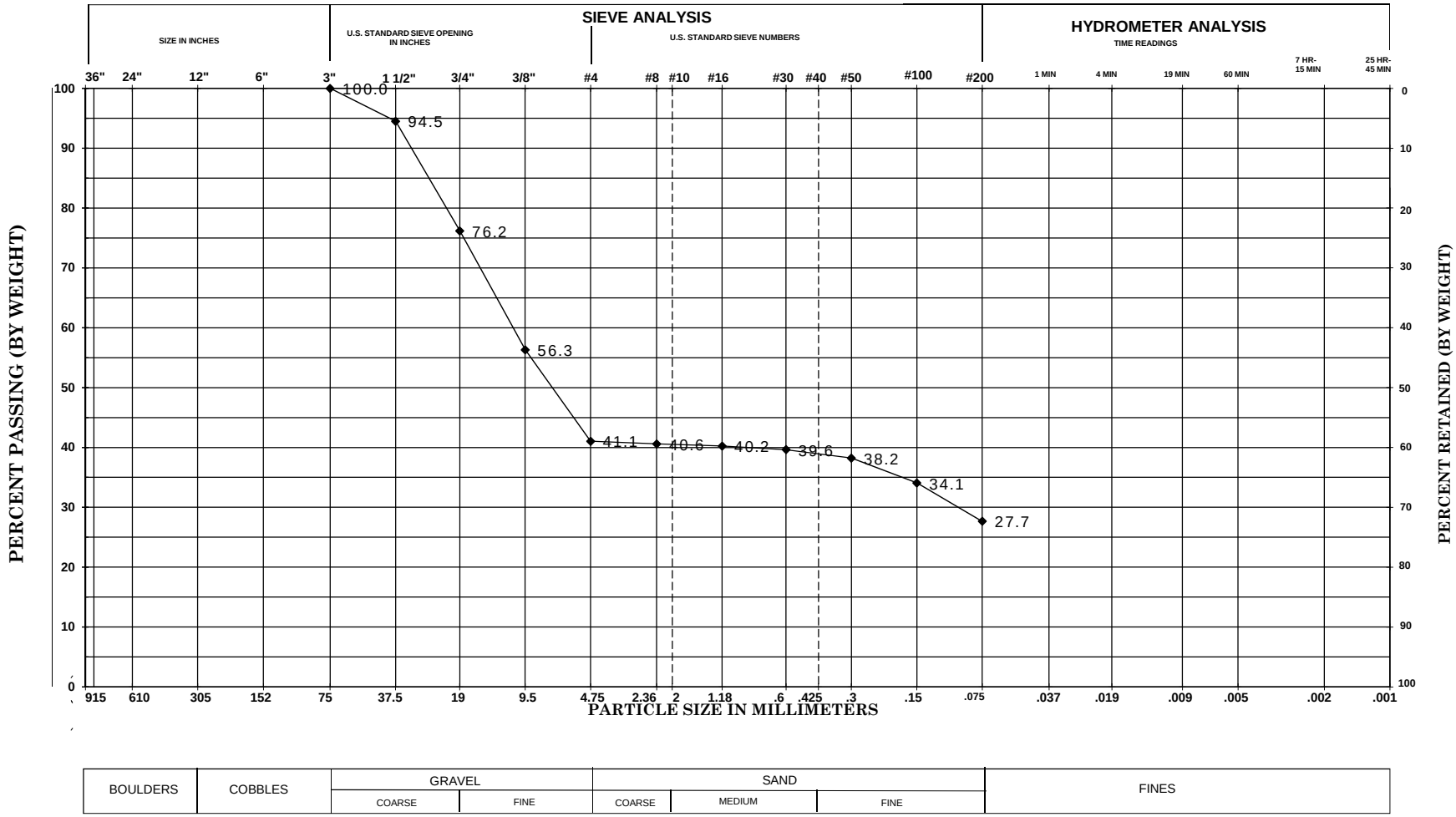
NCAWSFS - Tuba City

May, 2013

Date Sampled	Location	Depth	Unified Soil Classification		% Gravel	% Sand	% Fines	Max. Size	C_U	C_C	Moisture Content	In-place Dry Density (lbm/ft³)	Lab. Max Dry Density (lbm/ft³)	Optimum Moisture Content %	Liquid Limit	Plasticity Index
05/07/13	TP-69	0'-4.5'	GP	Poorly Graded Gravel	59	13	28	5"	-	-	-	-	-	-	-	-
05/07/13	TP-69	clay stone	CL	Lean Clay with Sand	0	31	69	No.4	-	-	-	-	-	-	31.0	14.4
05/07/13	TP-70	10'-12'	SP-SM	Poorly Graded Sand with Silt	0	91	9	No.8	2.3	0.8	1.2	-	102.1	15.3	-	NP
05/07/13	TP-71	0'-9'	SM	Silty Sand	9	69	22	1.5"	23.8	5.5	1.9	108.7	121.4	10.8	-	NP
05/07/13	TP-72		SM	Silty Sand	0	87	13	No.4	4.0	1.2	1.3	102.6	106.1	13.5	-	NP
05/07/13	TP-75	0'-4.8'	SM	Silty Sand	0	68	32	No.4	-	-	2.7	-	-	-	-	NP
05/07/13	TP-76	0'-6'	SM	Silty Sand	0	69	31	No.8	6.5	2.3	3.1	-	114.1	11.0	-	NP
05/08/13	TP-77	0'-5.5'	SM	Silty Sand	0	85	15	No.8	4.2	1.2	2.2	-	118.5	11.3	20.6	2.3
05/08/13	TP-78	0'-6'	SM	Silty Sand	0	69	31	No.4	-	-	4.1	-	122.2	10.0	18.4	2.4
05/08/13	TP-79	5'	SM	Silty Sand	0	88	12	No.4	2.9	1.2	1.5	107.8	107.2	13.9	-	NP
05/08/13	TP-80	0'-6'	SM	Silty Sand	0	78	22	No.8	3.1	1.5	1.9	108.7	106.6	13.2	-	NP
05/08/13	TP-81	0'-6'	SP-SM	Poorly Graded Sand with Silt	0	95	5	No.16	2.5	1.3	1.0	99.4	105.4	14.9	-	NP

NCAWSFS Tuba City TP - 69 Soil As Excavated 0' to 4.5' 05/07/13

GRAIN SIZE DISTRIBUTION



Unified Soil Classification: **GP Poorly Graded Gravel**

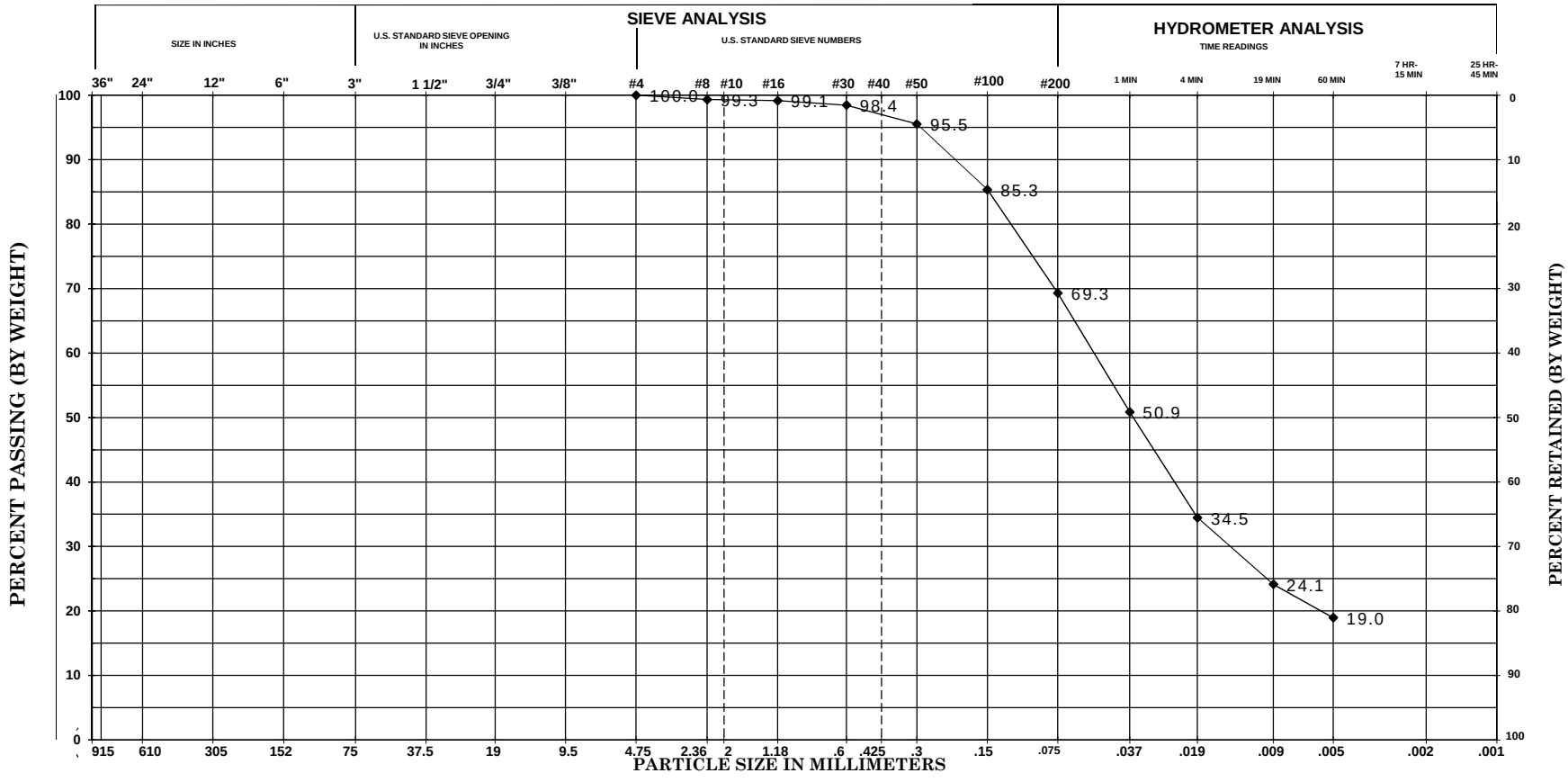
Sample Collected by: J. Fitzsimmons

58.9 % Gravel	Maximum Size: 5"	In-place Dry Density:	lbm/ft³	D_{50}:	7.131 mm 0.281 in
13.4 % Sand	Moisture Content:	Lab. Max Dry Density:	lbm/ft³	C_U:	
27.7 % Fines	Liquid Limit:	Optimum Moisture:	%	C_C:	
4.8 % Oversize	Plasticity Index:				

Note: The coarse material in this sample readily broke down on exposure to water. Resulting in a material that would be classified as CL Lean Clay.

NCAWSFS Tuba City TP - 69 Clay Stone After Water Exposure 0' to 4.5' 05/07/13

GRAIN SIZE DISTRIBUTION



Unified Soil Classification: **CL Lean Clay with Sand**

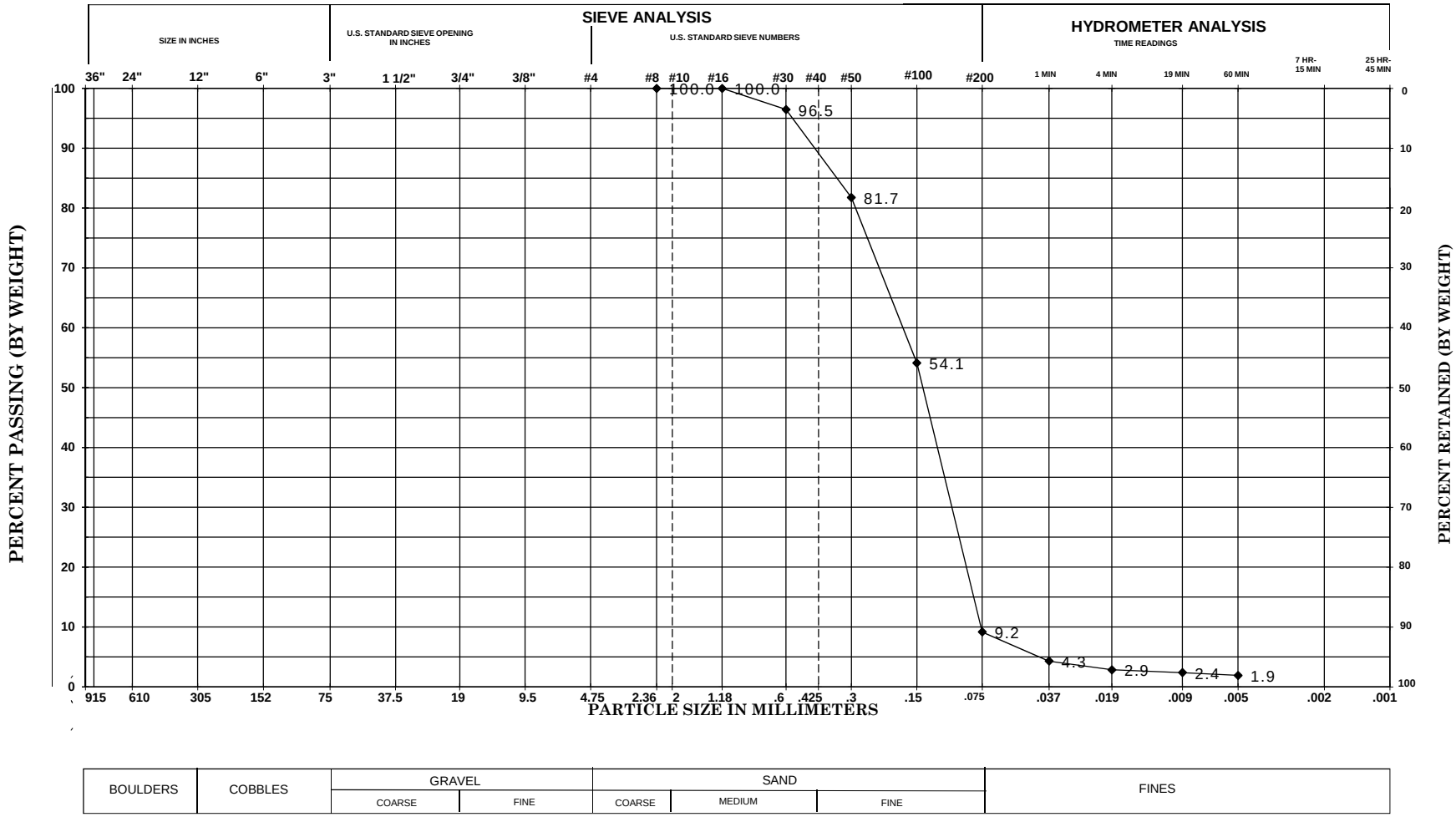
Sample Collected by: J. Fitzsimmons

0.0 % Gravel	Maximum Size: No. 4	In-place Dry Density:	-	lbm/ft³	D_{50}:	0.036 mm	0.001 in
30.7 % Sand	Moisture Content:	Lab. Max Dry Density:	-	lbm/ft³	C_U:		
69.3 % Fines	Liquid Limit: 31.0	Optimum Moisture:	-	%	C_C:		
% Oversize	Plasticity Index: 14.4						

Note: Sample of Clay Stone subjected to standard Hydrometer Analysis
Earth Maual USBR 5330, ASTM D-422

NCAWSFS Tuba City **TP - 70** **10' to 12'** **05/07/13**

GRAIN SIZE DISTRIBUTION



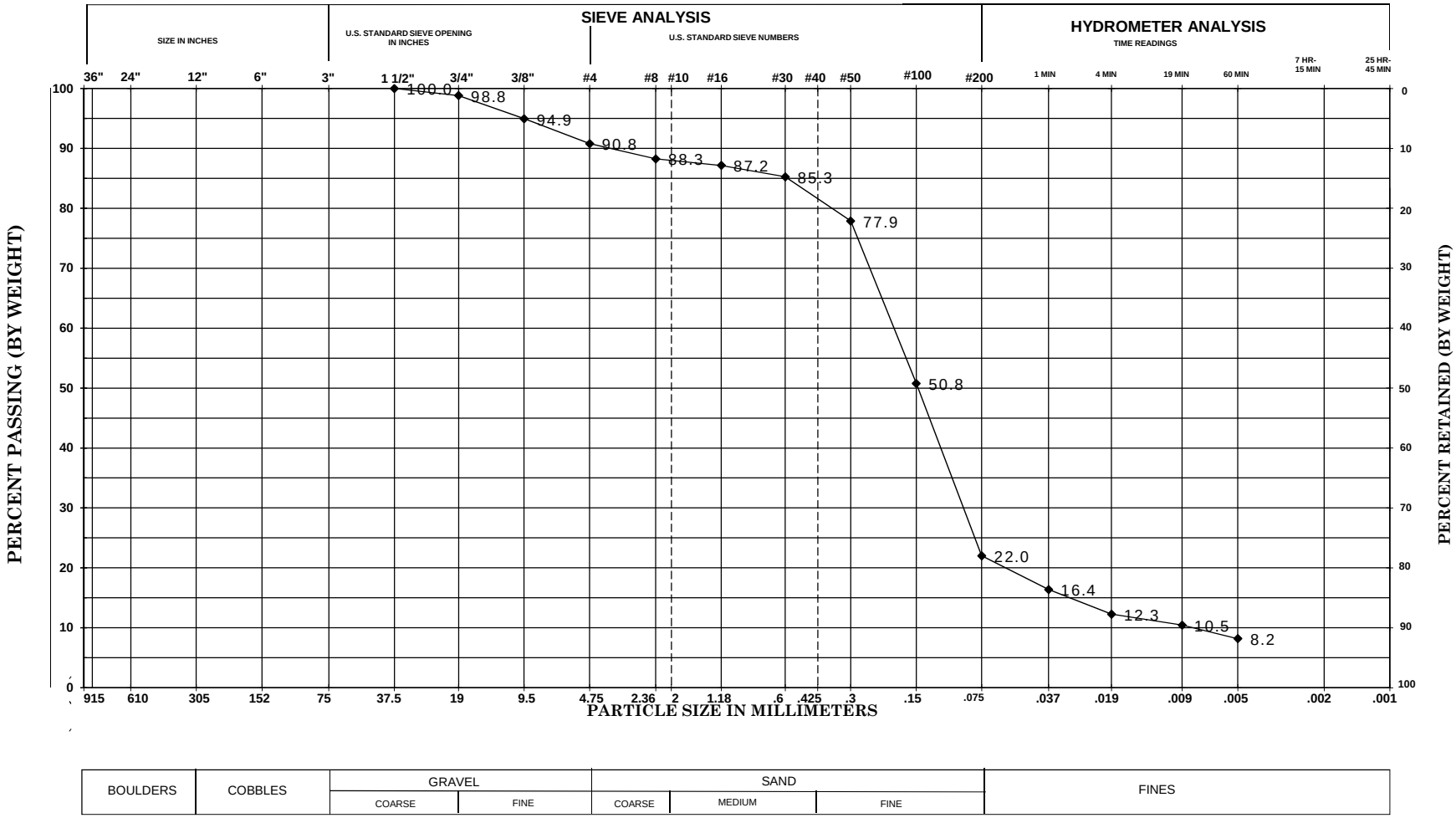
Unified Soil Classification: **SP-SM Poorly Graded Sand with Silt**

Sample Collected by: M. Miller

0.0 % Gravel	Maximum Size: No. 8	In-place Dry Density:	-	lbm/ft³	D_{50}:	0.141 mm	0.006 in
90.8 % Sand	Moisture Content: 1.2 %	Lab. Max Dry Density:	102.1	lbm/ft³	C_U:	2.3	
9.2 % Fines	Liquid Limit:	Optimum Moisture:	15.3	%	C_C:	0.8	
% Oversize	Plasticity Index: Nonplastic						

NCAWSFS Tuba City **TP - 71** **0' to 9'** **05/07/13**

GRAIN SIZE DISTRIBUTION



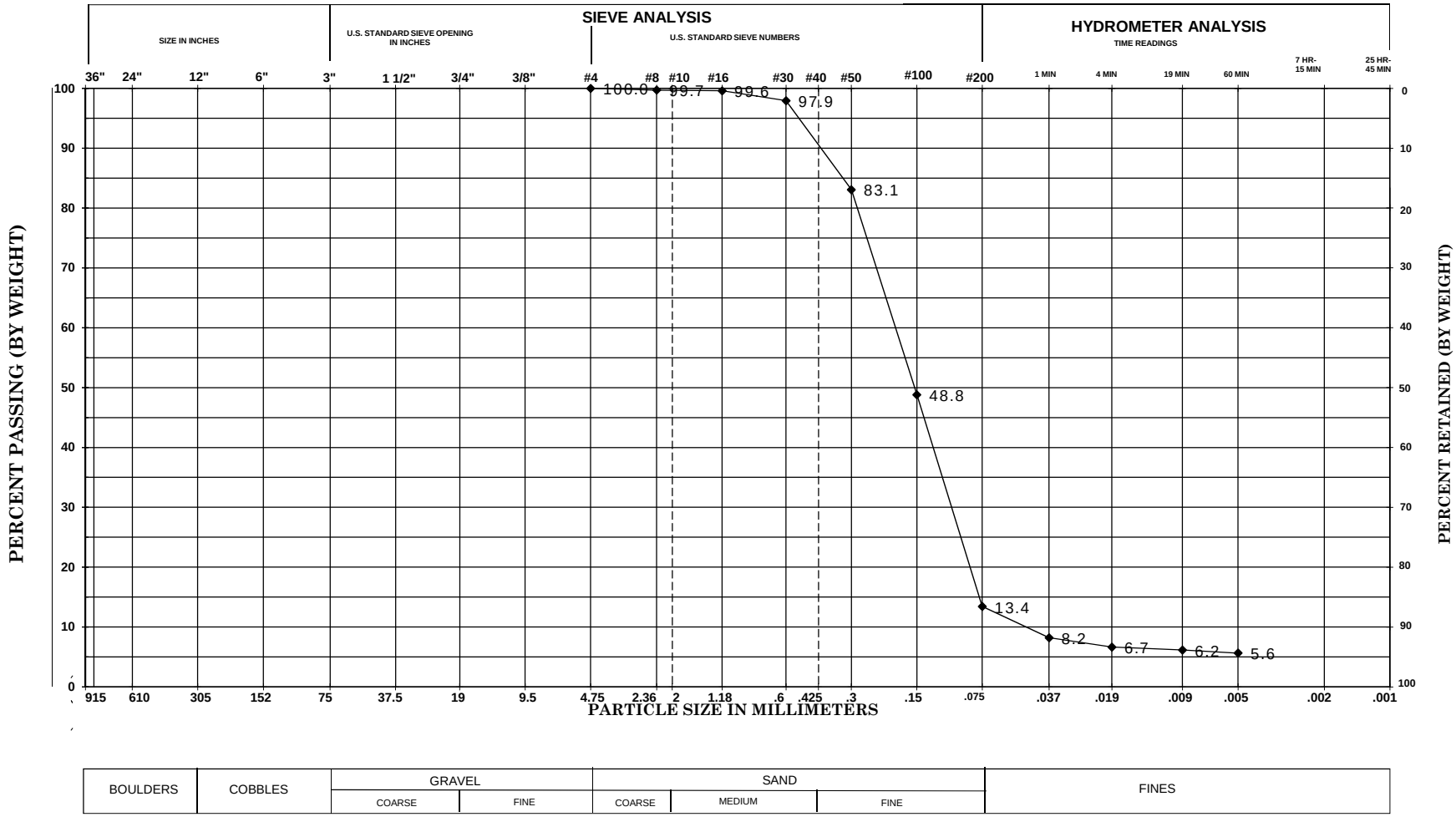
Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J. Fitzsimmons

9.2 % Gravel	Maximum Size: 1 1/2"	In-place Dry Density:	108.7	lbm/ft³	D_{50}:	0.147 mm	0.006 in
68.8 % Sand	Moisture Content: 1.9 %	Lab. Max Dry Density:	121.4	lbm/ft³	C_U:	23.8	
22.0 % Fines	Liquid Limit:	Optimum Moisture:	10.8	%	C_C:	5.5	
% Oversize	Plasticity Index: Nonplastic						

NCAWSFS Tuba City **TP - 72** **05/07/13**

GRAIN SIZE DISTRIBUTION



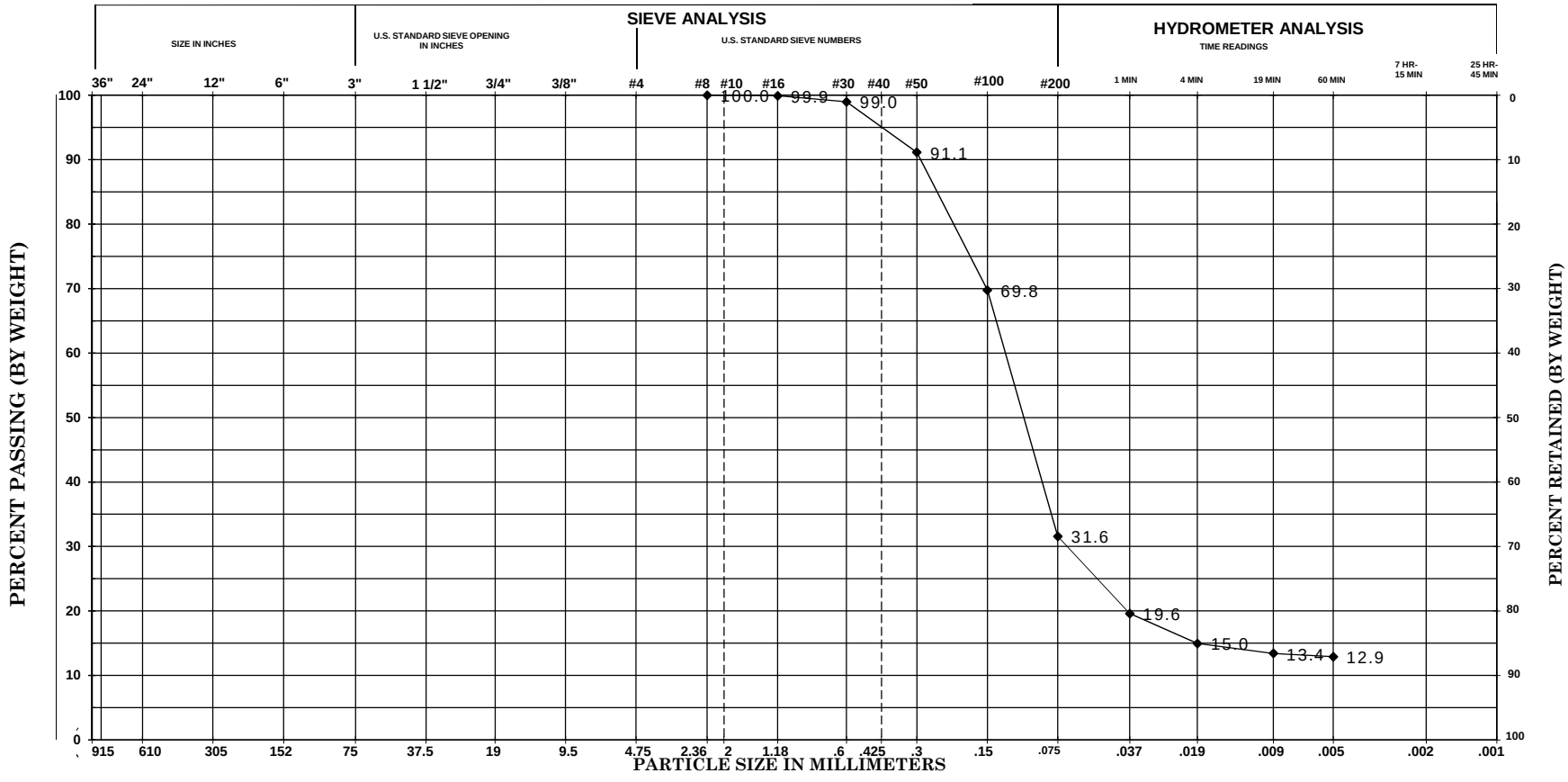
Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J. Fitzsimmons

0.0 % Gravel	Maximum Size: No. 4	In-place Dry Density:	102.6	lbm/ft³	D_{50}:	0.154 mm	0.006 in
86.6 % Sand	Moisture Content: 1.3 %	Lab. Max Dry Density:	106.1	lbm/ft³	C_U:	4.0	
13.4 % Fines	Liquid Limit:	Optimum Moisture:	13.5	%	C_C:	1.2	
% Oversize	Plasticity Index: Nonplastic						

NCAWSFS Tuba City **TP - 75** **0' to 4.8'** **05/07/13**

GRAIN SIZE DISTRIBUTION



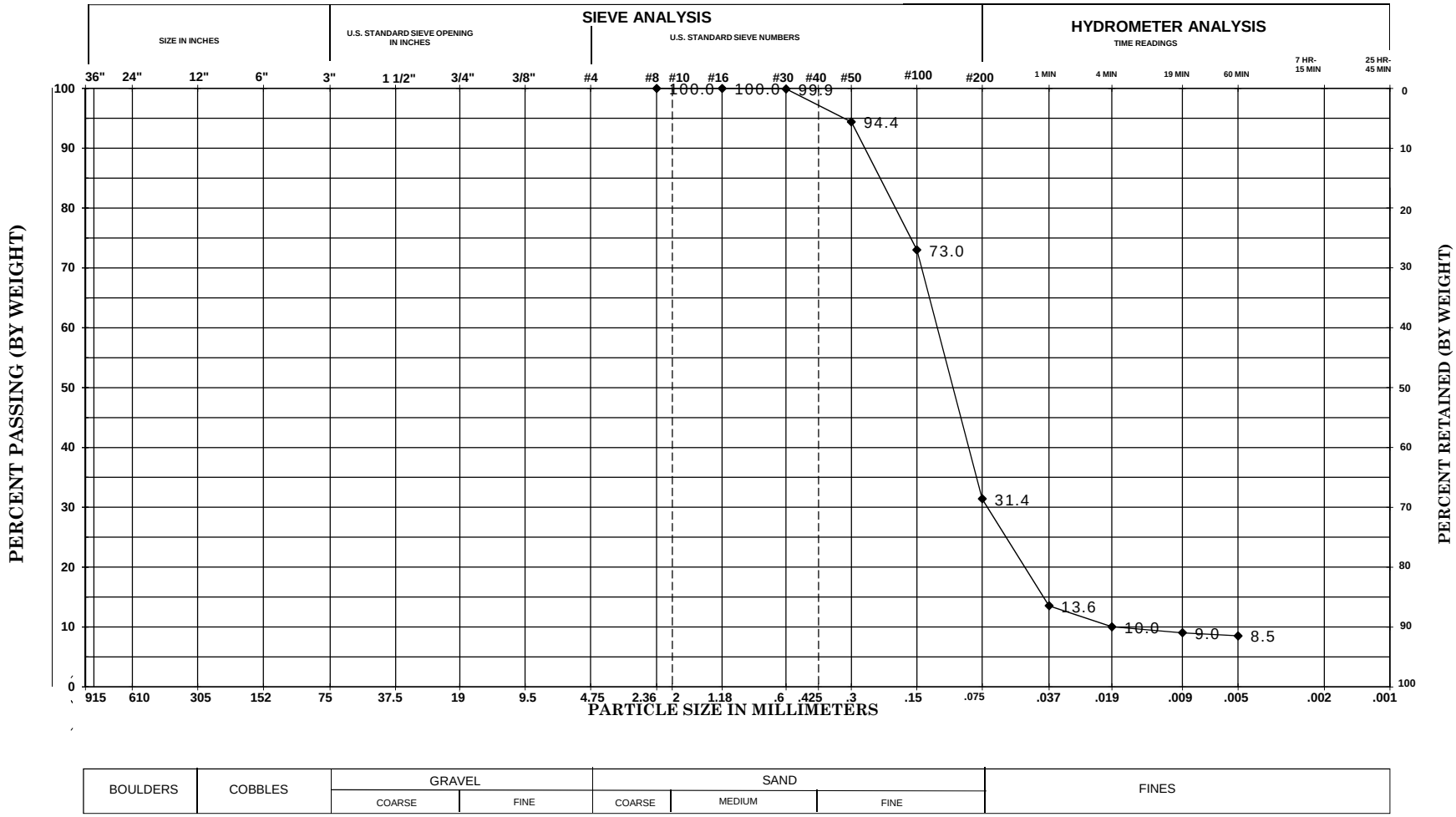
Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J. Fitzsimmons

0.0 % Gravel	Maximum Size: No. 4	In-place Dry Density:	lbm/ft³	D_{50}:	0.105 mm	0.004 in
68.4 % Sand	Moisture Content: 2.7 %	Lab. Max Dry Density:	lbm/ft³	C_U:		
31.6 % Fines	Liquid Limit:	Optimum Moisture:	%	C_C:		
% Oversize	Plasticity Index: Nonplastic					

NCAWSFS Tuba City **TP - 76** **0' to 6'** **05/07/13**

GRAIN SIZE DISTRIBUTION



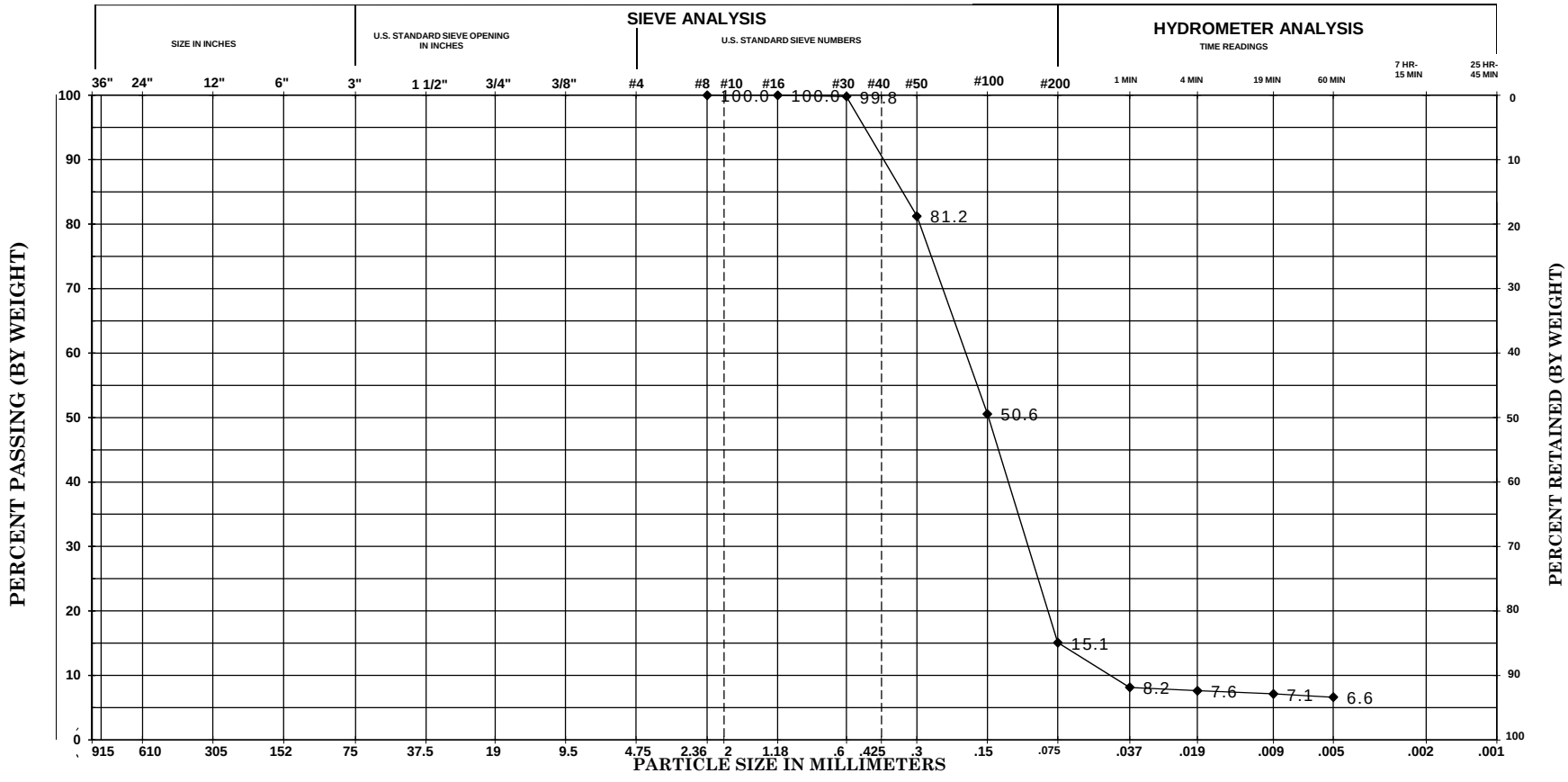
Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J. Fitzsimmons

0.0 % Gravel	Maximum Size: No. 8	In-place Dry Density:	-	lbm/ft³	D_{50}:	0.102 mm	0.004 in
68.6 % Sand	Moisture Content: 3.1 %	Lab. Max Dry Density:	114.1	lbm/ft³	C_U:	6.5	
31.4 % Fines	Liquid Limit:	Optimum Moisture:	11.0	%	C_C:	2.3	
% Oversize	Plasticity Index: Nonplastic						

NCAWSFS Tuba City **TP - 77** **0' to 5.5'** **05/08/13**

GRAIN SIZE DISTRIBUTION



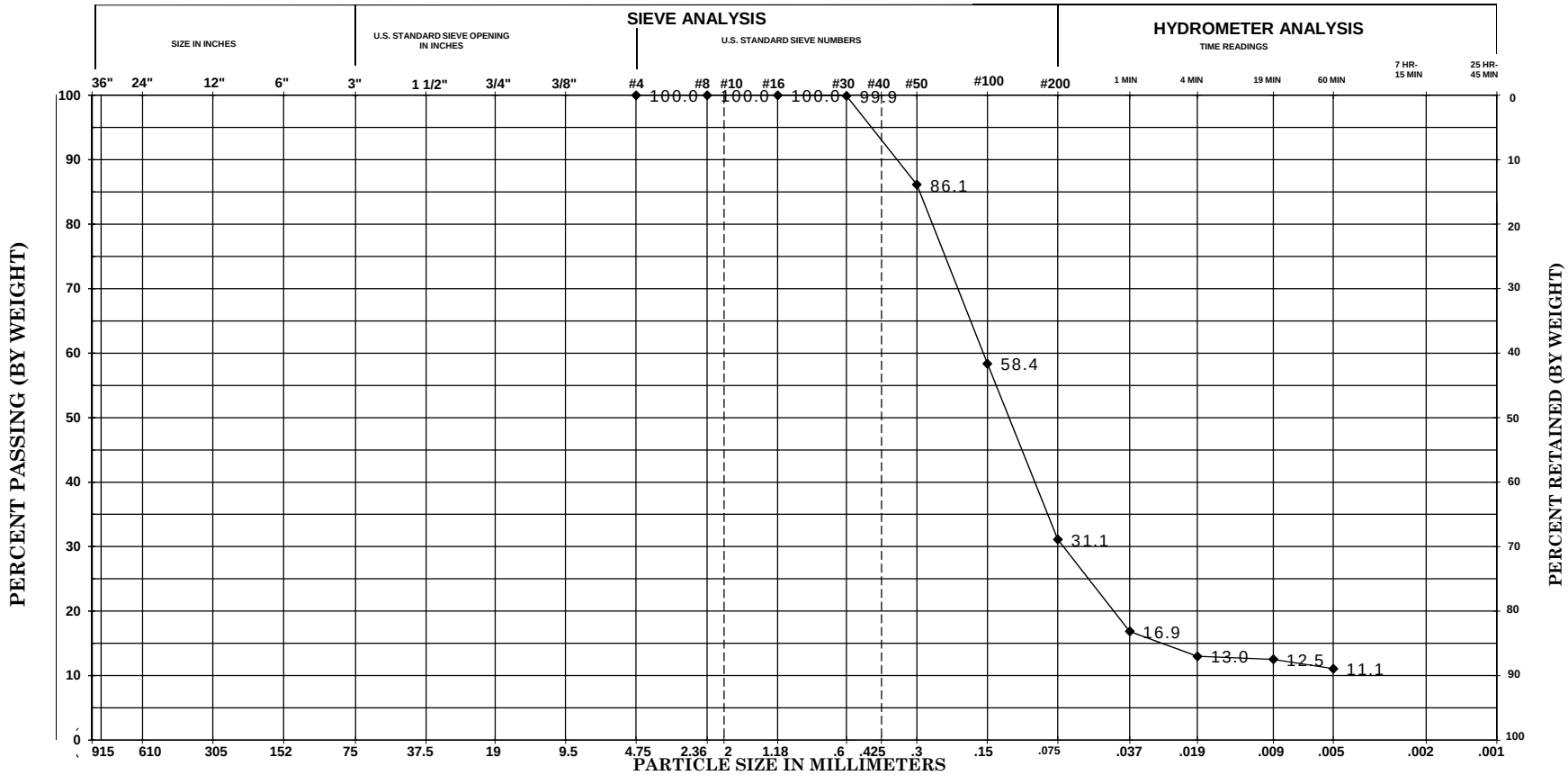
Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J. Fitzsimmons

0.0 % Gravel	Maximum Size: No. 8	In-place Dry Density:	-	lbm/ft³	D_{50}:	0.148 mm	0.006 in
84.9 % Sand	Moisture Content: 2.2 %	Lab. Max Dry Density:	118.5	lbm/ft³	C_U:	4.2	
15.1 % Fines	Liquid Limit: 20.6	Optimum Moisture:	11.3	%	C_C:	1.2	
% Oversize	Plasticity Index: 2.3						

NCAWSFS Tuba City **TP - 78** **0' to 6'** **05/08/13**

GRAIN SIZE DISTRIBUTION



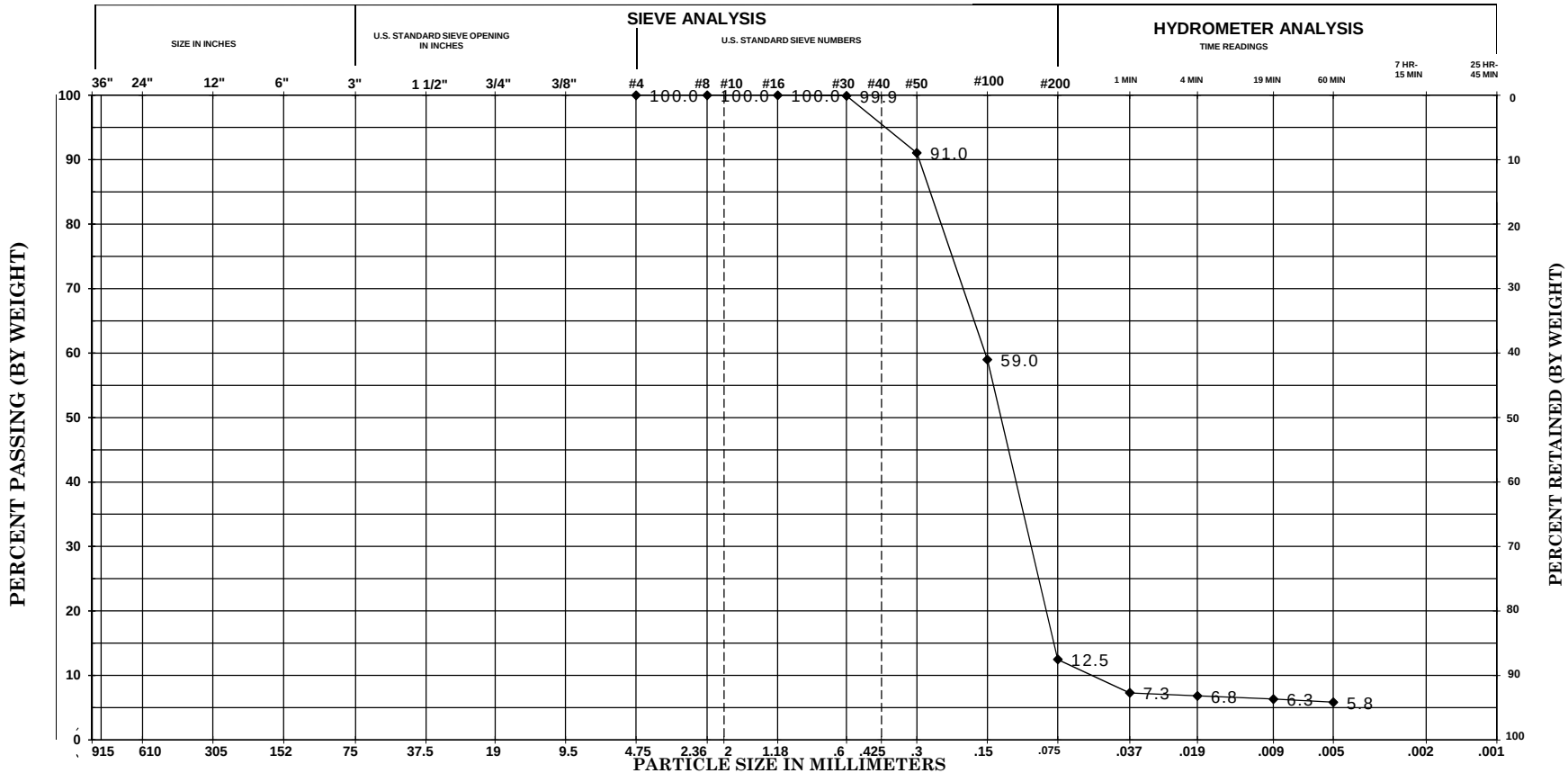
Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J. Fitzsimmons

0.0 % Gravel	Maximum Size: No. 4	In-place Dry Density:	-	lbm/ft³	D_{50}:	0.121 mm	0.005 in
68.9 % Sand	Moisture Content: 4.1 %	Lab. Max Dry Density:	122.3	lbm/ft³	C_U:		
31.1 % Fines	Liquid Limit: 18.4	Optimum Moisture:	10.0	%	C_C:		
% Oversize	Plasticity Index: 2.4						

NCAWSFS Tuba City **TP - 79** **5'** **05/08/13**

GRAIN SIZE DISTRIBUTION



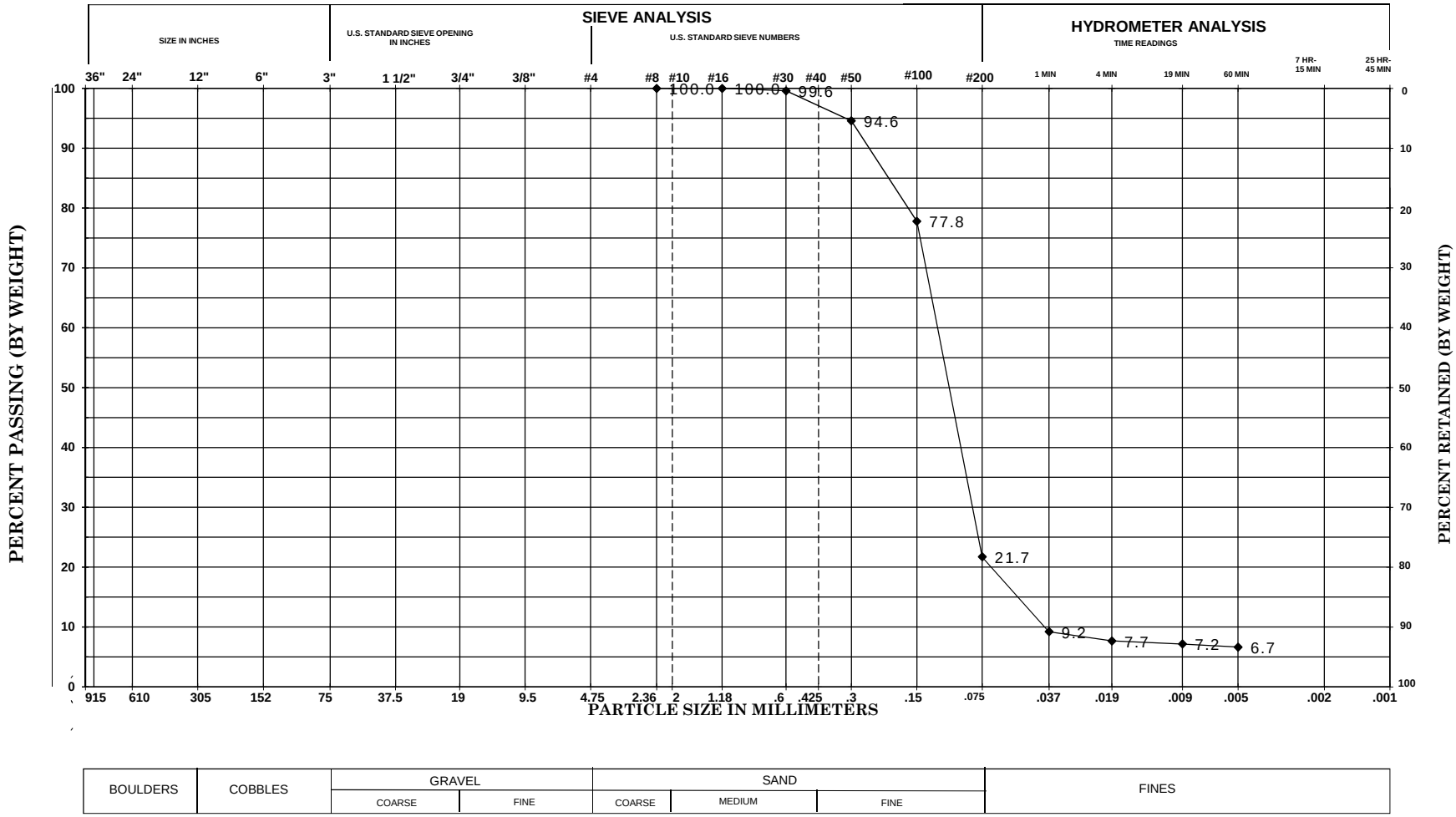
Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J. Fitzsimmons

0.0 % Gravel	Maximum Size: No. 4	In-place Dry Density:	107.8	lbm/ft³	D_{50}:	0.131 mm	0.005 in
87.5 % Sand	Moisture Content: 1.5 %	Lab. Max Dry Density:	107.2	lbm/ft³	C_U:	2.9	
12.5 % Fines	Liquid Limit:	Optimum Moisture:	13.9	%	C_C:	1.2	
% Oversize	Plasticity Index: Nonplastic						

NCAWSFS Tuba City **TP - 80** **0' to 6'** **05/08/13**

GRAIN SIZE DISTRIBUTION



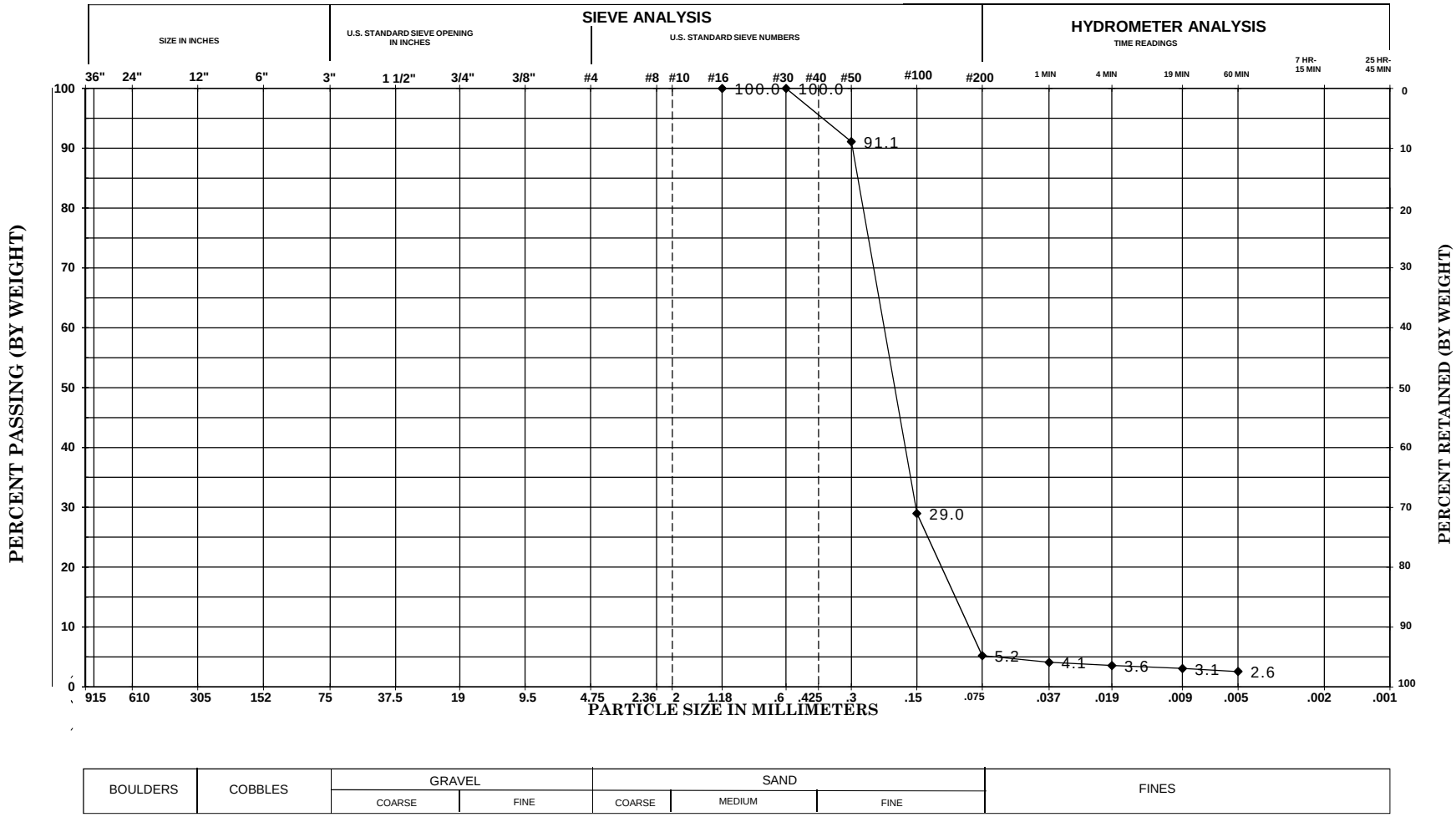
Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J. Fitzsimmons

0.0 % Gravel	Maximum Size: No. 8	In-place Dry Density:	108.7	lbm/ft³	D_{50}:	0.106 mm	0.004 in
78.3 % Sand	Moisture Content: 1.9	Lab. Max Dry Density:	106.6	lbm/ft³	C_U:	3.1	
21.7 % Fines	Liquid Limit:	Optimum Moisture:	13.2	%	C_C:	1.5	
% Oversize	Plasticity Index: Nonplastic						

NCAWSFS Tuba City **TP - 81** **0' to 6'** **05/08/13**

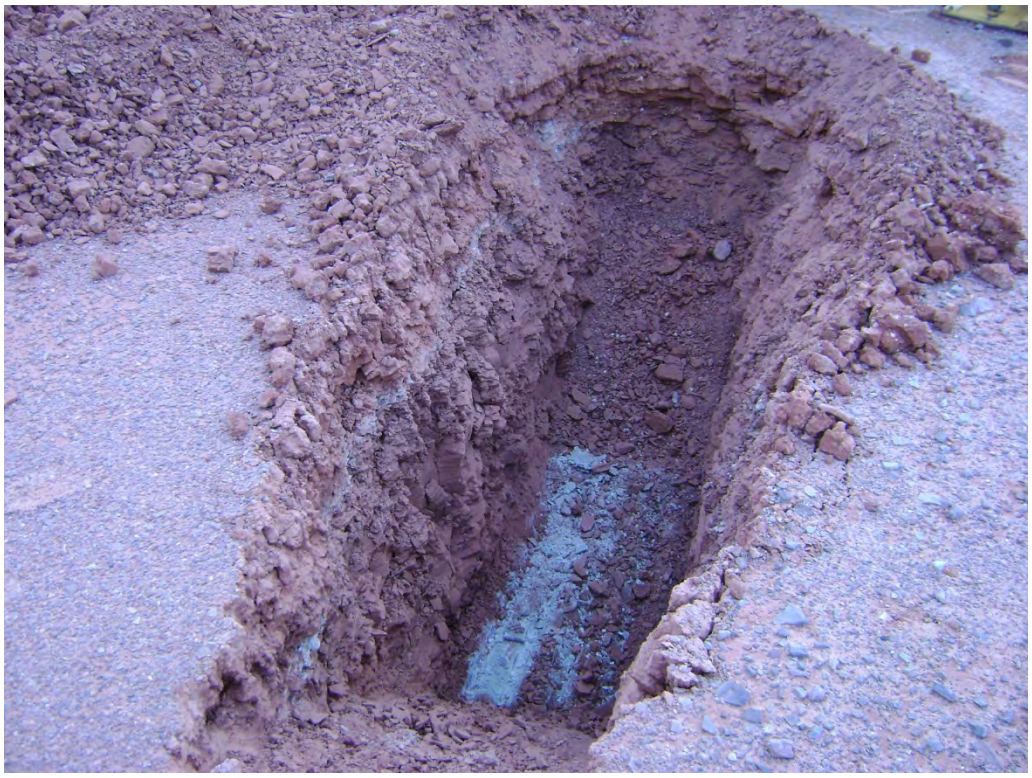
GRAIN SIZE DISTRIBUTION



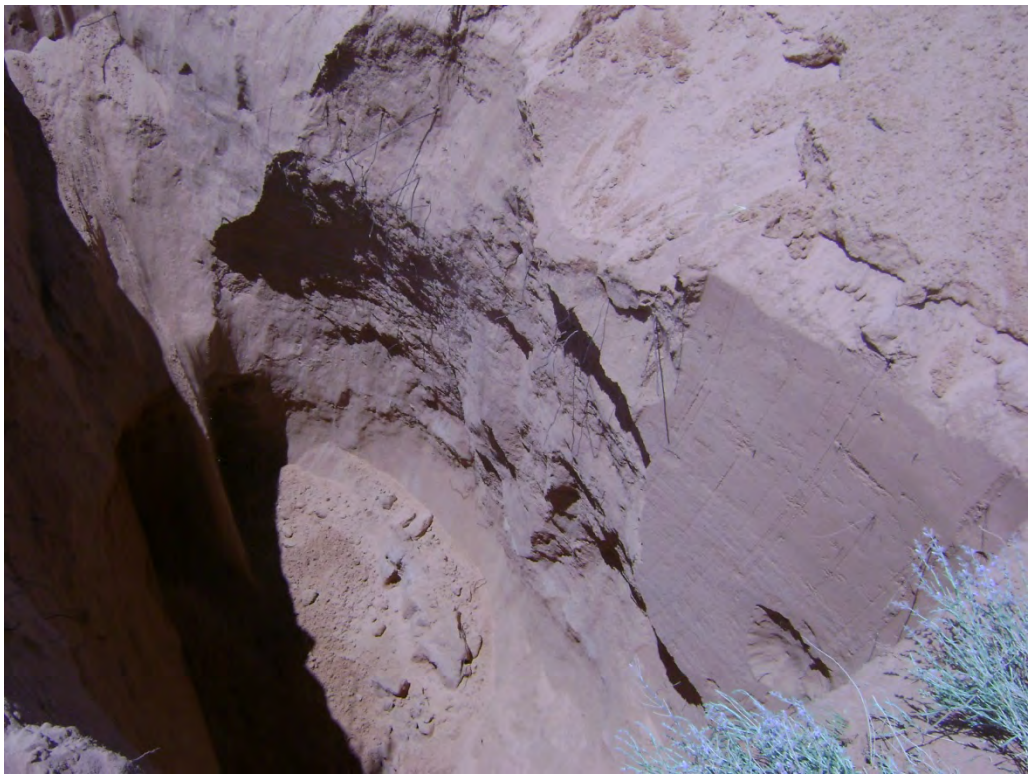
Unified Soil Classification: **SP-SM Poorly Graded Sand with Silt**

Sample Collected by: J. Fitzsimmons

0.0 % Gravel	Maximum Size: No. 16	In-place Dry Density:	99.4	lbm/ft³	D_{50}:	0.19 mm	0.007 in
94.8 % Sand	Moisture Content: 1.0 %	Lab. Max Dry Density:	105.4	lbm/ft³	C_U:	2.5	
5.2 % Fines	Liquid Limit:	Optimum Moisture:	14.9	%	C_C:	1.3	
% Oversize	Plasticity Index: Nonplastic						



Test pit TP-69 excavated from 0-4.5 ft. in mudstone interbedded with sandstone where the backhoe met refusal.



Test pit TP-70 excavated from 0.0-13.0 ft. in poorly graded sand with silt (SP-SM .



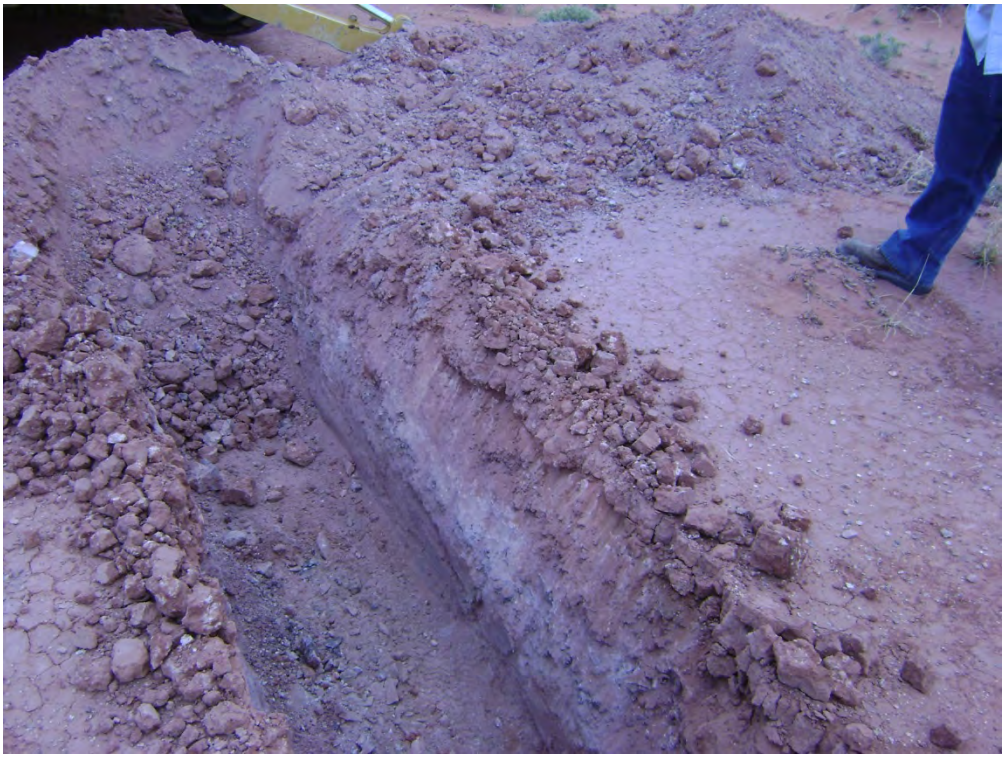
Test pit TP-71 excavated from 0.0 to 9.0 ft. in silty sand (SM) and from 9.0 to 9.5 ft. in mudstone where the backhoe met refusal.



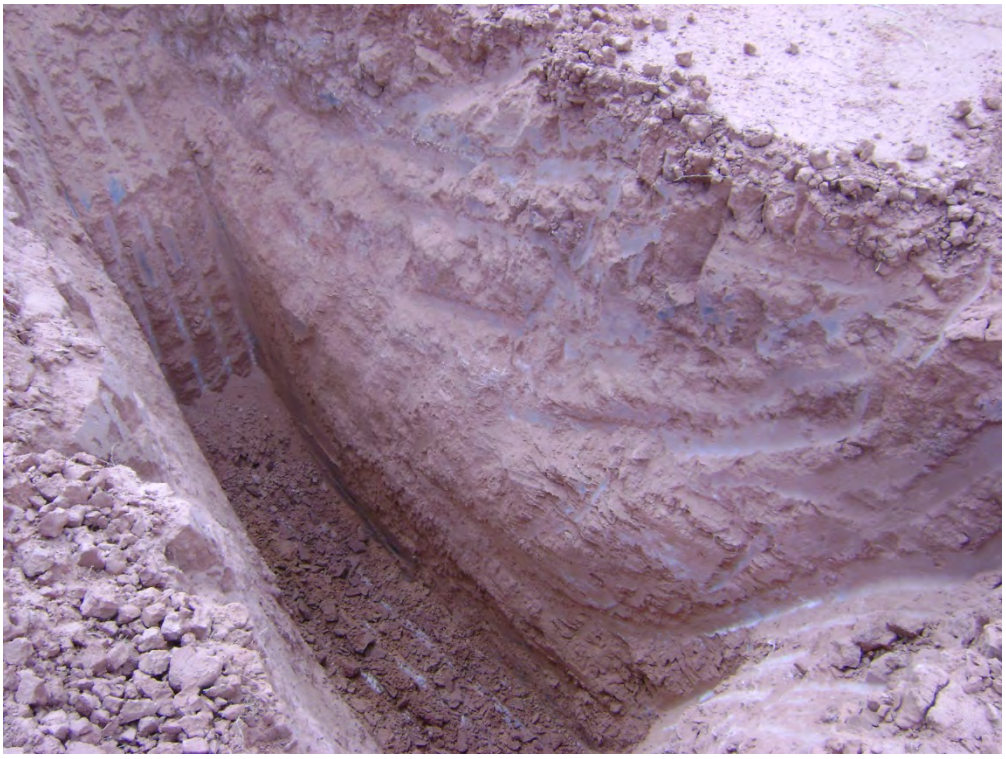
Test pit TP-72 excavated from 0.0-12.0 ft. in poorly graded sand with silt (SP-SM).



Test pit TP-73 excavated from 0.0-2.5 ft. in poorly graded sand with silt (SP-SM) and from 2.5-3.8 ft. in mudstone with interbedded sandstone where the backhoe met refusal.



Test pit TP-74 excavated from 0.0-0.9 ft. in poorly graded sand with silt (SP-SM) and from 0.9-2.4 ft. in sandstone where the backhoe met refusal.



Test pit TP-75 excavated from 0.0-8.6 ft. in silty sand (SM) and from 8.6-8.7 ft. in sandstone where the backhoe met refusal.



Test pit TP-76 excavated from 0.0 to 6.0 ft. in silty sand (SM) and from 6.0-6.5 ft. in sandstone where the backhoe met refusal.



Test pit TP-77 excavated from 0.0 to 5.5 ft. in silty sand (SM) and from 5.5-9.0 ft. in sandstone where the backhoe met refusal.



Test pit TP-78 excavated from 0.0 to 6.0 ft. in silty sand (SM). At 6.0 ft. the backhoe met refusal on sandstone.



Test pit TP-79 excavated from 0.0 to 7.7 ft. in silty sand (SM) and from 7.7-11.0.0 ft. in sandstone where the backhoe met refusal.



Test pit TP-80 excavated from 0.0 to 6.0 ft. in silty sand (SM) and from 6.0-9.0 ft. in sandstone where the backhoe met refusal.



Test pit TP-81 excavated from 0.0 to 9.5 ft. in poorly graded sand (SP). At 9.5 ft. the backhoe met refusal on sandstone.

North Central Arizona Water Supply Feasibility Study - Hopi Spur
Test Pit Investigations 2015

INTRODUCTION

The Bureau of Reclamation (Reclamation) is conducting a study to determine the feasibility of constructing the North Central Arizona Pipeline to deliver water from Lake Powell, south to Cameron, with laterals to Bitter Springs and Keams Canyon. The study is being funded under the Rural Water Act and is referred to as the North Central Arizona Water Supply Feasibility Study (NCAWSFS).

PREVIOUS INVESTIGATIONS

Reclamation performed eighty-nine seismic refraction surveys along portions of the proposed pipeline alignment in 2008, to determine the rippability of the material that would be encountered during construction. In order to calibrate the seismic refraction surveys with actual excavation conditions, seventeen test pits were excavated in specified areas that had already been surveyed. The proposed pipeline alignment was geologically mapped at a scale of 1 inch equals 10,000 feet. Rock types and their engineering characteristics were recorded at each seismic refraction survey site and at selected outcrops along the alignment. The report is titled "Proposed Western Navajo-Hopi Pipeline - Rippability of Materials Based on Seismic Wave Velocities". Drawings in the report give an indication of the rippability of the excavation based on the wave velocity and geologic mapping.

In June 2012, Reclamation excavated sixty-four test pits along portions of the proposed North Central Arizona Pipeline in order to determine the depth to bedrock and to obtain soil samples for materials testing. Test pits TP-1 through TP-48 were excavated along US Highway 89 or along the old US Highway 89, which runs parallel to US 89 (TP-17 was not excavated since bedrock was at the surface). Test pits TP-49 through TP-68 were excavated along Tribal Route 20 (Copper Mine Road) from The Gap to about 6 miles north of Coppermine Chapter. Test pits TP-64, TP-65 and TP-66 were omitted because bedrock was at or near the surface. The test pits were approximately 20 feet long by 6 feet wide and 13 to 15 feet deep unless the backhoe met refusal. The pits were visually classified by a Reclamation geologist and representative samples taken and sent to a lab for gradation sieve analysis, testing for moisture content, Atterberg limits, Proctor compaction pH, conductivity, and sulfate, sulfide and chloride content. Selected soils were tested for shrink/swell potential (expansion index) and in-place densities were measured using a sand cone apparatus in selected test pits at depths ranging from 3 to 5 feet. The report is titled "North Central Arizona Water Supply Feasibility Study - Test Pit Investigations 2012".

In May 2013, Reclamation excavated thirteen test pits along a 7-mile-long alignment extending from Moenave to Tuba City, Arizona, to determine the depth to bedrock and to obtain samples to conduct engineering soil tests. The test pits TP-69 through TP-81 were excavated in mostly wind deposited sand and ranged in depth from 2.4 to 13.0 feet deep. Pits were approximately 20 feet long by 4 to 8 feet wide and 13 feet deep unless the backhoe met refusal. The materials encountered were visually classified by a Reclamation geologist and representative soil samples sent to the Yuma Area Office's materials lab and tested for standard physical properties including gradations, moisture content, Atterberg limits and Proctor compaction in accordance with Reclamation Earth Manual laboratory standards. In-place density tests were conducted in

selected pits at a depth of 5 feet utilizing a sand cone apparatus. The report is titled "North Central Arizona Water Supply Feasibility Study - Tuba City Spur - Test Pit Investigations 2013".

CURRENT INVESTIGATION

Reclamation excavated twenty-one (21) test pits at specified sites along State Route 264 from east of Coalmine Chapter to Hotevilla, Arizona to determine the depth to bedrock and obtain samples and conduct engineering soil tests for a proposed water pipeline. Test pits are numbered TP-216 through TP-237 and were excavated from October 5 to October 7, 2015, to a depth of 13 feet or to refusal. TP-223 was not excavated due to its proximity to sandstone outcrop. The pits were located along State Road 264 within the Arizona Department of Transportation's right-of-way and were generally offset from the pipeline alignment by 60 to 100 feet.

Representative samples were collected and laboratory tested for standard physical properties including gradations, moisture content, Atterberg limits and Proctor compaction in accordance with Reclamation Earth Manual laboratory standards. In-place density tests were conducted in selected test pits at about 5 feet of depth utilizing a sand cone apparatus. Soil samples were taken from test pits TP-224, TP-227 and TP-235 and tested to determine the pH and resistivity of the soil for corrosion potential.

Photographs, test pit logs and test results follow this text. Test pit locations are shown on Figure 1. Test pit coordinates are given in Table 1.


Tuba City
Navajo Trail
160
264
TP-216
TP-217
TP-218
TP-219
TP-220
TP-221
TP-222
TP-224
TP-225
TP-226
TP-227
TP-228
TP-229
TP-230
TP-231
TP-232
TP-233
TP-234
TP-235
TP-236
TP-237
Howell Mesa
Hotevilla-Bacavi

Figure 1

Table 1. Test Pit Coordinates

TEST PIT	NAD83 GEOGRAPHIC		NAD83 UTM ZONE 12 (m)		AZ STATE PLANE CENTRAL		Approx.	SR 264
	Latitude (N)	Longitude (W)	Northing	Easting	Northing	Easting	Elev	MILEPOST
TP-216	35.982346	110.991512	3981990.4	500765.2	1814140	973710	5994	340.8
TP-217	35.975657	110.975059	3981248.8	502248.6	1811752	978601	6056	341.8
TP-218	35.969193	110.959097	3980532.3	503687.9	1809445	983347	6111	342.8
TP-219	35.962069	110.941646	3979742.9	505261.8	1806903	988537	6122	343.9
TP-220	35.953880	110.926827	3978835.6	506598.7	1803966	992953	6047	345.1
TP-221	35.943121	110.910734	3977643.5	508051.1	1800098	997756	5944	346.3
TP-222	35.935709	110.899490	3976822.3	509066.1	1797435	1001113	6071	347.1
TP-224	35.907522	110.882346	3973697.7	510616.2	1787227	1006297	6309	349.4
TP-225	35.913706	110.864651	3974385.7	512212.0	1789535	1011513	6332	350.6
TP-226	35.927257	110.855635	3975889.9	513023.2	1794496	1014129	6295	351.7
TP-227	35.960570	110.851772	3979585.3	513366.1	1806635	1015140	6133	354.0
TP-228	35.971210	110.829578	3980768.7	515365.3	1810581	1021665	5917	355.6
TP-229	35.969489	110.810914	3980580.9	517048.4	1810017	1027195	5845	356.7
TP-230	35.972644	110.781465	3980936.4	519702.9	1811265	1035896	5704	358.4
TP-231	35.974931	110.767279	3981193.0	520981.2	1812147	1040084	5733	359.2
TP-232	35.978818	110.743393	3981629.5	523133.6	1813646	1047135	5712	360.5
TP-233	35.981875	110.724927	3981973.1	524797.4	1814825	1052585	5711	361.6
TP-234	35.982055	110.705463	3981998.2	526552.0	1814962	1058343	5724	362.8
TP-235	35.969818	110.693742	3980644.2	527612.9	1810550	1061867	5775	363.8
TP-236	35.957770	110.684626	3979310.5	528439.1	1806198	1064620	5956	364.8
TP-237	35.946156	110.675799	3978025.0	529239.4	1802004	1067286	5967	365.1



Test pit TP-216 was excavated from 0 to 6 ft. in silty sand and from 6 to 12 ft. in sandstone. An in-place density was taken at 4 ft. utilizing a sand cone apparatus.



Test pit TP-217 was excavated from 0 to 3 ft. in sandy silt and from 3 to 12 ft. in easily excavatable sandstone.



Test pit TP-218 encountered shale from the Mancos Shale Formation at 3 ft.



Test pit TP-219 was excavated from 0 to 3 ft. in weakly cemented clayey sand, from 3 to 6 ft. in strongly cemented silty sand and from 6 to 11 ft. in soft sandstone.



Test pit TP-220 encountered shale from the Mancos Shale Formation from 7.5 to 12 ft.



Test pit TP-221encountered silty sand from 0 to 7.5 ft. and shale from 7.5 to 10.5 ft. where the backhoe met refusal.



Test pit TP-222 was excavated from 0 to 11 ft. in silty sand and from 11 to 12 ft. in shale and interbedded siltstone from the Mancos Shale Formation.



Shale outcrops from the Mancos Shale Formation located north of test pit TP-222.



Test pit TP-224 located on a gentle slope within ADOT's ROW.



Test pit TP-224 encountered silty sand from 0 to 4.8 ft. and soft mudstone from the Toreva Formation of the Mesaverde Group from 4.8 to 10 ft. where it was terminated at the reach of the backhoe.



Test pit TP-225 was excavated from 0 to 8 ft. in silty sand and from 8 to 11 ft. in soft mudstone from the Toreva Formation of the Mesaverde Group.



TP-226 encountered silty sand from 0 to 5.5 ft. and sandstone and mudstone from 5.5 to 10. 5 ft.



Test pit TP-227 encountered silty sand from 0 to 6 ft. and shale with interbedded siltstone from 6 to 12 ft.



Test pit TP-229 showing the interbedded siltstone, sandstone and coal of the Dakota Sandstone Formation encountered from 4 to 11.5 ft.



Test pit TP-230 was excavated within ADOT's ROW and encountered sandy lean clay from 0 to 11 ft.



Test pit TP-233 encountered sandy lean clay from 0 to 11 ft. Shale outcrops of the Mancos Shale Formation can be seen in the background.



View of sandstone outcrop from the Lower Sandstone Member of the Toreva Formation, Mesaverde Group. TP-236, located in the middle ground of the photo, encountered shale from the Mancos Shale Formation indicating the contact between the two units is located near the base of the cliff.



Dinnebito Wash located near test pit TP-234.

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-216**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1814140 **E.** 973710 **GROUND ELEVATION:** 5994

APPROXIMATE DIMENSIONS: 15' x 6' x 12' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/5/2015 **DATE LOGGED:** 10/5/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class. Lab sample taken from 0.0-6.0 ft. SM Lab Class. **6.0 ft.**	**0.0 - 6.0 ft. Silty Sand (SM):** About 65% predominantly fine to coarse sand, 35% nonplastic fines with high dry strength, rapid dilatancy and low toughness, trace of gravel. Max. size, 1 inch. Strong reaction with HCl. In-place condition: hard consistency, homogenous, dry, weak cementation. Thin stringers (1/16 to 1/8 inch thick) of $CaCO_3$ present. Color is yellowish brown. Lab test data from 0.0-6.0 ft.: Lab classification is Silty Sand (SM): 64% sand, 36% fines, trace of gravel. Nonplastic; Field Moisture = 4.7%. Proctor Test (max. dry density) = 121.5 lbm/ft^3; Optimum Moisture = 10.9%. In-Place Density taken at 4.0 ft. with sand cone apparatus = 101.6 lbm/ft^3. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
Ss Visual Class. **12.0 ft.**	**6.0 - 12.0 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand cemented with silica. Intensely weathered and soft, fragments crumble with manual pressure. Becomes slightly harder with depth. No reaction with HCl. Color is grayish orange (10YR 7/4). A few rounded gravels present in the last bucket. The sandstone is part of the conglomerate and sandstone sequence mapped as Tsy and deposited on top of the Mancos Shale Formation **Geologic Interpretation:** Pliocene to Mid-Miocene Deposits (Tsy)			

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-217**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1811752 **E.** 978601 **GROUND ELEVATION:** 6056

APPROXIMATE DIMENSIONS: 15' x 3' x 12' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/5/2015 **DATE LOGGED:** 10/5/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
s(ML) Visual Class.	**0.0 - 3.0 ft. Sandy Silt s(ML):** About 50% nonplastic fines with high dry strength, rapid dilatancy and low toughness, 50% predominantly fine to coarse sand, trace of gravel. Max. size, 3/4 inch. Strong reaction with HCl. In-place condition: hard consistency, homogenous, dry, Thin stringers (1/16 to 1/8 inch thick) of $CaCO_3$ present. Color is yellowish brown.	0	0	0
Lab sample taken from 0.0-3.0 ft. s(ML) Lab Class.	Lab test data from 0.0-3.0 ft.: Lab classification is Sandy Silt s(ML): 51% fines, 49% sand, trace of gravel. Liquid Limit (LL) = 21.1; Plasticity Index (PI) = 2.3; Field Moisture = 4.7%. Proctor Test (max. dry density) = 121.8 lbm/ft^3; Optimum Moisture = 11.7%.			
3.0 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
Ss Visual Class. \	**3.0 - 12.0 ft. Sandstone (Ss):** Sandstone consists of predominately coarse sand partially cemented with $CaCO_3$. $CaCO_3$ makes up to 30% of the material by volume. Intensely weathered and soft, most fragments crumble with manual pressure. Becomes slightly harder with depth. Strong reaction with HCl. Color is grayish orange (10YR 7/4) to grayish pink (5R 8/2). Rounded to angular gravels up to 3-inches in diameter present in excavated material, but not seen in sandstone fragments. Interval easily excavated by backhoe. The sandstone is part of the conglomerate and sandstone sequence mapped as Tsy and deposited on top of the Mancos Shale Formation			
12.0 ft.	**Geologic Interpretation:** Pliocene to Mid-Miocene Deposits (Tsy)			

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-218**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1809445 **E.** 983347 **GROUND ELEVATION:** 6111

APPROXIMATE DIMENSIONS: 15' x 3' x 6.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/5/2015 **DATE LOGGED:** 10/5/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class. . **3.0 ft.**	**0.0 - 3.0 ft. Silty Sand (SM):** About 60% predominantly fine to coarse sand, 40% nonplastic fines with high dry strength, rapid dilatancy and low toughness, trace of gravel. Max. size, 1 inch. Strong reaction with HCl. In-place condition: hard consistency, homogenous, dry, weak cementation. Thin stringers (1/16 to 1/8 inch thick) of $CaCO_3$ present. Color is yellowish brown. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
Sh Visual Class. **6.5 ft.**	**3.0 - 6.5 ft. Shale (Sh):** Shale with interbedded siltstone. Shale is a very fine-grained, clastic sedimentary rock composed of silt- to clay-sized particles. The shale is intensely weathered and soft, fragments crumble with manual pressure. Laminated, bedding less than 3/8 inch thick and fissile. Color is light brownish gray (5YR 6/1). Encountered siltstone layers at about 5 feet; siltstone is very fine-grained, moderately soft to moderately hard, some fragments break with heavy manual pressure. Very thinly bedded, bedding ½ to 1 inch thick. Color is pale grayish orange (10YR 8/4). **Geologic Interpretation:** Mancos Shale (Km)			

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336
Bureau of Reclamation

LOG OF TEST PIT OR AUGER HOLE

HOLE NO. TP-219

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1806903 **E.** 988537 **GROUND ELEVATION:** 6122

APPROXIMATE DIMENSIONS: 15' x 6' x 11' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/5/2015 **DATE LOGGED:** 10/5/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	CLASSIFICATION AND DESCRIPTION OF MATERIAL SEE USBR 5000, 5005	% PLUS 3 in (75 mm) BY VOLUME		
		3 – 5 in	5 – 12 in	PLUS 12 in
SC Visual Class. Lab sample taken from 0.0-6.0 ft. SC Lab Class. **3.0 ft.**	**0.0 - 3.0 ft. Clayey Sand (SC):** About 60% predominantly fine to coarse sand, 40% fines with low plasticity, high dry strength, slow dilatancy and low toughness, trace of gravel. Max. size, 1 inch. Strong reaction with HCl. In-place condition: firm consistency, homogenous, dry, weak cementation. Color is reddish brown. Lab test data from 0.0-3.0 ft.: Lab classification is Clayey Sand (SC): 60% sand, 40% fines, trace of gravel. Liquid Limit (LL) = 20.0; Plasticity Index (PI) = 8.1; Field Moisture = 4.3%. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
SM Visual Class. Lab sample taken from 3.0-6.0 ft. SM Lab Class. **6.0 ft.**	**3.0 - 6.0 ft. Silty Sand (SM):** About 70% fine to coarse sand, 20% nonplastic fines with high dry strength, rapid dilatancy and low toughness, 10% predominantly fine to coarse gravel. Max. size, 1 inch. Strong reaction with HCl. In-place condition: hard consistency, homogenous, dry, strong cementation. Thin stringers (1/16 to 1/8 inch thick) of $CaCO_3$ present. From about 4 to 6 feet, material is strongly cemented with caliche ($CaCO_3$). Color is reddish brown. Lab test data from 3.0-6.0 ft.: Lab classification is Silty Sand (SM): 74% sand, 18% fines, 8% gravel. Nonplastic. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
Ss Visual Class. **11.0 ft.**	**6.0 - 11.0 ft. Sandstone (Ss):** Sandstone consists of fine to predominantly coarse, subrounded sand, fine to coarse gravel and a trace of fine cobbles weakly cemented with $CaCO_3$. Intensely weathered and soft, fragments crumble with manual pressure. Becomes slightly harder with depth. No reaction with HCl. Color is grayish orange (10YR 7/4). The sandstone is part of the conglomerate and sandstone sequence mapped as Tsy and deposited on top of the Mancos Shale Formation **Geologic Interpretation:** Pliocene to Mid-Miocene Deposits (Tsy)			

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-220**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1803966 **E.** 992953 **GROUND ELEVATION:** 6071

APPROXIMATE DIMENSIONS: 15' x 6' x 12.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/5/2015 **DATE LOGGED:** 10/5/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class. Lab sample taken from 0.0-4.0 ft. SM Lab Class. **7.5 ft.**	**0.0 - 7.5 ft. Silty Sand (SM):** About 85% predominantly fine to coarse sand and 15% nonplastic fines with high dry strength, rapid dilatancy and low toughness. Max. size, coarse sand. Strong reaction with HCl. In-place condition: loose at the surface becoming firm consistency with depth, homogenous, dry, no to weak cementation. Color is light reddish brown. Lab test data from 0.0-4.0 ft.: Lab classification is Silty Sand (SM): 87% sand, 13% fines. Nonplastic; Field Moisture = 2.4%. Proctor Test (max. dry density) = 116.9 lbm/ft^3; Optimum Moisture = 9.8%. In-Place Density taken at 3.8 ft. with sand cone apparatus = 104.1 lbm/ft^3. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
Sh Visual Class. **12.0 ft.**	**7.5 - 12.0 ft. Shale (Sh):** Shale is a very fine-grained, clastic sedimentary rock composed of silt- to clay-sized particles. The shale is moderately weathered and soft, fragments crumble with manual pressure. Laminated, bedding less than 3/8 inch thick and fissile. Color is light bluish gray (5B 7/1) to light brownish gray (5YR 6/1). $CaCO_3$ crystals and thin stringers present, especially in the upper 3 feet. **Geologic Interpretation:** Mancos Shale (Km)			

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-221**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1800098 **E.** 997756 **GROUND ELEVATION:** 5944

APPROXIMATE DIMENSIONS: 15' x 3' x 10.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/6/2015 **DATE LOGGED:** 10/6/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class. Lab sample taken from 4.0-7.5 ft. SM Lab Class. **7.5 ft.**	**0.0 - 7.5 ft. Silty Sand (SM):** About 85% predominantly fine to coarse sand and 15% nonplastic fines with high dry strength, rapid dilatancy and low toughness. Max. size, coarse sand. Strong reaction with HCl. In-place condition: loose at the surface becoming firm consistency with depth, homogenous, dry, no to weak cementation. Color is light reddish brown. Lab test data from 4.0-7.5 ft.: Lab classification is Silty Sand (SM): 85% sand, 15% fines. Nonplastic; Field Moisture = 1.8%. Proctor Test (max. dry density) = 117.4 lbm/ft^3; Optimum Moisture = 12.9%. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
Sh Visual Class. **10.5 ft.**	**7.5 - 10.5 ft. Shale (Sh):** Shale with interbedded siltstone. Shale is a very fine-grained, clastic sedimentary rock composed of silt- to clay-sized particles. The shale is moderately weathered and soft, fragments crumble with manual pressure. Laminated, bedding less than 3/8 inch thick and fissile. Color is medium light gray (N6). Interbedded siltstone is very fine-grained, moderately soft to moderately hard, some fragments break with heavy manual pressure others require light hammer blow to break. Very thinly bedded, bedding ½ to 1 inch thick. Color is pinkish gray (5YR 8/1). **Geologic Interpretation:** Mancos Shale (Km)			

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-222

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1797435 **E.** 1001113 **GROUND ELEVATION:** 6071

APPROXIMATE DIMENSIONS: 15' x 3' x 12.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/6/2015 **DATE LOGGED:** 10/6/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class.	**0.0 - 11.0 ft. Silty Sand (SM):** About 80% predominantly fine to coarse sand, 20% nonplastic fines with high dry strength, rapid dilatancy and low toughness, trace of gravel. Max. size, 1 inch. Strong reaction with HCl. In-place condition: loose at the surface developing a very hard consistency with depth, homogenous, dry, no cementation at surface becoming strongly cemented with depth. From 3.5 to 4.5 ft. and 10.0 to 11.0 ft. material is well cemented with caliche ($CaCO_3$) and hard to dig. Color is light reddish brown.	0	0	0
Lab sample taken from 4.0-10.0 ft. SM Lab Class.	Lab test data from 4.0-10.0 ft.: Lab classification is Silty Sand (SM): 82% sand, 11% fines, trace of gravel. Nonplastic; Field Moisture = 2.7%. Proctor Test (max. dry density) = 118.0 lbm/ft^3; Optimum Moisture = 10.4%.			
11.0 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
Sh Visual Class.	**11.0 - 12.0 ft. Shale (Sh):** Shale with interbedded siltstone. Shale is a very fine-grained, clastic sedimentary rock composed of silt- to clay-sized particles. The shale is moderately weathered and soft, fragments crumble with manual pressure. Laminated, bedding less than 3/8 inch thick and fissile. Color is medium light gray (N6). Interbedded siltstone is very fine-grained, moderately soft to moderately hard, some fragments break with heavy manual pressure others require light hammer blow to break. Very thinly bedded, bedding ½ to 1 inch thick. Color is pinkish gray (5YR 8/1).			
12.0 ft.	**Geologic Interpretation:** Mancos Shale (Km)			

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at reach of equipment, but material becoming hard to excavate.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-224**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1787227 **E.** 1006297 **GROUND ELEVATION:** 6309

APPROXIMATE DIMENSIONS: 15' x 6' x 10.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/6/2015 **DATE LOGGED:** 10/6/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class.	**0.0 - 4.8 ft. Silty Sand (SM):** About 80% predominantly fine to coarse sand, 20% nonplastic fines with high dry strength, rapid dilatancy and low toughness, trace of gravel. Max. size, 1 inch. Strong reaction with HCl. In-place condition: loose at the surface developing a very hard consistency with depth, homogenous, dry, no cementation at surface becoming strongly cemented with depth. From 3.5 to 4.5 ft. and 10.0 to 11.0 ft. material is well cemented with caliche ($CaCO_3$) and hard to dig. Color is light reddish brown.	0	0	0
Lab sample taken from 0.0-4.8 ft. SM Lab Class.	Lab test data from 0.0-4.8 ft.: Lab classification is Silty Sand (SM): 86% sand, 14% fines. Nonplastic; Field Moisture = 4.3%. Proctor Test (max. dry density) = 118.4 lbm/ft^3; Optimum Moisture = 9.4%. In-Place Density taken at 4.0 ft. with sand cone apparatus = 117.6 lbm/ft^3. Corrosion Potential Testing 0.0-4.8 ft.: pH = 8.7, Resistivity = 8,224 ohm/cm.			
4.8 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
Mdst Visual Class.	**4.8 - 10.0 ft. Mudstone (Mdst):** Mudstone with interbedded siltstone. Mudstone is a very fine-grained, clastic sedimentary rock composed of silt- to clay-sized particles. Mudstone is moderately weathered and soft, fragments crumble with manual pressure. Bedding not apparent. Color is medium light gray (N6).			
10.0 ft.	**Geologic Interpretation:** Mesaverde Group, Toreva Formation, Middle Member (Kmv)			

REMARKS: **S**urface: slight slope within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-225

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1789535 **E.** 1011513 **GROUND ELEVATION:** 6332

APPROXIMATE DIMENSIONS: 15' x 3' x 11.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/6/2015 **DATE LOGGED:** 10/6/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class. Lab sample taken from 0.0-8.0 ft. SM Lab Class. **8.0 ft.**	**0.0 - 8.0 ft. Silty Sand (SM):** About 80% predominantly fine to coarse sand, 20% nonplastic fines with high dry strength, rapid dilatancy and low toughness, trace of gravel. Max. size, 1 inch. From 0.0-4.0 ft. no reaction with HCl; from 4.0-4.5 ft. strong reaction with HCl. In-place condition: loose at the surface developing a very hard consistency with depth, homogenous, dry, no cementation at surface becoming strongly cemented with depth. From 4.0-4.5 ft. material is well cemented with caliche ($CaCO_3$) and hard to dig. Color is reddish brown. Lab test data from 0.0-8.0 ft.: Lab classification is Silty Sand (SM): 84% sand, 16% fines, trace of gravel. Nonplastic; Field Moisture = 2.2%. Proctor Test (max. dry density) = 117.1 lbm/ft^3; Optimum Moisture = 10.6%. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
Mdst Visual Class. **11.0 ft.**	**8.0 - 11.0 ft. Mudstone (Mdst):** Mudstone is a very fine-grained, clastic sedimentary rock composed of silt- to clay-sized particles. Mudstone is moderately weathered and soft, fragments crumble with manual pressure. Bedding not apparent. From 8.0-8.5 ft. mudstone is laced with $CaCO_3$ veins up to ¾ inch thick. Strong reaction with HCl. Color is medium light gray (N6). **Geologic Interpretation:** Mesaverde Group, Toreva Formation, Middle Member (Kmv)			

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-226

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1794496 **E.** 1014129 **GROUND ELEVATION:** 6295

APPROXIMATE DIMENSIONS: 15' x 3' x 10.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/6/2015 **DATE LOGGED:** 10/6/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class.	**0.0 - 5.5 ft. Silty Sand (SM):** About 80% predominantly fine to coarse sand, 20% nonplastic fines with high dry strength, rapid dilatancy and low toughness, trace of gravel. Max. size, 1 inch. From 0.0-2.5 ft. no reaction with HCl; from 2.5-5.5 ft. strong reaction with HCl. In-place condition: loose at the surface developing a very hard consistency with depth, homogenous, dry, no cementation at surface becoming strongly cemented with depth. From 2.5-5.5 ft. material is well cemented with caliche ($CaCO_3$). Color is reddish brown.	0	0	0
5.5 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
Ss Visual Class.	**5.5 - 6.0 ft. Sandstone (Ss):** Sandstone consists of predominately coarse sand partially cemented with $CaCO_3$. Very intensely weathered and very soft, fragments crumble with manual pressure. Strong reaction with HCl. Color is grayish orange (10YR 7/4).			
6.0 ft.	**Geologic Interpretation:** Mesaverde Group, Toreva Formation, Middle Member (Kmv)			
Mdst Visual Class.	**6.0 - 10.5 ft. Mudstone (Mdst):** Mudstone is a very fine-grained, clastic sedimentary rock composed of silt- to clay-sized particles. Mudstone is moderately weathered and soft, fragments crumble with manual pressure. Bedding not apparent. From 9.5-10.5 ft. mudstone is iron oxide stained and rusty colored. Color is medium light gray (N6).			
10.5 ft.	**Geologic Interpretation:** Mesaverde Group, Toreva Formation, Middle Member (Kmv)			

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-227

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1806635 **E.** 1015140 **GROUND ELEVATION:** 6133

APPROXIMATE DIMENSIONS: 15' x 3' x 12.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/6/2015 **DATE LOGGED:** 10/6/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class.	**0.0 - 6.0 ft. Silty Sand (SM):** About 80% predominantly fine to coarse sand, 20% nonplastic fines with high dry strength, rapid dilatancy and low toughness, trace of gravel. Max. size, 3/4 inch. Strong reaction with HCl. In-place condition: loose at the surface developing a very hard consistency with depth, homogenous, dry, no cementation at surface becoming strongly cemented with depth. From 3.0-6.0 ft. material is well cemented with caliche ($CaCO_3$). Color is reddish brown.	0	0	0
6.0 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
Sh Visual Class.	**6.0 - 12.0 ft. Shale (Sh):** Shale with interbedded siltstone. Shale is a very fine-grained, clastic sedimentary rock composed of silt- to clay-sized particles. The shale is intensely weathered and soft, fragments crumble with manual pressure. Laminated, bedding less than 3/8 inch thick and fissile. Color is grayish orange (10YR 7/4). Interbedded siltstone is very fine-grained, moderately soft to moderately hard, some fragments break with heavy manual pressure. Very thinly bedded, bedding is 1/4 to ½ to inch thick. Color is pale grayish orange (10YR 8/4). Corrosion Potential Testing 6.0-10.0 ft.: pH = 8.0, Resistivity = 423ohm/cm.			
12.0 ft.	**Geologic Interpretation:** Mancos Shale (Km)			

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-228

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1810581 **E.** 1021665 **GROUND ELEVATION:** 5917

APPROXIMATE DIMENSIONS: 15' x 3' x 9.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/6/2015 **DATE LOGGED:** 10/6/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class.	**0.0 - 6.0 ft. Silty Sand (SM):** About 80% predominantly fine to coarse sand, 20% nonplastic fines with high dry strength, rapid dilatancy and low toughness, trace of gravel. Max. size, 3/4 inch. Strong reaction with HCl. In-place condition: loose at the surface developing a very hard consistency with depth, homogenous, dry, no cementation at surface becoming strongly cemented with depth. From 3.0-6.0 ft. material is well cemented with caliche ($CaCO_3$). Color is light reddish brown.	0	0	0
6.0 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
Ss Visual Class.	**6.0 - 9.0 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand cemented with silica and iron oxide. Moderately weathered and soft to moderately soft, fragments break with manual pressure. Becomes slightly harder with depth. No reaction with HCl. Bedding not discernible in pit walls, but probably 1-3 inches thick (seen in outcrop). Iron oxide stained. Color is pale grayish orange (10YR 8/4).			
9.0 ft.	**Geologic Interpretation:** Dakota Sandstone (Kd)			

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-229**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1810017 **E.** 1027195 **GROUND ELEVATION:** 5845

APPROXIMATE DIMENSIONS: 15' x 3' x 11.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/6/2015 **DATE LOGGED:** 10/6/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SC-SM Visual Class.	**0.0 - 4.0 ft. Silty Clayey Sand (SC-SM):** About 55% predominantly fine to coarse sand, 45% fines with low plasticity, high dry strength, slow dilatancy and low toughness, trace of gravel. Max. size, 1 inch. Strong reaction with HCl. In-place condition: loose at the surface developing a very hard consistency with depth, homogenous, dry, no cementation at surface becoming strongly cemented with depth. From 3.0-6.0 ft. material is well cemented with caliche ($CaCO_3$). Color is light brown.	0	0	0
Lab sample taken from 0.0-4.0 ft. SC-SM Lab Class.	Lab test data from 0.0-4.0 ft.: Lab classification is Silty Clayey Sand (SM): 53% sand, 47% fines, trace of gravel. Liquid Limit (LL) = 21.8; Plasticity Index (PI) = 5.4; Field Moisture = 5.2%. Proctor Test (max. dry density) = 118.2 lbm/ft^3; Optimum Moisture = 12.3%.			
4.0 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
Sh Visual Class.	**4.0 - 11.5 ft. Shale (Sh):** Shale with interbedded siltstone, sandstone and coal. Shale is a very fine-grained, clastic sedimentary rock composed of silt- to clay-sized particles. The shale is intensely weathered and soft, fragments crumble with manual pressure. Laminated, bedding less than 3/8 inch thick and fissile. Color is medium dark gray (N4). Interbedded siltstone is very fine-grained, moderately soft to moderately hard, some fragments break with heavy manual pressure. Very thinly bedded, bedding is 1/4 to ½ to inch thick. Color is grayish orange (10YR 7/4). Sandstone consists of predominately fine sand cemented with $CaCO_3$. Moderately weathered and soft to moderately soft, fragments break with manual pressure. Color is pale grayish orange (10YR 8/4). Coal occurs as very thin, intermittent layers.			
11.5 ft.	**Geologic Interpretation:** Dakota Sandstone, Middle Carbonaceous Member (Kd)			

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-230**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1811265 **E.** 1035896 **GROUND ELEVATION:** 5704

APPROXIMATE DIMENSIONS: 15' x 3' x 11.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/6/2015 **DATE LOGGED:** 10/6/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
s(CL) Visual Class.	**0.0 - 11.0 ft. Sandy Lean Clay s(CL):** About 55% fines with medium plasticity, high dry strength, slow dilatancy and low toughness, 45% predominantly fine to coarse sand. Max. size, coarse sand. Strong reaction with HCl. In-place condition: loose at the surface developing a very hard consistency with depth, homogenous, dry, no cementation at surface becoming strongly cemented with depth. Material becomes sandier near the bottom of the excavation. Color is pinkish gray.	0	0	0
Lab sample taken from 0.0-6.0 ft. s(CL) Lab Class.	Lab test data from 0.0-6.0 ft.: Lab classification is Sandy Lean Clay s(CL): 52% fines, 48% sand. Liquid Limit (LL) = 24.7; Plasticity Index (PI) = 13.2; Field Moisture = 6.6%. Proctor Test (max. dry density) = 119.6 lbm/ft^3; Optimum Moisture = 12.8%.			
11.0 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-231**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1812147 **E.** 1040084 **GROUND ELEVATION:** 5733

APPROXIMATE DIMENSIONS: 15' x 6' x 12.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/6/2015 **DATE LOGGED:** 10/6/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class. Lab sample taken from 0.0-4.5 ft. SM Lab Class. **12.0 ft.**	**0.0 - 12.0 ft. Silty Sand (SM):** About 55% predominantly fine to coarse sand, 45% nonplastic fines with high dry strength, rapid dilatancy and low toughness. Max. size, coarse sand. Strong reaction with HCl. In-place condition: loose at the surface developing a very hard consistency with depth, homogenous, dry, no cementation at surface becoming variably cemented with depth. Color is very pale brown. Lab test data from 0.0-4.5 ft.: Lab classification is Silty Sand (SM): 55% sand, 45% fines. Nonplastic; Field Moisture = 3.6%. Proctor Test (max. dry density) = 116.5 lbm/ft^3; Optimum Moisture = 12.9%. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-232

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1813646 **E.** 1047135 **GROUND ELEVATION:** 5712

APPROXIMATE DIMENSIONS: 15' x 6' x 13.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/7/2015 **DATE LOGGED:** 10/7/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SC/CL Visual Class. Lab sample taken from 0.0-4.5 ft. SC/CL Lab Class. **13.0 ft.**	**0.0 - 13.0 ft. Clayey Sand (SC/CL):** About 50% predominantly fine to coarse sand, 50% fines with medium to low plasticity, high dry strength, slow dilatancy and medium toughness, trace of fine to coarse gravel. Max. size, 1 inch. Strong reaction with HCl. At about 8.0 ft. encountered a discontinuous layer of sandstone cobbles from 0.3-1.0 ft. in diameter . In-place condition: loose at the surface developing a very hard consistency with depth, homogenous, dry, no cementation at surface becoming weakly cemented with depth; easily excavated. Color is very pale brown. Lab test data from 0.0-4.5 ft.: Lab classification is Clayey Sand (SC/CL): 51% sand, 49% fines, trace of gravel. Liquid Limit (LL) = 22.3; Plasticity Index (PI) = 9.3; Field Moisture = 4.3%. Proctor Test (max. dry density) = 118.9 lbm/ft^3; Optimum Moisture = 12.4%. In-Place Density taken at 4.5 ft. with sand cone apparatus = 90.8 lbm/ft^3. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336
Bureau of Reclamation

LOG OF TEST PIT OR AUGER HOLE

HOLE NO. TP-233

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1814825 **E.** 1052585 **GROUND ELEVATION:** 5711

APPROXIMATE DIMENSIONS: 15' x 3' x 11.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/7/2015 **DATE LOGGED:** 10/7/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
s(CL) Visual Class. Lab sample taken from 0.0-7.0 ft. s(CL) Lab Class. **11.0 ft.**	**0.0 - 11.0 ft. Sandy Lean Clay s(CL):** About 65% fines with medium to low plasticity, high dry strength, slow dilatancy and medium toughness, 35% predominantly fine to coarse sand, trace of fine gravel. Max. size, 1/2 inch. Strong reaction with HCl. In-place condition: loose at the surface developing a very hard consistency with depth, homogenous, dry, no cementation at surface becoming strongly cemented with depth. From 5.5- 6.0 ft. $CaCO_3$ veinlets up to 1/8 inch present. Below 7.0 ft, caliche ($CaCO_3$). Color is very pale brown. Lab test data from 0.0-7.0 ft.: Lab classification is Sandy Lean Clay s(CL): 64% fines, 36% sand, trace of gravel. Liquid Limit (LL) = 23.6; Plasticity Index (PI) = 12.1; Field Moisture = 5.3%. Proctor Test (max. dry density) = 115.1 lbm/ft^3; Optimum Moisture = 13.8%. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** **TP-234**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1814962 **E.** 1058343 **GROUND ELEVATION:** 5724

APPROXIMATE DIMENSIONS: 15' x 3' x 13.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/7/2015 **DATE LOGGED:** 10/7/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(CL)s Visual Class. Lab sample taken from 0.0-13.0 ft. (CL)s Lab Class. **13.0 ft.**	**0.0 - 13.0 ft. Lean Clay with Sand (CL)s:** About 75% fines with medium to low plasticity, high dry strength, slow dilatancy and medium toughness, 25% predominantly fine to coarse sand. Max. size, coarse sand. Strong reaction with HCl. In-place condition: loose at the surface developing a very hard consistency with depth, homogenous, dry, no cementation at surface becoming strongly cemented with depth. Color is very pale brown. Lab test data from 0.0-13.0 ft.: Lab classification is Lean Clay with Sand (CL)s): 76% fines, 25% sand. Liquid Limit (LL) = 33.8; Plasticity Index (PI) = 21.1; Field Moisture = 9.0%. Proctor Test (max. dry density) = 109.9 lbm/ft^3; Optimum Moisture = 16.4%. **Geologic Interpretation:** Quaternary Alluvium	0	0	0

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-235**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1810550 **E.** 1061867 **GROUND ELEVATION:** 5775

APPROXIMATE DIMENSIONS: 15' x 6' x 15.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/7/2015 **DATE LOGGED:** 10/7/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class.	**0.0 - 15.0 ft. Silty Sand (SM):** About 75% predominantly fine to coarse sand, 25% nonplastic fines with high dry strength, rapid dilatancy and low toughness, trace of fine to coarse gravel. Max. size, 1 inch. Strong reaction with HCl. In-place condition: loose at the surface developing a very hard consistency with depth, homogenous, dry, no cementation at surface becoming moderately cemented with depth. Color is very pale brown.	0	0	0
Lab sample taken from 0.0-5.0 ft. SM Lab Class.	Lab test data from 0.0-5.0 ft.: Lab classification is Silty Sand (SM): 78% sand, 22% fines, trace of gravel. Nonplastic; Field Moisture = 2.3%. Proctor Test (max. dry density) = 121.0 lbm/ft^3; Optimum Moisture = 12.6%. In-Place Density taken at 4.0 ft. with sand cone apparatus = 100.4 lbm/ft^3.			
15.0 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-236**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1806198 **E.** 1064620 **GROUND ELEVATION:** 5956

APPROXIMATE DIMENSIONS: 15' x 3' x 13.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/7/2015 **DATE LOGGED:** 10/7/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SP-SM Visual Class. Lab sample taken from 0.0-7.0 ft. SP-SM Lab Class. **8.0 ft.**	**0.0 - 8.0 ft. Poorly Graded Sand with Silt (SP-SM):** About 90% predominantly fine to coarse sand and 10% nonplastic fines with high dry strength, rapid dilatancy and low toughness, trace of fine to coarse gravel. Max. size, 1 inch. No reaction with HCl. In-place condition: loose, soft consistency, homogenous, dry, no cementation. Color is light reddish brown. Lab test data from 0.0-7.0 ft.: Lab classification is Poorly Graded Sand with Silt (SP-SM): 88% sand, 12% fines, trace of gravel. Nonplastic. Proctor Test (max. dry density) = 109.9 lbm/ft^3; Optimum Moisture = 10.2%. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
Sh Visual Class. **13.5 ft.**	**8.0 - 13.5 ft. Shale (Sh):** Shale with interbedded siltstone and sandstone. Shale is a very fine-grained, clastic sedimentary rock composed of silt- to clay-sized particles. The shale is intensely weathered and very soft, fragments crumble with manual pressure. Bedding is not discernible; resembles mudstone. Color is grayish orange (10YR 7/4). Siltstone is very fine-grained, moderately soft, fragments break with heavy manual pressure. Very thinly bedded, bedding is 1/4 to ½ to inch thick. Surfaces are iron oxide stained. Color is light grayish brown (5YR 6/1). Sandstone is fine grained, intensely weathered and soft to moderately soft, fragments break with manual pressure. Color is very pale orange (10YR 8/2). **Geologic Interpretation:** Mancos Shale (Km)			

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-237

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1802004 **E.** 1067286 **GROUND ELEVATION:** 5967

APPROXIMATE DIMENSIONS: 15' x 3' x 12.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/7/2015 **DATE LOGGED:** 10/7/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class.	**0.0 - 12.0 ft. Silty Sand (SM):** About 85% predominantly fine to coarse sand and 15% nonplastic fines with rapid dilatancy and low toughness, trace of fine to coarse gravel. Max. size, 1 inch. No reaction with HCl. In-place condition: loose, soft consistency, homogenous, dry, no cementation. Color is light reddish brown. Lab test data from 0.0-12.0 ft.: Lab classification is Silty Sand (SM): 85% sand, 115% fines, trace of gravel. Nonplastic; Field Moisture = 1.7%. Proctor Test (max. dry density) = 112.1 lbm/ft^3; Optimum Moisture = 11.6%. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
Lab sample taken from 0.0-12.0 ft. SM Lab Class.				
12.0 ft.				

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

Summary of Test Pits

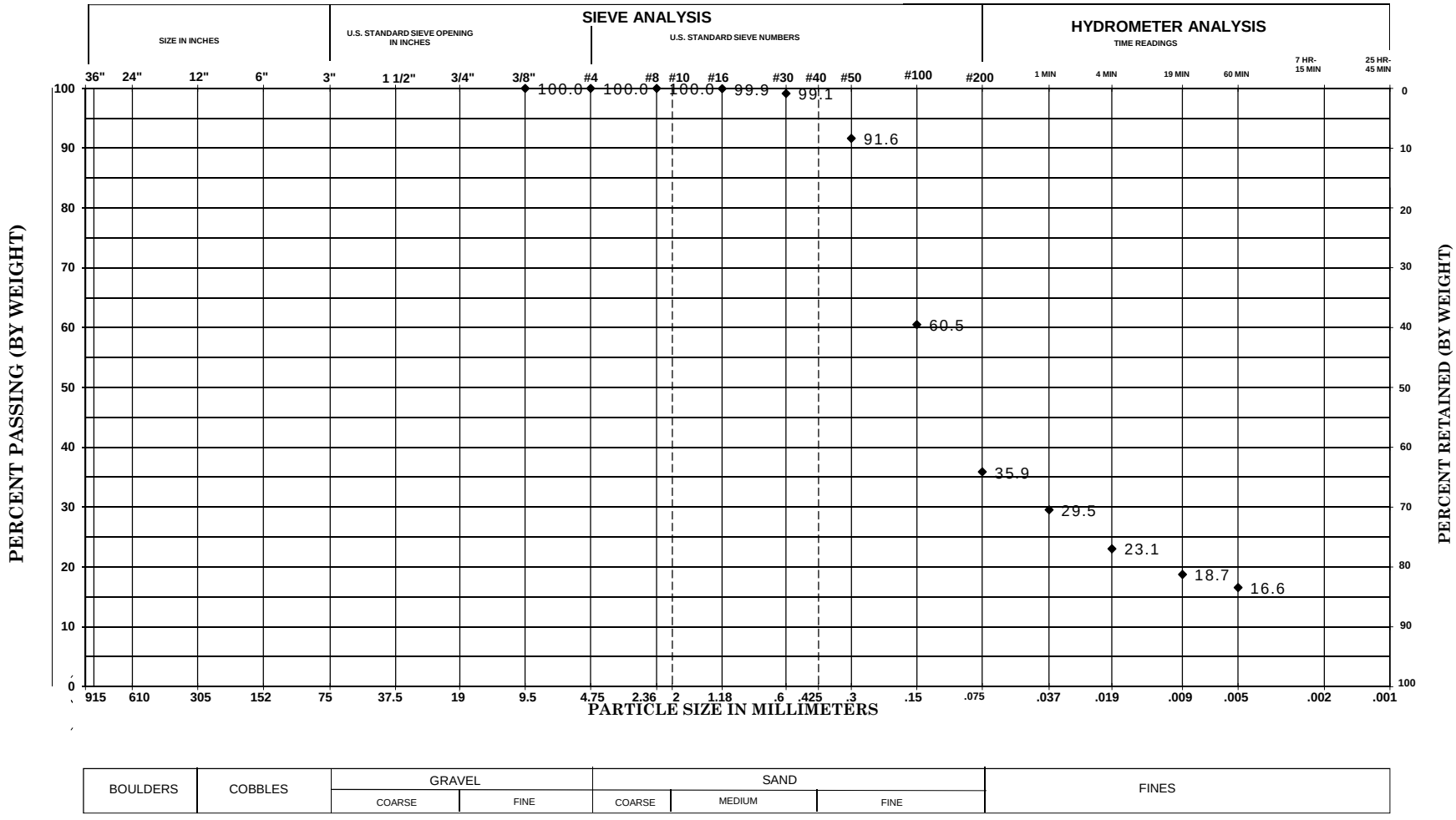
NCAWSFS - Hopi Test Pits (Tuba City)

October 2015

Date Sampled	Location	Depth	Unified Soil Classification		% Gravel	% Sand	% Fines	Max. Size	C_U	C_C	Inplace Moisture Content %	In-place Dry Density (lbm/ft³)	Lab. Max Dry Density (lbm/ft³)	Optimum Moisture Content %	Liquid Limit	Plasticity Index
10/05/15	TP-216	0' to 6'	SM	Silty Sand	Trace	64	36	1/2"	-	-	4.7	101.6	121.5	10.9		NP
10/05/15	TP-217	0' to 3'	ML	Sandy Silt	Trace	49	51	3/4"	-	-	4.7	-	121.8	11.7	21.1	2.3
10/05/15	TP-219	0' to 3'	SC	Clayey Sand	Trace	60	40	3/4"	-	-	4.3	-	122.5	11.0	20.0	8.1
10/05/15	TP-219	3'' to 6'	SM	Silty Sand	8	74	18	3/4"	55.0	11.2	-	-	-	-		NP
10/05/15	TP-220	0' to 4'	SM	Silty Sand	0	87	13	No. 8	8.2	2.7	2.4	104.1	116.9	9.8		NP
10/06/15	TP-221	4' to 7.5'	SM	Silty Sand	0	85	15	No. 4	4.9	1.4	1.8	-	117.4	12.9		NP
10/06/15	TP-222	4' to 10'	SM	Silty Sand	Trace	82	18	3/4"	-	-	2.7	-	118.0	10.4		NP
10/06/15	TP-224	0' to 4.8'	SM	Silty Sand	0	86	14	1/2"	9.7	1.7	4.3	117.6	118.4	9.4		NP
10/06/15	TP-225	0' to 8'	SM	Silty Sand	Trace	84	16	3/4"	9.1	2.6	2.2	-	117.1	10.6		NP
10/06/15	TP-229	0' to 4'	SC-SM	Silty Clayey Sand	Trace	53	47	1"	-	-	5.2	-	118.2	12.3	21.8	5.4
10/06/15	TP-230	0' to 6'	CL	Sandy Lean Clay	0	48	52	No. 4	-	-	6.6	-	119.6	12.8	24.7	13.2
10/06/15	TP-231	0' to 4.5'	SM	Silty Sand	0	55	45	No. 8	-	-	3.6	94.0	116.5	12.9		NP
10/07/15	TP-232	0' to 4.5'	SC/CL	Clayey Sand	Trace	51	49	3/4"	-	-	4.3	90.8	118.9	12.4	22.3	9.3
10/07/15	TP-233	0' to 7'	CL	Sandy Lean Clay	Trace	36	64	1/2"	-	-	5.3	-	115.1	13.8	23.6	12.1
10/07/15	TP-234	0' to 13'	CL	Lean Clay with Sand	0	24	76	No. 8	-	-	9.0	-	109.9	16.4	33.8	21.1
10/07/15	TP-235	0' to 5'	SM	Silty Sand	Trace	78	22	3/4"	30.4	7.8	2.3	100.4	121.0	12.6		NP
10/07/15	TP-236	0' to 7'	SP-SM	Poorly Graded Sand with Silt	Trace	88	12	1/2"	4.1	1.8	-	-	109.9	10.2		NP
10/07/15	TP-237	0' to 12'	SM	Silty Sand	Trace	85	15	3/4"	5.2	1.7	-	-	112.1	11.6		NP

NCAWSFS **TP-216** **0' to 6'** **10/05/15**

GRAIN SIZE DISTRIBUTION



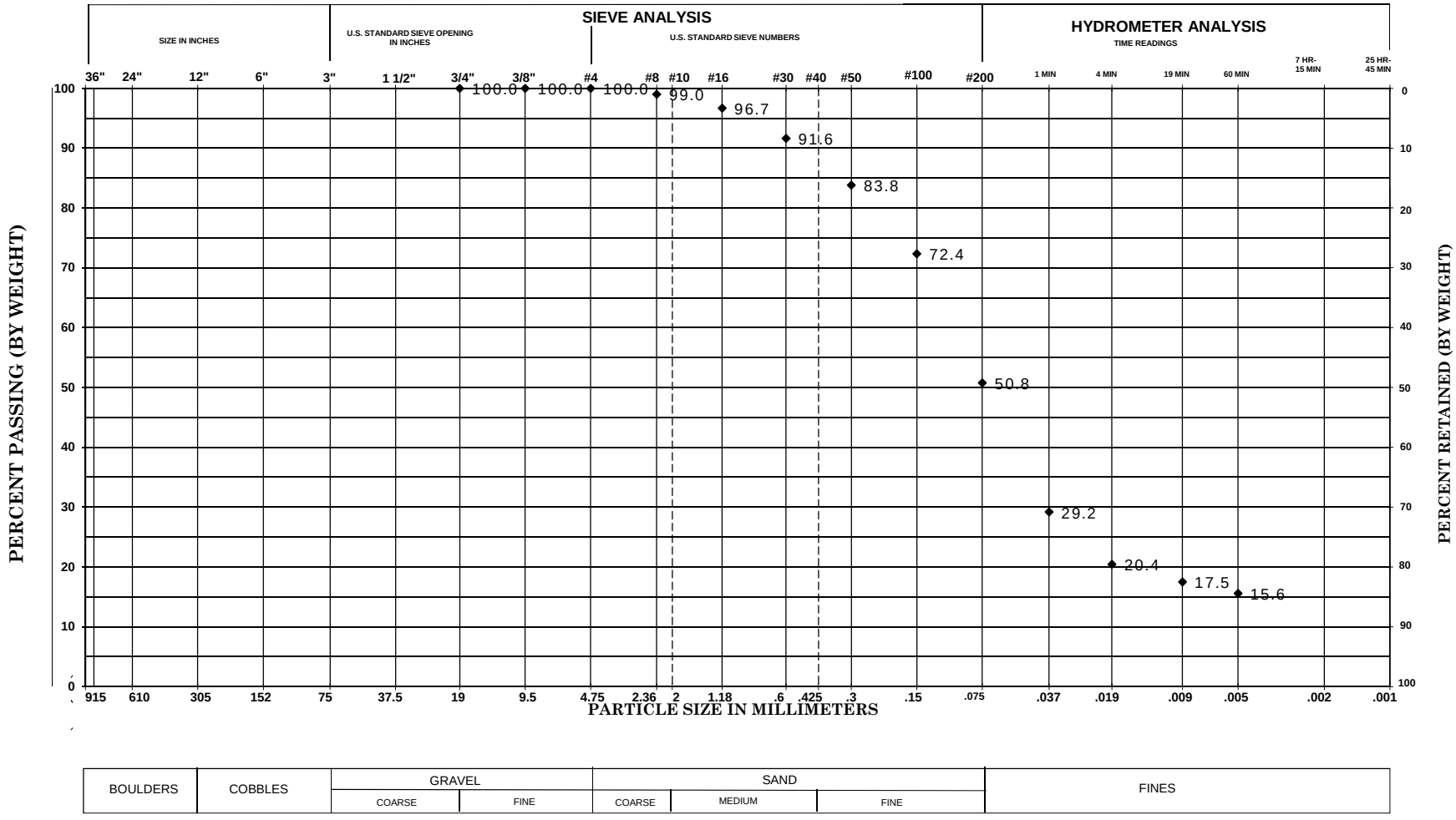
Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J.Fitzsimmons

Trace % Gravel	Maximum Size: 1/2"	Specific Gravity	D_{50}: 0.004 in
64.1 % Sand	Moisture Content: 4.7%	Plus No. 4:	C_U:
35.9 % Fines	Liquid Limit:	Minus No. 4:	C_C:
% Oversize	Plasticity Index: Nonplastic		

NCAWSFS **TP-217** **0' to 3'** **10/05/15**

GRAIN SIZE DISTRIBUTION



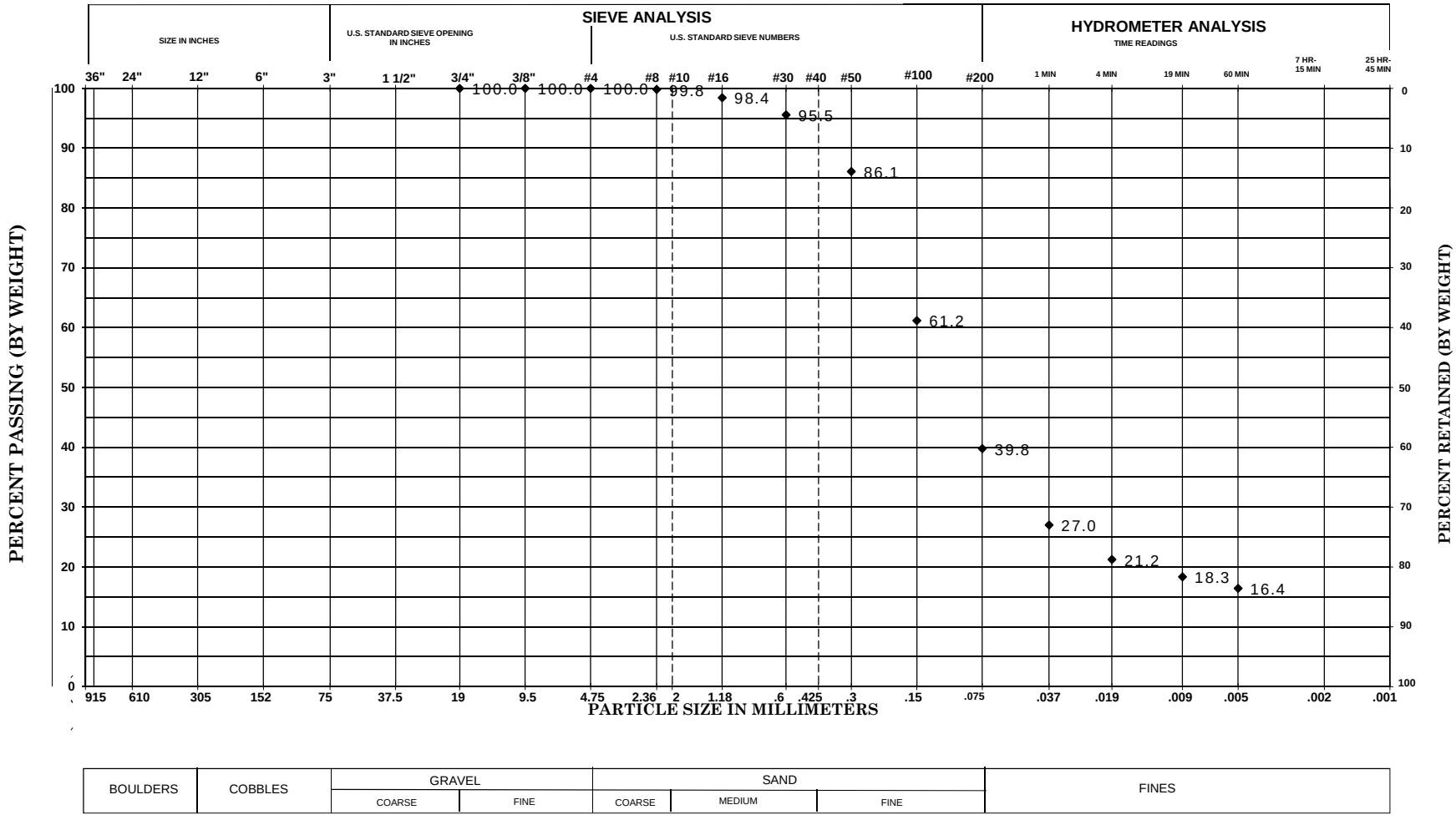
Unified Soil Classification: **ML Sandy Silt**

Sample Collected by: J.Fitzsimmons

Trace % Gravel	Maximum Size: 3/4"	Specific Gravity	D_{50}: 0.003 in
49.2 % Sand	Moisture Content: 4.7%	Plus No. 4:	C_U:
50.8 % Fines	Liquid Limit: 21.1	Minus No. 4:	C_C:
% Oversize	Plasticity Index: 2.3		

NCAWSFS **TP-219** **0' to 3'** **10/05/15**

GRAIN SIZE DISTRIBUTION



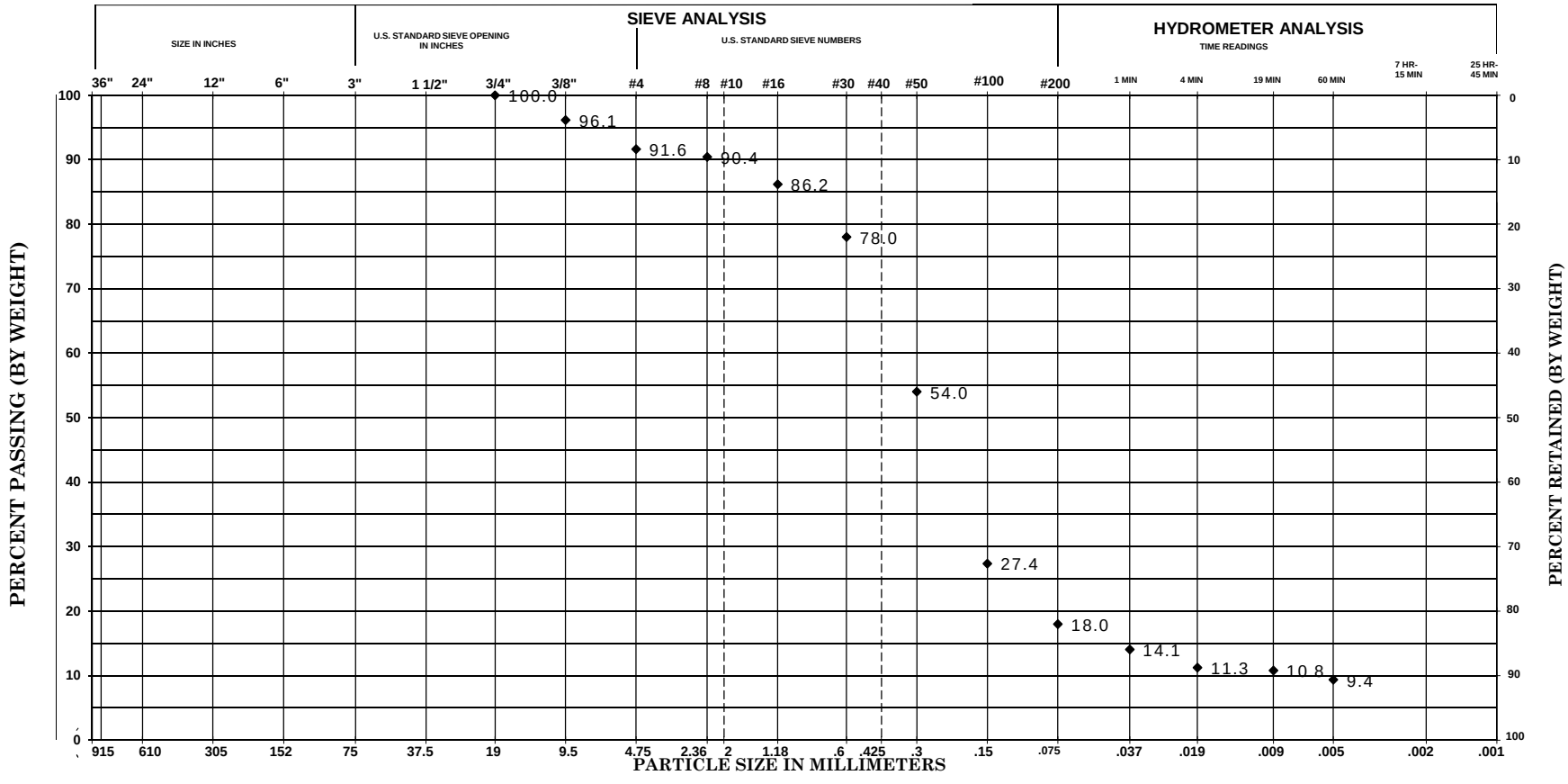
Unified Soil Classification: **SC Clayey Sand**

Sample Collected by: J.Fitzsimmons

Trace % Gravel	Maximum Size: 3/4"	Specific Gravity	D_{50}: 0.004 in
60.2 % Sand	Moisture Content: 4.3%	Plus No. 4:	C_U:
39.8 % Fines	Liquid Limit: 20.0	Minus No. 4:	C_C:
% Oversize	Plasticity Index: 8.1		

NCAWSFS	TP-219	3' to 6'	10/05/15

GRAIN SIZE DISTRIBUTION



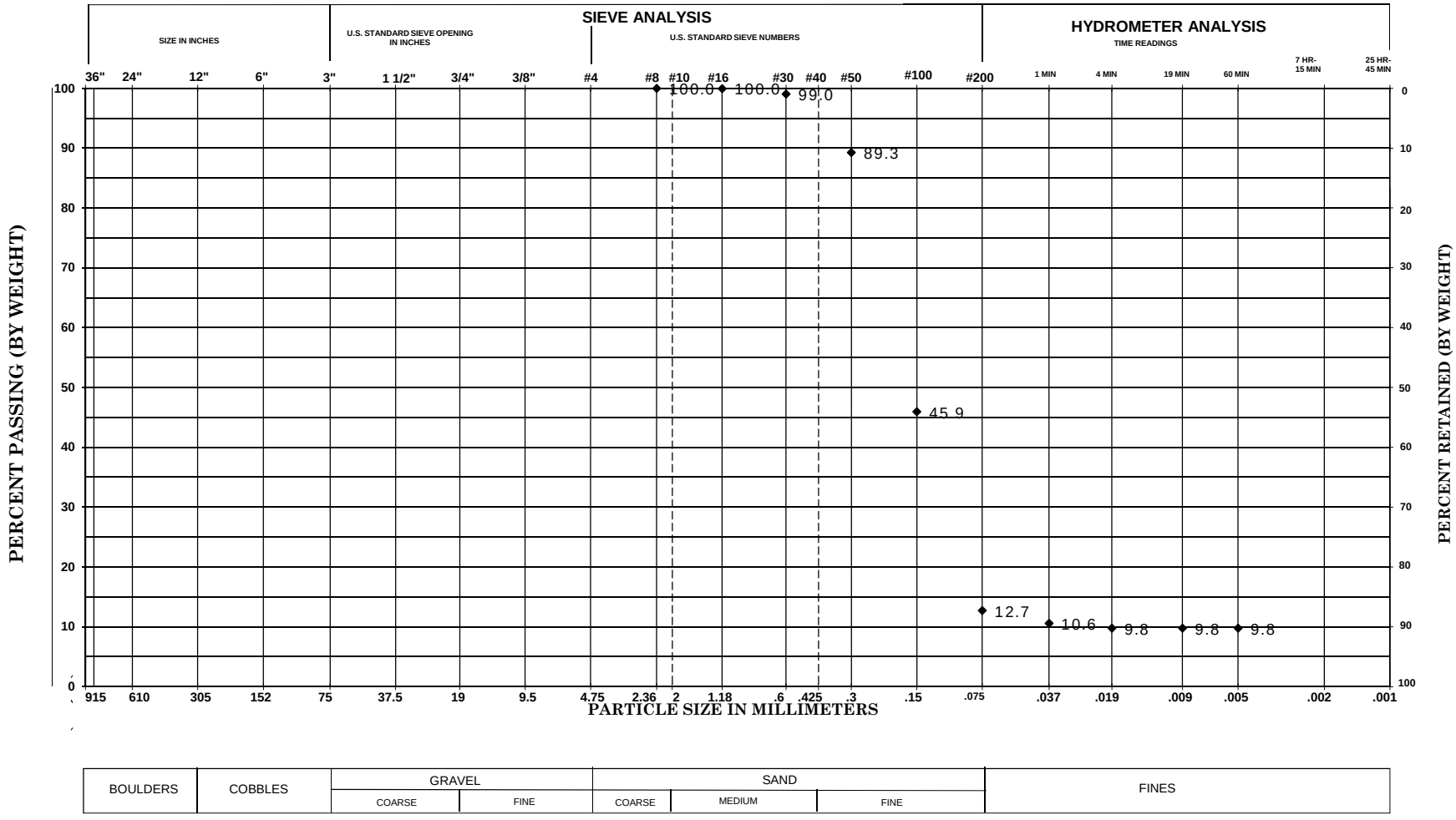
Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J.Fitzsimmons

8.4 % Gravel	Maximum Size: 3/4"	Specific Gravity	D_{50}: 0.011 in
73.6 % Sand	Moisture Content:	Plus No. 4:	C_U: 55.0
18.0 % Fines	Liquid Limit:	Minus No. 4:	C_C: 11.2
% Oversize	Plasticity Index: Nonplastic		

NCAWSFS **TP-220** **0' to 4'** **10/05/15**

GRAIN SIZE DISTRIBUTION



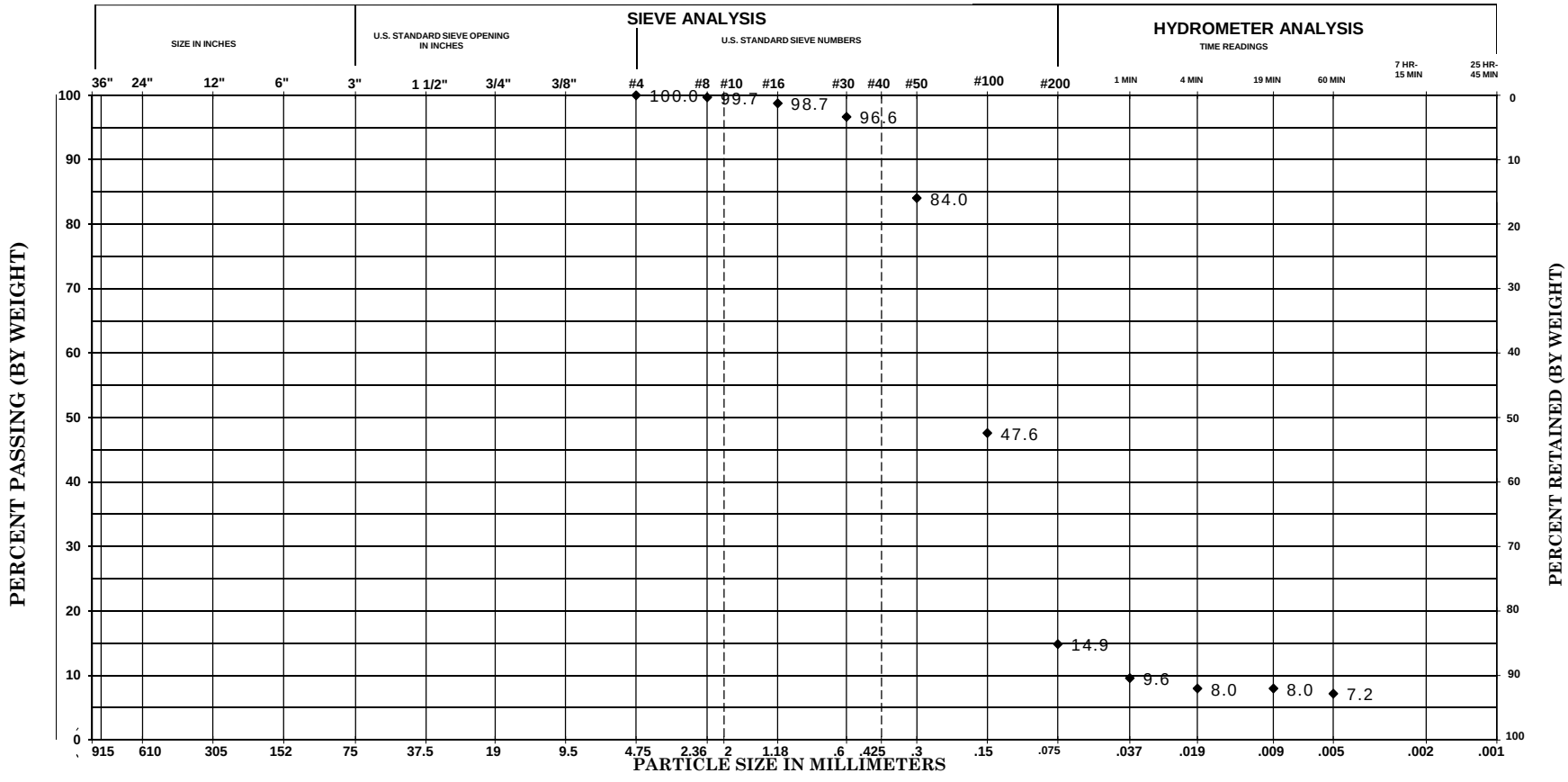
Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J.Fitzsimmons

0.0 % Gravel	Maximum Size: No. 8	Specific Gravity	D_{50}: 0.006 in
87.3 % Sand	Moisture Content: 2.4%	Plus No. 4:	C_U: 8.2
12.7 % Fines	Liquid Limit:	Minus No. 4:	C_C: 2.7
% Oversize	Plasticity Index: Nonplastic		

NCAWSFS **TP-221** **4' to 7.5'** **10/06/15**

GRAIN SIZE DISTRIBUTION



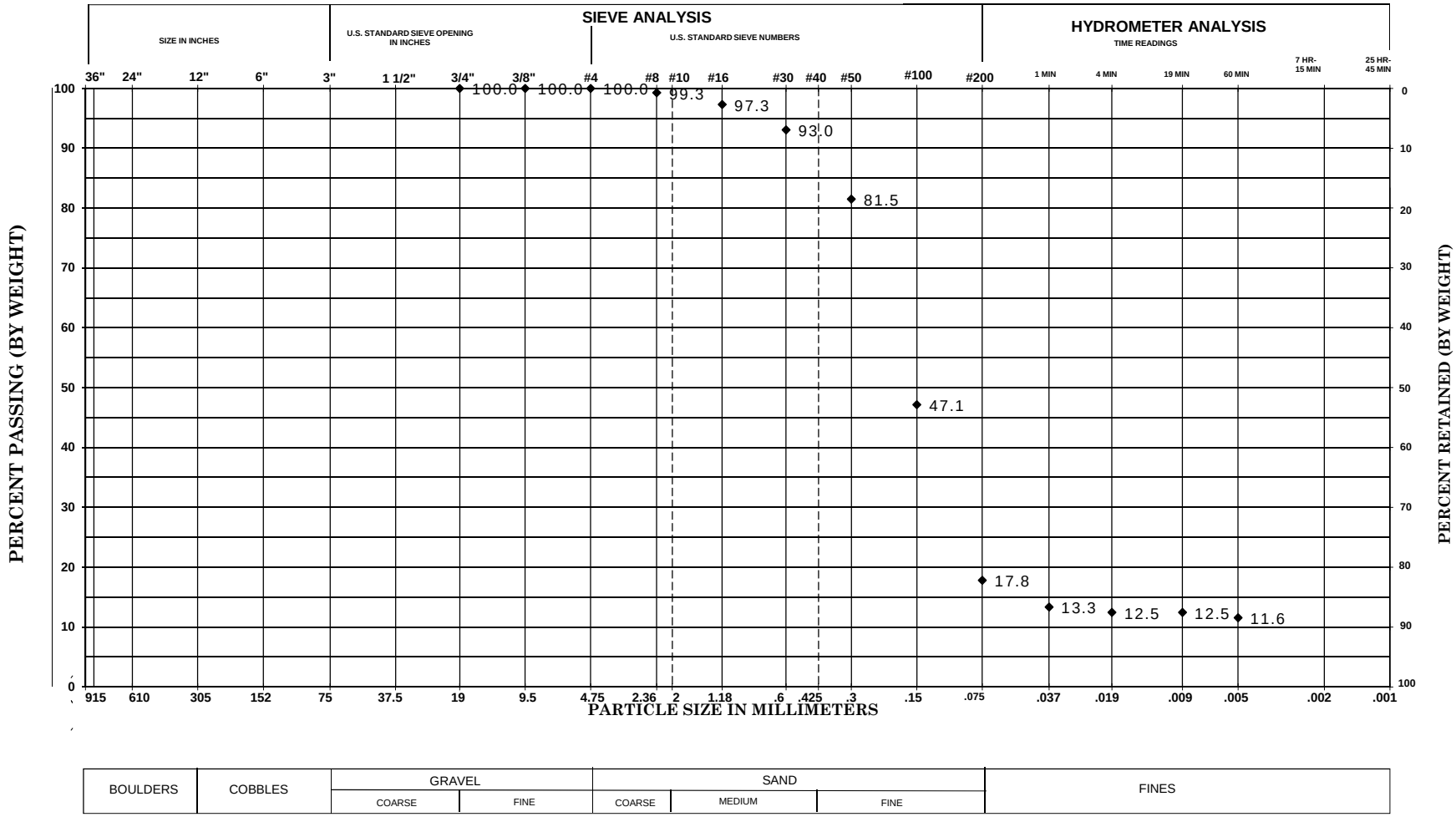
Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J.Fitzsimmons

0.0 % Gravel	Maximum Size: No. 4	Specific Gravity	D_{50}: 0.006 in
85.1 % Sand	Moisture Content: 1.8%	Plus No. 4:	C_U: 4.9
14.9 % Fines	Liquid Limit:	Minus No. 4:	C_C: 1.4
% Oversize	Plasticity Index: Nonplastic		

NCAWSFS **TP-222** **4' to 10'** **10/06/15**

GRAIN SIZE DISTRIBUTION



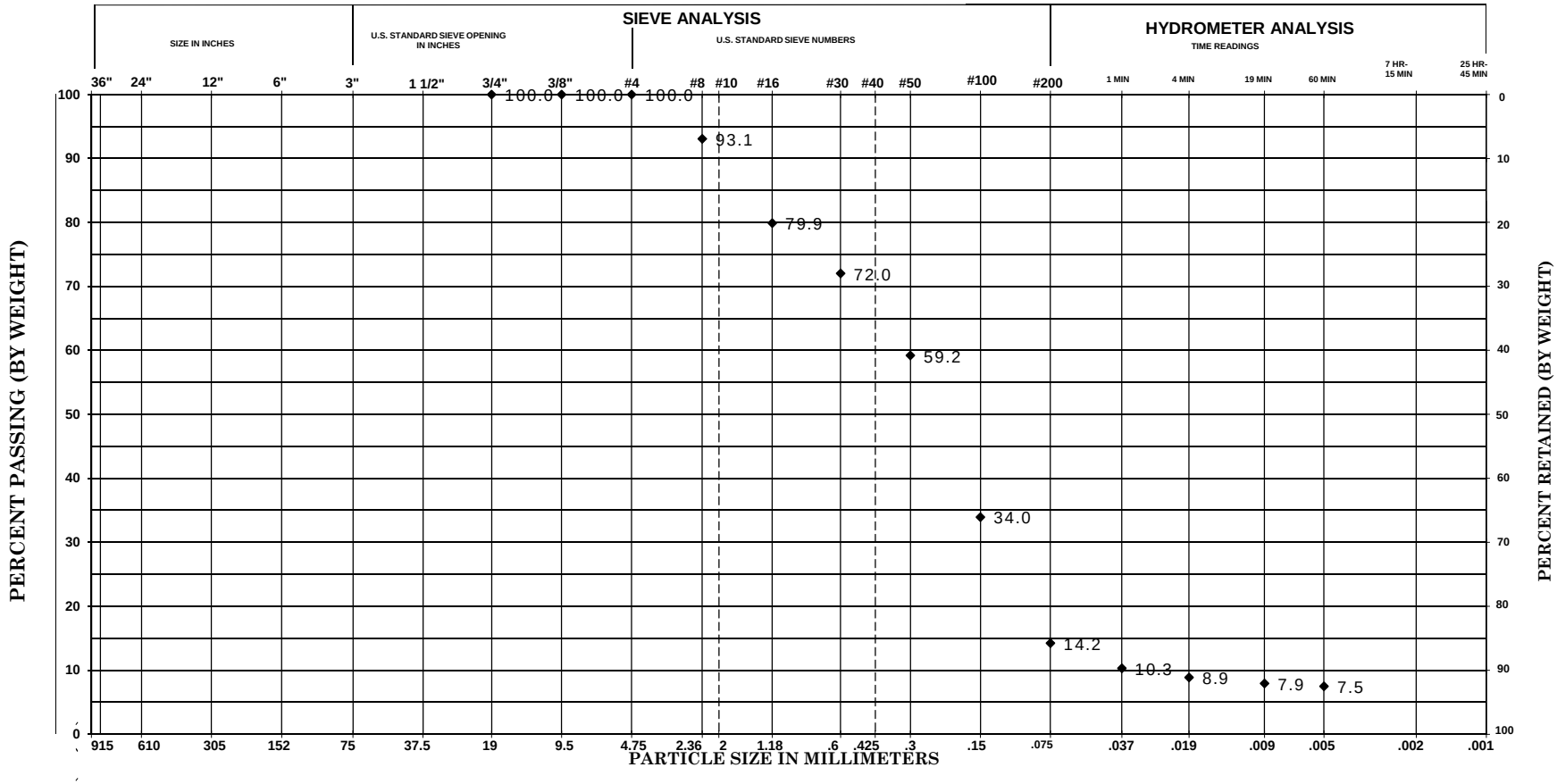
Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J.Fitzsimmons

Trace % Gravel	Maximum Size: 3/4"	Specific Gravity	D_{50}: 0.006 in
82.2 % Sand	Moisture Content: 2.7%	Plus No. 4:	C_U:
17.8 % Fines	Liquid Limit:	Minus No. 4:	C_C:
% Oversize	Plasticity Index: Nonplastic		

NCAWSFS **TP-224** **0' to 4.8'** **10/06/15**

GRAIN SIZE DISTRIBUTION



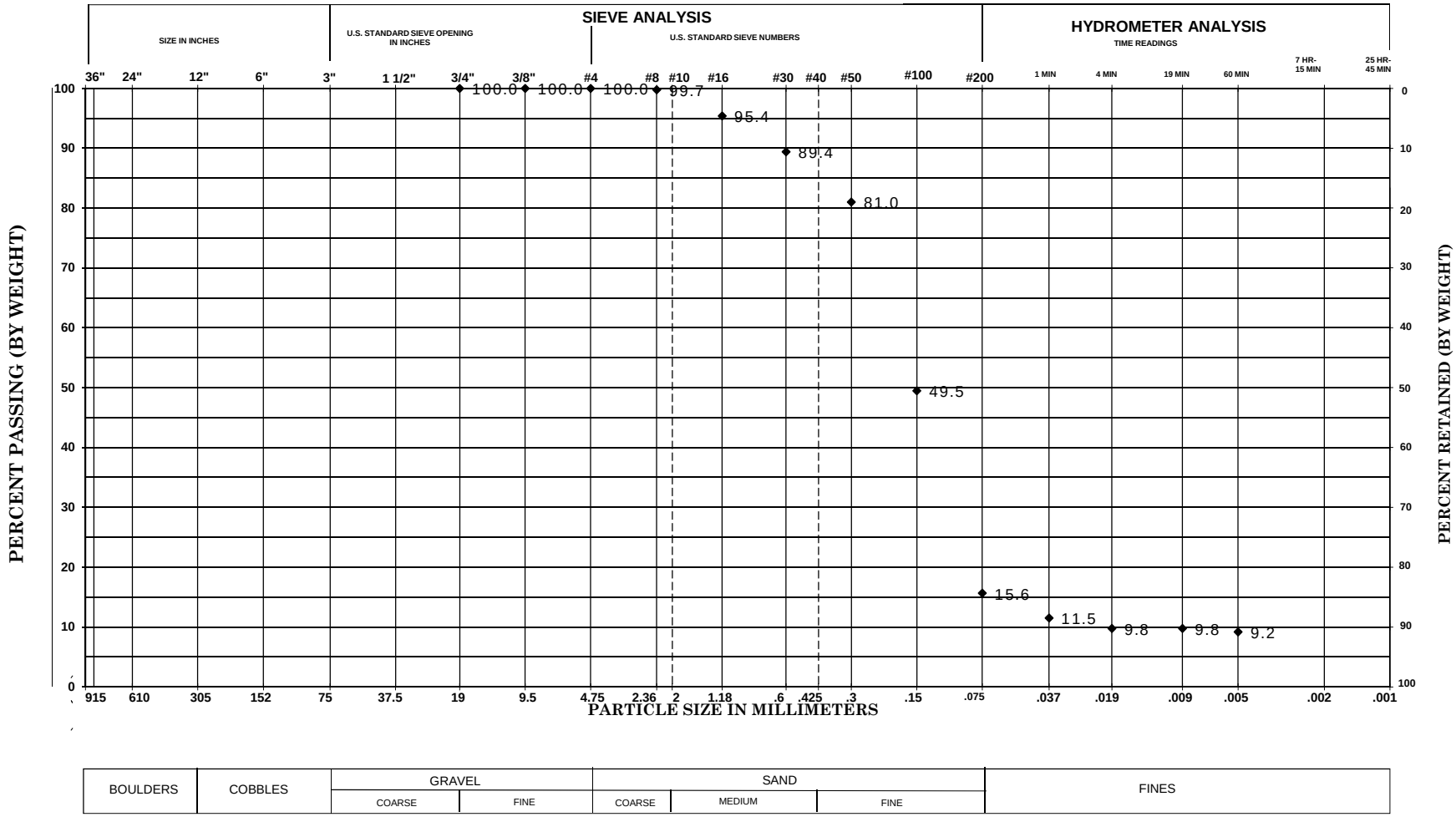
Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J.Fitzsimmons

Trace % Gravel	Maximum Size: 1/2"	Specific Gravity	D_{50}: 0.009 in
85.8 % Sand	Moisture Content: 4.3%	Plus No. 4:	C_U: 9.7
14.2 % Fines	Liquid Limit:	Minus No. 4:	C_C: 1.7
% Oversize	Plasticity Index: Nonplastic		

NCAWSFS **TP-225** **0' to 8'** **10/06/15**

GRAIN SIZE DISTRIBUTION



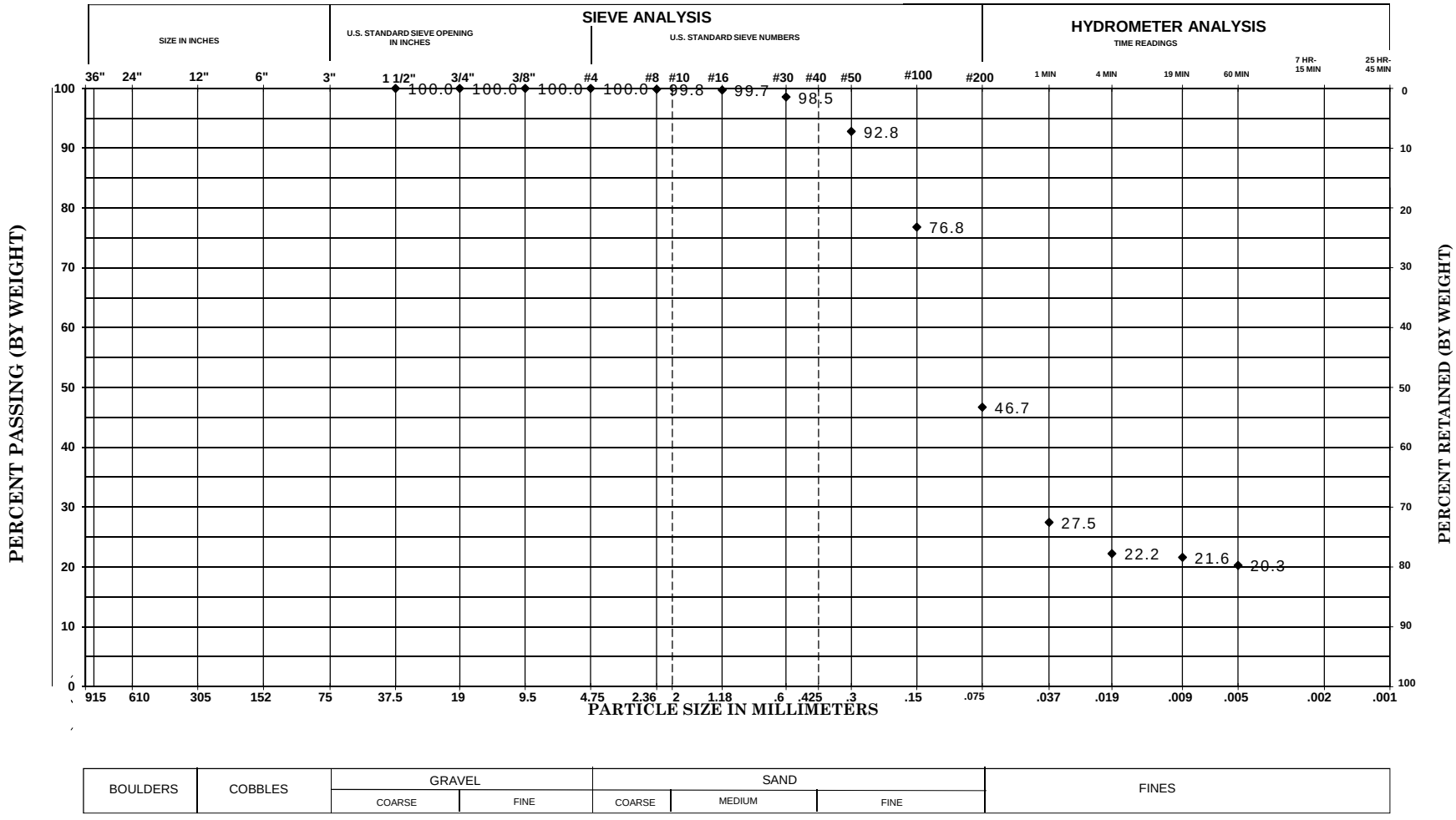
Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J.Fitzsimmons

Trace % Gravel	Maximum Size: 3/4"	Specific Gravity	D_{50}: 0.006 in
84.3 % Sand	Moisture Content: 2.2%	Plus No. 4:	C_U: 9.1
15.6 % Fines	Liquid Limit:	Minus No. 4:	C_C: 2.6
% Oversize	Plasticity Index: Nonplastic		

NCAWSFS **TP-229** **0' to 4'** **10/06/15**

GRAIN SIZE DISTRIBUTION



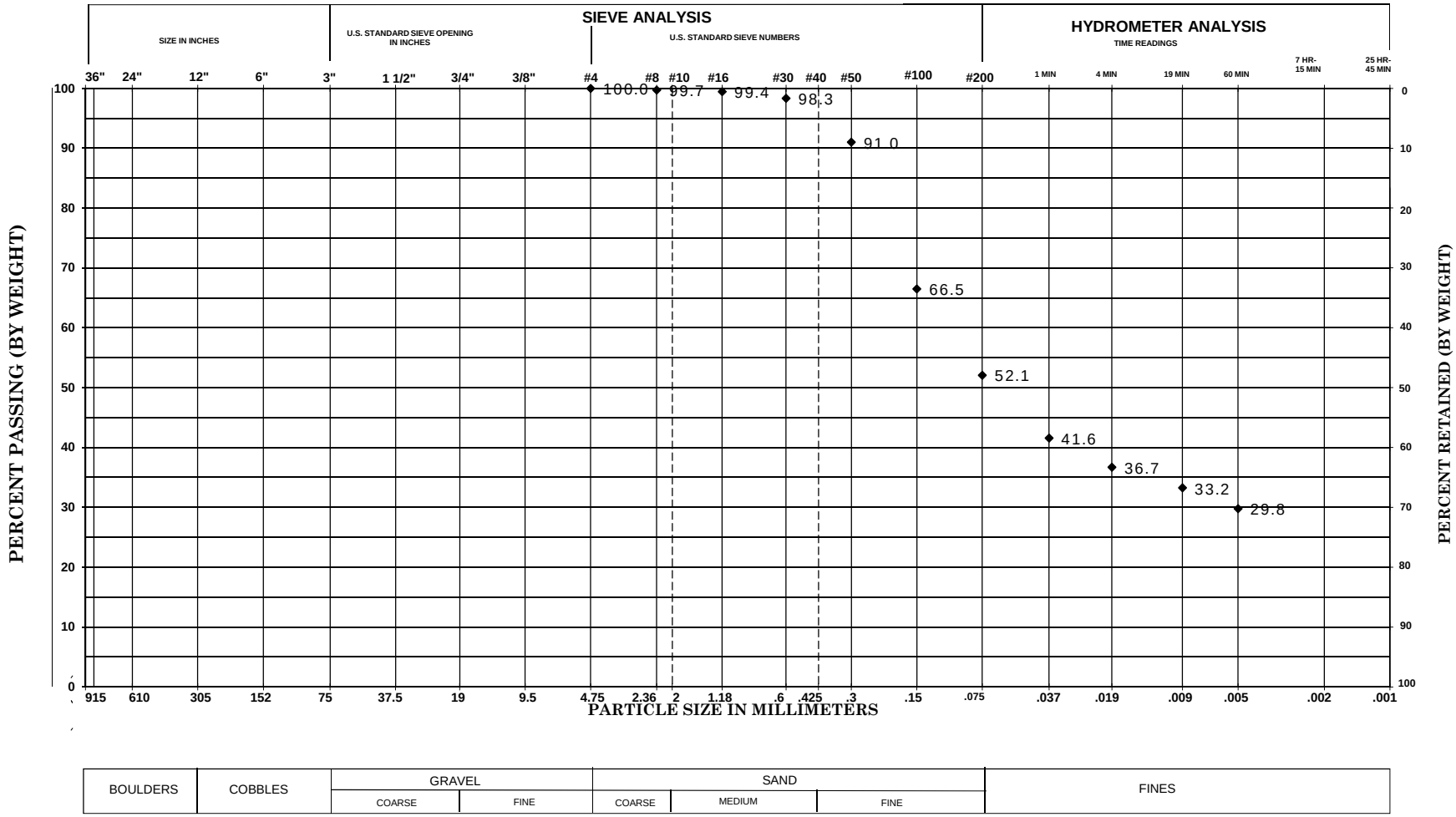
Unified Soil Classification: **SC-SM Silty Clayey Sand**

Sample Collected by: J.Fitzsimmons

Trace % Gravel	Maximum Size: 1"	Specific Gravity	D_{50}:	0.003 in
53.3 % Sand	Moisture Content: 5.2%	Plus No. 4:	C_U:	
46.7 % Fines	Liquid Limit: 21.8	Minus No. 4:	C_C:	
% Oversize	Plasticity Index: 5.4			

NCAWSFS **TP-230** **0' to 6'** **10/06/15**

GRAIN SIZE DISTRIBUTION



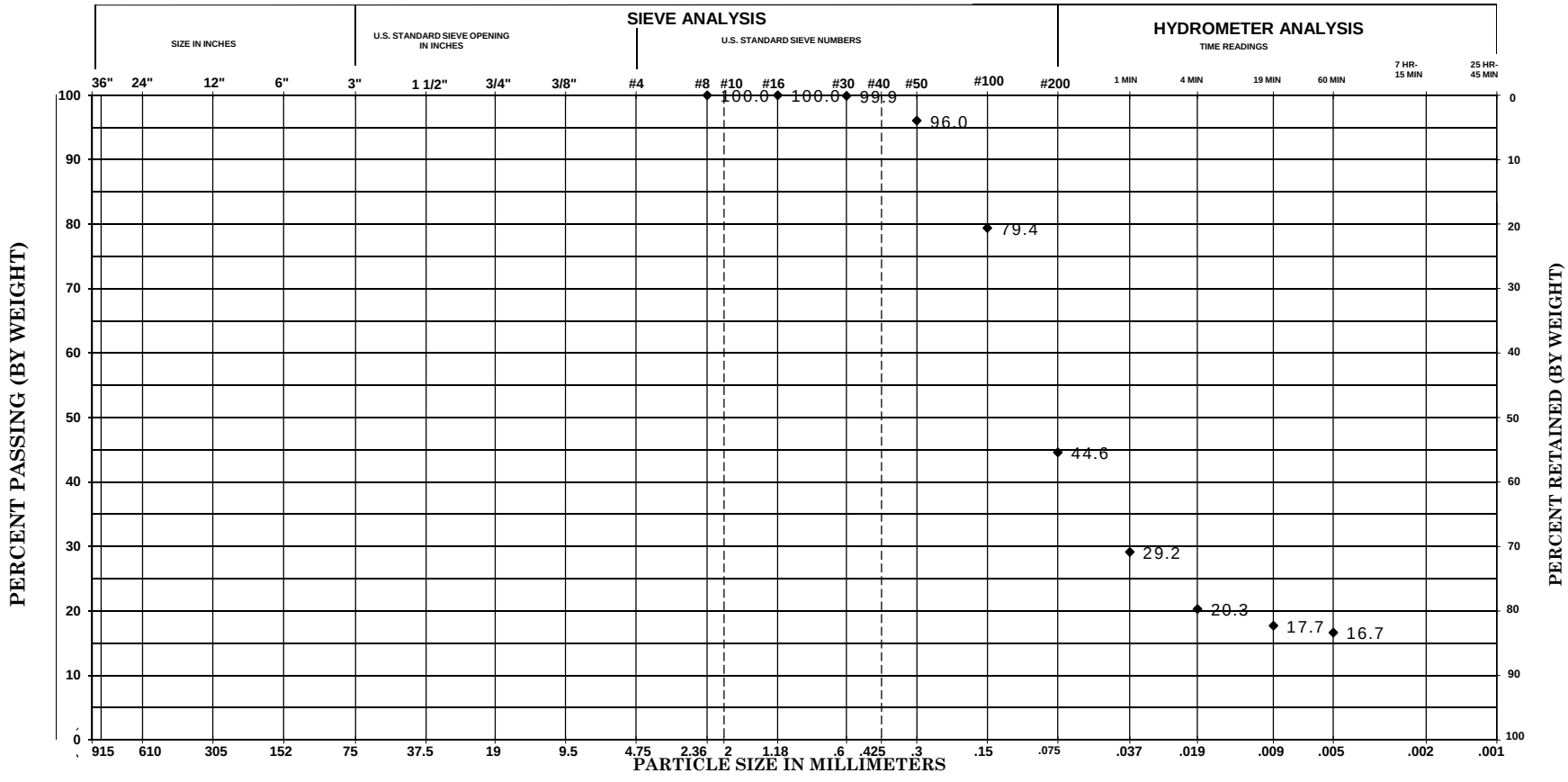
Unified Soil Classification: **CL Sandy Lean Clay**

Sample Collected by: J.Fitzsimmons

0.0 % Gravel	Maximum Size: No. 4	Specific Gravity	D_{50}:	0.003 in
47.9 % Sand	Moisture Content: 6.6%	Plus No. 4:	C_U:	
52.1 % Fines	Liquid Limit: 24.7	Minus No. 4:	C_C:	
% Oversize	Plasticity Index: 13.2			

NCAWSFS **TP-231** **0' to 4.5'** **10/06/15**

GRAIN SIZE DISTRIBUTION



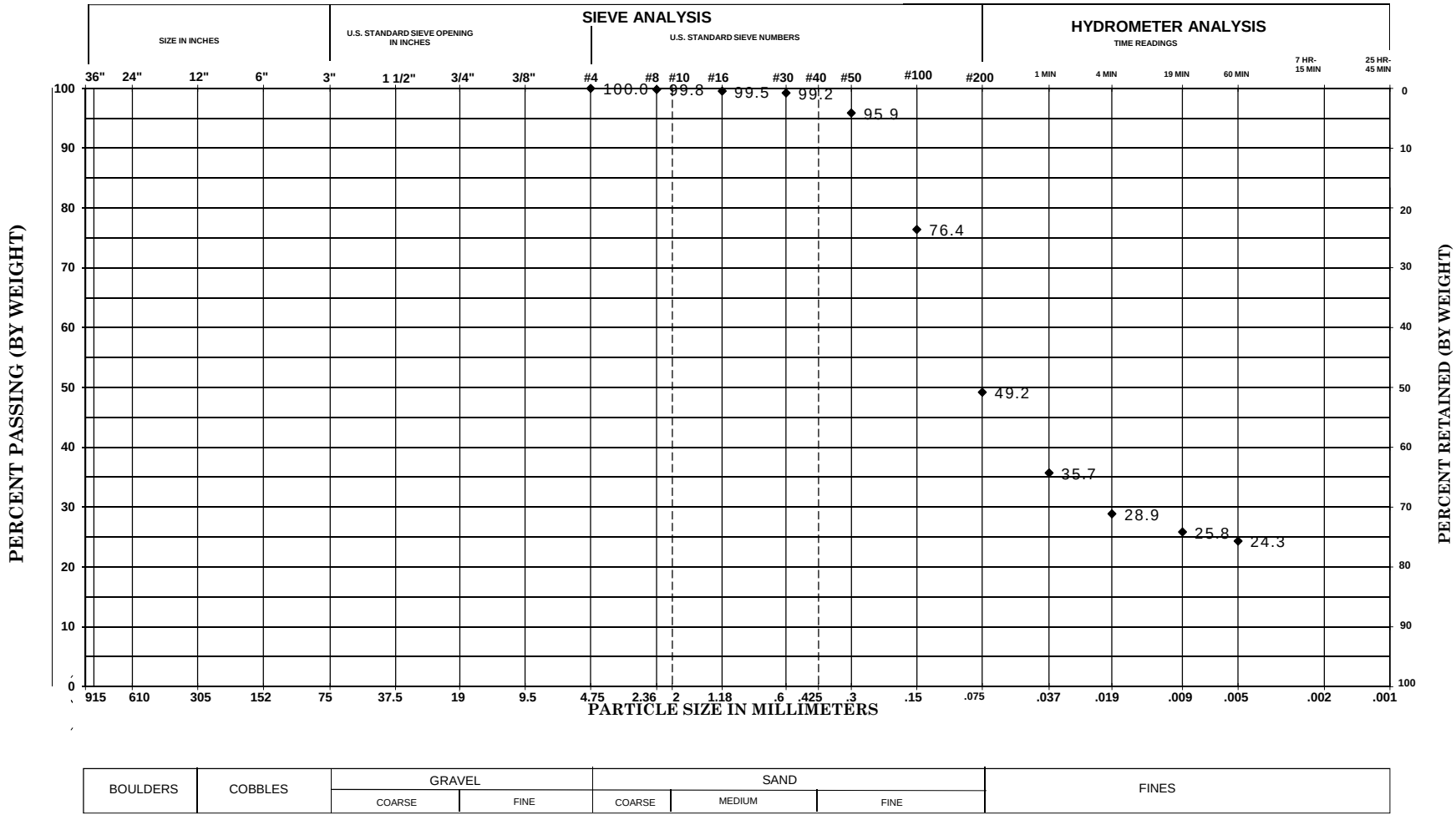
Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J.Fitzsimmons

0.0 % Gravel	Maximum Size: No. 8	Specific Gravity	D_{50}: 0.003 in
55.4 % Sand	Moisture Content: 3.6%	Plus No. 4:	C_U:
44.6 % Fines	Liquid Limit:	Minus No. 4:	C_C:
% Oversize	Plasticity Index: Nonplastic		

NCAWSFS **TP-232** **0' to 4.5'** **10/07/15**

GRAIN SIZE DISTRIBUTION



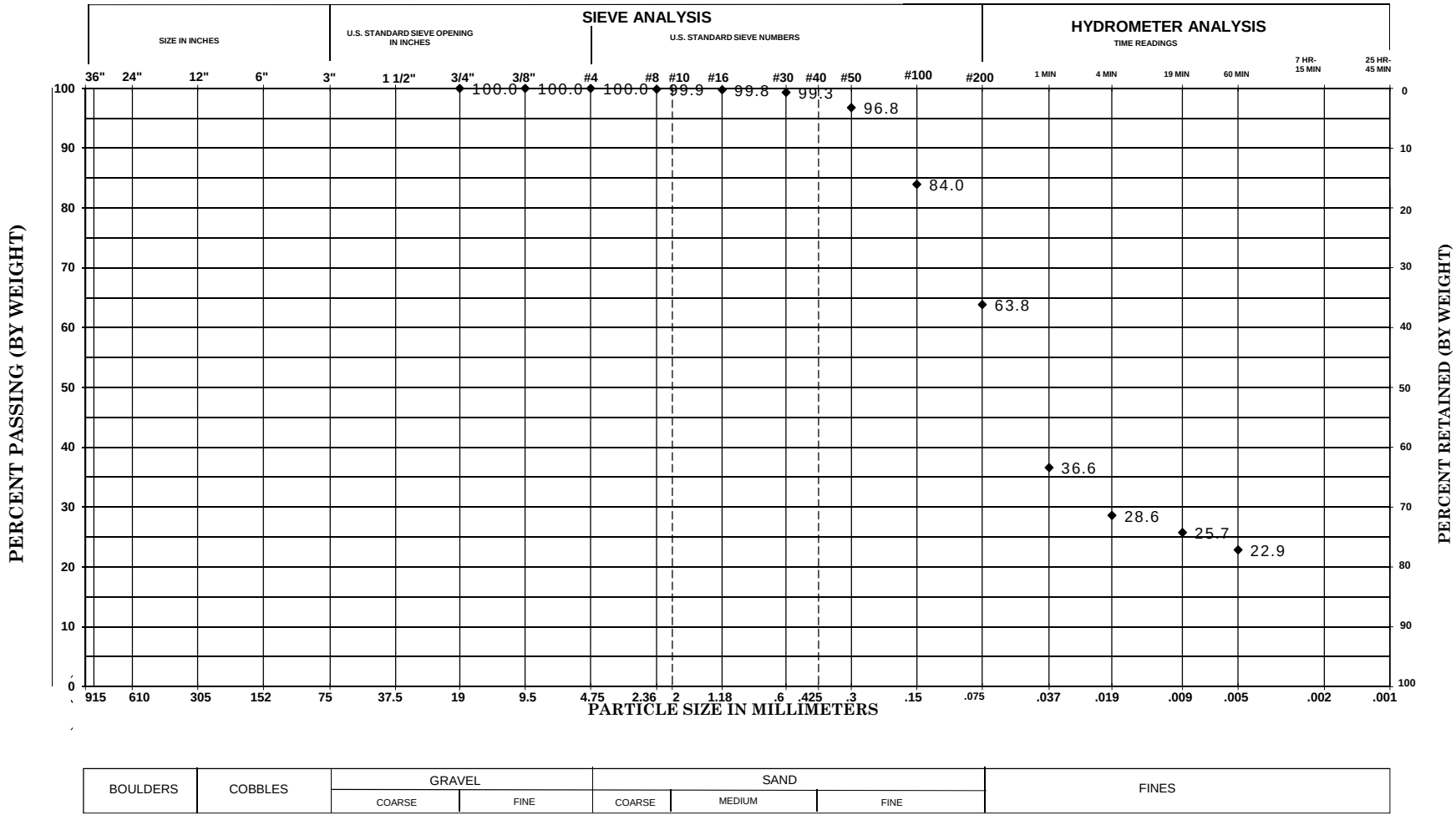
Unified Soil Classification: **SC/CL Clayey Sand**

Sample Collected by: J.Fitzsimmons

Trace % Gravel	Maximum Size: 3/4"	Specific Gravity	D_{50}: 0.003 in
50.7 % Sand	Moisture Content: 4.3%	Plus No. 4:	C_U:
49.2 % Fines	Liquid Limit: 22.3	Minus No. 4:	C_C:
% Oversize	Plasticity Index: 9.3		

NCAWSFS **TP-233** **0' to 7'** **10/07/15**

GRAIN SIZE DISTRIBUTION



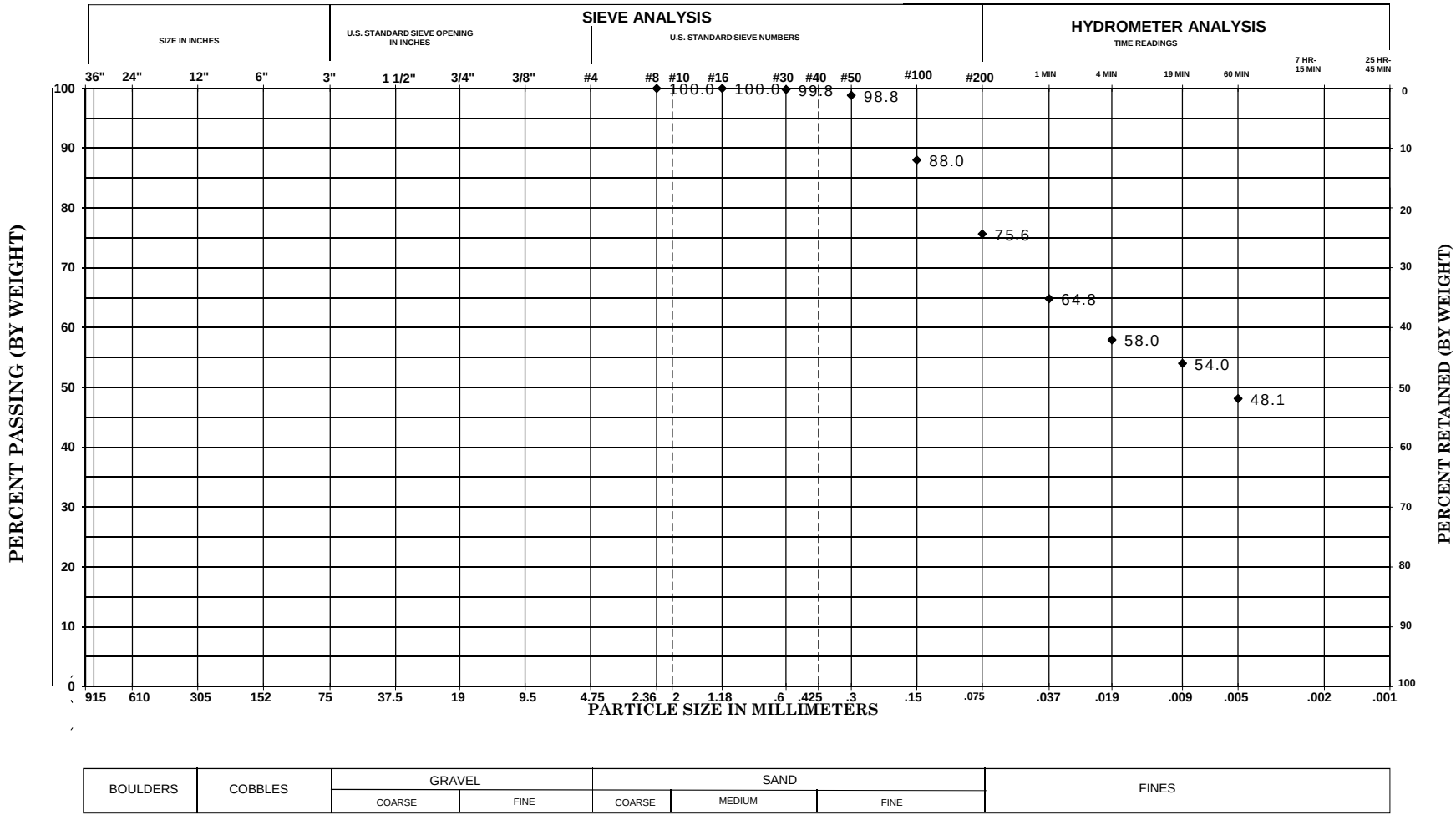
Unified Soil Classification: **CL Sandy Lean Clay**

Sample Collected by: J.Fitzsimmons

Trace % Gravel	Maximum Size: 1/2"	Specific Gravity	D_{50}: 0.002 in
36.1 % Sand	Moisture Content: 5.3%	Plus No. 4:	C_U:
63.8 % Fines	Liquid Limit: 23.6	Minus No. 4:	C_C:
% Oversize	Plasticity Index: 12.1		

NCAWSFS **TP-234** **0' to 13'** **10/07/15**

GRAIN SIZE DISTRIBUTION



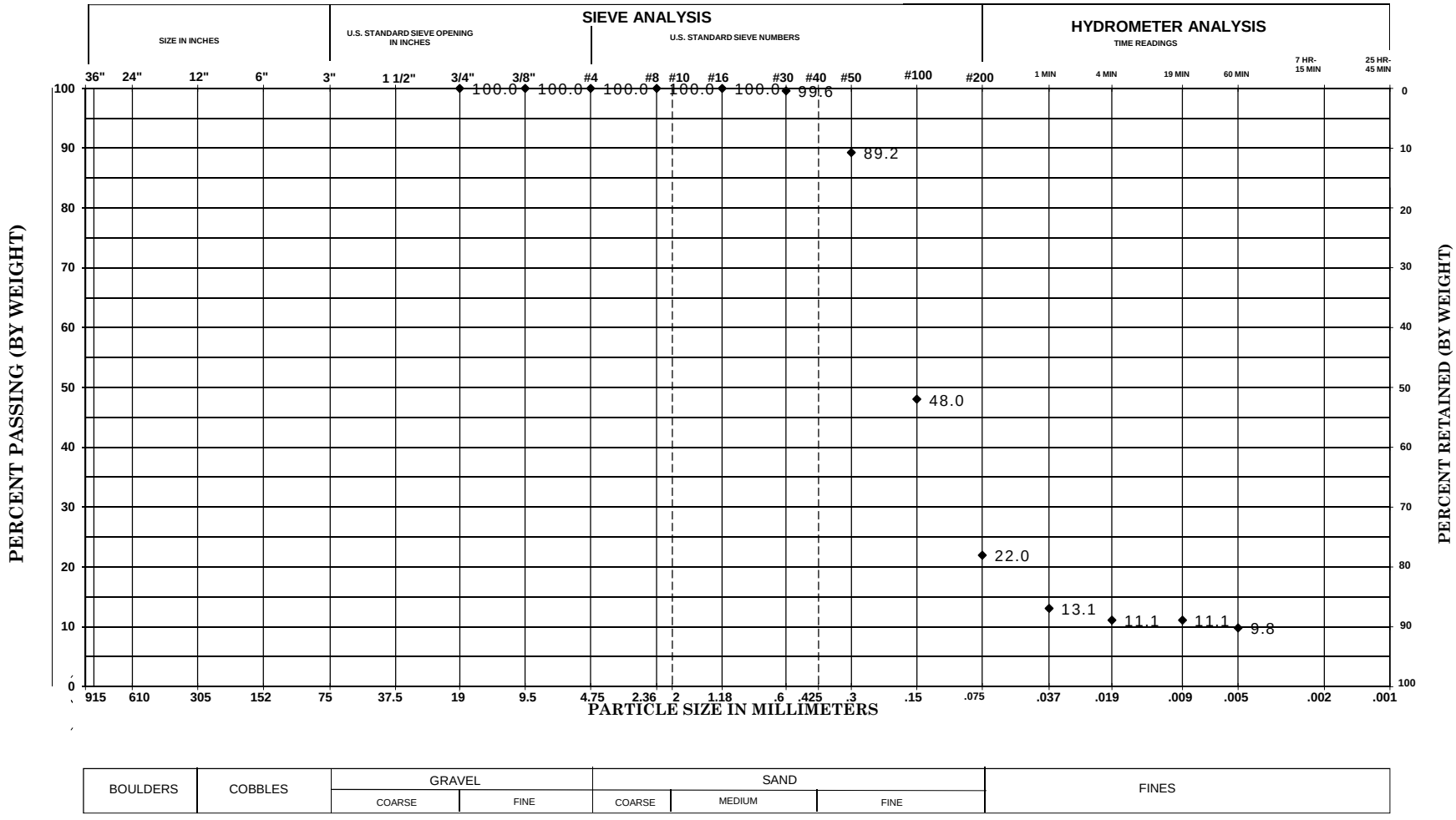
Unified Soil Classification: **CL Lean Clay with Sand**

Sample Collected by: J.Fitzsimmons

0.0 % Gravel	Maximum Size: No. 8	Specific Gravity	D_{50}:	0.000 in
24.4 % Sand	Moisture Content: 9.0%	Plus No. 4:	C_U:	
75.6 % Fines	Liquid Limit: 33.8	Minus No. 4:	C_C:	
% Oversize	Plasticity Index: 21.1			

NCAWSFS **TP-235** **0' to 5'** **10/07/15**

GRAIN SIZE DISTRIBUTION



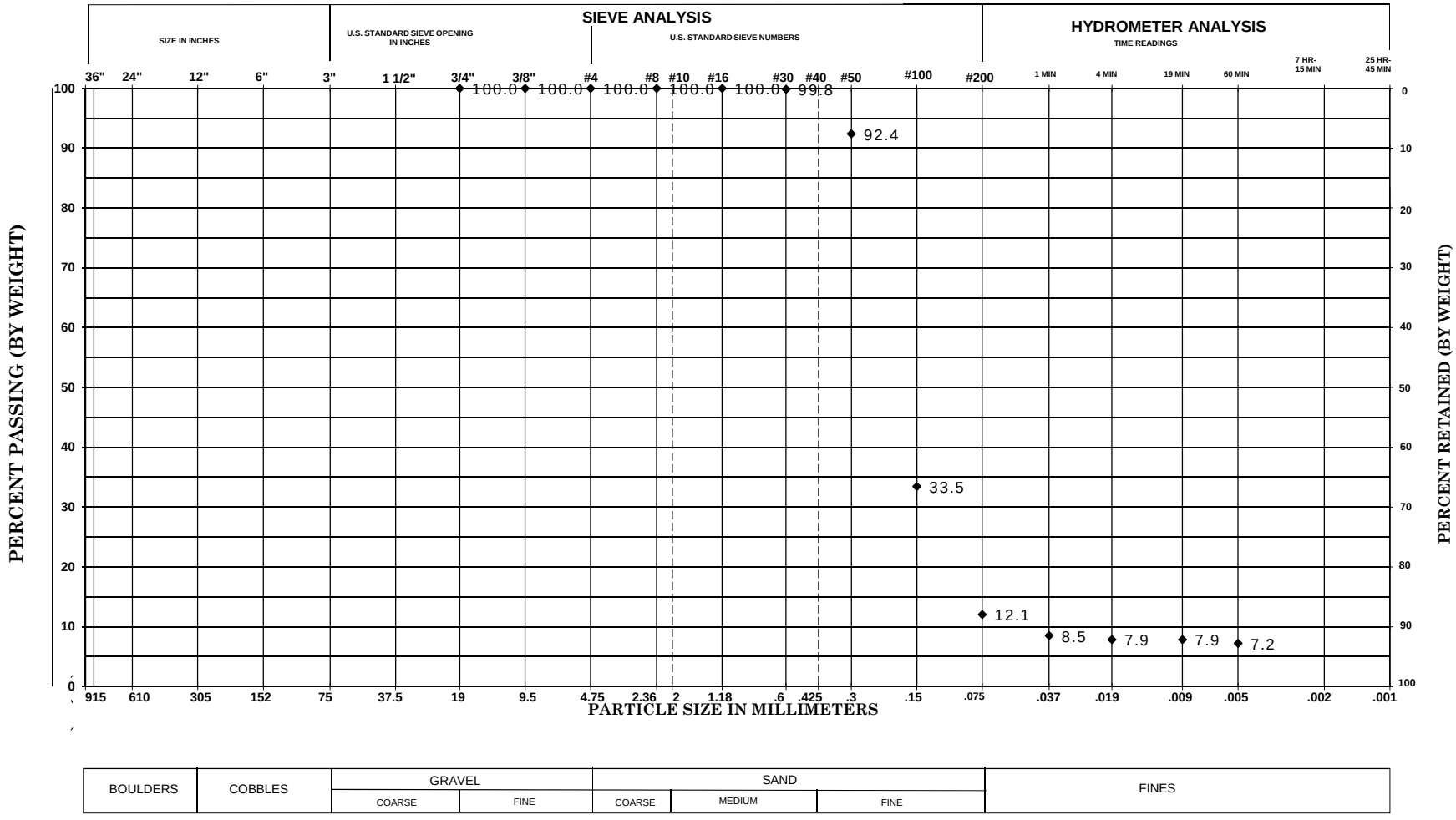
Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J.Fitzsimmons

Trace % Gravel	Maximum Size: 3/4"	Specific Gravity	D_{50}: 0.006 in
78.0 % Sand	Moisture Content: 2.3%	Plus No. 4:	C_U: 30.4
22.0 % Fines	Liquid Limit:	Minus No. 4:	C_C: 7.8
% Oversize	Plasticity Index: Nonplastic		

NCAWSFS **TP-236** **0' to 7'** **10/07/15**

GRAIN SIZE DISTRIBUTION



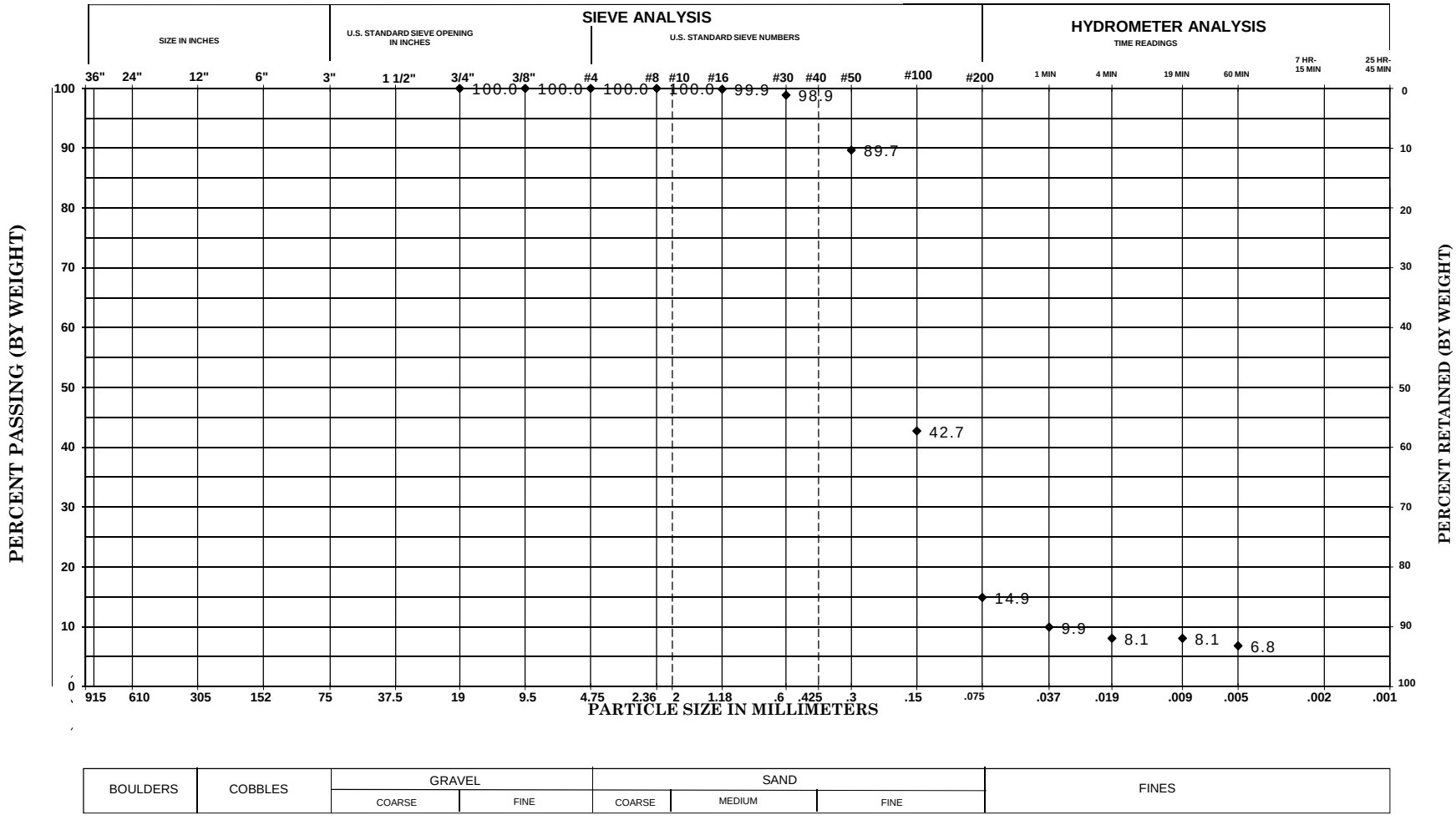
Unified Soil Classification: **SP-SM Poorly Graded Sand with Silt**

Sample Collected by: J.Fitzsimmons

Trace % Gravel	Maximum Size: 1/2"	Specific Gravity	D_{50}: 0.007 in
87.9 % Sand	Moisture Content: -	Plus No. 4:	C_U: 4.1
12.1 % Fines	Liquid Limit:	Minus No. 4:	C_C: 1.8
% Oversize	Plasticity Index: Nonplastic		

NCAWSFS **TP-237** **0' to 12'** **10/07/15**

GRAIN SIZE DISTRIBUTION



Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J.Fitzsimmons

Trace % Gravel	Maximum Size: 3/4"	Specific Gravity	D_{50}: 0.007 in
85.1 % Sand	Moisture Content: -	Plus No. 4:	C_U: 5.2
14.9 % Fines	Liquid Limit:	Minus No. 4:	C_C: 1.7
% Oversize	Plasticity Index: Nonplastic		

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Since 1955

3737 East Broadway Road
Phoenix, AZ 85040
(602) 437-3737

PHYSICAL PROPERTIES OF SOILS & AGGREGATES

Client **BUREAU OF RECLAMATION**
6150 W THUNDERBIRD RD
GLENDALE, AZ 85306

Date of Report: **10-22-15**
Job No. **2143JL115**
Event / Invoice No. **G115-006** Lab No. **65087**
Authorized by **MIKE MILLER** Date **10-13-15**
Sampled by **CLIENT** Date **10-13-15**
Submitted by **MIKE MILLER** Date **10-13-51**

Project **NCAWSFSORY SERVICES**
Contractor **--**
Type / Use of Material **SOIL**
Sample Source / Location **TP224**
Testing Authorized :
Special Instructions :

Location **HOPI RESERVATION**
Arch. / Engr. **--**
Supplier / Source **PROJECT SITE**
Source / Location Desig. By **CLIENT** Date **10-13-15**

TEST RESULTS

SIEVE ANALYSIS :
FINER THAN NO. 200 :

SIEVE	ACCUMULATIVE % PASSING	SPECIFICATION

LABORATORY COMPACTION CHARACTERISTICS : METHOD

DRY UNIT WEIGHT, LBF/FT^3

SAMPLE PREPARATION WET DRY
RAMMER USED:
2 IN. CIRCULAR FACE OTHER
MECHANICAL MANUAL

MAXIMUM DENSITY, LBF/FT^3 →
OPTIMUM MOISTURE CONTENT, % →

OVERSIZE AGGREGATE :
BULK SPECIFIC GRAVITY :
ABSORPTION, % :
% OVERSIZE IN LAB SAMPLE :

SPECIFIC GRAVITY IN ZERO AIR VOID CURVE :

MOISTURE, % DRY WEIGHT

TEST PROCEDURE	RESULT	SPECS
LIQUID & PLASTIC PROPERTIES :		
LIQUID LIMIT →		
ESTIMATED % RETAINED ON NO. 40 PLASTIC LIMIT →		
SAMPLE AIR DRIED YES NO PLASTICITY INDEX →		
MOISTURE CONTENT :		
PORTION TESTED % DRY WEIGHT →		
EXPANSION / COMPRESSION PROPERTIES OF COHESIVE SOIL :		
EXPANSION COMPRESSION, % →		
MAXIMUM SWELL PRESSURE, KSF →		
SURCHARGE, KSF		
INITIAL WATER CONTENT, % DRY DENSITY, PCF		

TEST PROCEDURE	RESULT	SPECS
RESISTANCE TO DEGRADATION OF SMALL-SIZE COARSE AGGREGATES BY ABRASION :		
GRADING 100 REV, % LOSS →		
GRADING 500 REV, % LOSS →		
SPECIFIC GRAVITY :		
MAX. PARTICLE SIZE, IN SPECIFIC GRAVITY @ 20 C		
pH DETERMINATION : AZ 237 →		
pH →	8.7	
SOLUBLE SALTS :		
PPM →		
MINIMUM RESISTIVITY : AZ 236		
OHM-CM →	8224	

SOIL CLASSIFICATION : GROUP SYMBOL :
NAME :

Comments :

Copies to : **CLIENT**

THE SERVICES REFERRED TO HEREIN WERE PERFORMED IN ACCORDANCE WITH THE STANDARD OF CARE PRACTICED LOCALLY FOR THE REFERENCED METHOD(S) AND RELATE ONLY TO THE CONDITIONS OBSERVED OR SAMPLE(S) TESTED AT THE TIME AND PLACE STATED HEREIN. WESTERN TECHNOLOGIES INC. MAKES NO OTHER WARRANTY OR REPRESENTATION EXPRESSED OR IMPLIED AND HAS NOT CONTROLLED INFORMATION INCLUDING SOURCE OF MATERIALS SUBMITTED BY OTHERS.

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PHYSICAL PROPERTIES OF SOILS & AGGREGATES

Client **BUREAU OF RECLAMATION**
6150 W THUNDERBIRD RD
GLENDALE, AZ 85306

Date of Report: **10-22-15**
Job No. **2143JL115**
Event / Invoice No. **G115-006** Lab No. **65086**
Authorized by **MIKE MILLER** Date **10-13-15**
Sampled by **CLIENT** Date **10-13-15**
Submitted by **MIKE MILLER** Date **10-13-15**

Project **NCAWSFS**
Contractor **--**
Type / Use of Material **SOIL**
Sample Source / Location **TP227**
Testing Authorized :
Special Instructions :

Location **HOPI RESERVATION**
Arch. / Engr. **--**
Supplier / Source **PROJECT SITE**
Source / Location Desig. By **CLIENT** Date **10-13-15**

TEST RESULTS

SIEVE ANALYSIS :
FINER THAN NO. 200 :

SIEVE	ACCUMULATIVE % PASSING	SPECIFICATION

LABORATORY COMPACTION CHARACTERISTICS : METHOD

DRY UNIT WEIGHT, LBF/FT^3

SAMPLE PREPARATION WET DRY
RAMMER USED:
2 IN. CIRCULAR FACE OTHER
MECHANICAL MANUAL

MAXIMUM DENSITY, LBF/FT^3 →
OPTIMUM MOISTURE CONTENT, % →

OVERSIZE AGGREGATE :
BULK SPECIFIC GRAVITY :
ABSORPTION, % :
% OVERSIZE IN LAB SAMPLE :

SPECIFIC GRAVITY IN ZERO AIR VOID CURVE :

MOISTURE, % DRY WEIGHT

TEST PROCEDURE	RESULT	SPECS
LIQUID & PLASTIC PROPERTIES :		
LIQUID LIMIT →		
ESTIMATED % RETAINED ON NO. 40 PLASTIC LIMIT →		
SAMPLE AIR DRIED YES NO PLASTICITY INDEX →		
MOISTURE CONTENT :		
PORTION TESTED % DRY WEIGHT →		
EXPANSION / COMPRESSION PROPERTIES OF COHESIVE SOIL :		
EXPANSION COMPRESSION, % →		
MAXIMUM SWELL PRESSURE, KSF →		
SURCHARGE, KSF		
INITIAL WATER CONTENT, % DRY DENSITY, PCF		

TEST PROCEDURE	RESULT	SPECS
RESISTANCE TO DEGRADATION OF SMALL-SIZE COARSE AGGREGATES BY ABRASION :		
GRADING 100 REV, % LOSS →		
GRADING 500 REV, % LOSS →		
SPECIFIC GRAVITY :		
MAX. PARTICLE SIZE, IN SPECIFIC GRAVITY @ 20 C		
pH DETERMINATION : AZ 237 →		
pH →	8.0	
SOLUBLE SALTS :		
PPM →		
MINIMUM RESISTIVITY : AZ 236		
OHM-CM →	423	

SOIL CLASSIFICATION : GROUP SYMBOL :
NAME :

Comments :

Copies to : **CLIENT**

THE SERVICES REFERRED TO HEREIN WERE PERFORMED IN ACCORDANCE WITH THE STANDARD OF CARE PRACTICED LOCALLY FOR THE REFERENCED METHOD(S) AND RELATE ONLY TO THE CONDITIONS OBSERVED OR SAMPLE(S) TESTED AT THE TIME AND PLACE STATED HEREIN. WESTERN TECHNOLOGIES INC. MAKES NO OTHER WARRANTY OR REPRESENTATION EXPRESSED OR IMPLIED AND HAS NOT CONTROLLED INFORMATION INCLUDING SOURCE OF MATERIALS SUBMITTED BY OTHERS.

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(602) 437-3737

PHYSICAL PROPERTIES OF SOILS & AGGREGATES

Client **BUREAU OF RECLAMATION**
6150 W THUNDERBIRD RD
GLENDALE, AZ 85306

Date of Report: **10-22-15**
Job No. **2143JL115**
Event / Invoice No. **G115-006** Lab No. **65088**
Authorized by **MIKE MILLER** Date **10-13-15**
Sampled by **CLIENT** Date **10-13-15**
Submitted by **MIKE MILLER** Date **10-13-15**

Project **NCAWSFS**
Contractor **--**
Type / Use of Material **SOIL**
Sample Source / Location **TP235**
Testing Authorized :
Special Instructions :

Location **HOPI RESERVATION**
Arch. / Engr. **--**
Supplier / Source **PROJECT SITE**
Source / Location Desig. By **CLIENT** Date **10-13-15**

TEST RESULTS

SIEVE ANALYSIS :
FINER THAN NO. 200 :

SIEVE	ACCUMULATIVE % PASSING	SPECIFICATION

LABORATORY COMPACTION CHARACTERISTICS : METHOD

DRY UNIT WEIGHT, LBF/FT^3

SAMPLE PREPARATION WET DRY
RAMMER USED:
2 IN. CIRCULAR FACE OTHER
MECHANICAL MANUAL

MAXIMUM DENSITY, LBF/FT^3 →
OPTIMUM MOISTURE CONTENT, % →

OVERSIZE AGGREGATE :
BULK SPECIFIC GRAVITY :
ABSORPTION, % :
% OVERSIZE IN LAB SAMPLE :

SPECIFIC GRAVITY IN ZERO AIR VOID CURVE :

MOISTURE, % DRY WEIGHT

TEST PROCEDURE	RESULT	SPECS
LIQUID & PLASTIC PROPERTIES :		
LIQUID LIMIT →		
ESTIMATED % RETAINED ON NO. 40 PLASTIC LIMIT →		
SAMPLE AIR DRIED YES NO PLASTICITY INDEX →		
MOISTURE CONTENT :		
PORTION TESTED % DRY WEIGHT →		
EXPANSION / COMPRESSION PROPERTIES OF COHESIVE SOIL :		
EXPANSION COMPRESSION, % →		
MAXIMUM SWELL PRESSURE, KSF →		
SURCHARGE, KSF		
INITIAL WATER CONTENT, % DRY DENSITY, PCF		

TEST PROCEDURE	RESULT	SPECS
RESISTANCE TO DEGRADATION OF SMALL-SIZE COARSE AGGREGATES BY ABRASION :		
GRADING 100 REV, % LOSS →		
GRADING 500 REV, % LOSS →		
SPECIFIC GRAVITY :		
MAX. PARTICLE SIZE, IN SPECIFIC GRAVITY @ 20 C		
pH DETERMINATION : AZ 237 →		
pH →	8.5	
SOLUBLE SALTS :		
PPM →		
MINIMUM RESISTIVITY : AZ 236		
OHM-CM →	2181	

SOIL CLASSIFICATION : GROUP SYMBOL :
NAME :

Comments :

Copies to : **CLIENT**

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North Central Arizona Water Supply Feasibility Study - Hopi Spur
Test Pit Investigations 2016

INTRODUCTION

The Bureau of Reclamation (Reclamation) is conducting a study to determine the feasibility of constructing the North Central Arizona Pipeline to deliver water from Lake Powell, south to Cameron, with laterals to Bitter Springs and Keams Canyon. The study is being funded under the Rural Water Act and is referred to as the North Central Arizona Water Supply Feasibility Study (NCAWSFS).

PREVIOUS INVESTIGATIONS

Reclamation performed eighty-nine (89) seismic refraction surveys along portions of the proposed pipeline alignment in 2008, to determine the rippability of the material that would be encountered during construction. In order to calibrate the seismic refraction surveys with actual excavation conditions, seventeen test pits were excavated in specified areas that had already been surveyed. The proposed pipeline alignment was geologically mapped at a scale of 1 inch equals 10,000 feet. Rock types and their engineering characteristics were recorded at each seismic refraction survey site and at selected outcrops along the alignment. The report is titled "Proposed Western Navajo-Hopi Pipeline - Rippability of Materials Based on Seismic Wave Velocities". Drawings in the report give an indication of the rippability of the excavation based on the wave velocity and geologic mapping.

In June 2012, Reclamation excavated sixty-four (64) test pits along portions of the proposed North Central Arizona Pipeline in order to determine the depth to bedrock and to obtain soil samples for materials testing. Test pits TP-1 through TP-48 were excavated along US Highway 89 or along the old US Highway 89, which runs parallel to US 89 (TP-17 was not excavated since bedrock was at the surface). Test pits TP-49 through TP-68 were excavated along Tribal Route 20 (Copper Mine Road) from The Gap to about 6 miles north of Coppermine Chapter. Test pits TP-64, TP-65 and TP-66 were omitted because bedrock was at or near the surface. The test pits were approximately 20 feet long by 6 feet wide and 13 to 15 feet deep unless the backhoe met refusal. The pits were visually classified by a Reclamation geologist and representative samples taken and sent to a lab for gradation sieve analysis, testing for moisture content, Atterberg limits, Proctor compaction pH, conductivity, and sulfate, sulfide and chloride content. Selected soils were tested for shrink/swell potential (expansion index) and in-place densities were measured using a sand cone apparatus in selected test pits at depths ranging from 3 to 5 feet. The report is titled "North Central Arizona Water Supply Feasibility Study - Test Pit Investigations 2012".

In May 2013, Reclamation excavated thirteen (13) test pits along a 7-mile-long alignment extending from Moenave to Tuba City, Arizona, to determine the depth to bedrock and to obtain samples to conduct engineering soil tests. The test pits TP-69 through TP-81 were excavated in mostly wind deposited sand and ranged in depth from 2.4 to 13.0 feet deep. Pits were approximately 20 feet long by 4 to 8 feet wide and 13 feet deep unless the backhoe met refusal. The materials encountered were visually classified by a Reclamation geologist and representative soil samples sent to the Yuma Area Office's materials lab and tested for standard physical properties including gradations, moisture content, Atterberg limits and Proctor compaction in accordance with Reclamation Earth Manual laboratory standards. In-place density tests were

conducted in selected pits at a depth of 5 feet utilizing a sand cone apparatus. The report is titled "North Central Arizona Water Supply Feasibility Study - Tuba City Spur - Test Pit Investigations 2013".

In October 2015, Reclamation excavated twenty-one (21) test pits along State Route 264 from east of Coalmine Chapter to Hotevilla, Arizona at approximately 1 mile intervals. The pits were excavated to determine the depth to bedrock and to obtain samples to conduct engineering soil tests for the proposed water pipeline. Test pits were numbered TP-216 through TP-237 and were excavated to a depth of 12 to 15 feet or to refusal. TP-223 was not excavated due to its close proximity to sandstone outcrops. The pits were located within the Arizona Department of Transportation's right-of-way and were generally offset from the pipeline alignment by 60 to 100 feet.

Representative samples were collected and laboratory tested for standard physical properties including gradations, moisture content, Atterberg limits and Proctor compaction in accordance with Reclamation Earth Manual laboratory standards. In-place density tests were conducted in selected test pits at about 5 feet of depth utilizing a sand cone apparatus. Soil samples were taken from test pits TP-224, TP-227 and TP-235 and tested to determine the pH and resistivity of the soil for corrosion potential. The report is titled "North Central Arizona Water Supply Feasibility Study - Hopi Spur - Test Pit Investigations 2015".

CURRENT INVESTIGATION

Reclamation excavated fourteen (14) test pits at specified sites along State Route 264 from east of Moenkopi to Coalmine Canyon Chapter, Arizona to determine the depth to bedrock and to obtain samples to conduct soil tests for the proposed pipeline. Test pits were numbered TP-201 through TP-215 and were excavated to a depth of 12 to 15 feet or to refusal. TP-214 was not excavated due to poor access and its close proximity to shale outcrops. The pits were located within the Arizona Department of Transportation's right-of-way and were generally offset from the pipeline alignment by 75 to 100 feet.

Photographs, test pit logs and test results follow this text. Test pit locations are shown on Figure 1. Test pit coordinates are given in Table 1.

Table 1. Test Pit Coordinates

TEST PIT	NAD83 GEOGRAPHIC		NAD83 UTM ZONE 12		AZ STATE PLANE CENTRAL	
	Latitude	Longitude	Northing	Easting	Northing	Easting
TP-201	36.074664	-111.184738	3992245.6	483365.7	1847260	916290
TP-202	36.059965	-111.181944	3990614.8	483614.2	1841915	917156
TP-203	36.046490	-111.181940	3989120.2	483611.8	1837010	917194
TP-204	36.035660	-111.181513	3987918.9	483648.0	1833069	917350
TP-205	36.030923	-111.165034	3987390.9	485131.7	1831382	922235
TP-206	36.027086	-111.151675	3986963.3	486334.6	1830016	926196
TP-207	36.022714	-111.136381	3986476.4	487711.8	1828460	930731
TP-208	36.019697	-111.115351	3986139.3	489596.3	1827412	936926
TP-209	36.016316	-111.097585	3985762.5	491206.7	1826225	942223
TP-210	36.012966	-111.080151	3985389.5	492777.4	1825050	947389
TP-211	36.009548	-111.062834	3985009.3	494337.6	1823850	952522
TP-212	36.004476	-111.046000	3984445.9	495854.4	1822048	957517
TP-213	35.997990	-111.030029	3983725.9	497293.5	1819729	962262
TP-215	35.988689	-111.007185	3982693.9	499352.3	1816406	969051


Tuba City Turnout
Water Tanks
Tuba City
Navajo Trail
Rare Metals
U.S. Hwy 160
160
Moenkopi
TP-201
TP-202
TP-203
TP-204
TP-205
TP-206
TP-207
TP-208
TP-209
TP-210
TP-211
TP-212
TP-213
TP-214
TP-215

Figure 1



Test pit TP-201 was excavated from 0 to 6.5 ft. in silty sand and from 6.5 to 12.5 ft. in sandstone. An in-place density was taken at 5.5 ft. utilizing a sand cone apparatus.



Test pit TP-202 was excavated from 0 to 3.5 ft. in silty sand, from 3.5 to 7 ft. in decomposed sandstone and from 7 to 9 ft. in soft sandstone that was difficult to excavate beyond 9 ft.



Test pit TP-203 was excavated in silty sand from 0 to 13 ft. and encountered an irregularly shaped gravel layer from about 2.3 to 3.5 ft.



Test pit TP-204 was excavated from 0 to 7 ft. in silty sand, from 7 to 9.5 ft. in decomposed sandstone and from 9.5 to 11.5 ft. in soft sandstone that was difficult to excavate beyond 11.5 ft.



Test pit TP-205 excavated silty sand from 0 to 11 ft. and soft sandstone from 11 to 13 ft.



Test pit TP-206 encountered silty sand from 0 to 15 ft.



Test pit TP-207 was excavated from 0 to 14 ft. in silty sand.



Test pit TP-208 was excavated from 0 to 5 ft. in silty sand, from 5 to 6.5 ft. in decomposed sandstone and from 6.5 to 7.5 ft. in soft sandstone that was difficult to excavate beyond 7.5 ft.



Test pit TP-209 was excavated from 0 to 4.5 ft. in silty sand, from 4.5 to 5 ft. in decomposed sandstone and from 5 to 8 ft. in soft sandstone that was difficult to excavate beyond 8 ft.



Test pit TP-210 encountered silty sand from 0 to 6 ft. and soft sandstone from the Navajo Sandstone Formation from 6 to 9 ft. that was difficult to excavate beyond 9 ft.



Test pit TP-211 encountered soft siltstone and sandstone from the Dakota Formation at 3 ft. The pit was terminated at 8 ft. at refusal.



Test pit TP-212 encountered moderately soft to moderately hard sandstone from the Dakota Formation at 2 ft. The pit was terminated at 5.5 ft. at refusal.



Test pit TP-213 excavated sandy lean clay from 0 to 7 ft.



Test pit TP-215 was excavated from 0 to 2 ft. in silty sand, from 2 to 5 ft. in sandy lean clay, from 5 to 6.5 in sandy conglomerate and from 6.5 to 9 ft. in soft sandstone that was difficult to excavate beyond 9 ft.

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-201**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1847260 **E.** 916290 **GROUND ELEVATION:** 5089

APPROXIMATE DIMENSIONS: 15' x 6' x 12.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 4/19/2016 **DATE LOGGED:** 4/19/2016

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class.	**0.0 - 6.5 ft. Silty Sand (SM):** About 85% predominantly fine to coarse sand, 15% nonplastic fines with low dry strength, rapid dilatancy and low toughness. Max. size, coarse sand. Strong reaction with HCl. In-place condition: very soft consistency with firm clumps, homogenous, dry, no to weak cementation. Color is reddish tan.	0	0	0
Lab sample taken from 0.0-5.5 ft. SM Lab Class.	Lab test data from 0.0-5.5 ft.: Lab classification is Silty Sand (SM): 85% sand, 15% fines. Nonplastic; Field Moisture = 1.9%. Proctor Test (max. dry density) = 109.3 lbm/ft^3; Optimum Moisture = 13.2%. In-Place Density taken at 5.5 ft. with sand cone apparatus = 98.5 lbm/ft^3.			
6.5 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
Ss Visual Class.	**6.5 - 12.5 ft. Sandstone (Ss):** Sandstone consists of predominantly fine, subrounded sand moderately cemented with silica; crossbedded, beds are 1/8 to 3 in. thick. Soft to moderately soft, edges of hand-size fragments break with light manual pressure; thicker portions require heavy manual pressure to break. No reaction with HCl. Color is very light gray to white (N8 to N9).			
12.5 ft.	**Geologic Interpretation:** Navajo Sandstone Formation (Jn)			

REMARKS: **S**urface: slightly sloping, loose sand within ADOT ROW covered with scattered grasses. Outcrop of white sandstone (Navajo Sandstone Formation) across road in wind-blown depression. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-202**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1841915 **E.** 917156 **GROUND ELEVATION:** 5177

APPROXIMATE DIMENSIONS: 15' x 4' x 9' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 4/19/2016 **DATE LOGGED:** 4/19/2016

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SP-SM Visual Class.	**0.0 - 3.5 ft. Poorly Graded Sand with Silt (SP-SM):** About 90% predominantly fine to coarse sand, 10% nonplastic fines with low dry strength, rapid dilatancy and low toughness, trace of fine to coarse gravel. Max. size, 1.5 in. Strong reaction with HCl. In-place condition: very soft consistency, homogenous, dry, no cementation. Color is reddish tan. Lab test data from 0.0-3.5 ft.: Lab classification is Poorly Graded Sand with Silt (SP-SM): 94% sand, 6% fines, trace of gravel. Nonplastic; Field Moisture = 0.9%. Proctor Test (max. dry density) = 110.4 lbm/ft^3; Optimum Moisture = 12.7%. Corrosion Potential Testing 0.0-3.5 ft.: pH = 8.8, Resistivity = 3,802 ohm/cm.	0	0	0
Lab sample taken from 0.0-3.5 ft. SP-SM Lab Class.				
3.5 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
SP Visual Class.	**3.5 - 7.0 ft. Poorly Graded Sand (SP):** About 95% predominantly fine sand, 5% nonplastic fines. Max. size, fine sand. No reaction with HCl. In-place condition: very soft consistency, homogenous, dry, no cementation. Color is white.	0	0	0
7.0 ft.	**Geologic Interpretation:** Quaternary Colluvium derived from in-place weathering of the underlying sandstone.			
Ss Visual Class.	**7.0 - 9.0 ft. Sandstone (Ss):** Sandstone consists of predominantly fine, subrounded sand moderately cemented with silica; crossbedded, beds are 1/8 to 1 in. thick. Soft to moderately soft, edges of hand-size fragments break with light manual pressure; thicker portions require heavy manual pressure to break. No reaction with HCl. Color is very light gray to white (N8 to N9). Although sandstone can be broken with manual pressure in hand specimen, backhoe met refusal.			
9.0 ft.	**Geologic Interpretation:** Navajo Sandstone Formation (Jn)			

REMARKS: **S**urface: slightly sloping loose sand within ADOT ROW covered with scattered grasses. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-203**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1837010 **E.** 917194 **GROUND ELEVATION:** 5318

APPROXIMATE DIMENSIONS: 15' x 6' x 13' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 4/19/2016 **DATE LOGGED:** 4/19/2016

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class.	**0.0 - 13.0 ft. Silty Sand (SM):** About 80% predominantly fine to coarse sand, 20% nonplastic fines with low dry strength, rapid dilatancy and low toughness, trace of fine to coarse gravel from 5.5 to 13.0 ft. Max. size, 2 in. Strong reaction with HCl. In-place condition: very soft to soft consistency, dry, weak cementation. Irregularly shaped layer of angular to rounded, fine to coarse gravel occurs from about 2.3 to 3.5 ft. Color is reddish tan.	0	0	0
Lab sample taken from 0.0-5.5 ft. SM Lab Class.	Lab test data from 0.0-5.5 ft.: Lab classification is Silty Sand (SM): 79% sand, 21% fines, trace of gravel. Nonplastic; Field Moisture = 1.7%. Proctor Test (max. dry density) = 115.2 lbm/ft^3; Optimum Moisture = 10.6%. In-Place Density taken at 5.5 ft. with sand cone apparatus = 105.7 lbm/ft^3.			
13.0 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			

REMARKS: **S**urface: slightly sloping, loose sand within ADOT ROW covered with scattered grasses. Outcrop of white sandstone (Navajo Sandstone Formation) in drainage about 100 ft. downstream along road. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-204**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1833069 **E.** 917350 **GROUND ELEVATION:** 5478

APPROXIMATE DIMENSIONS: 15' x 4' x 11.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 4/19/2016 **DATE LOGGED:** 4/19/2016

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class. Lab sample taken from 0.0-7.0 ft. SM Lab Class. **7.0 ft.**	**0.0 - 7.0 ft. Silty Sand (SM):** About 80% predominantly fine to coarse sand, 20% nonplastic fines with low dry strength, rapid dilatancy and low toughness, trace of gravel. Max. size, 1.5 in. Strong reaction with HCl. In-place condition: very soft to soft consistency, homogenous, dry, no cementation. Color is reddish tan. Lab test data from 0.0-7.0 ft.: Lab classification is Silty Sand (SM): 81% sand, 17% fines, 2% gravel. Nonplastic; Field Moisture = 1.9%. Proctor Test (max. dry density) = 115.4 lbm/ft^3; Optimum Moisture = 8.6%. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
SP Visual Class. **9.5 ft.**	**7.0 - 9.5 ft. Poorly Graded Sand (SP):** About 95% predominantly fine sand, 5% nonplastic fines. Max. size, fine sand. Strong reaction with HCl. In-place condition: soft consistency, homogenous, dry, no cementation. Color is white. **Geologic Interpretation:** Quaternary Colluvium derived from in-place weathering of the underlying sandstone.	0	0	0
Ss Visual Class. **11.5 ft.**	**9.5 - 11.5 ft. Sandstone (Ss):** Sandstone consists of predominantly fine, subrounded sand moderately cemented with silica; crossbedded, beds are 1/8 to 1 in. thick. Soft to moderately soft, edges of hand-size fragments break with light manual pressure; thicker portions require heavy manual pressure to break. No reaction with HCl. Color is very light gray to white (N8 to N9). Although sandstone can be broken with manual pressure in hand specimen, backhoe met refusal. **Geologic Interpretation:** Navajo Sandstone Formation (Jn)			

REMARKS: **S**urface: level, loose sand within ADOT ROW covered with scattered grasses. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-205**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1831382 **E.** 922235 **GROUND ELEVATION:** 5381

APPROXIMATE DIMENSIONS: 15' x 6' x 13.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 4/19/2016 **DATE LOGGED:** 4/19/2016

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class.	**0.0 - 11.0 ft. Silty Sand (SM):** About 80% predominantly fine to coarse sand, 20% nonplastic fines with low dry strength, rapid dilatancy and low toughness. Max. size, coarse sand. Strong reaction with HCl. In-place condition: very soft to firm consistency, homogenous, dry, weak to moderate cementation. A few localized pockets of uncemented, fine gravel present. Color is reddish tan to tan.	0	0	0
Lab sample taken from 0.0-4.6 ft. SM Lab Class.	Lab test data from 0.0-11.0 ft.: Lab classification is Silty Sand (SM): 85% sand, 15% fines. Nonplastic; Field Moisture = 1.5%. Proctor Test (max. dry density) = 109.1 lbm/ft^3; Optimum Moisture = 13.3%. In-Place Density taken at 4.6 ft. with sand cone apparatus = 105.6 lbm/ft^3.			
11.0 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
Ss Visual Class.	**11.0 - 13.0 ft. Sandstone (Ss):** Sandstone consists of predominantly fine, subrounded sand moderately cemented with silica; crossbedded, beds are 1/8 to 3 in. thick. Soft, fragments break with light manual pressure. Moderate reaction with HCl. Color is very light gray to white (N8 to N9).			
13.0 ft.	**Geologic Interpretation:** Navajo Sandstone Formation (Jn)			

REMARKS: **S**urface: level ground, loose sand within ADOT ROW covered with scattered grasses. Outcrop of white sandstone (Navajo Sandstone Formation) across road in wind-blown depression. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** **TP-206**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1830016 **E.** 926196 **GROUND ELEVATION:** 5405

APPROXIMATE DIMENSIONS: 15' x 3' x 15' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 4/19/2016 **DATE LOGGED:** 4/19/2016

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class.	**0.0 - 15.0 ft. Silty Sand (SM):** About 80% predominantly fine to coarse sand, 20% nonplastic fines with low dry strength, rapid dilatancy and low toughness. Max. size, coarse sand. Strong reaction with HCl. In-place condition: very soft to soft consistency, homogenous, dry, weak cementation. Color is tan.	0	0	0
Lab sample taken from 0.0-15.0 ft. SM Lab Class.	Lab test data from 0.0-15.0 ft.: Lab classification is Silty Sand (SM): 78% sand, 22% fines. Nonplastic; Field Moisture = 3.5%. Proctor Test (max. dry density) = 115.7 lbm/ft^3; Optimum Moisture = 13.7%. Corrosion Potential Testing 0.0-5.0 ft.: pH = 8.8, Resistivity = 2,735 ohm/cm.			
15.0 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			

REMARKS: **S**urface: flat ground, loose sand within ADOT ROW covered with scattered grasses. Located 30 feet upstream of manmade drainage. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336
Bureau of Reclamation

LOG OF TEST PIT OR AUGER HOLE

HOLE NO. TP-207

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1828460 **E.** 930731 **GROUND ELEVATION:** 5447

APPROXIMATE DIMENSIONS: 15' x 6' x 14' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 4/19/2016 **DATE LOGGED:** 4/19/2016

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class.	**0.0 - 14.0 ft. Silty Sand (SM):** About 70% predominantly fine to coarse sand, 30% nonplastic fines with low dry strength, rapid dilatancy and low toughness. Max. size, coarse sand. Strong reaction with HCl. In-place condition: very soft to firm consistency, homogenous, dry, weak cementation. Color is reddish tan.	0	0	0
Lab sample taken from 0.0-5.3 ft. SM Lab Class.	Lab test data from 0.0-5.3 ft.: Lab classification is Silty Sand (SM): 67% sand, 33% fines. Nonplastic; Field Moisture = 4.1%. Proctor Test (max. dry density) = 117.3 lbm/ft^3; Optimum Moisture = 13.6%. In-Place Density taken at 5.3 ft. with sand cone apparatus = 97.8 lbm/ft^3.			
14.0 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			

REMARKS: **S**urface: flat ground, loose sand within ADOT ROW covered with scattered grasses. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-208**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1827412 **E.** 936926 **GROUND ELEVATION:** 5624

APPROXIMATE DIMENSIONS: 15' x 3' x 7.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 4/19/2016 **DATE LOGGED:** 4/19/2016

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class. Lab sample taken from 0.0-5.0 ft. SM Lab Class. **5.0 ft.**	**0.0 - 5.0 ft. Silty Sand (SM):** About 80% predominantly fine to coarse sand, 20% nonplastic fines with low dry strength, rapid dilatancy and low toughness, trace of fine to coarse gravel. Max. size, 1 in. Strong reaction with HCl. In-place condition: very soft to soft consistency, homogenous, dry, weak cementation. Color is reddish tan. Lab test data from 0.0-5.0 ft.: Lab classification is Silty Sand (SM): 78% sand, 21% fines, 1% gravel. Nonplastic; Field Moisture = 2.2%. Proctor Test (max. dry density) = 117.0 lbm/ft^3; Optimum Moisture = 10.5 %. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
SP Visual Class. **6.5 ft.**	**5.0 - 6.5 ft. Poorly Graded Sand (SP):** About 95% predominantly fine sand, 5% nonplastic fines. Max. size, fine sand. Strong reaction with HCl. In-place condition: soft consistency, homogenous, dry, no cementation. Color is white. **Geologic Interpretation:** Quaternary Colluvium derived from in-place weathering of the underlying sandstone.	0	0	0
Ss Visual Class. **7.5 ft.**	**6.5 - 7.5 ft. Sandstone (Ss):** Sandstone consists of predominantly fine, subrounded sand moderately cemented with silica; crossbedded, beds are 1/8 to 1 in. thick. Soft to moderately soft, edges of hand-size fragments break with light manual pressure; thicker portions require heavy manual pressure to break. Strong reaction with HCl. Color is very light gray to white (N8 to N9). Although sandstone can be broken with manual pressure in hand specimen, backhoe met refusal. **Geologic Interpretation:** Carmel Formation (Jsc)			

REMARKS: **S**urface: level, loose sand within ADOT ROW covered with scattered grasses. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-209**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1826225 **E.** 942223 **GROUND ELEVATION:** 5654

APPROXIMATE DIMENSIONS: 15' x 3' x 8' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 4/20/2016 **DATE LOGGED:** 4/20/2016

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class. Lab sample taken from 0.0-4.5 ft. SM Lab Class. **4.5 ft.**	**0.0 - 4.5 ft. Silty Sand (SM):** About 80% predominantly fine to coarse sand, 20% nonplastic fines with low dry strength, rapid dilatancy and low toughness, trace of gravel. Max. size, 1.5 in. Strong reaction with HCl. In-place condition: very soft to soft consistency, homogenous, dry, weak cementation. Color is reddish tan. Lab test data from 0.0-4.5 ft.: Lab classification is **Silty Sand (SM):** 77% sand, 23% fines, trace of gravel. Nonplastic; Field Moisture = 2.4%. Proctor Test (max. dry density) = 118.3 lbm/ft^3; Optimum Moisture = 11.5%. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
SP Visual Class. **5.0 ft.**	**4.5 - 5.0 ft. Poorly Graded Sand (SP):** About 95% predominantly fine sand, 5% nonplastic fines. Max. size, fine sand. Strong reaction with HCl. In-place condition: soft consistency, homogenous, dry, no cementation. Color is white. **Geologic Interpretation:** Quaternary Colluvium derived from in-place weathering of the underlying sandstone.	0	0	0
Ss Visual Class. **8.0 ft.**	**5.0 - 8.0 ft. Sandstone (Ss):** Sandstone consists of predominantly fine, subrounded sand moderately cemented with silica; crossbedded, beds are 1/8 to 1 in. thick. Soft to moderately soft, edges of hand-size fragments break with light manual pressure; thicker portions require heavy manual pressure to break. No reaction with HCl except strong reaction on powdery coatings on some bedding joints. Color is very light gray to white (N8 to N9). Although sandstone can be broken with manual pressure in hand specimen, backhoe met refusal. **Geologic Interpretation:** Carmel Formation (Jsc)			

REMARKS: **S**urface: level, loose sand within ADOT ROW covered with scattered grasses. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-210**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1825050 **E.** 947389 **GROUND ELEVATION:** 5734

APPROXIMATE DIMENSIONS: 15' x 6' x 9.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 4/20/2016 **DATE LOGGED:** 4/20/2016

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class. Lab sample taken from 0.0-6.0 ft. SM Lab Class. **6.0 ft.**	**0.0 - 6.0 ft. Silty Sand (SM):** About 75% predominantly fine to coarse sand, 25% nonplastic fines with low dry strength, rapid dilatancy and low toughness. Max. size, coarse sand. Strong reaction with HCl. In-place condition: very soft to firm consistency, homogenous, dry, weak cementation. Color is reddish tan. Lab test data from 0.0-6.0 ft.: Lab classification is Silty Sand (SM): 81% sand, 19% fines. Nonplastic; Field Moisture = 1.6%. Proctor Test (max. dry density) = 120.4 lbm/ft^3; Optimum Moisture = 9.3%. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
Ss Visual Class. **9.0 ft.**	**6.0 - 9.0 ft. Sandstone (Ss):** Sandstone consists of predominantly fine, subrounded sand moderately cemented with silica; crossbedded, beds are 1/8 to 1 in. thick. Soft, fragments break with light manual pressure. No reaction with HCl, except strong reaction on $CaCO_3$ coatings on bedding planes. Color is very light gray to white (N8 to N9). **Geologic Interpretation:** Carmel Formation (Jsc)			

REMARKS: **S**urface: level ground, loose sand within ADOT ROW covered with scattered grasses. Outcrop of white sandstone (Navajo Sandstone Formation) across road in wind-blown depression. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-211**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1823850 **E.** 952522 **GROUND ELEVATION:** 5797

APPROXIMATE DIMENSIONS: 15' x 3' x 8' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 4/20/2016 **DATE LOGGED:** 4/20/2016

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
s(CL) Visual Class.	**0.0 - 3.0 ft. Sandy Lean Clay s(CL):** About 60% fines with medium plasticity, low dry strength, slow dilatancy and low toughness. 40% predominantly fine to coarse sand, trace of fine to coarse, rounded to subrounded gravel. Max. size, 2 in. Strong reaction with HCl. In-place condition: very hard consistency, homogenous, dry, moderate to strong cementation. Color is reddish tan. Lab test data from 0.0-3.0 ft.:	0	0	0
Lab sample taken from 0.0-3.0 ft. s(CL) Lab Class.	Lab classification is Sandy Lean Clay s(CL): 53% fines, 47% sand, trace of gravel. Liquid Limit (LL) = 21.4; Plasticity Index (PI) = 10.2; Field Moisture = 6.1%. Proctor Test (max. dry density) = 116.7 lbm/ft^3; Optimum Moisture = 11.5%. Corrosion Potential Testing 0.0-3.0 ft.: pH = 8.5, Resistivity = 2,068 ohm/cm.			
3.0 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
Sltst Visual Class.	**3.0 - 3.5 ft. Siltstone (Sltst):** Siltstone consists of silt to very fine sand cemented with $CaCO_3$; thinly bedded, beds are 1/8 to 1/2 in. thick. Soft, fragments break with light manual pressure. Strong reaction with HCl. Color is light brownish gray (5YR 6/1).			
Ss Visual Class.	**3.5 - 8.0 ft. Sandstone (Ss):** Sandstone consists of predominantly fine sand moderately cemented with $CaCO_3$; bedding is 1/2 to 2 in. thick. Soft, fragments break with light manual pressure. Moderate reaction with HCl, except strong reaction on $CaCO_3$ coating bedding planes. Color is pale yellowish orange (10 YR 8/6).			
8.0 ft.	**Geologic Interpretation:** Dakota Formation (Kd)			

REMARKS: **S**urface: level ground, loose sand within ADOT ROW covered with scattered grasses. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-212

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1822048 **E.** 957517 **GROUND ELEVATION:** 5848

APPROXIMATE DIMENSIONS: 15' x 3' x 5.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 4/20/2016 **DATE LOGGED:** 4/20/2016

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class. Lab sample taken from 0.0-2.0 ft. SM Lab Class. **2.0 ft.**	**0.0 - 2.0 ft. Silty Sand (SM):** About 60% predominantly fine to medium sand, 40% nonplastic fines with low dry strength, rapid dilatancy and low toughness, trace of fine to coarse gravel. Max. size, 2 in. Strong reaction with HCl. In-place condition: very soft to firm consistency, homogenous, dry, weak cementation. Color is reddish tan. Lab test data from 0.0-2.0 ft.: Lab classification is Silty Sand (SM): 56% sand, 43% fines, 1% gravel. Liquid Limit (LL) = 19.6; Plasticity Index (PI) = 3.9; Field Moisture = 4.2%. Proctor Test (max. dry density) = 119.6 lbm/ft^3; Optimum Moisture = 12.1%. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
Ss Visual Class. **5.5 ft.**	**2.0 - 5.5 ft. Sandstone (Ss):** Sandstone consists of silt to predominantly fine sand moderately cemented with $CaCO_3$; bedding is 1/2 to 2 in. thick. Moderately weathered, moderately soft to moderately hard; thin fragments break with manual pressure, thicker fragments require light hammer blow to break. Strong reaction with HCl. Color is mottled dark yellowish orange and pale yellowish orange (10YR 6/6 and 10 YR 8/6). **Geologic Interpretation:** Dakota Formation (Kd)			

REMARKS: **S**urface: level ground, loose sand within ADOT ROW covered with scattered grasses. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-213**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1819729 **E.** 962262 **GROUND ELEVATION:** 5872

APPROXIMATE DIMENSIONS: 15' x 6' x 7' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 4/20/2016 **DATE LOGGED:** 4/20/2016

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
s(CL) Visual Class. Lab sample taken from 0.0-6.0 ft. s(CL) Lab Class. **7.0 ft.**	**0.0 - 7.0 ft. Sandy Lean Clay s(CL):** About 55% fines with high plasticity, high dry strength, slow dilatancy and low toughness. 45% predominantly fine to coarse sand. Max. size, coarse sand. Strong reaction with HCl. In-place condition: very hard consistency, homogenous, dry, strong cementation. Color is medium brown. Lab test data from 0.0-6.0 ft.: Lab classification is Sandy Lean Clay s(CL): 53% fines, 47% sand. Liquid Limit (LL) = 24.7; Plasticity Index (PI) = 14.0; Field Moisture = 5.5%. Proctor Test (max. dry density) = 117.8 lbm/ft^3; Optimum Moisture = 12.9%. **Geologic Interpretation:** Quaternary Colluvium	0	0	0

REMARKS: **S**urface: low spot along road - evidence of standing water within ADOT ROW. Covered with scattered grasses. Bottom of pit at 5 ft. was too hard too level and dig to perform in-place density with a sand cone. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-215

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1816406 **E.** 969051 **GROUND ELEVATION:** 5973

APPROXIMATE DIMENSIONS: 15' x 3' x 9' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 4/20/2016 **DATE LOGGED:** 4/20/2016

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class.	**0.0 - 2.0 ft. Silty Sand (SM):** About 75% predominantly fine to medium sand, 25% nonplastic fines with low dry strength, rapid dilatancy and low toughness. Max. size, medium sand. Strong reaction with HCl. In-place condition: very soft to firm consistency, homogenous, dry, weak cementation. Color is reddish tan.	0	0	0
2.0 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
s(CL) Visual Class.	**2.0 - 5.0 ft. Sandy Lean Clay s(CL):** About 55% fines with high plasticity, high dry strength, slow dilatancy and low toughness. 45% predominantly fine to coarse sand. Max. size, coarse sand. Strong reaction with HCl. In-place condition: very hard consistency, homogenous, dry, strong cementation. Color is medium brown.	0	0	0
5.0 ft.	**Geologic Interpretation:** Quaternary Colluvium (derived from underlying sandstone)			
Cgl Visual Class.	**5.0 - 6.5 ft. Sandy Conglomerate:** Conglomerate consists of about 70% fine to coarse, subrounded gravel and 30% fine to coarse sand weakly cemented with calcium carbonate. Very intensely weathered to decomposed and very soft, material breaks into component parts when excavated. Strong reaction with HCl.			
Ss Visual Class.	**6.5 - 9.0 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand cemented with silica. Intensely weathered and soft, fragments crumble with manual pressure. Becomes slightly harder with depth. No reaction with HCl. Color is grayish orange (10YR 7/4). The conglomerate and sandstone are part of the sequence mapped as Tsy deposited on top of the Mancos Shale Formation.			
9.0 ft.	**Geologic Interpretation:** Pliocene to Mid-Miocene Deposits (Tsy)			

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

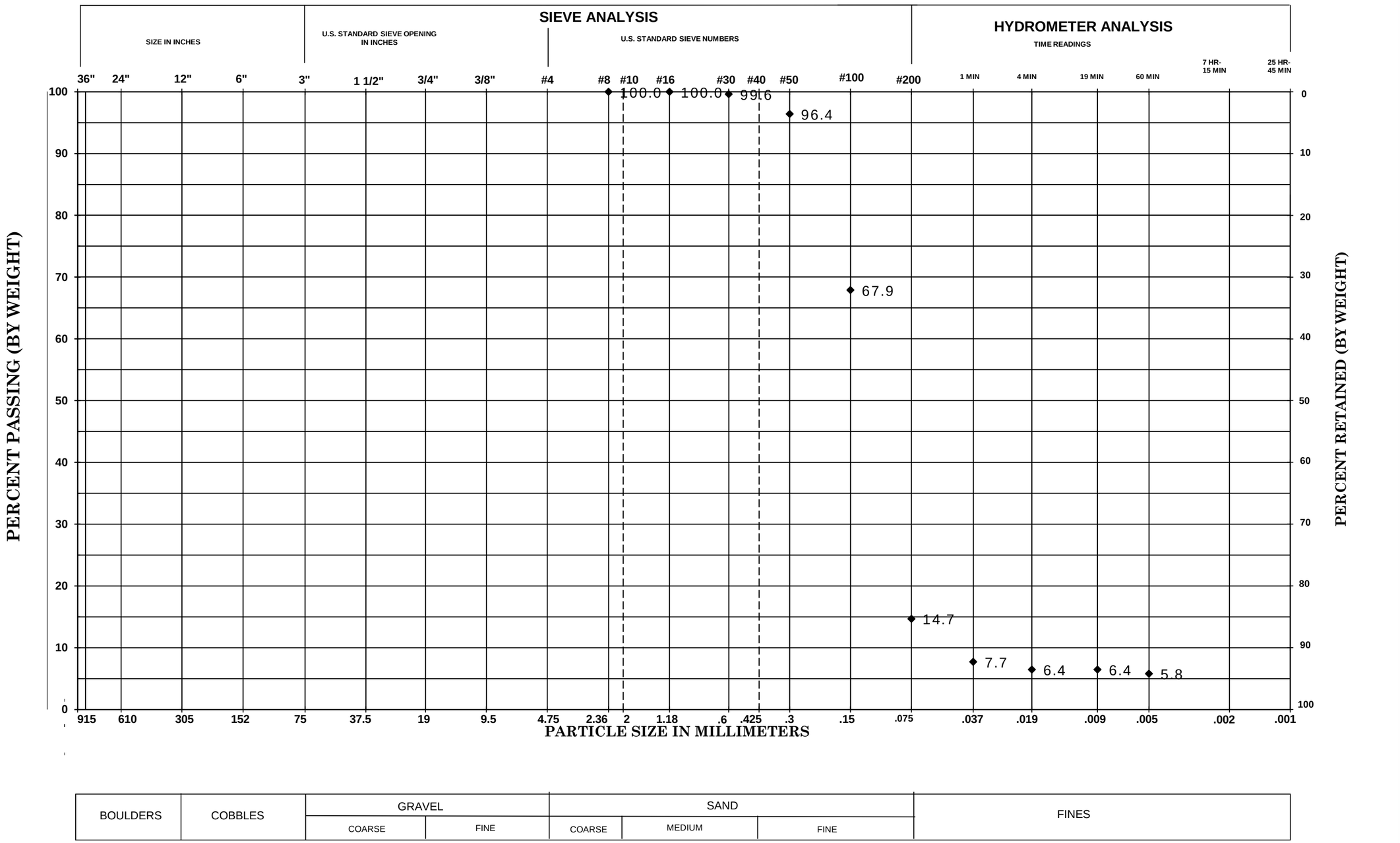
Summary of Test Pits

NCAWSFS - Test Pits (Tuba City)

April, 2016

Date Sampled	Location	Depth	Unified Soil Classification		% Gravel	% Sand	% Fines	Max. Size	C_U	C_C	Inplace Moisture Content %	In-place Dry Density (lbm/ft³)	Lab. Max Dry Density (lbm/ft³)	Optimum Moisture Content %	Liquid Limit	Plasticity Index
04/19/16	TP-201	0' to 5.5'	SM	Silty Sand	0	85	15	No. 8	2.9	1.3	1.9	98.5	109.3	13.2		NP
04/19/16	TP-202	0' to 3.5'	SP-SM	Poorly Graded Sand with Silt	Trace	94	6	1.5"	2.7	1.1	0.9	-	110.4	12.7		NP
04/19/16	TP-203	0' to 5.5'	SM	Silty Sand	Trace	79	21	1"	5.3	1.3	1.7	105.7	115.2	10.6		NP
04/19/16	TP-204	0' to 7'	SM	Silty Sand	2	81	17	1.5"	5.9	1.5	1.9	-	115.4	8.6		NP
04/19/16	TP-205	0' to 4.6'	SM	Silty Sand	0	85	15	No. 8	5.0	1.5	1.5	105.6	109.1	13.3		NP
04/19/16	TP-206	0' to 15'	SM	Silty Sand	0	78	22	No. 8	-	-	3.5	-	115.7	13.7		NP
04/19/16	TP-207	0' to 5.3'	SM	Silty Sand	0	67	33	No. 8	-	-	4.1	97.8	117.3	13.6		NP
04/19/16	TP-208	0' to 5'	SM	Silty Sand	1	78	21	1"	14.7	3.9	2.2	-	117.0	10.5		NP
04/20/16	TP-209	0' to 4.5'	SM	Silty Sand	Trace	77	23	1.5"	25.6	6.4	2.4	-	118.3	11.5		NP
04/20/16	TP-210	0' to 6'	SM	Silty Sand	0	81	19	No. 8	7.0	1.6	1.6	-	120.4	9.3		NP
04/20/16	TP-211	0' to3'	CL	Sandy Lean Clay	Trace	47	53	.75"	-	-	6.1	-	116.7	11.5	21.4	10.2
04/20/16	TP-212	0' to 2'	SM	Silty Sand	1	56	43	2"	-	-	4.2	-	119.6	12.1	19.6	3.9
04/20/16	TP-213	0' to 6'	CL	Sandy Lean Clay	0	47	53	No. 4	-	-	5.5	-	117.8	12.9	24.7	14.0

GRAIN SIZE DISTRIBUTION

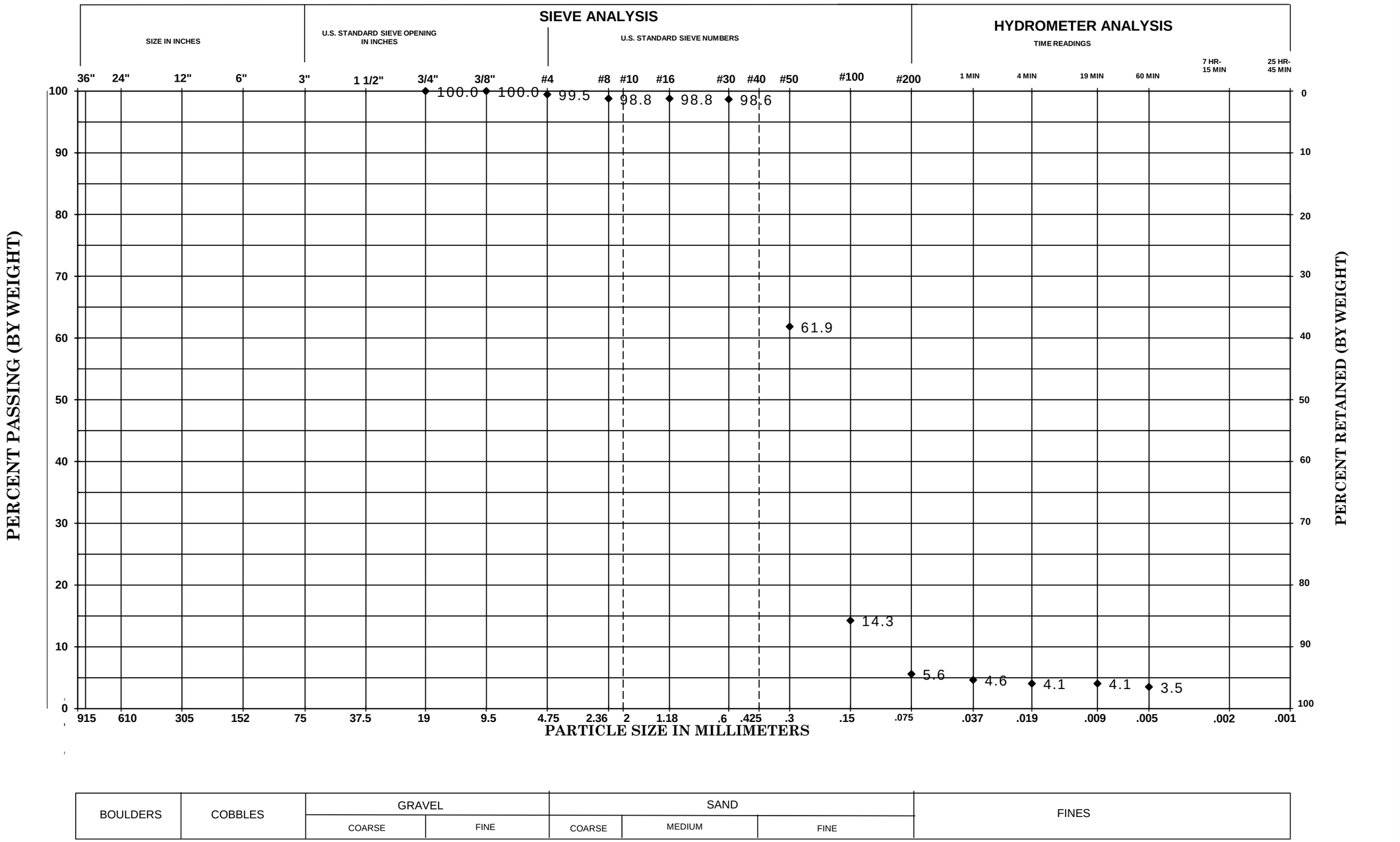


Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J.Fitzsimmons

0.0 % Gravel	Maximum Size: No. 8	Specific Gravity	D_{50}: 0.005 in
85.3 % Sand	Moisture Content: 1.9%	Plus No. 4:	C_U: 2.9
14.7 % Fines	Liquid Limit:	Minus No. 4:	C_C: 1.3
% Oversize	Plasticity Index: Nonplastic		

GRAIN SIZE DISTRIBUTION

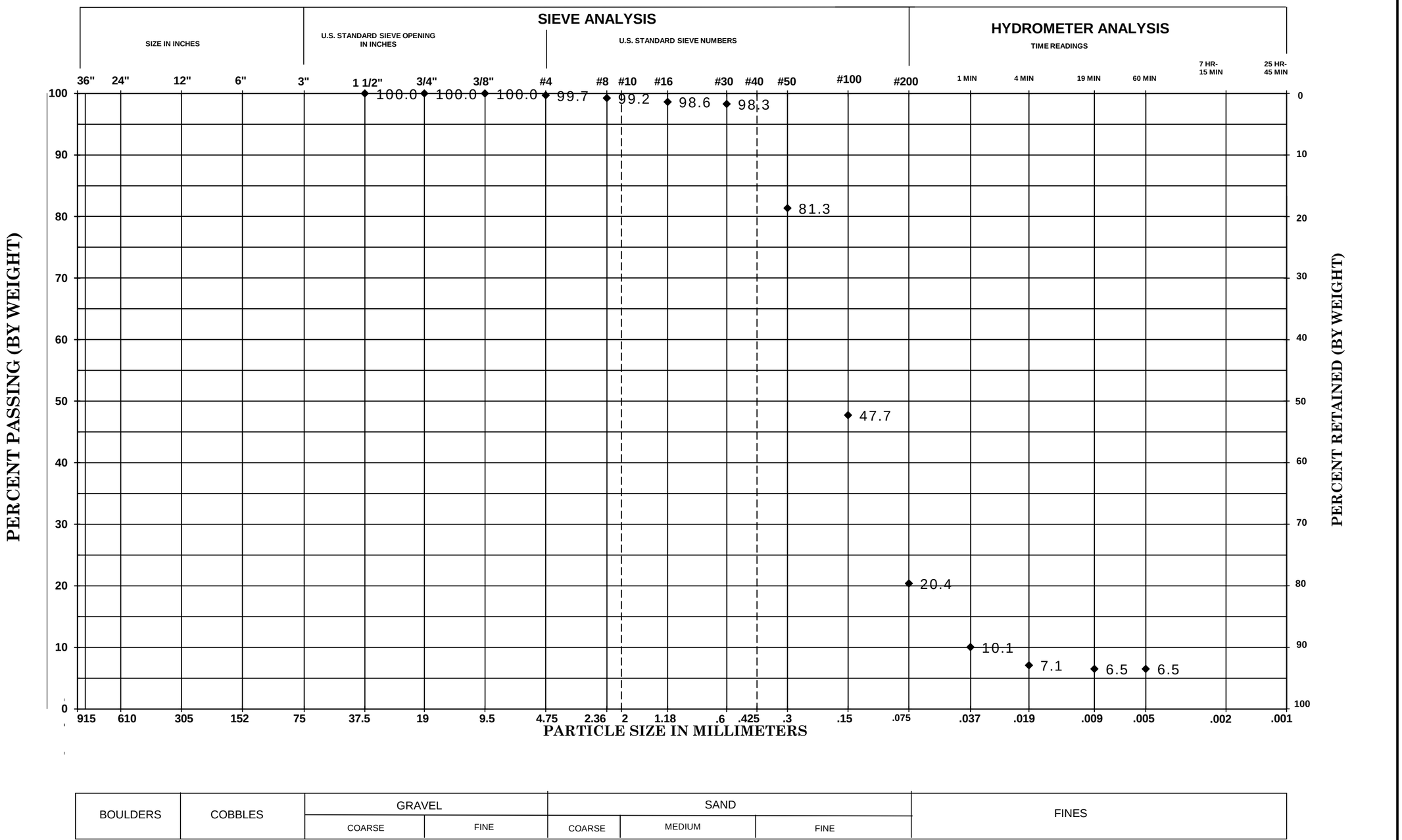


Unified Soil Classification: **SP-SM Poorly Graded Sand with Silt**

Sample Collected by: J.Fitzsimmons

0.5 % Gravel	Maximum Size: 1 1/2"	Specific Gravity	D_{50}: 0.010 in
93.9 % Sand	Moisture Content: 0.9%	Plus No. 4:	C_U: 2.7
5.6 % Fines	Liquid Limit:	Minus No. 4:	C_C: 1.1
% Oversize	Plasticity Index: Nonplastic		

GRAIN SIZE DISTRIBUTION

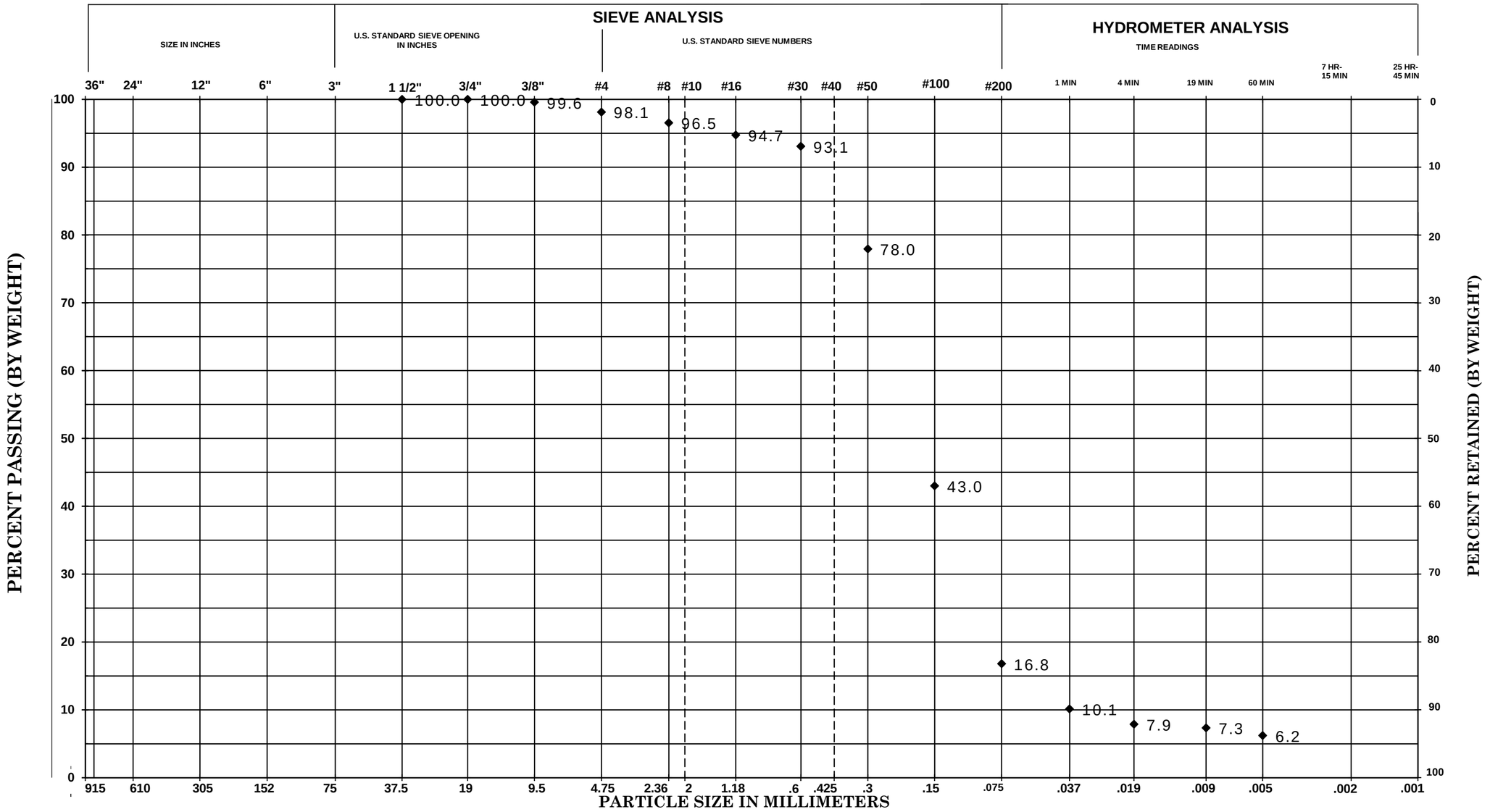


Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J.Fitzsimmons

Trace % Gravel	Maximum Size: 1"	Specific Gravity	D_{50}: 0.006 in
79.3 % Sand	Moisture Content: 1.7%	Plus No. 4:	C_U: 5.3
20.4 % Fines	Liquid Limit:	Minus No. 4:	C_C: 1.3
% Oversize	Plasticity Index: Nonplastic		

GRAIN SIZE DISTRIBUTION



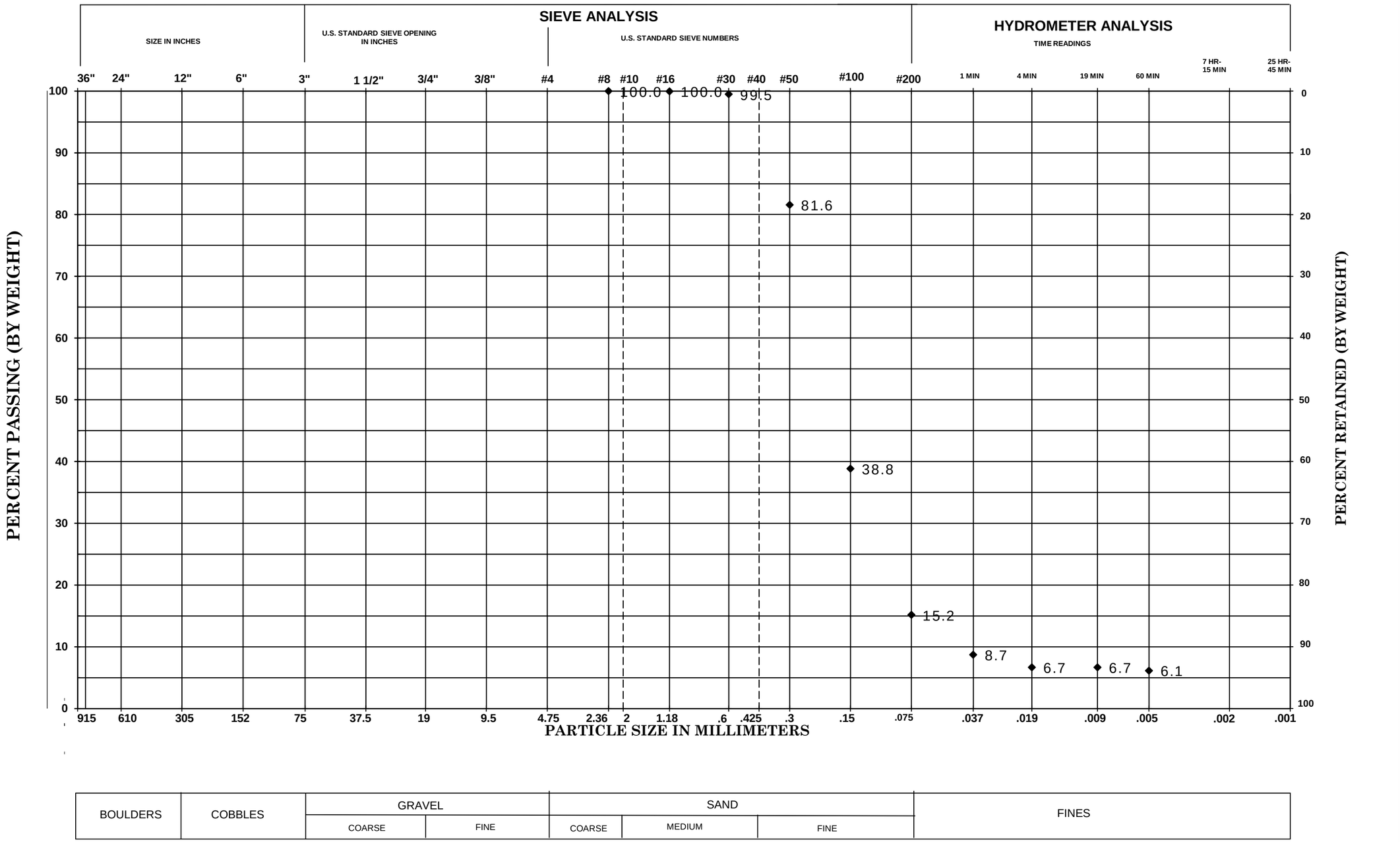
BOULDERS	COBBLES	GRAVEL		SAND			FINES
		COARSE	FINE	COARSE	MEDIUM	FINE	

Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J.Fitzsimmons

1.9 % Gravel	Maximum Size: 1 1/2"	Specific Gravity	D_{50}: 0.007 in
81.3 % Sand	Moisture Content: 1.9%	Plus No. 4:	C_U: 5.9
16.8 % Fines	Liquid Limit:	Minus No. 4:	C_C: 1.5
% Oversize	Plasticity Index: Nonplastic		

GRAIN SIZE DISTRIBUTION

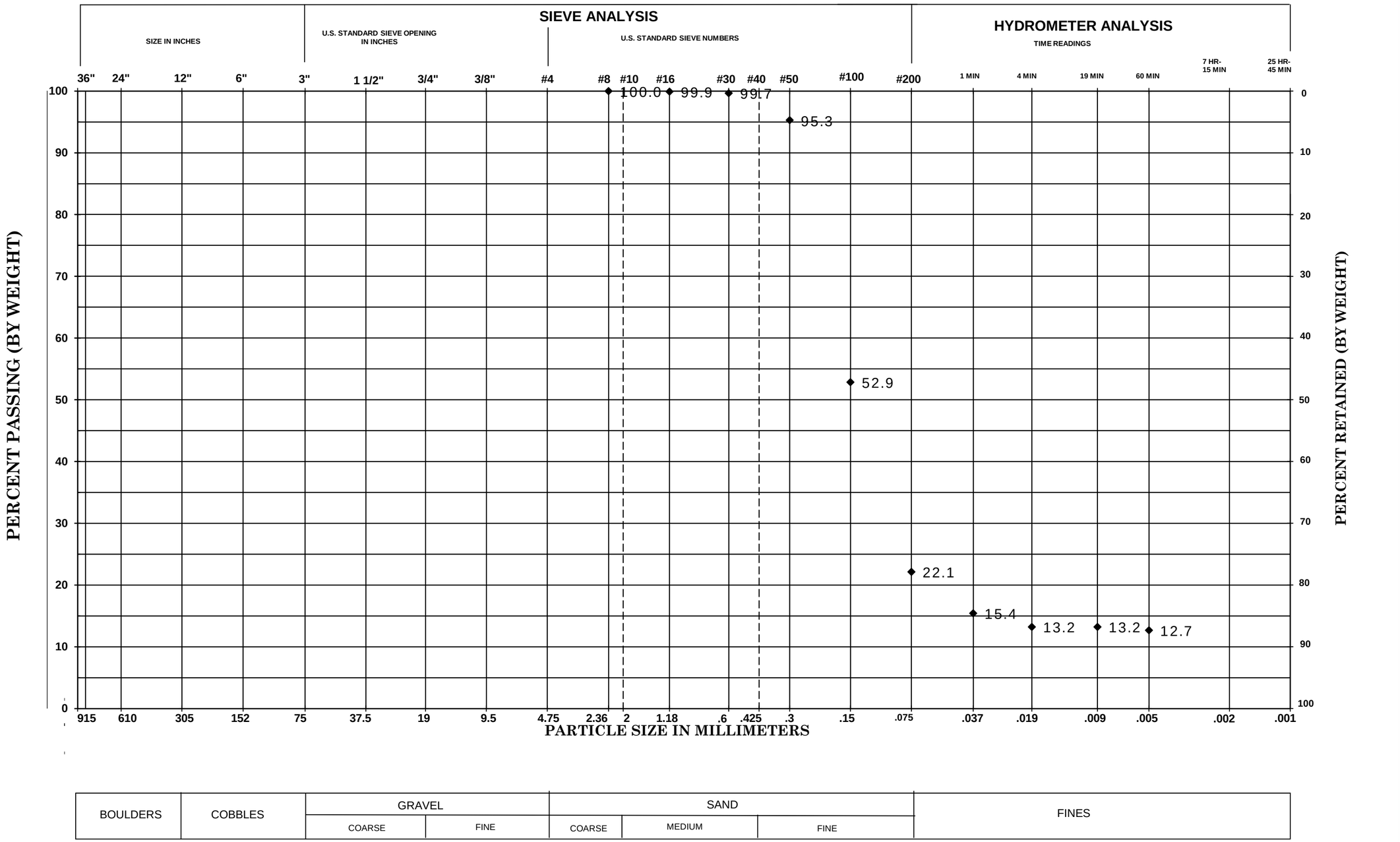


Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J.Fitzsimmons

0.0 % Gravel	Maximum Size: No. 8	Specific Gravity	D_{50}: 0.007 in
84.8 % Sand	Moisture Content: 1.5%	Plus No. 4:	C_U: 5.0
15.2 % Fines	Liquid Limit:	Minus No. 4:	C_C: 1.5
% Oversize	Plasticity Index: Nonplastic		

GRAIN SIZE DISTRIBUTION



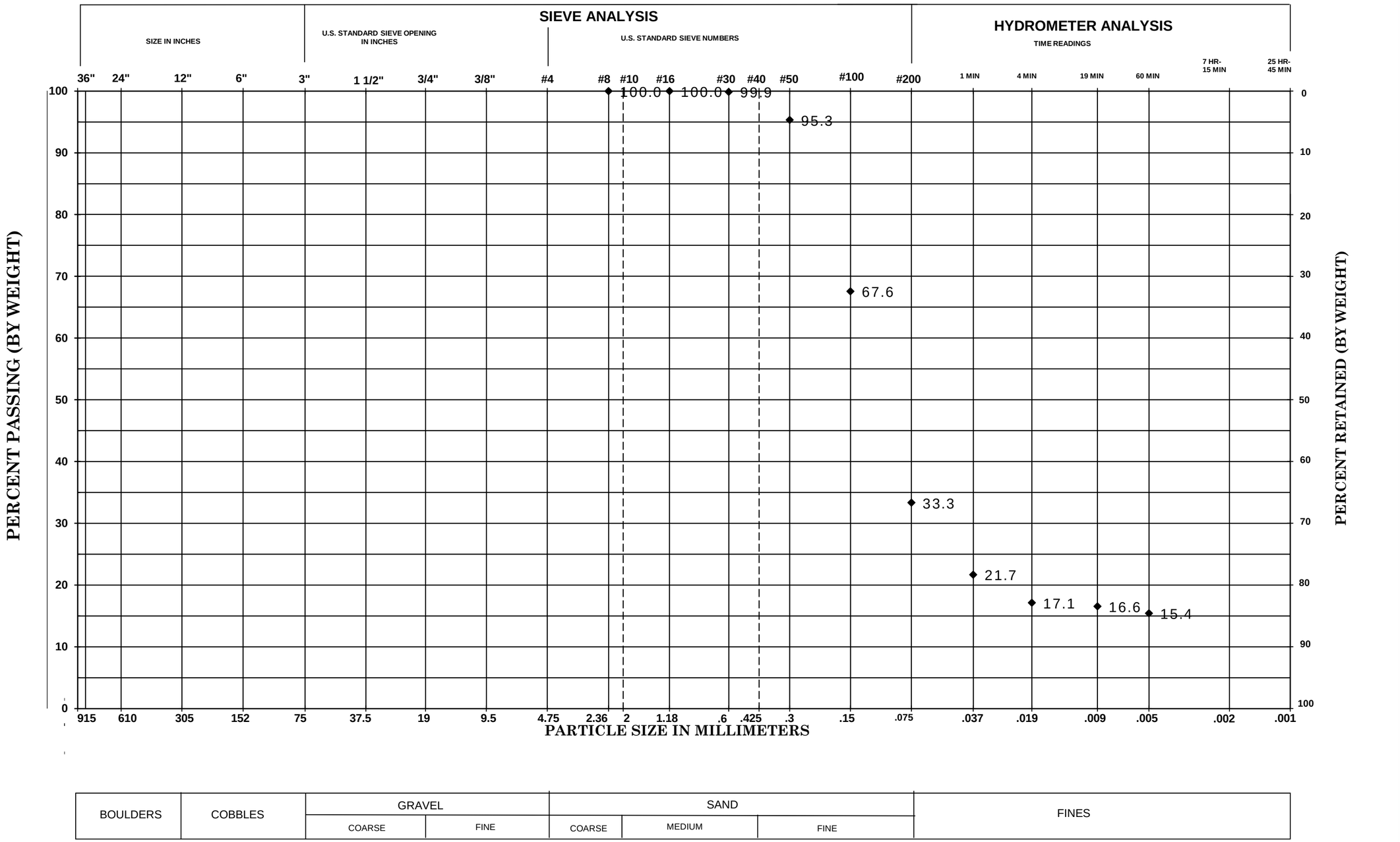
Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J.Fitzsimmons

0.0 % Gravel	Maximum Size: No. 8	Specific Gravity	D_{50}: 0.006 in
77.9 % Sand	Moisture Content: 3.5%	Plus No. 4:	C_U:
22.1 % Fines	Liquid Limit:	Minus No. 4:	C_C:
% Oversize	Plasticity Index: Nonplastic		

Note; Clayey bits in sample.

GRAIN SIZE DISTRIBUTION

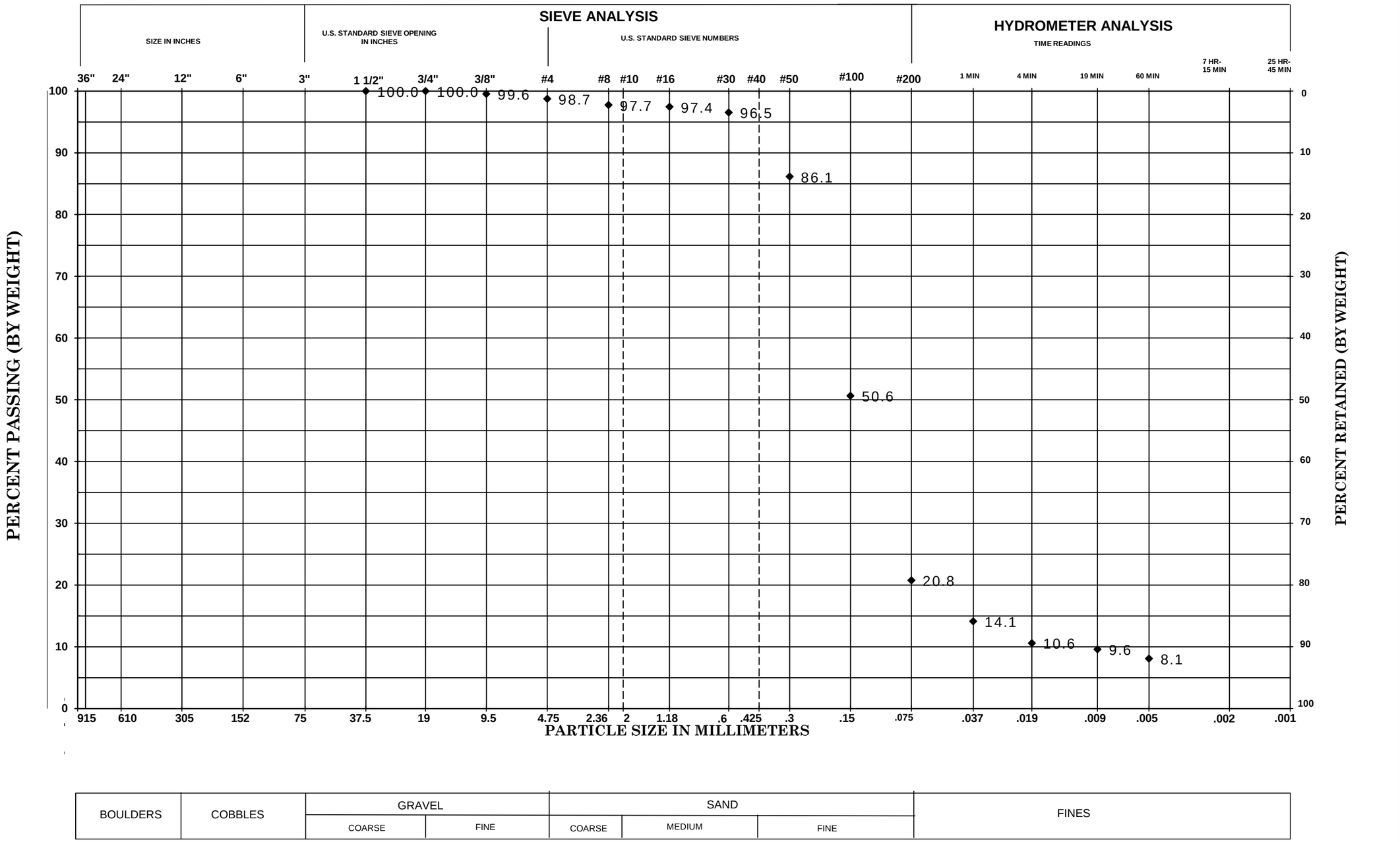


Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J.Fitzsimmons

0.0 % Gravel	Maximum Size: No. 8	Specific Gravity	D_{50}: 0.004 in
66.7 % Sand	Moisture Content: 4.1%	Plus No. 4:	C_U:
33.3 % Fines	Liquid Limit:	Minus No. 4:	C_C:
% Oversize	Plasticity Index: Nonplastic		

GRAIN SIZE DISTRIBUTION

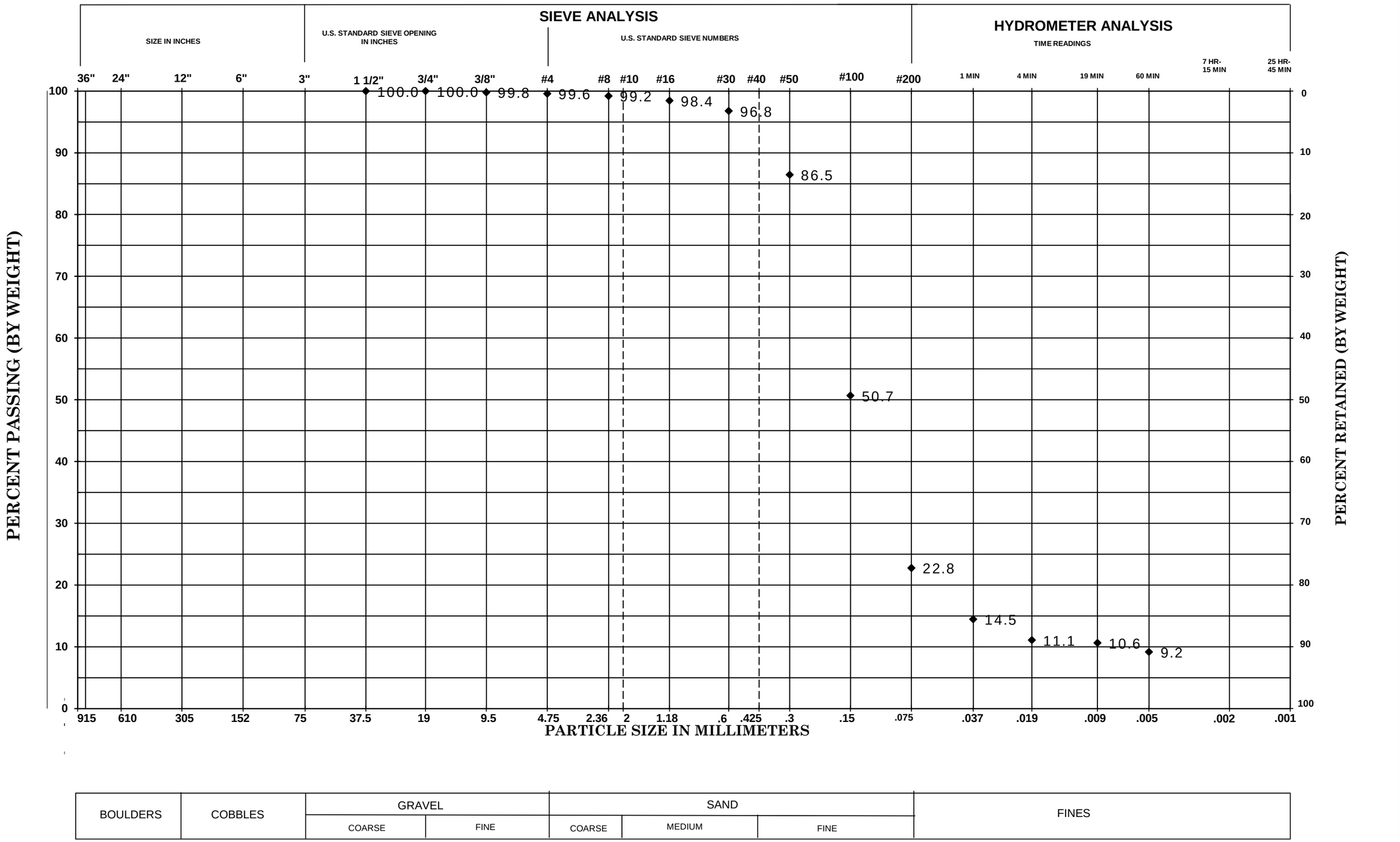


Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J.Fitzsimmons

1.3 % Gravel	Maximum Size: 1"	Specific Gravity	D_{50}: 0.006 in
78.0 % Sand	Moisture Content: 2.2%	Plus No. 4:	C_U: 14.7
20.8 % Fines	Liquid Limit:	Minus No. 4:	C_C: 3.9
% Oversize	Plasticity Index: Nonplastic		

GRAIN SIZE DISTRIBUTION

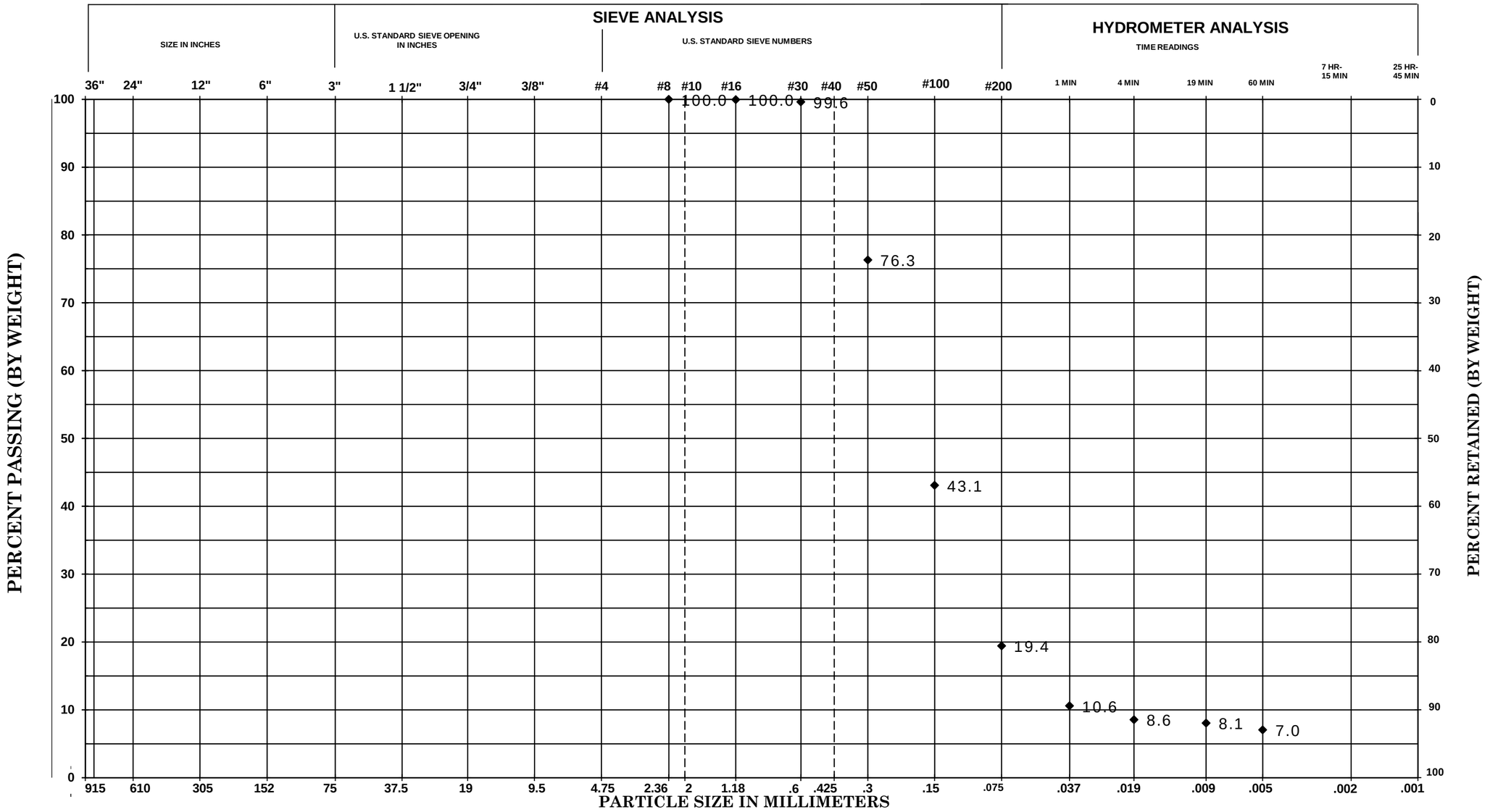


Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J.Fitzsimmons

Trace % Gravel	Maximum Size: 1 1/2"	Specific Gravity	D_{50}: 0.006 in
76.8 % Sand	Moisture Content: 2.4%	Plus No. 4:	C_U: 25.6
22.8 % Fines	Liquid Limit:	Minus No. 4:	C_C: 6.4
% Oversize	Plasticity Index: Nonplastic		

GRAIN SIZE DISTRIBUTION



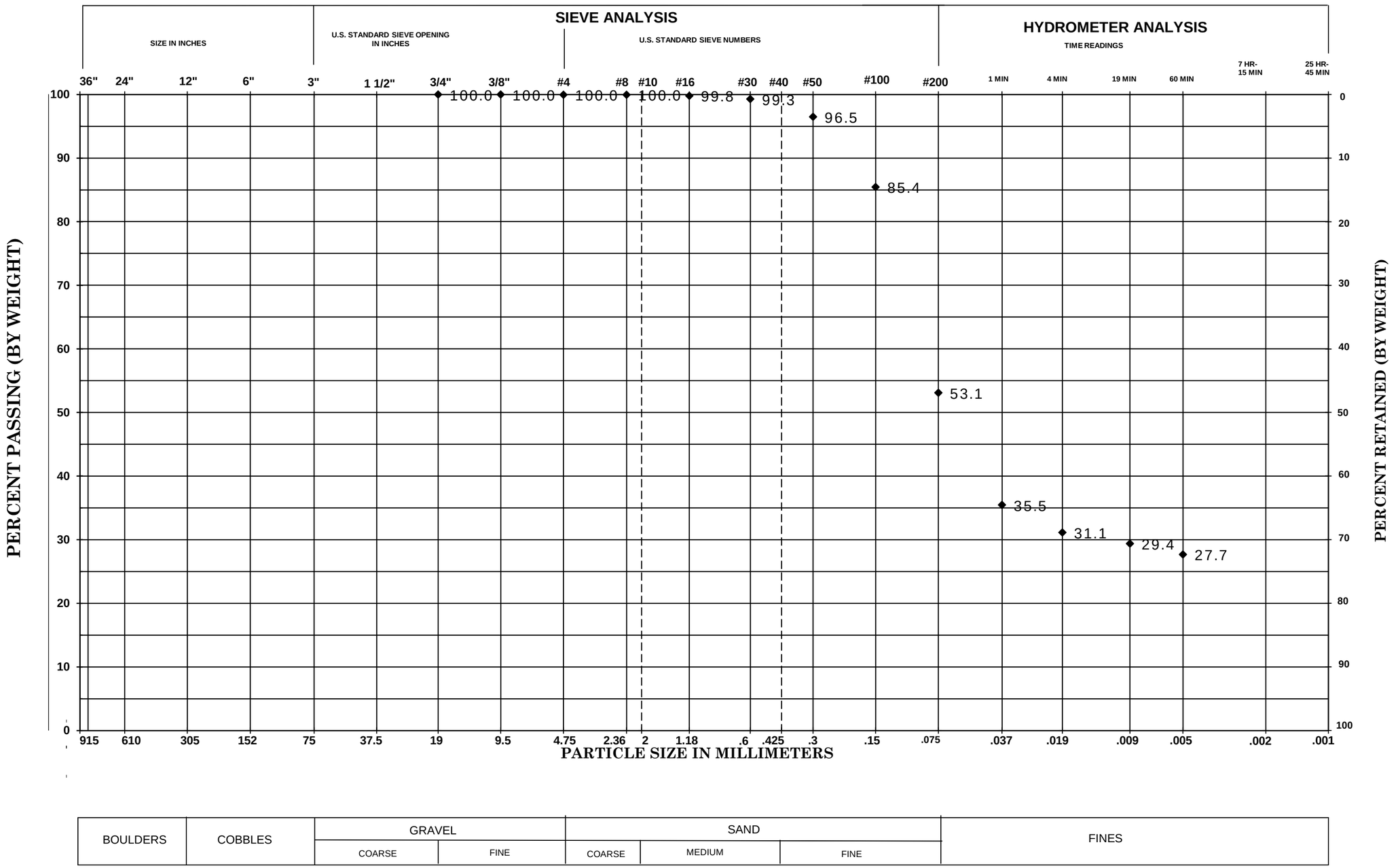
BOULDERS	COBBLES	GRAVEL		SAND			FINES
		COARSE	FINE	COARSE	MEDIUM	FINE	

Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J.Fitzsimmons

0.0 % Gravel	Maximum Size: No. 8	Specific Gravity	D_{50}: 0.007 in
80.6 % Sand	Moisture Content: 1.6%	Plus No. 4:	C_U: 7.0
19.4 % Fines	Liquid Limit:	Minus No. 4:	C_C: 1.6
% Oversize	Plasticity Index: Nonplastic		

GRAIN SIZE DISTRIBUTION

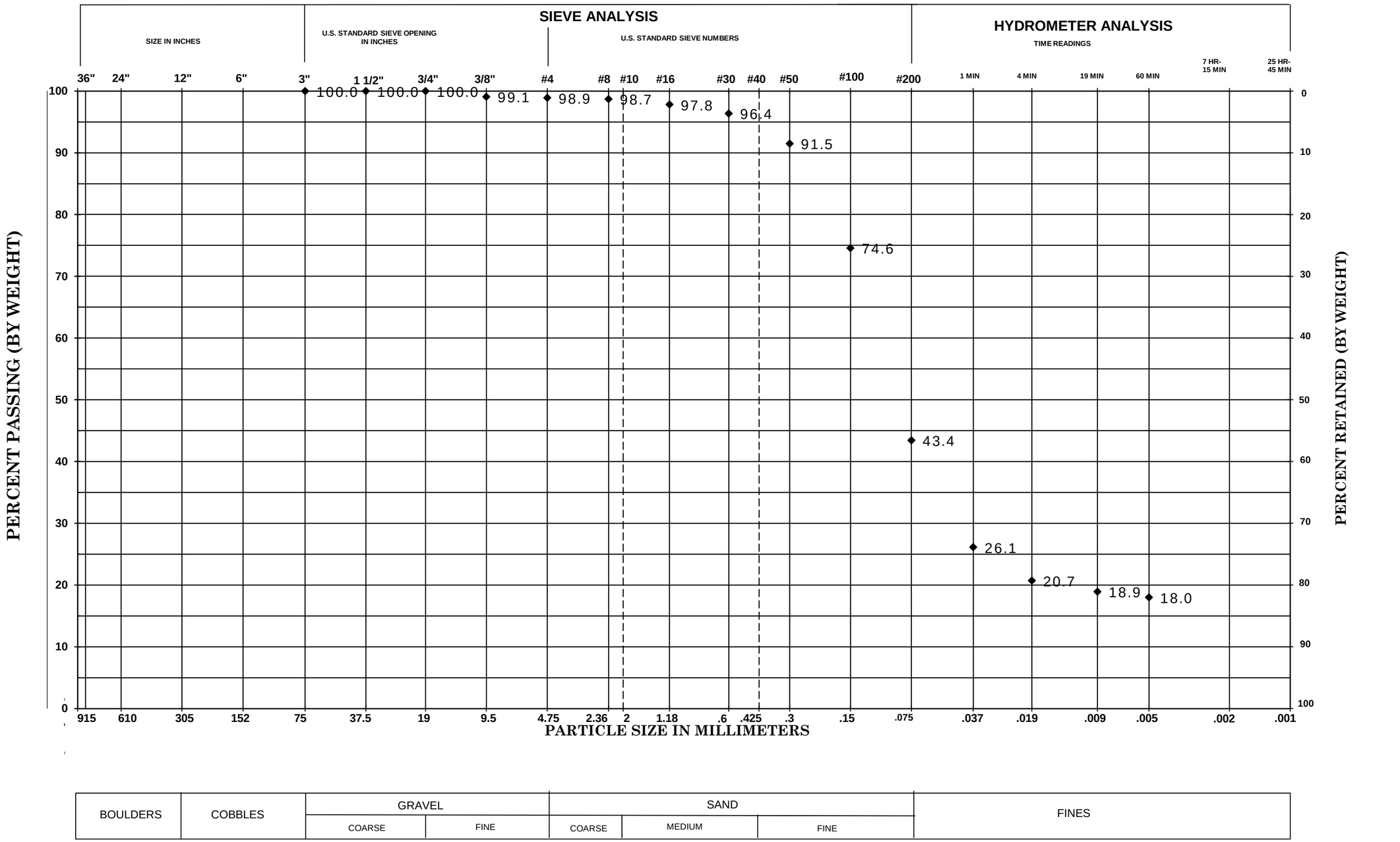


Unified Soil Classification: **CL Sandy Lean Clay**

Sample Collected by: J.Fitzsimmons

Trace % Gravel	Maximum Size: 3/4"	Specific Gravity	D_{50}: 0.003 in
46.9 % Sand	Moisture Content: 6.1%	Plus No. 4:	C_U:
53.1 % Fines	Liquid Limit: 21.4	Minus No. 4:	C_C:
% Oversize	Plasticity Index: 10.2		

GRAIN SIZE DISTRIBUTION

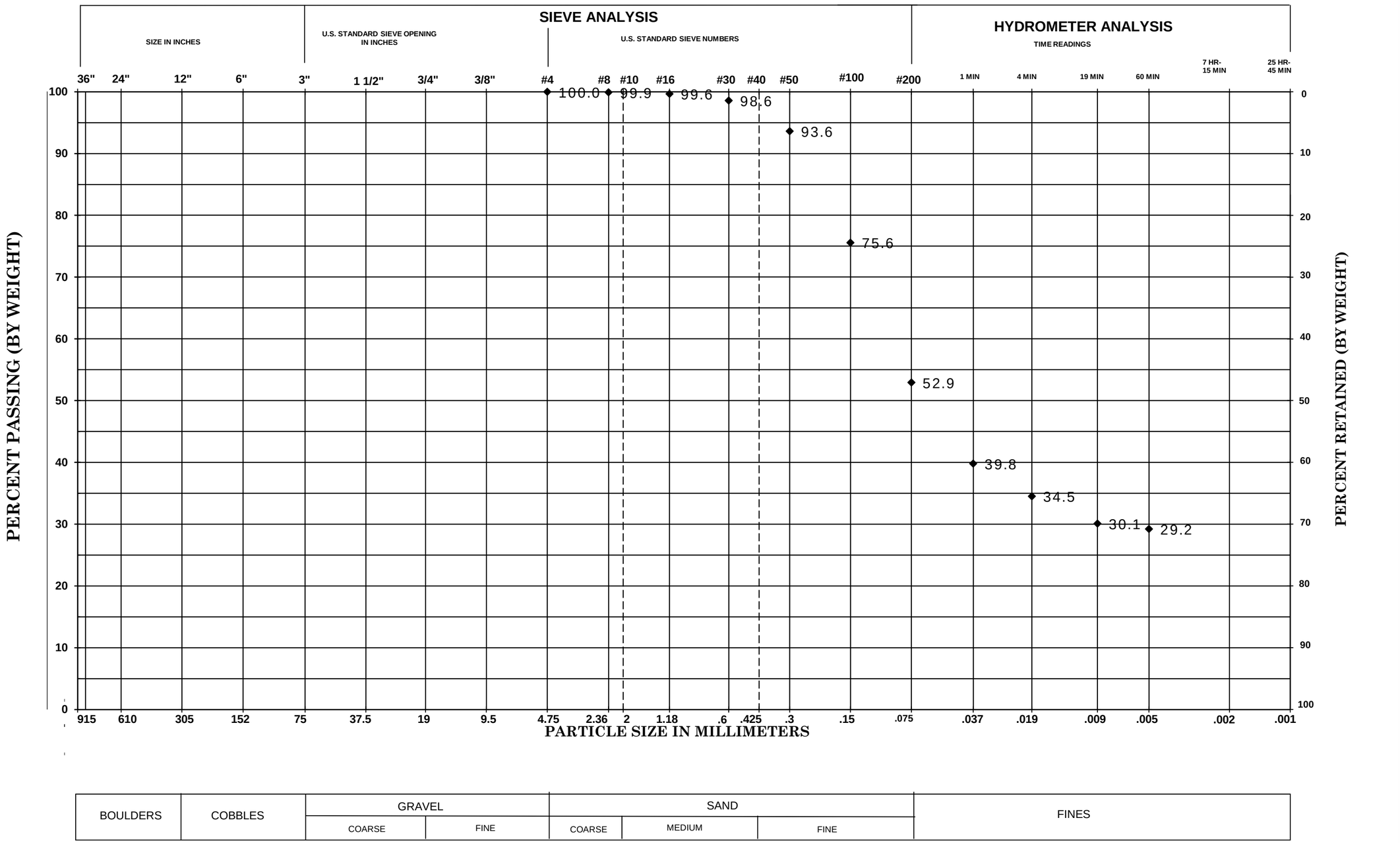


Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J.Fitzsimmons

1.1 % Gravel	Maximum Size: 2"	Specific Gravity	D_{50}: 0.003 in
55.5 % Sand	Moisture Content: 4.2%	Plus No. 4:	C_U:
43.4 % Fines	Liquid Limit: 19.6	Minus No. 4:	C_C:
% Oversize	Plasticity Index: 3.9		

GRAIN SIZE DISTRIBUTION



Unified Soil Classification: **CL Sandy Lean Clay**

Sample Collected by: J.Fitzsimmons

0.0 % Gravel	Maximum Size: No. 4	Specific Gravity	D_{50}: 0.003 in
47.1 % Sand	Moisture Content: 5.5%	Plus No. 4:	C_U:
52.9 % Fines	Liquid Limit: 24.7	Minus No. 4:	C_C:
% Oversize	Plasticity Index: 14.0		

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3737 East Broadway Road
Phoenix, AZ 85040
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PHYSICAL PROPERTIES OF SOILS & AGGREGATES

Date of Report **04-27-16**
Job No. **2146JL123**

Client **BUREAU OF RECLAMATION**
6150 W THUNDERBIRD RD
GLENDALE, AZ 85306

Event / Invoice No. 1 — Lab No. **68311**
Authorized by **MIKE MILLER** — Date **04-21-16**
Sampled by **MIKE MILLER** — Date **04-19-16**
Submitted by **MIKE MILLER** — Date **04-21-16**
Source / Location Designated by **MIKE MILLER** — Date **04-19-16**

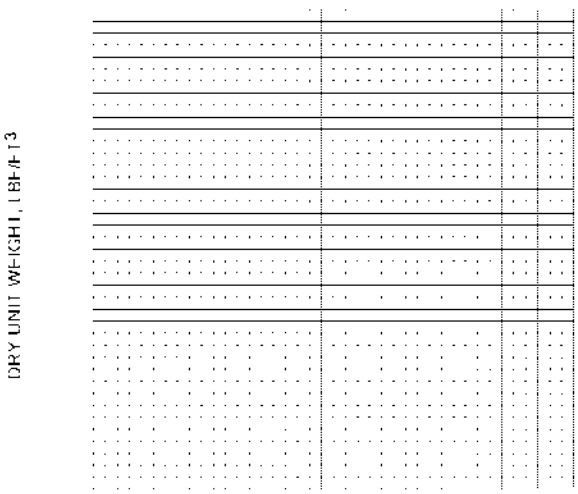
Project	**HPI SPUR**
Location	**SR 264**
Type / Use of Material	**EXISTING SOIL**
Supplier / Source	**PROJECT SITE**
Sample Source / Location	**TP-202 0-3.5'**
Special Instructions	

TEST RESULTS

SIEVE ANALYSIS :
FINER THAN NO. 200 :

SIEVE	ACCUMULATIVE % PASSING	SPECIFICATION

LABORATORY COMPACTION CHARACTERISTICS : METHOD



SAMPLE PREPARATION: ☐ WET ☐ DRY
RAMMER USED:
2 IN. CIRCULAR FACE — OTHER
MECHANICAL — MANUAL

MAXIMUM DRY UNIT WEIGHT, LBF/FT^3 →
OPTIMUM WATER CONTENT, % →

OVERSIZE AGGREGATE :
BULK SPECIFIC GRAVITY :
ABSORPTION, % :
% OVERSIZE IN LAB SAMPLE :

SPECIFIC GRAVITY IN ZERO AIR VOID CURVE :

WATER CONTENT, % DRY WEIGHT

TEST PROCEDURE	RESULT	SPECS
LIQUID & PLASTIC PROPERTIES :		
LIQUID LIMIT →		
ESTIMATED % RETAINED ON NO. 40 — PLASTIC LIMIT →		
SAMPLE AIR DRIED ☐ YES ☐ NO — PLASTICITY INDEX →		
MOISTURE CONTENT :		
PORTION TESTED — % DRY WEIGHT →		
EXPANSION / COMPRESSION PROPERTIES OF COHESIVE SOIL :		
☐ EXPANSION ☐ COMPRESSION, % →		
MAXIMUM SWELL PRESSURE, KSF →		
SURCHARGE, PSF		
INITIAL WATER CONTENT, % — DRY UNIT WEIGHT LBF/FT^3		
EXPANSION INDEX OF SOIL :		
INITIAL WATER CONTENT, % :		
INITIAL DRY UNIT WEIGHT LBF/FT^3 : — EI →		
INITIAL DEGREE OF SATURATION :		
FINAL WATER CONTENT, % :		

TEST PROCEDURE	RESULT	SPECS
RESISTANCE TO DEGRADATION OF SMALL-SIZE COARSE AGGREGATES BY ABRASION :		
GRADING — 100 REV, % LOSS →		
GRADING — 500 REV, % LOSS →		
SPECIFIC GRAVITY :		
MAX. PARTICLE SIZE, IN — SPECIFIC GRAVITY @ 20 C →		
pH DETERMINATION : AZ 237		
pH →	**8.8**	
SOLUBLE SALTS :		
PPM →		
MINIMUM RESISTIVITY : AZ 236		
OHM-CM →	**3802**	
SOIL CLASSIFICATION : — GROUP SYMBOL:		
NAME:		

Comments :

Copies to : **CLIENT**

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PHYSICAL PROPERTIES OF SOILS & AGGREGATES

Client **BUREAU OF RECLAMATION**
6150 W THUNDERBIRD RD
GLENDALE, AZ 85306

Date of Report: **04-27-16**
Job No. **2146JL123**
Event / Invoice No. 1 — Lab No. **68310**
Authorized by **MIKE MILLER** — Date **04-21-16**
Sampled by **MIKE MILLER** — Date **04-19-16**
Submitted by **MIKE MILLER** — Date **04-21-16**
Source / Location Designated by **MIKE MILLER** — Date **04-19-16**

Project	**HOPI SPUR**
Location	**SR 264**
Type / Use of Material	**EXISTING SOIL**
Supplier / Source	**PROJECT SITE**
Sample Source / Location	**TP-206 0-5'**
Special Instructions	

TEST RESULTS

SIEVE ANALYSIS :
FINER THAN NO. 200 :

SIEVE	ACCUMULATIVE % PASSING	SPECIFICATION

LABORATORY COMPACTION CHARACTERISTICS : METHOD

SAMPLE PREPARATION: WET DRY
RAMMER USED: 2 IN. CIRCULAR FACE OTHER
MECHANICAL MANUAL

MAXIMUM DRY UNIT WEIGHT, LBF/FT³ →
OPTIMUM WATER CONTENT, % →

OVERSIZE AGGREGATE :
BULK SPECIFIC GRAVITY :
ABSORPTION, % :
% OVERSIZE IN LAB SAMPLE :

SPECIFIC GRAVITY IN ZERO AIR VOID CURVE :

DRY UNIT WEIGHT, LBF/FT³

WATER CONTENT, % DRY WEIGHT

TEST PROCEDURE	RESULT	SPECS
LIQUID & PLASTIC PROPERTIES :		
LIQUID LIMIT →		
ESTIMATED % RETAINED ON NO. 40 — PLASTIC LIMIT →		
SAMPLE AIR DRIED YES NO — PLASTICITY INDEX →		
MOISTURE CONTENT :		
PORTION TESTED — % DRY WEIGHT →		
EXPANSION / COMPRESSION PROPERTIES OF COHESIVE SOIL :		
EXPANSION — COMPRESSION, % →		
MAXIMUM SWELL PRESSURE, KSF →		
SURCHARGE, PSF		
INITIAL WATER CONTENT, % — DRY UNIT WEIGHT LBF/FT³		
EXPANSION INDEX OF SOIL :		
INITIAL WATER CONTENT, %		
INITIAL DRY UNIT WEIGHT LBF/FT³ — EI →		
INITIAL DEGREE OF SATURATION		
FINAL WATER CONTENT, %		

TEST PROCEDURE	RESULT	SPECS
RESISTANCE TO DEGRADATION OF SMALL-SIZE COARSE AGGREGATES BY ABRASION :		
GRADING — 100 REV, % LOSS →		
GRADING — 500 REV, % LOSS →		
SPECIFIC GRAVITY :		
MAX. PARTICLE SIZE IN — SPECIFIC GRAVITY @ 20 C →		
pH DETERMINATION : AZ 237		
pH →	8.8	
SOLUBLE SALTS :		
PPM →		
MINIMUM RESISTIVITY : AZ 236		
OHM-CM →	2735	
SOIL CLASSIFICATION : GROUP SYMBOL:		
NAME:		

Comments :

Copies to : **CLIENT**

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PHYSICAL PROPERTIES OF SOILS & AGGREGATES

Client **BUREAU OF RECLAMATION**
6150 W THUNDERBIRD RD
GLENDALE, AZ 85306

Date of Report **04-27-16**
Job No. **2146JL123**
Event / Invoice No. 1 — Lab No. **68312**
Authorized by **MIKE MILLER** — Date **04-21-16**
Sampled by **MIKE MILLER** — Date **04-20-16**
Submitted by **MIKE MILLER** — Date **04-21-16**
Source / Location Designated by **MIKE MILLER** — Date **04-20-16**

Project	**HOPI SPUR**
Location	**SR 264**
Type / Use of Material	**EXISTING SOIL**
Supplier / Source	**PROJECT SITE**
Sample Source / Location	**TP-211 0-3'**
Special Instructions	

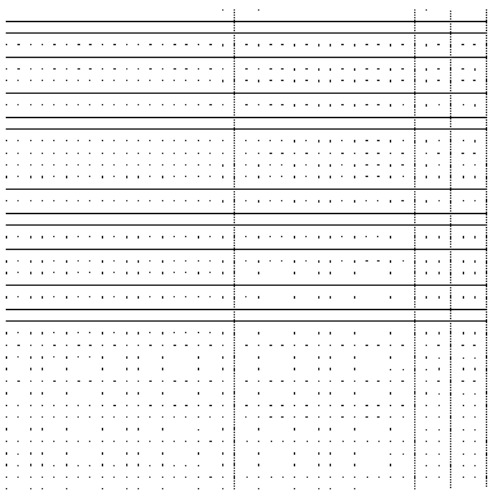
TEST RESULTS

SIEVE ANALYSIS :
FINER THAN NO. 200 :

SIEVE	ACCUMULATIVE % PASSING	SPECIFICATION

LABORATORY COMPACTION CHARACTERISTICS : METHOD

DRY UNIT WEIGHT, LBF/FT3



SAMPLE PREPARATION: ☐ WET ☐ DRY
RAMMER USED:
☐ 2 IN. CIRCULAR FACE ☐ OTHER
☐ MECHANICAL ☐ MANUAL

MAXIMUM DRY UNIT WEIGHT, LBF/FT^3 →
OPTIMUM WATER CONTENT, % →

OVERSIZE AGGREGATE :
BULK SPECIFIC GRAVITY :
ABSORPTION, % :
% OVERSIZE IN LAB SAMPLE :

SPECIFIC GRAVITY IN ZERO AIR VOID CURVE :

WATER CONTENT, % DRY WEIGHT

TEST PROCEDURE	RESULT	SPECS
LIQUID & PLASTIC PROPERTIES :		
LIQUID LIMIT →		
ESTIMATED % RETAINED ON NO. 40 — PLASTIC LIMIT →		
SAMPLE AIR DRIED ☐ YES ☐ NO — PLASTICITY INDEX →		
MOISTURE CONTENT :		
PORTION TESTED — % DRY WEIGHT →		
EXPANSION / COMPRESSION PROPERTIES OF COHESIVE SOIL :		
☐ EXPANSION ☐ COMPRESSION, % →		
MAXIMUM SWELL PRESSURE, KSF →		
SURCHARGE, PSF		
INITIAL WATER CONTENT, % — DRY UNIT WEIGHT LBF/FT^3		
EXPANSION INDEX OF SOIL :		
INITIAL WATER CONTENT, % :		
INITIAL DRY UNIT WEIGHT LBF/FT^3 : — EI →		
INITIAL DEGREE OF SATURATION :		
FINAL WATER CONTENT, % :		

TEST PROCEDURE	RESULT	SPECS
RESISTANCE TO DEGRADATION OF SMALL-SIZE COARSE AGGREGATES BY ABRASION :		
GRADING — 100 REV, % LOSS →		
GRADING — 500 REV, % LOSS →		
SPECIFIC GRAVITY :		
MAX. PARTICLE SIZE, IN — SPECIFIC GRAVITY @ 20 C →		
pH DETERMINATION : AZ 237		
pH →	**8.5**	
SOLUBLE SALTS :		
PPM →		
MINIMUM RESISTIVITY : AZ 236		
OHM-CM →	**2068**	
SOIL CLASSIFICATION : GROUP SYMBOL:		
NAME:		

Comments :

Copies to : **CLIENT**

THE SERVICES REFERRED TO HEREIN WERE PERFORMED IN ACCORDANCE WITH THE STANDARD OF CARE PRACTICED LOCALLY FOR THE REFERENCED METHOD(S) AND RELATE ONLY TO THE CONDITION(S) OR SAMPLE(S) TESTED AS STATED HEREIN. WESTERN TECHNOLOGIES INC. MAKES NO OTHER WARRANTY OR REPRESENTATION, EXPRESSED OR IMPLIED, AND HAS NOT CONFIRMED INFORMATION INCLUDING SOURCE OF MATERIALS SUBMITTED BY OTHERS.

REVIEWED BY M. WHITMAN
(SIGNED COPY ON FILE)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-1

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 2046005 **E.** 777169 **GROUND ELEVATION:** 5160

APPROXIMATE DIMENSIONS: 20' x 4' x 12.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/14/2012 **DATE LOGGED:** 6/14/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken))	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM)b Visual Class.	**0.0 - 8.0 ft. Silty Sand with Trace of Boulders (SM)b:** About 85% predominantly fine to medium sand, 15% nonplastic fines with very high dry strength, rapid dilatancy and low toughness and a trace of fine gravel. Max. size, fine gravel. Strong reaction with HCl. Total sample (by volume): Trace of plus 12 in. blocky, hard, sandstone boulders; remainder minus 3 in.; maximum size, 1.6 ft. In-place condition: soft and weakly cemented from 0.0-4.0 ft., grading to very hard and moderately cemented with depth, homogenous, dry, reddish brown material with weak cementation. Lab test data from 0.0-8.0 ft.: 82% sand, 15% fines, 3% gravel; LL and PI not tested; Field Moisture = 2.3%. pH = 8.82, Resistivity = 6,218 ohm/cm, Sulfates = 14 ppm, Sulfides = 2 ppm, Chlorides = 17 ppm. Lab classification is Silty Sand (SM).	0	0	T
Lab sample taken from 0.0-8.0 ft. (SM) Lab Class.				
8.0 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
(SP-SM)cb Visual Class.	**8.0 - 12.0 ft. Poorly Graded Sand with Silt, Cobbles and Boulders (SP-SM)cb:** About 90% predominantly fine to medium sand and 10% nonplastic fines with very high dry strength, rapid dilatancy and low toughness. Max. size, 3 in. Strong reaction with HCl. Total sample (by volume): About 5% 3 to 5 in. platy, moderately hard sandstone cobbles; about 10% 5 to 12 in. angular, blocky, hard, sandstone cobbles; trace of plus 12 in. blocky, hard sandstone boulders; remainder minus 3 in.; maximum size, 1.8 ft. In-place condition: very hard, homogenous, dry, reddish brown material with weak cementation. Difficult digging.	5	10	T
12.0 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			

REMARKS: Surface: gently sloping to west with loose sand and scattered grasses. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-2

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 2037004 **E.** 776281 **GROUND ELEVATION:** 5170.5

APPROXIMATE DIMENSIONS: 20' x 10' x 13.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/14/2012 **DATE LOGGED:** 6/14/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken))	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM)g Visual Class.	**0.0 - 13.0 ft. Silty Sand with Gravel (SM)g:** About 50% predominantly fine to medium sand, 35% nonplastic fines with medium to high dry strength, rapid dilatancy and low toughness and 15% fine, subrounded to subangular gravel. Max. size, 10 mm. Strong reaction with HCl. From 0.0-4.0 ft., discontinuous gravel layers and pockets present; max. size, 1 in. At around 8 ft., trace of rounded to angular, platy cobbles up to 8 in. in diameter seen in pit wall.	0	0	0
Lab sample taken from 0.0-12.0 ft.	In-place condition: very soft to soft, irregular stratification of sand and gravel layers, dry, light brown material with weak cementation. From 12.0-13.0 ft. gravel size increases to maximum of 3 inch diameter			
(SM)g Lab Class.	Lab test data from 0.0-12.0 ft.: 47% sand, 37% fines, 16% gravel; Nonplastic; Field Moisture = 4.0%. pH = 8.48, Resistivity = 473 ohm/cm, Sulfates = 1,400 ppm, Sulfides = < 1 ppm, Chlorides = 120 ppm. Lab classification is Silty Sand with Gravel (SM)g.			
	In-place density of 98.4 lb/ft^3 taken at 3.5 ft. with sand cone apparatus.			
13.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			

REMARKS: **S**urface: flat with loose sand and scattered bushes about 500 ft. south of bridge crossing Tanner Wash. Kaibab Formation outcrops west across the highway. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-3

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 2031517 **E.** 778873 **GROUND ELEVATION:** 5221

APPROXIMATE DIMENSIONS: 20' x 4' x 13.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/14/2012 **DATE LOGGED:** 6/14/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken))	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP)cb Visual Class.	**0.0 - 4.0 ft. Poorly Graded Sand with Trace of Cobbles and Boulders (SP)cb:** About 90% predominantly fine to medium sand, 5% fine, subrounded to subangular gravel and 5% nonplastic fines with very high dry strength, rapid dilatancy and low toughness. Contains clumps of weakly cemented silt up to 10 mm in size that break up with manual pressure. Max. size, 20 mm. Strong reaction with HCl. Total sample (by volume): Trace of 3 to 5 in. subrounded cobbles; trace of plus 12 in. blocky, subrounded, hard boulders; remainder minus 3 in.; maximum size, 3.0 ft. In-place condition: very soft to soft, homogenous, dry, light brown material with weak cementation.	T	0	T
4.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(SM)gcb Visual Class. Lab sample taken from 4.0-13.0 ft. (SP-SM)g Lab Class.	**4.0 - 13.0 ft. Silty Sand with Gravel, Cobbles and Boulders (SM)gcb:** About 55% predominantly fine to coarse sand, 30% fine to coarse, subrounded to subangular, flat gravel and 15% nonplastic fines with very high dry strength, rapid dilatancy and low toughness. Max. size, 3 in. Strong reaction with HCl. Total sample (by volume): About 5% 3 to 5 in. subrounded to subangular, hard, sandstone cobbles; 5% 5 to 12 in. subrounded to subangular, hard, sandstone cobbles; trace of plus 12 in. subangular to angular, hard, sandstone boulders; remainder minus 3 in.; maximum size, 2.0 ft. In-place condition: hard, irregular stratification, dry, light brown material with weak cementation. Lab test data from 4.0-13.0 ft.: 65% sand, 27% gravel, 8% fines; LL and PI not tested; Field Moisture = 1.6%. pH = 9, Resistivity = 3,712 ohm/cm, Sulfates = 25 ppm, Sulfides = < 1 ppm, Chlorides = 62 ppm. Lab classification is Poorly Graded Sand with Silt and Gravel (SP-SM)g.	5	5	T
13.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			

REMARKS: **S**urface: flat loose sand with scattered bushes. Culvert and drainage runs under highway about 150 ft. south of pit. Sandstone from the Kaibab Formation outcrops west across the highway and is lower in elev. than the pit. Tanner Wash is about 300 ft. east of pit. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-4**

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 2024279 **E.** 782353 **GROUND ELEVATION:** 5295

APPROXIMATE DIMENSIONS: 20' x 10' x 13.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/14/2012 **DATE LOGGED:** 6/14/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken))	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP-SM)gcb Visual Class.	**0.0 - 4.0 ft. Poorly Graded Sand with Silt, Gravel, Cobbles and Boulders (SP-SM)gcb:** About 60% predominantly fine to coarse sand, 30% fine to coarse, flat, subrounded to subangular gravel and 10% nonplastic fines with very high dry strength, rapid dilatancy and low toughness. Max. size, 3 in. Strong reaction with HCl. From 1.2-1.7 ft., discontinuous gravel layer seen in pit wall; no sample taken. Total sample (by volume): About 5% 5 to 12 in. subangular, hard cobbles; trace of plus 12 in. blocky, hard boulders; remainder minus 3 in.; maximum size, 1.5 ft. In-place condition: soft, irregular stratification, dry, light brown material with weak cementation. In-place density of 91.4 lb/ft^3 taken at 3.8 ft. with sand cone apparatus.	0	5	T
4.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(GM)scb Visual Class. Lab sample taken from 4.0-13.0 ft. (GC-GM)s Lab Class.	**4.0 - 13.0 ft. Silty Gravel with Sand, Cobbles and Boulders (GM)scb:** About 45% fine to coarse, subrounded to subangular gravel, 40% predominantly fine to coarse sand, and 15% nonplastic fines with very high dry strength, rapid dilatancy and low toughness. Max. size, 3 in. Strong reaction with HCl. Total sample (by volume): About 10% 3 to 5 in. subrounded to subangular, hard cobbles; 10% 5 to 12 in. subrounded to subangular, hard cobbles; 10% plus 12 in. subangular to angular, hard boulders; remainder minus 3 in.; maximum size, 2.5 ft. In-place condition: soft to firm, irregular stratification, dry, light brown material with weak cementation. Lab test data from 4.0-13.0 ft.: 47% gravel, 38% sand, 15% fines; LL= 22%, PI= 4%; Field Moisture = 2.6%. pH = 8.1, Resistivity = 483 ohm/cm, Sulfates = 530 ppm, Sulfides = < 1 ppm, Chlorides = 170 ppm. Lab classification is Silty Clayey Gravel with Sand (GC-GM)s.	10	10	10
13.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			

REMARKS: Surface: flat loose sand with scattered grasses; Kaibab Formation outcrop west of highway dipping toward pit. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit caving from 9.0 to 13.0 ft., edges ragged; terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-5

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 2018245 **E.** 786586 **GROUND ELEVATION:** 5346

APPROXIMATE DIMENSIONS: 20' x 4' x 12.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/14/2012 **DATE LOGGED:** 6/14/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken))	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP) Visual Class.	**0.0 - 2.0 ft. Poorly Graded Sand (SP):** About 60% predominantly fine to coarse sand and 40% nonplastic fines with very high dry strength, rapid dilatancy and low toughness. Max. size, coarse sand. Strong reaction with HCl. In-place condition: very hard, homogenous, dry, light brown material with moderate cementation.	0	0	0
2.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(CL)s Visual Class. Lab sample taken from 2.0-12.0 ft. (CL)s Lab Class.	**2.0 - 12.0 ft. Lean Clay with Sand (CL)s:** About 65% fines with low plasticity, slow dilatancy and low toughness, 25% fine to coarse sand and 10% fine to coarse, subangular to angular, hard gravel. Max. size, 3 in. Strong reaction with HCl. In-place condition: soft grading to very hard, layered, dry, light brown material with weak cementation. Discontinuous and irregular gravel layers throughout. Lab test data from 2.0-12.0 ft.: 72% fines, 28% sand, 0% gravel; LL = 28%, PI = 13%; Field Moisture = 2.0%. pH = 8.45, Resistivity = 1.021 ohm/cm, Sulfates = 30 ppm, Sulfides = < 1 ppm, Chlorides = 92 ppm. Lab classification is Lean Clay with Sand (CL)s.	0	0	0
12.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			

REMARKS: **S**urface: flat loose sand with scattered grasses; Kaibab Formation outcrop west of highway dipping toward pit. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-6

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 2013801 **E.** 790189 **GROUND ELEVATION:** 5387

APPROXIMATE DIMENSIONS: 20' x 4' x 13.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/14/2012 **DATE LOGGED:** 6/14/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP)cb Visual Class.	**0.0 - 4.0 ft. Poorly Graded Sand with Cobbles and Boulders (SP)cb:** About 85% predominantly fine to coarse sand, 10% predominantly fine to coarse, platy gravel and 5% nonplastic fines. Max. size 3 in. Strong reaction with HCl. Total sample (by volume): About 5% 5 to 12 in. subrounded, hard cobbles; trace of plus 12 in. blocky, hard, sandstone boulders; remainder minus 3 in.; maximum size, 1.8 by 0.9 ft. In-place condition: soft grading to very hard, homogeneous, dry, light brown material with weak grading to very strong cementation. Gravel and cobble fraction increases with depth.	0	5	T
4.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(SM)g Visual Class. Lab sample taken from 4.0-10.0 ft. (SM) Lab Class.	**4.0 - 10.0 ft. Silty Sand with Gravel (SM)g:** About 65% predominantly fine to coarse sand, 20% predominantly fine to coarse, angular gravel and 15% nonplastic fines. Max. size 3 in. Strong reaction with HCl. In-place condition: very hard, stratified, dry, brown material with moderate cementation. Lab test data from 4.0-10.0 ft.: 72% sand, 15% fines, 13% gravel; LL and PI not tested; Field Moisture = 1.3%. pH = 8.88, Resistivity = 2,783 ohm/cm, Sulfates = 34 ppm, Sulfides = 3 ppm, Chlorides = 24 ppm. Lab classification is Silty Sand (SM).	0	0	0
10.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(Ls) Visual Class.	**10.0 - 13.5 ft. Limestone (Ls):** Limestone is aphanic to fine grained and calcareous. Moderately hard in hand specimen, breaks with moderate hammer blow, but hard to very hard in outcrop, requiring repeated heavy blow to break; slightly weathered. Bedding spaced 1 to 3 in. apart. Strong reaction with HCl. Color is very light gray. Upon excavation with a backhoe, limestone breaks up into blocky chunks 6 in. or smaller in size. .			
13.5 ft.	**Geologic Interpretation:** Kaibab Formation			

REMARKS: Surface: flat with scattered grass and bushes on loose sand; sandy limestone of the Kaibab Formation outcrops about 100 ft. west, across the highway. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-7

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 2008851 **E.** 793831 **GROUND ELEVATION:** 5449

APPROXIMATE DIMENSIONS: 20' x 10' x 14.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/11/2012 **DATE LOGGED:** 6/11/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken))	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SC)c Visual Class.	**0.0 - 14.0 ft. Clayey Sand with Trace of Cobbles (SC)c:** About 60% predominantly fine to coarse sand, 40% fines with low plasticity, slow dilatancy and low toughness and a trace of fine, subrounded gravel. Max. size, 15 mm. Strong reaction with HCl. From about 4.0-4.5 ft. gravelly layer seen in pit wall; no sample taken.	0	T	0
Lab sample taken from 0.0-14.0 ft.	Total sample (by volume): Trace of 5 to 12 in. subangular, sandstone cobbles; remainder minus 3 in.; maximum size, 8 in.			
(SC-SM) Lab Class.	In-place condition: hard to very hard, homogenous, dry, brown material with moderate to strong cementation. Lab test data from 0.0-14.0 ft.: 49% sand, 42% fines, 9% gravel; LL = 20%, PI = 5%, Field Moisture = 3.0%. pH = 8.68, Resistivity = 1,021 ohm/cm, Sulfates = 160 ppm, Sulfides = 2 ppm, Chlorides = 100 ppm. Lab classification is Silty, Clayey Sand (SC-SM). In-place density of 104.0 lb/ft^3 taken at 3.5 ft. with sand cone apparatus.			
14.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			

REMARKS: **S**urface: flat with scattered bushes; poorly graded sand with gravel at surface. Moenkopi shale outcrop about 400 ft. southeast of pit and Kaibab limestone outcrop about 400-500 ft. west across highway. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-8

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 2001299 **E.** 798647 **GROUND ELEVATION:** 5527

APPROXIMATE DIMENSIONS: 14' x 4' x 7.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/11/2012 **DATE LOGGED:** 6/11/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken))	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SC)c Visual Class.	**0.0 - 6.0 ft. Clayey Sand with Trace of Cobbles (SC)c:** About 50% fine to coarse sand, 40% fines with low to medium plasticity, slow dilatancy and low toughness and 10% fine to coarse, subangular to angular, flat gravel. Max. size, 3 in. Strong reaction with HCl. Total sample (by volume): Trace of 3 to 5 in. platy, moderately hard, sandstone cobbles; remainder minus 3 in.; maximum size, 5 in.	T	0	0
Lab sample taken from 0.0-6.0 ft.	In-place condition: hard to very hard, homogenous, dry, brown material with moderate cementation.			
(SC)g Lab Class.	Lab test data from 0.0-6.0 ft.: 42% fines, 33% sand, 25% gravel; LL = 26%, PI = 11%, Field Moisture = 3.9%. pH = 8.7, Resistivity = 1,856 ohm/cm, Sulfates = 110 ppm, Sulfides = 6 ppm, Chlorides = 55 ppm. Lab classification is Clayey Sand with Gravel (SC)g.			
6.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(Mdst) Visual Class.	**6.0 - 7.5 ft. Mudstone (Mdst):** Mudstone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting of about 90% clay and 10% silt. Moderately soft to moderately hard, thicker fragments require moderate hammer blow to break and slightly weathered. No reaction with HCl. Color is grayish brown.			
\	Upon excavation with a backhoe, mudstone breaks up into angular, mostly hand-size and smaller chunks.			
7.5 ft.	**Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: Surface: flat with scattered grasses. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336
Bureau of Reclamation

LOG OF TEST PIT OR AUGER HOLE

HOLE NO. TP-9

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1996746 **E.** 800141 **GROUND ELEVATION:** 5586

APPROXIMATE DIMENSIONS: 20' x 4' x 12.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/13/2012 **DATE LOGGED:** 6/13/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken))	CLASSIFICATION AND DESCRIPTION OF MATERIAL SEE USBR 5000, 5005	% PLUS 3 in (75 mm) BY VOLUME		
		3 – 5 in	5 – 12 in	PLUS 12 in
(SM)g Visual Class. **4.0 ft.**	**0.0 - 4.0 ft. Silty Sand with Gravel (SM)g:** About 65% fine to coarse sand, 20% nonplastic fines with rapid dilatancy and low toughness and 15% predominantly fine to coarse, subangular to angular, hard, flattened gravel. Max. size, 3 in. Strong reaction with HCl. In-place condition: hard to very hard, homogenous, dry, brown material with weak to moderate cementation. **Geologic Interpretation:** Quaternary Alluvium	0	0	0
(GP-GM)sc Visual Class. **5.8 ft.**	**4.0 - 5.8 ft. Poorly Graded Gravel with Silt, Sand and Cobbles (GP-GM)sc:** About 50% predominantly fine to coarse, hard, angular to platy gravel, 40% fine to coarse sand, 10% nonplastic fines. Max. size, 3 in. Strong reaction with HCl. Total sample (by volume): About 5% 5 to 12 in. blocky, hard cobbles; about 5% plus 12 in. subangular to subrounded, hard boulders; remainder minus 3 in.; maximum size, 10 in. In-place condition: very hard, discontinuous layers, dry, medium brown material with strong cementation. **Geologic Interpretation:** Quaternary Alluvium	0	5	0
(SC)g Visual Class. Lab sample taken from 5.8-10.0 ft. (SC-SM)g Lab Class. **10.0 ft.**	**5.8 - 10.0 ft. Clayey Sand with Gravel (SC)g:** About 50% predominantly fine sand , 25% fines with medium plasticity, medium toughness and high dry strength and 25% fine gravel. Max. size 10mm. Strong reaction with HCl. In-place condition: very hard, homogeneous, dry, reddish brown material with strong cementation. Lab test data from 7.0-14.5 ft.: 50% sand, 29% gravel, 21% fines; LL = 21%, PI = 6%, Field Moisture = 3.9%. pH = 8.22, Resistivity = 659 ohm/cm, Sulfates = 1,500 ppm, Sulfides = < 1 ppm, Chlorides = 160 ppm. Lab classification is Silty, Clayey Sand with Gravel (SC-SM)g. **Geologic Interpretation:** Quaternary Alluvium	0	0	0
(Ss) Visual Class. **12.0 ft.**	**10.0 - 12.0 ft. Sandstone (Ss):** Sandstone consists of predominately fine sand moderately cemented with silica. Moderately hard, fragments require a moderate hammer blow to break; moderately weathered. No reaction with HCl. Color is white to light gray with yellowish orange specks (limonite staining). Upon excavation with a backhoe, sandstone breaks up into angular, mostly hand-size and smaller chunks. **Geologic Interpretation:** Chinle Formation, Shinarump Member			

REMARKS: **S**urface: flat; sandstone outcrop west across road. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-10**

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1991819 **E.** 801708 **GROUND ELEVATION:** 5632

APPROXIMATE DIMENSIONS: 20' x 4' x 13.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/11/2012 **DATE LOGGED:** 6/11/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken))	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM)gcb Visual Class. Lab sample taken from 0.0-9.4 ft. (SC-SM)g Lab Class. **9.4 ft.**	**0.0 - 9.4 ft. Silty Sand with Gravel, Cobbles and Boulders (SM)gcb:** About 55% fine to coarse sand, 25% fine to coarse, subangular to angular, hard gravel and 20% nonplastic fines with rapid dilatancy, low toughness and high dry strength. Max. size, 3 in. Strong reaction with HCl. Total sample (by volume): About 3% 3 to 5 in. angular, moderately hard cobbles; about 2% 5 to 12 in. angular, moderately hard cobbles; trace of plus 12 in. angular, hard boulders; remainder minus 3 in.; maximum size, 1.0 ft. In-place condition: hard, homogenous, dry, brown material with weak cementation. Lab test data from 0.0-9.4 ft.: 37% sand, 33% gravel, 30% fines; LL = 21%, PI = 5%, Field Moisture = 2.6%. pH = 8.48, Resistivity = 2,042 ohm/cm, Sulfates = 400 ppm, Sulfides = < 1 ppm, Chlorides = 140 ppm. Lab classification is Silty, Clayey Sand with Gravel (SC-SM)g. **Geologic Interpretation:** Quaternary Alluvium	3	2	T
(Mdst) Visual Class. \ **13.0 ft.**	**9.4 - 13.0 ft. Mudstone (Mdst):** Mudstone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting mostly of clay. From 9.4-12.0 ft. soft to moderately soft, hand-size fragment break with manual pressure; from 12.0-13.0 moderately soft to moderately hard, thicker fragments require moderate hammer blow to break and slightly weathered. No reaction with HCl, except on thin veinlets of white $CaCO_3$. Color is medium gray with white veinlets. Upon excavation with a backhoe, sandstone breaks up into angular, mostly hand-size and smaller chunks. **Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: Surface: flat with scattered grasses. Coordinates and elevation obtained from GPS. Test pit terminated at reach of equipment. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-11

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1986910 **E.** 803390 **GROUND ELEVATION:** 5669

APPROXIMATE DIMENSIONS: 20' x 10' x 11.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/13/2012 **DATE LOGGED:** 6/13/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken))	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SC)g Visual Class. Lab sample taken from 0.0-6.0 ft. (SC)g Lab Class. **6.0 ft.**	**0.0 - 6.0 ft. Clayey Sand with Gravel (SC)g:** About 45% fine to coarse sand, 35% fines with low plasticity, slow dilatancy and low toughness and 20% fine to coarse, subangular to angular, hard gravel. Max. size, 3 in. Strong reaction with HCl. In-place condition: firm to hard, layered, dry, light brown material with weak cementation. Discontinuous and irregular gravel layers throughout. Lab test data from 0.0-6.0 ft.: 39% sand, 38% fines, 23% gravel; LL = 22%, PI = 8%, Field Moisture = 3.2%. pH = 7.26, Resistivity = 854 ohm/cm, Sulfates = 1,700 ppm, Sulfides = < 1 ppm, Chlorides = 72 ppm. Lab classification is Clayey Sand with Gravel (SC)g. In-place density of 97.6 lb/ft^3 taken at 4.2 ft. with sand cone apparatus. **Geologic Interpretation:** Quaternary Alluvium	0	0	0
(GP)s Visual Class. **7.5 ft.**	**6.0 - 7.5 ft. Poorly Graded Gravel with Sand (GP)s:** About 60% predominantly fine to coarse, hard, angular to platy gravel, 35% fine to coarse sand, 5% nonplastic fines. Max. size, 3 in. Strong reaction with HCl. In-place condition: very hard, discontinuous layers, dry, medium brown material with moderate cementation. **Geologic Interpretation:** Quaternary Alluvium	0	0	0
(Ss) Visual Class. **11.5 ft.**	**7.5 - 11.5 ft. Sandstone (Ss):** Sandstone consists of predominately fine sand moderately cemented with silica. Moderately hard, fragments require a moderate hammer blow to break; moderately weathered. No reaction with HCl. Color is white to light gray with yellowish orange specks (limonite staining). Upon excavation with a backhoe, sandstone breaks up into angular, mostly hand-size and smaller chunks. Hard digging below 8.0 ft. **Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: Surface: on small berm (Old U.S. Highway 89) with scattered grasses; Moenkopi Formation outcrop about 1,000 ft. west across road. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-12

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1981405 **E.** 805942 **GROUND ELEVATION:** 5711.5

APPROXIMATE DIMENSIONS: 20' x 4' x 11.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/11/2012 **DATE LOGGED:** 6/11/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP)c Visual Class.	**0.0 - 3.8 ft. Poorly Graded Sand with Cobbles (SP)c:** About 85% fine to coarse sand, 10% fine to coarse, subangular gravel and 10% nonplastic fines. Max. size, 3 in. Strong reaction with HCl. Total sample (by volume): About 5% 3 to 5 in. platy, moderately hard, sandstone cobbles; remainder minus 3 in.; maximum size, 5 in. In-place condition: firm to hard, homogenous, dry, brown material with weak cementation.	5	0	0
3.8 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(SC) Visual Class.	**3.8 - 11.5 ft. Clayey Sand (SC):** About 70% fine to coarse sand, 30% fines with low plasticity, very high dry strength, slow dilatancy and low toughness and a trace of gravel. Max. size, 25 mm. Strong reaction with HCl.	0	0	0
Lab sample taken from 3.8-11.5 ft.	In-place condition: hard, homogeneous, dry, brown material with moderate cementation.			
(SC) Lab Class.	Lab test data from 3.8-11.5 ft.: 61% sand, 30% fines, 9% gravel; LL = 22%, PI = 8%, Field Moisture = 4.8%. pH = 7.66, Resistivity = 1,856 ohm/cm, Sulfates = 51 ppm, Sulfides = < 1 ppm, Chlorides = 57 ppm. Lab classification is Clayey Sand (SC).			
11.5 ft.	**Geologic Interpretation:** Quaternary Alluvium			

REMARKS: Surface: gently slopes toward small wash about 300 ft. east of pit. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-13**

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1976939 **E.** 808012 **GROUND ELEVATION:** 5771

APPROXIMATE DIMENSIONS: 20' x 4' x 11.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/11/2012 **DATE LOGGED:** 6/11/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SC) Visual Class. Lab sample taken from 0.0-4.5 ft. (SC-SM) Lab Class. **4.5 ft.**	**0.0 - 4.5 ft. Clayey Sand (SC):** About 85% predominantly fine to coarse sand, 30% fines with low plasticity and trace of fine, subrounded gravel. Max. size 10 mm. Strong reaction with HCl. In-place condition: firm, homogeneous, dry, brown material with weak cementation. Lab test data from 1.8-7.5 ft.: 59% sand, 39% fines, 2% gravel; LL = 21%, PI = 7%, Field Moisture = 4.9%. pH = 8.5, Resistivity = 1,949 ohm/cm, Sulfates = 22 ppm, Sulfides = 2 ppm, Chlorides = 60 ppm. Lab classification is Silty, Clayey Sand (SC-SM). **Geologic Interpretation:** Quaternary Alluvium	0	0	0
(Mdst) Visual Class. **11.0 ft.**	**4.5 - 11.0 ft. Mudstone (Mdst):** Mudstone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting mostly of clay with about 10% very fine sand. Moderately soft, fragments break with manual pressure and are intensely to moderately weathered from 4.5 to 8.0 ft.; moderately hard and moderately weathered from 8.0-11.0 ft. Strong reaction with HCl. Color is dark gray with white mottling from 4.5-8.0 ft. and mottled grayish red with light greenish gray spots. Bedding not discernible in pit, but excavated fragments break into 1 to 4 in. thick slabs. **Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: Surface: gently sloping east toward wash with scattered grasses on loose sand. Moderately hard to hard, purplish gray and white sandstone (Shinarump) outcrops west across highway with Moenkopi shale outcrops further west. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-14

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1972911 **E.** 809681 **GROUND ELEVATION:** 5786

APPROXIMATE DIMENSIONS: 20' x 4' x 11.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/11/2012 **DATE LOGGED:** 6/11/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM) Visual Class. Lab sample taken from 0.0-8.0 ft. (SM) Lab Class. **8.0 ft.**	**0.0 - 8.0 ft. Silty Sand (SM):** About 85% predominantly fine to coarse sand and 15% nonplastic fines. Max. size coarse sand. Strong reaction with HCl. In-place condition: soft, homogeneous, dry, light brown material with weak cementation. Lab test data from 0.0-8.0 ft.: 76% sand, 15% fines, 9% gravel; LL and PI not tested; Field Moisture = 1.9%. pH = 8.32, Resistivity = 1,949 ohm/cm, Sulfates = 18 ppm, Sulfides = 2 ppm, Chlorides = 24 ppm. Lab classification is Silty Sand (SM). **Geologic Interpretation:** Quaternary Alluvium	0	0	0
(SP)g Visual Class. **10.0 ft.**	**8.0 - 10.0 ft. Poorly Graded Sand with Gravel (SP)g:** About 80% predominantly fine to coarse sand, 15% fine to coarse, subangular to subrounded gravel and 5% nonplastic fines. Max. size 2.5 in. Strong reaction with HCl. In-place condition: hard, homogeneous, dry, light brown material with weak cementation. **Geologic Interpretation:** Quaternary Alluvium	0	0	0
(Ss) Visual Class. **11.0 ft.**	**10.0 - 11.0 ft. Sandstone (Ss):** Sandstone consists of about 90% fine to predominately coarse sand and 10% flat, angular gravel moderately cemented with $CaCo_3$. Sandstone is moderately soft, fragments break with manual pressure and intensely to moderately weathered. Strong reaction with HCl. Color is medium gray with black and dark yellowish orange streaks mottled with light gray and brown. Upon excavation with a backhoe, sandstone breaks up into angular, 6 in and smaller chunks. Backhoe could only excavate 1.0 ft.; teeth grooved bottom, but could not penetrate. **Geologic Interpretation:** Chinle Formation, Shinarump Member			

REMARKS: Surface: flat with moderate cover of bushes; shale fragments derived from the Moenkopi Formation at surface. Small wash about 60 ft. east of pit. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-15

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1966236 **E.** 812753 **GROUND ELEVATION:** 5865

APPROXIMATE DIMENSIONS: 14' x 4' x 7.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/11/2012 **DATE LOGGED:** 6/11/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP)g Visual Class. **0.9 ft.**	**0.0 - 0.9 ft. Poorly Graded Sand with Gravel (SP)g:** About 95% predominantly fine to coarse sand and 5% nonplastic fines. Max. size, coarse sand. Strong reaction with HCl. From 0.3-0.9 ft., encountered asphalt and gravel from Old U.S. Highway 89. In-place condition: soft, homogeneous, dry, light brown material with weak cementation. **Geologic Interpretation:** Quaternary Alluvium and Old U.S. Highway 89	0	0	0
(SM) Visual Class. Lab sample taken from 0.9-5.5 ft. (SC-SM) Lab Class. **5.5 ft.**	**0.9 - 5.5 ft. Silty Sand (SM):** About 70% fine to coarse sand, 20% nonplastic fines with medium to high dry strength, slow to rapid dilatancy and low toughness and 10% fine, subangular to subrounded gravel. Max. size, 20 mm. Strong reaction with HCl. In-place condition: firm to hard, homogeneous, dry, medium brown material with weak to moderate cementation. Lab test data from 0.9-5.5 ft.: 62% sand, 23% fines, 15% gravel; LL = 20%, PI = 5%, Field Moisture = 3.4%. pH = 8.8, Resistivity = 2.042 ohm/cm, Sulfates = 30 ppm, Sulfides = < 1 ppm, Chlorides = 23 ppm. Lab classification is Silty, Clayey Sand (SC-SM). **Geologic Interpretation:** Quaternary Alluvium	0	0	0
(Ss) Visual Class. **7.0 ft.**	**5.5 - 7.0 ft. Sandstone (Ss):** Sandstone consists of fine to medium sand moderately cemented with $CaCo_3$. Sandstone is moderately hard, fragments require moderate hammer blow to break and moderately weathered. Bedding not discernible in pit walls, but excavated fragments are 1-5 in. thick. Strong reaction with HCl. Color is white. Upon excavation with a backhoe, sandstone breaks up into angular, slabs 1.5 by 0.5 ft. in size and smaller. Backhoe met refusal at 7.0 ft. **Geologic Interpretation:** Chinle Formation, Shinarump Member			

REMARKS: Surface: flat with moderate cover of bushes; encountered asphalt and gravel from Old U.S. Highway 89 at 0.3 ft. below surface. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-16**

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1961708 **E.** 815643 **GROUND ELEVATION:** 5925

APPROXIMATE DIMENSIONS: 14' x 4' x 6.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/11/2012 **DATE LOGGED:** 6/11/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
s(CL) Visual Class.	**0.0 - 3.5 ft. Sandy Lean Clay s(CL):** About 50% fines with low plasticity, very high dry strength, slow dilatancy and low toughness, 40% fine to coarse sand and 10% fine, flat, subangular gravel. Max. size, 20 mm. Strong reaction with HCl.	0	0	0
Lab sample taken from 0.0-3.5 ft.	In-place condition: hard to very hard, homogeneous, dry, brown material with moderate to strong cementation.			
s(CL) Lab Class.	Lab test data from 0.0-3.5 ft.: 51% fines, 36% sand, 13% gravel; LL and PI not tested, Field Moisture = 5.4%. pH = 8.48, Resistivity = 2.227 ohm/cm, Sulfates = 11 ppm, Sulfides = 4 ppm, Chlorides = 22 ppm. Lab classification is Sandy Lean Clay s(CL).			
3.5 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(Ss) Visual Class.	**3.5 - 6.0 ft. Sandstone (Ss):** Sandstone consists of fine to medium sand moderately cemented with $CaCo_3$. Sandstone is moderately hard, fragments require moderate hammer blow to break and moderately weathered. Bedding not discernible in pit walls, but excavated fragments are 1-5 in. thick. Strong reaction with HCl. Color is very light gray and white.			
	From 3.5-5.5 ft., sandstone appears intensely fractured and intensely weathered; may indicate original weathered surface.			
	Upon excavation with a backhoe, sandstone breaks up into angular, slabs 1.0 by 0.5 ft. in size and smaller. Backhoe met refusal at 6.0 ft.			
6.0 ft.	**Geologic Interpretation:** Chinle Formation, Shinarump Member			

REMARKS: Surface: flat with scattered grasses; shale fragments derived from the Moenkopi Formation at surface. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-18

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: OLD U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1944164 **E.** 823905 **GROUND ELEVATION:** 5509

APPROXIMATE DIMENSIONS: 20' x 4' x 9.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/7/2012 **DATE LOGGED:** 6/7/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(CL)s Visual Class.	**0.0 - 2.5 ft. Lean Clay with Sand (CL)s:** About 75 % fines with medium plasticity, medium toughness and very high dry strength, 25% predominantly fine to medium sand and trace of fine, subrounded gravel. Max. size, 15 mm. Strong reaction with HCl. In-place condition: hard, homogeneous, dry, medium brown material with weak to moderate cementation.	0	0	0
2.5 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(Mdst) Visual Class. Lab sample taken from 2.5-9.5 ft. (CL) Lab Class.	**2.5 - 9.5 ft. Mudstone (Mdst):** Mudstone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting mostly of clay; bedding not discernible. Soft to moderately soft, edges of hand-size fragment break with light manual pressure; thicker portions require heavy pressure or light hammer blow to break. No reaction with HCl. Color is medium dark gray to gray. Upon excavation with a backhoe, mudstone breaks up into angular, hand-size and smaller chunks. A 75 mm chunk of mudstone placed in water broke down into 10 mm pieces within 1 hr., but did not break down further or soften into clay within 48 hrs. Lab test data from 2.5-9.5 ft.: 94% fines, 6% sand, 0% gravel; LL and PI not tested, Field Moisture = 16.0%, Expansion Index = 49. pH = 7.25, Resistivity = 752 ohm/cm, Sulfates = 73 ppm, Sulfides = 3 ppm, Chlorides = 74 ppm. Lab classification is Lean Clay (CL). Note: material originated from mudstone.			
9.5 ft.	**Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: **S**urface: scattered grass and bushes on loose sand; low rounded hills of claystone from the Chinle Formation surround area. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-19

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HAMBLIN WASH **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1934744 **E.** 830704 **GROUND ELEVATION:** 5363.5

APPROXIMATE DIMENSIONS: 20' x 4' x 14.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/13/2012 **DATE LOGGED:** 6/13/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken))	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SC)gcb Visual Class.	**0.0 - 10.0 ft. Clayey Sand with Gravel, Cobbles and Boulders (SP-SC)gcb:** About 60% fine to coarse sand, 25% fine to coarse, subangular to subrounded, hard gravel and 15% fines with low plasticity, slow dilatancy and low toughness. Max. size, 3 in. Strong reaction with HCl. Total sample (by volume): About 5% 3 to 5 in. platy, hard, sandstone cobbles; about 5% 5 to 12 in. blocky, hard, sandstone cobbles; about 5% plus 12 in. blocky, hard, sandstone boulders; remainder minus 3 in.; maximum size, 2.5 by 1.0 by 1.0 ft.	5	5	5
Lab sample taken from 0.0-10.0 ft. (SC)g Lab Class.	In-place condition: firm to hard, layered, dry, becoming moist at 5.2 ft., medium brown material with weak to moderate cementation. Discontinuous and irregular gravel layers throughout. Lab test data from 0.0-10.0 ft.: 55% sand, 26% gravel, 19% fines; LL = 22%, PI = 9%, Field Moisture = 6.0%. pH = 8.54, Resistivity = 928 ohm/cm, Sulfates = 210 ppm, Sulfides = 2 ppm, Chlorides = 420 ppm. Lab classification is Clayey Sand with Gravel (SC)g.			
10.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(Mdst) Visual Class.	**10.0 - 14.0 ft. Mudstone (Mdst):** Mudstone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting mostly of clay. Soft, fragments break with manual pressure: moderately weathered. Moist; no reaction with HCl. Color is medium dark gray from 10.0-12.0 ft., dark greenish gray from 12.0-14.0 ft.. Upon excavation with a backhoe, mudstone breaks up into angular, hand-size and smaller chunks.			
14.0 ft.	**Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: **S**urface: flat with scattered bushes; cobbles and some boulders up to 1.5 ft. on surface; pit is about 100 ft. west of Hamblin Wash. Chinle Formation outcrops about 100 ft. west of pit. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-20

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HAMBLIN WASH **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1931844 **E.** 833272 **GROUND ELEVATION:** 5322

APPROXIMATE DIMENSIONS: 20' x 10' x 12.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/13/2012 **DATE LOGGED:** 6/13/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken))	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM)c Visual Class.	**0.0 - 8.7 ft. Silty Sand with Trace of Cobbles (SM)c:** About 75% fine to coarse sand, 20% nonplastic fines and 5% fine to coarse, moderately hard, gravel in the form of platy sandstone fragments. Max. size, 3 in. Strong reaction with HCl. Total sample (by volume): Trace of 5 to 12 in. platy, hard sandstone cobbles; remainder minus 3 in.; maximum size, 6 in.	0	T	0
Lab sample taken from 0.0-8.7 ft.	In-place condition: firm at top grading to very hard at bottom of interval, homogeneous, dry, brown material with weak cementation at top grading to moderate cementation at bottom of interval.			
(SC-SM) Lab Class.	Lab test data from 0.0-8.7 ft.: 66% sand, 28% fines, 6% gravel; LL = 23%, PI = 5%, Field Moisture = 3.8%. pH = 8.41, Resistivity = 1,856 ohm/cm, Sulfates = 29 ppm, Sulfides = < 1 ppm, Chlorides = 66 ppm. Lab classification is Silty Clayey Sand (SC-SM) In-place density of 106.2 lb/ft^3 taken at 5.0 ft. with sand cone apparatus.			
8.7 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(GP)sc Visual Class.	**8.7 -9.5 ft. Poorly Graded Gravel with Sand and Cobbles (GP)sc:** About 55% fine to coarse, hard, subrounded gravel, 40% fine to coarse sand, 5% nonplastic fines. Max. size, 3 in. Strong reaction with HCl. Total sample (by volume): About 10% 3 to 5 in., subrounded, hard cobbles; remainder minus 3 in.; maximum size, 5 in. In-place condition: very hard, homogenous, dry, mottled tan material with moderate cementation.	10	0	0
9.5 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(Mdst) Visual Class.	**9.5 - 12.0 ft. Mudstone (Mdst):** Mudstone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting mostly of clay. Moderately soft, fragments break with manual pressure, thicker portion requires light hammer blow to break; moderately weathered. Slightly moist; no reaction with HCl except on thin white veinlets of $CaCO_3$. Color is grayish brown with light greenish gray spots. Upon excavation with a backhoe, mudstone breaks up into angular, hand-size and smaller chunks.			
12.0 ft.	**Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: Surface: flat with scattered bushes; pit is about 50 ft. west of Hamblin Wash. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336
Bureau of Reclamation

LOG OF TEST PIT OR AUGER HOLE

HOLE NO. TP-21

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HAMBLIN WASH **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1927080 **E.** 837375 **GROUND ELEVATION:** 5249.7

APPROXIMATE DIMENSIONS: 20' x 10' x 14.0' DEEP **LOGGED BY:** B. PRUDHOM

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/13/2012 **DATE LOGGED:** 6/13/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	CLASSIFICATION AND DESCRIPTION OF MATERIAL SEE USBR 5000, 5005	% PLUS 3 in (75 mm) BY VOLUME		
		3 – 5 in	5 – 12 in	PLUS 12 in
(SM) Visual Class. **3.0 ft.**	**0.0 - 3.0 ft. Silty Sand (SM):** About 55% predominantly fine to medium sand, 45% fines with low plasticity, low to medium toughness and medium dry strength and trace of fine, subangular, moderately hard to hard, gravel. Max. size, 15 mm. Strong reaction with HCl. In-place condition: hard, homogeneous and somewhat blocky, dry, moderate to pale reddish brown material with weak cementation. **Geologic Interpretation:** Quaternary Alluvium	0	0	0
(GC)sc Visual Class. Lab sample taken from 3.0-5.0 ft. (SW-SC)g Lab Class. **8.5 ft.**	**3.0 - 8.5 ft. Clayey Gravel with Sand and Cobbles (GC)sc:** About 45% fine to coarse, subrounded to angular (predominantly subangular) moderately hard to hard, flattened and elongated gravel, 35% fine to predominantly medium and coarse, flat, angular sand and 20% fines with medium to high plasticity, high dry strength, no to slow dilatancy and medium toughness. Max. size, 90 mm. Strong reaction with HCl. Total sample (by volume): About 5% 3 to 5 in. blocky, hard, sandstone cobbles; remainder minus 3 in.; maximum size, 5 in. In-place condition: hard, homogeneous, slightly moist from 3.0-5.0 and moist 5.0-8.5 ft., pale to dark reddish brown material with weak cementation. Lab test data from 3.0-5.0 ft.: 57% sand, 38% gravel, 5% fines; LL and PI not tested, Field Moisture = 2.0%. pH = 9.7, Resistivity = 3,526 ohm/cm, Sulfates = 96 ppm, Sulfides = 3 ppm, Chlorides = 67 ppm. Lab classification is Well Graded Sand with Clay and Gravel (SW-SC)g. In-place density of 127.2 lb/ft^3 taken at 3.0 ft. with sand cone apparatus. **Geologic Interpretation:** Quaternary Alluvium	5	0	0
(Mdst) Visual Class. Lab sample taken from 8.5-14.0 ft. s(CL) Lab Class. **14.0 ft.**	**8.5 - 14.0 ft. Mudstone (Mdst):** Mudstone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting mostly of clay, but locally silty. Soft to moderately soft, fragments break with manual pressure, becoming moderately hard after drying. Weak to moderate reaction with HCl. Color is pale reddish brown to grayish red. Upon excavation with a backhoe, mudstone breaks up into angular, 3 in. and smaller chunks. Lab test data from 8.5-14.0 ft.: 68% fines, 32% sand, 0% gravel,; LL = 42%, PI = 18%, Field Moisture = 13.6%. pH = 8.83, Resistivity = 2,877 ohm/cm, Sulfates = 14 ppm, Sulfides = < 1 ppm, Chlorides = 46 ppm. Lab classification is Sandy Lean Clay s(CL). **Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: **S**urface: flat with loose sand and sparse bushes, about 100 ft. east of low mesa and terrace deposits. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-22

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HAMBLIN WASH **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1923535 **E.** 839803 **GROUND ELEVATION:** 5203

APPROXIMATE DIMENSIONS: 20' x 10' x 14.0' DEEP **LOGGED BY:** B. PRUDHOM

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/13/2012 **DATE LOGGED:** 6/13/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM) Visual Class.	**0.0 - 4.0 ft. Silty Sand (SM):** About 55% predominantly fine to medium sand, 45% fines with low plasticity, low to medium toughness and medium dry strength and trace of fine, subangular, moderately hard to hard, gravel. Max. size, 15 mm. Strong reaction with HCl. In-place condition: hard, homogeneous and somewhat blocky, dry, moderate to pale reddish brown material with weak cementation. Roots from 0.0-1.0 ft.	0	0	0
4.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(GM)sc Visual Class.	**4.0 - 7.0 ft. Silty Gravel with Sand and Cobbles (GM)sc:** About 55% fine to coarse, subrounded to angular (predominantly subangular), moderately hard to hard, flattened and elongated gravel, 30% fine to coarse, subrounded to angular sand and 15% fines with no to low plasticity, low dry strength, slow dilatancy and low toughness. Max. size, 30 mm. Strong reaction with HCl. Total sample (by volume): About 5% 3 to 5 in. subangular to subrounded, hard cobbles; remainder minus 3 in.; maximum size, 7 in. In-place condition: hard, homogeneous, moist, pale to dark reddish brown material with moderate to strong cementation. In-place density of 120.9 lb/ft^3 taken at 4.0 ft. with sand cone apparatus.	5	0	0
7.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(SC)gcb Visual Class. Lab sample taken from 7.0-14.0 ft. (SW-SC)g Lab Class.	**7.0 -14.0 ft. Clayey Sand with Gravel, Cobbles and Boulders (SC)gcb:** About 45% predominantly fine to coarse, subrounded to subangular sand, 40% predominantly fine to coarse, subrounded to predominantly subangular, moderately soft to moderately hard, flat gravel, 15% fines with medium to high plasticity, high dry strength, no dilatancy and medium toughness and. Max. size, 25 mm. Strong reaction with HCl. Total sample (by volume): About 10% 3 to 5 in. subangular to subrounded, hard cobbles; trace of plus 12 in. blocky, hard boulders; remainder minus 3 in.; maximum size, 2.0 ft. In-place condition: hard, homogeneous, moist, dark reddish brown material with weak to moderate cementation. Lab test data from 7.0-14.0 ft.: 45% sand, 43% gravel, 12% fines; LL and PI not tested, Field Moisture = 12.2%. pH = 10.16, Resistivity = 780 ohm/cm. Lab classification is Well Graded Sand with Clay and Gravel (SW-SC)g.	10	0	T
14.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			

REMARKS: **S**urface: flat with loose sand and sparse bushes. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-23**

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HAMBLIN WASH **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1921434 **E.** 841152 **GROUND ELEVATION:** 5175.5

APPROXIMATE DIMENSIONS: 20' x 10' x 14.0' DEEP **LOGGED BY:** B. PRUDHOM

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/13/2012 **DATE LOGGED:** 6/13/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM) Visual Class.	**0.0 - 4.0 ft. Silty Sand (SM):** About 55% predominantly fine to medium sand, 45% fines with low plasticity, low to medium toughness and medium dry strength and trace of fine, subangular, moderately hard to hard, gravel. Max. size, 5 mm. Strong reaction with HCl.	0	0	0
Lab sample taken from 0.0 - 4.0 ft.	In-place condition: hard, homogeneous and somewhat blocky, dry, moderate to pale reddish brown material with weak cementation.			
(SM) Lab Class.	Lab test data from 0.0-4.0 ft.: 68% sand, 31% fines, 1% gravel; Nonplastic, Field Moisture= 2.6%. pH = 9.29, Resistivity = 2,227 ohm/cm, Sulfates = 22 ppm, Sulfides = 2 ppm, Chlorides = 26 ppm. Lab classification is Silty Sand (SM).			
	In-place density of 100.1 lb/ft^3 taken at 4.0 ft. with sand cone apparatus.			
4.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(GC-GM)scb Visual Class.	**4.0 - 14.0 ft. Clayey Silty Gravel with Sand, Cobbles and Boulders (GC-GM)scb:** About 45% predominantly fine to coarse, subrounded to subangular, moderately hard to hard, flat gravel, 35% predominantly fine to coarse, rounded to angular sand and 20% fines with no to low plasticity, medium dry strength, slow dilatancy and low toughness. Max. size, 60 mm. Strong reaction with HCl.	5	10	T
Lab sample taken from 6.0-8.0 ft.	Total sample (by volume): About 5% 3 to 5 in. subangular to subrounded, hard cobbles; about 10% 5 to 12 in. subangular, hard cobbles; trace of plus 12 in. angular, hard boulders; remainder minus 3 in.; maximum size, 1.5 ft.			
(SC)g Lab Class.	In-place condition: hard, gravel lenses up to 6 in. thick in finer grained soil, dry from 4.0-12.0 ft. and moist from 12.0-14.0 ft., moderate reddish brown material with weak to moderate cementation.			
	Lab test data from 6.0-8.0 ft.: 67% sand, 18% fines, 15% gravel; LL = 22%, PI = 9%, Field Moisture = 9.0%. pH = 9.83, Resistivity = 1,949 ohm/cm, Sulfates = 12 ppm, Sulfides = 3 ppm, Chlorides = 17 ppm. Lab classification is Clayey Sand with Gravel (SC)g.			
14.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			

REMARKS: Surface: flat with loose sand and sparse bushes, about 400 ft. west of Hamblin Wash. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-24

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: OLD U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1917157 **E.** 844861 **GROUND ELEVATION:** 5128

APPROXIMATE DIMENSIONS: 20' x 10' x 15.0' DEEP **LOGGED BY:** B. PRUDHOM

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/12/2012 **DATE LOGGED:** 6/12/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SC)b Visual Class.	**0.0 - 4.0 ft. Clayey Sand with Trace of Boulders (SC)b:** About 55% predominantly very fine to medium sand and 45% fines with mostly low to medium plasticity, slow to rapid dilatancy, low toughness and high dry strength. Max. size, medium sand. Strong reaction with HCl. Total sample (by volume): Trace of plus 12 in. subrounded to angular, moderately hard boulders; remainder minus 3 in.; maximum size, 2 by 1 ft. In-place condition: hard, homogeneous, dry, pale reddish brown material with mostly weak to moderate cementation. In-place density of 123.7 lb/ft^3 taken at 3.5 ft. with sand cone apparatus.	0	0	T
4.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(GM)s Visual Class. Lab sample taken from 4.0-10.0 ft. (SP-SM)g Lab Class.	**4.0 - 10.0 ft. Silty Gravel with Sand (GM)s:** About 55% predominantly fine to coarse, subrounded to subangular, moderately hard to hard, flat gravel, 35% predominantly fine and medium to coarse, rounded to angular sand and 15% nonplastic fines with medium to high dry strength, slow to rapid dilatancy and low toughness. Max. size, 45 mm. Strong reaction with HCl. In-place condition: very hard, lensed, fining upward, dry to moist, pale reddish brown to grayish material with moderate cementation. Lab test data from 4.0-10.0 ft.: 51% sand, 42% gravel, 7% fines; LL and PI not tested, Field Moisture = 2.4%. pH = 9.11, Resistivity = 1,578 ohm/cm, Sulfates = 80 ppm, Sulfides = 2 ppm, Chlorides = 34 ppm. Lab classification is Poorly Graded Sand with Silt and Gravel (SP-SM)g.	0	0	0
10.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(GM)sc Visual Class.	**10.0 - 15.0 ft. Silty Gravel with Sand and Cobbles (GM)sc:** About 55% predominantly fine to coarse, subrounded to subangular, moderately hard to hard, flat gravel, 35% predominantly fine and medium to coarse, rounded to angular sand and 15% nonplastic fines with medium to high dry strength, slow to rapid dilatancy and low toughness. Max. size, 45 mm. Strong reaction with HCl. Total sample (by volume): About 5% 3 to 5 in. subrounded to angular, moderately hard cobbles; trace of 5 to 12 in. subangular, moderately hard cobbles; maximum size, 8 in. In-place condition: very hard, lensed, fining upward, dry to moist, pale reddish brown to grayish material with moderate cementation.	5	T	0
15.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			

REMARKS: **S**urface: flat with sparse bushes; pit located about 300 ft. northeast and 300 ft. southeast of Chinle Formation outcrops and about 300 ft. west of Hamblin Wash. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-25

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: OLD U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1910810 **E.** 847414 **GROUND ELEVATION:** 5051.5

APPROXIMATE DIMENSIONS: 20' x 4' x 12' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/7/2012 **DATE LOGGED:** 6/7/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP) Visual Class.	**0.0 - 5.0 ft. Poorly Graded Sand (SP):** About 95% predominantly fine to medium sand and 5% nonplastic fines. Max. size, medium sand. Contains rounded silt pebbles up to 10 mm in diameter. Strong reaction with HCl. In-place condition: very hard, layered, dry, light brown material with weak cementation.	0	0	0
5.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(SP)g Visual Class.	**5.0 - 8.0 ft. Poorly Graded Sand with Gravel (SP)g:** About 60% predominantly fine to coarse sand, 35% predominantly fine to coarse gravel, 5% nonplastic fines. Max. size, 2 in. Strong reaction with HCl. In-place condition: firm, homogeneous, dry, brown material with moderate cementation with $CaCO_3$.	0	0	0
8.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(SP-SC) Visual Class. Lab sample taken from 8.0-12.0 ft. (SC-SM) Lab Class.	**8.0 - 12.0 ft. Poorly Graded Sand with Clay (SP-SC):** About 90% predominantly fine sand and 10% fines with medium plasticity, medium toughness and high dry strength. Max. size fine sand. Strong reaction with HCl. In-place condition: very hard, homogeneous, dry, reddish brown material with strong cementation. Lab test data from 8.0-12.0 ft.: 77% sand, 12% fines, 11% gravel; LL and PI not tested, Field Moisture = 2.8%. pH = 7.31, Resistivity = 4,640 ohm/cm, Sulfates = 7 ppm, Sulfides = < 1 ppm, Chlorides = 17 ppm. Lab classification is Silty, Clayey Sand (SC-SM).	0	0	0
12.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			

REMARKS: Surface: in wash floodplain, about 250 ft. west of active channel; Chinle outcrops 150 ft. west of pit. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-26

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: OLD U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1906705 **E.** 849741 **GROUND ELEVATION:** 5003

APPROXIMATE DIMENSIONS: 20' x 4' x 10.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/7/2012 **DATE LOGGED:** 6/7/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP)g Visual Class.	**0.0 - 3.5 ft. Poorly Graded Sand with Gravel (SP)g:** About 75% predominantly fine to coarse sand, 20% fine to coarse, subrounded gravel and 5% nonplastic fines. Max. size 2 in. Strong reaction with HCl. In-place condition: hard, layered, dry, tan material with weak cementation. Gravelly lenses varying in thickness from 2-4 in. occur at 0.9 and 2.2 ft.	0	0	0
3.5 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(Ss) Visual Class. Lab sample taken from 3.5-10.5 ft. (SC-SM) Lab Class.	**3.5 - 10.5 ft. Sandstone (Ss):** Sandstone consists of predominately fine sand weakly cemented with silica; beds are ½ to 3 in. thick. Soft to moderately soft, breaks with light manual pressure; thicker portion requires heavy manual pressure. Slightly moist. Weak reaction with HCl. Color is grayish red purple with light greenish gray and white mottling. Upon excavation with a backhoe, sandstone breaks up into angular, hand-size and smaller chunks. Lab test data from 3.5-10.5 ft.: 86% sand, 12% fines, 2% gravel; LL and PI not tested, Field Moisture = 8.9%. pH = 8.8, Resistivity = 1,578 ohm/cm, Sulfates = 7 ppm, Sulfides = 5 ppm, Chlorides = 22 ppm. Lab classification is Silty Clayey Sand (SC-SM). Note: material originated from sandstone.			
10.5 ft.	**Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: **S**urface: wash floodplain strewn with cobbles and boulders and scattered bushes; low rounded hills of claystone from the Chinle Formation outcrop 150 ft. west. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-27

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: OLD U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1901714 **E.** 852434 **GROUND ELEVATION:** 4948

APPROXIMATE DIMENSIONS: 10' x 4' x 6.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: 4.5 **DATE:** 6/7/2012 **DATE LOGGED:** 6/7/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP) Visual Class.	**0.0 - 6.0 ft. Silty Sand (SP):** About 95% fine to coarse sand, 5% nonplastic fines, trace of subrounded to subangular, hard gravel. No dry strength, rapid dilatancy and low toughness. Max. size, 1 in. Strong reaction with HCl.	0	0	0
Lab sample taken from 0.0-5.0 ft.	In-place condition: very soft, homogenous, moist to wet, medium brown material with weak cementation.			
(SP-SM) Lab Class.	Lab test data from 0.0-5.0 ft.: 82% sand, 10% fines, 8% gravel; LL and PI not tested, Field Moisture = 11.5%. pH = 9.7, Resistivity = 2,042 ohm/cm, Sulfates = 33 ppm, Sulfides = < 1 ppm, Chlorides = 33 ppm. Lab classification is Poorly Graded Sand with Silt (SP-SM).			
6.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			

REMARKS: **S**urface: area surrounded by 15 ft. tall tamarisk, scattered bushes; pit located about 150 ft. west of Hamblin Wash; white salt crust observed on ground surface east of pit area. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated due to water flowing into pit, collapsing side walls.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-28

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: OLD U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1896558 **E.** 854163 **GROUND ELEVATION:** 4893

APPROXIMATE DIMENSIONS: 20' x 4' x 13.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/7/2012 **DATE LOGGED:** 6/7/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM)gcb Visual Class. Lab sample taken from 0.0-13.5 ft. (SM)g Lab Class. **13.5 ft.**	**0.0 - 13.5 ft. Silty Sand with Gravel, Cobbles and Boulders (SM)gcb:** About 65% fine to coarse sand, 20% platy, subrounded to subangular, hard gravel, 15% nonplastic fines with low dry strength, rapid dilatancy and low toughness. Max. size, 1.5 in.. Strong reaction with HCl. Total sample (by volume): About 5% 3 to 5 in. subangular to subrounded, hard cobbles; about 5% 5 to 12 in. subangular to subrounded, hard cobbles; trace of plus 12 in. hard, subrounded boulders; remainder minus 3 in.; maximum size, 1.5 ft. In-place condition: soft to firm, layered, dry, medium reddish brown material with weak cementation. Thin (1-2 in. thick) lenses of gravel scattered throughout interval. Ratio of coarse sand increases with depth. Lab test data from 0.0-13.5 ft.: 60% sand, 125% gravel, 5% fines; LL and PI not tested, Field Moisture = 5.5%. pH = 8.71, Resistivity = 510 ohm/cm, Sulfates = 28 ppm, Sulfides = 2 ppm, Chlorides = 28 ppm. Lab classification is Silty Sand with Gravel (SM)g. **Geologic Interpretation:** Quaternary Alluvium	5	5	T

REMARKS: **S**urface: scattered bushes; pit located about 450 ft. west of Hamblin Wash; few boulders (1-2 ft.) on surface. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-29**

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HAMBLIN WASH **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1891414 **E.** 854873 **GROUND ELEVATION:** 4841

APPROXIMATE DIMENSIONS: 20' x 10' x 10.0' DEEP **LOGGED BY:** B. PRUDHOM

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/12/2012 **DATE LOGGED:** 6/12/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM) Visual Class.	**0.0 - 0.5 ft. Silty Sand (SM):** About 55% predominantly fine to medium sand, 25% fines with medium plasticity, medium toughness and high dry strength and 20% fine, subrounded to angular, moderately soft to moderately hard gravel. Max. size, 20 mm. No reaction with HCl. In-place condition: soft to hard, homogeneous, dry, moderate to pale red material with moderate cementation.	0	0	0
0.5 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(Mdst) Visual Class.	**0.5 - 10.0 ft. Mudstone (Mdst):** Mudstone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting mostly of clay, but locally silty. Soft to moderately soft, fragments break with manual pressure, becoming moderately hard after drying. Weak to moderate reaction with HCl. Color is pale reddish brown to grayish red, mottled with greenish gray.			
Lab sample taken from 0.5-10.0 ft.	Lab test data from 0.5-10.0 ft.: 73% fines, 22% sand, 5% gravel; LL = 38%, PI = 20%, Field Moisture = 8.9%. pH = 8.85, Resistivity = 2,970 ohm/cm, Sulfates = 210 ppm, Sulfides = < 1 ppm, Chlorides = 2,400 ppm.			
(CL)s Lab Class.	Lab classification is Lean Clay with Sand (CL)s. Note: material originated from mudstone. In-place density of 115.5 lb/ft^3 taken at 3.0 ft. with sand cone apparatus. Upon excavation with a backhoe, mudstone breaks up into angular, 5 in. and smaller chunks.			
10.0 ft.	**Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: Surface: flat with no vegetation; weathered claystone outcrops of the Chinle Formation at surface. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-30

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: OLD U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1887625 **E.** 854288 **GROUND ELEVATION:** 4793

APPROXIMATE DIMENSIONS: 20' x 4' x 14.0 DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/7/2012 **DATE LOGGED:** 6/7/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken))	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP) Visual Class. . **2.3 ft.**	**0.0 - 2.3 ft. Poorly Graded Sand (SP):** About 95% fine to coarse sand, 5% nonplastic fines and trace of predominantly fine, hard gravel. Max. size 25 mm. Strong reaction with HCl. In-place condition: soft to firm, homogeneous, dry, brown material with weak cementation. **Geologic Interpretation:** Quaternary Alluvium	0	0	0
(Mdst) Visual Class. Lab sample taken from 2.3-14.0 ft. (CL)s Lab Class **14.0 ft.**	**2.3 - 14.0 ft. Mudstone (Mdst):** Mudstone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting of approximately 60% clay, 40% fine sand and a trace of lenticular gravel up to 10 mm long. Moderately soft, fragments break with manual pressure, thicker portion requires moderate hammer blow to break, moderately weathered. No reaction with HCl, except on $CaCO_3$ filled fractures and 1-2 mm grains. Color is medium gray. Upon excavation with a backhoe, mudstone breaks up into angular, hand-size and smaller chunks. Lab test data from 2.3-14.0 ft.: 78% fines, 22% sand, 0% gravel; LL = 22%, PI = 8%, Field Moisture = 24.2%, Expansion Index = 129. pH = 7.84, Resistivity = 408 ohm/cm, Sulfates = 86 ppm, Sulfides = < 1 ppm, Chlorides = 180 ppm. Lab classification is Lean Clay with Sand (CL)s. Note: material originated from mudstone. **Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: Surface: flat, scattered bushes on loose sand with some gravel up to 3 in. in diameter; pit located 300 ft. west of wash; sandstone from the Chinle Formation outcrops west across the highway. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-31

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: OLD U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1881084 **E.** 853659 **GROUND ELEVATION:** 4742.5

APPROXIMATE DIMENSIONS: 15' x 10' x 5.0' DEEP **LOGGED BY:** B. PRUDHOM

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/12/2012 **DATE LOGGED:** 6/12/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SC)g Visual Class. **1.0 ft.**	**0.0 - 1.0 ft. Clayey Sand with Gravel (SC)g:** About 60% predominantly fine to coarse sand, 25% fines with medium plasticity, medium to high toughness and high dry strength and 15% predominantly fine to coarse, subrounded to angular, moderately hard gravel. Max. size, 35 mm. Strong reaction with HCl. In-place condition: soft to hard, homogeneous, dry, moderate to grayish red to dark reddish brown material with weak cementation. **Geologic Interpretation:** Quaternary Alluvium	0	0	0
(Ss) Visual Class. Lab sample taken from 1.8-5.0 ft. (SC) Lab Class. **5.0 ft.**	**1.0 - 5.0 ft. Sandstone (Ss):** Sandstone consists of fine to coarse, subrounded to subangular sand in a weakly to moderately cemented fine sand and silt matrix; variably cemented with $CaCO_3$; indistinct bedding. Moderately soft and friable, fragments break with manual pressure; slightly to moderately weathered. Mostly no to weak reaction with HCl. Color is light gray. Lab test data from 1.8-5.0 ft.: 68% sand, 29% fines, 3% gravel; LL = 35%, PI = 16%, Field Moisture = 4.5%. pH = 8.9, Resistivity = 371 ohm/cm, Sulfates = 1800 ppm, Sulfides = 4 ppm, Chlorides = 268 ppm. Lab classification is Clayey Sand (SC). Note: material originated from sandstone. In-place density of 116.8 lb/ft^3 taken at 4.0 ft. with sand cone apparatus. Upon excavation with a backhoe, sandstone breaks up into angular, 5 in. and smaller chunks. **Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: Surface: flat with no vegetation. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-32

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: OLD U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1877655 **E.** 853639 **GROUND ELEVATION:** 4709

APPROXIMATE DIMENSIONS: 20' x 4' x 14' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/7/2012 **DATE LOGGED:** 6/7/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM)g Visual Class. Lab sample taken from 6.0-14.0 ft. (SM)g Lab Class. **14.0 ft.**	**0.0 - 14.0 ft. Silty Sand with Gravel (SM)g:** About 70% fine to coarse sand, 15% nonplastic fines, 15% platy, subrounded to subangular, hard gravel. Low dry strength, rapid dilatancy and low toughness. Max. size, 3 in.. Strong reaction with HCl. In-place condition: very hard, layered, dry, medium reddish brown material with moderate cementation. Thin (1 in. thick) lenses of gravel scattered throughout interval. Lab test data from 6.0-14.0 ft.: 68% sand, 19% gravel, 13% fines; LL and PI not tested, Field Moisture = 3.2%. pH = 8.91, Resistivity = 1,670 ohm/cm. Lab classification is Silty Sand with Gravel (SM)g. **Geologic Interpretation:** Quaternary Alluvium	0	0	0

REMARKS: Surface: flat; scattered bushes; Chinle Formation outcrop located 600 ft. east. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-33**

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1871372 **E.** 853700 **GROUND ELEVATION:** 4671

APPROXIMATE DIMENSIONS: 15' x 7' x 5.5' DEEP **LOGGED BY:** B. PRUDHOM

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/12/2012 **DATE LOGGED:** 6/12/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SC) Visual Class.	**0.0 - 3.0 ft. Clayey Sand (SC):** About 70% predominantly fine to medium, subangular to angular sand, 25% fines with medium to high plasticity, medium to high toughness and high dry strength and 5% fine subangular to angular, soft to moderately soft sandstone and moderately hard chert gravel. Max. size, 20 mm. Strong reaction with HCl. In-place condition: hard, homogeneous, dry, moderate brown to medium reddish brown to pale reddish brown material with weak to moderate cementation. Lab test data from 0.0-3.0 ft.: 70% sand, 23% fines, 7% gravel; LL = 24%, PI = 5%, Field Moisture = 2.8%. pH = 8.91, Resistivity = 1,021 ohm/cm, Sulfates = 180 ppm, Sulfides = 6 ppm, Chlorides = 49 ppm. Lab classification is Silty, Clayey Sand (SC-SM). In-place density attempted at 3.0 ft., but material too hard to dig.	0	0	0
Lab sample taken from 0.0-3.0 ft. (SC-SM) Lab Class.				
3.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(Ss) Visual Class.	**3.0 - 5.5 ft. Sandstone (Ss):** Sandstone consists of predominantly fine to medium, subrounded to subangular sand in a weakly to moderately cemented fine sand and silt matrix; variably cemented with $CaCO_3$; indistinct bedding. Moderately soft and friable, fragments break with manual pressure, larger pieces require moderate hammer blow to break; slightly to moderately weathered. No to weak reaction with HCl. Color is brownish gray. Upon excavation with a backhoe, sandstone breaks up into angular, slabs 2 ft. and smaller in size.			
5.5 ft.	**Geologic Interpretation:** Chinle Formation, Shinarump Member			

REMARKS: Surface: flat with no vegetation. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-34

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1864680 **E.** 854232 **GROUND ELEVATION:** 4620

APPROXIMATE DIMENSIONS: 20' x 4' x 13.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/7/2012 **DATE LOGGED:** 6/7/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SC) Visual Class.	**0.0 - 1.5 ft. Clayey Sand (SC):** About 70% predominantly fine to coarse sand, 25% fines with low plasticity and 5% fine, subrounded gravel. Max. size 25 mm. Strong reaction with HCl. In-place condition: soft, homogeneous, dry, tan material with weak cementation.	0	0	0
1.5 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(Mdst) Visual Class. Lab sample taken from 1.5-13.0 ft. (CL)s Lab Class.	**1.5 - 13.0 ft. Mudstone (Mdst):** Mudstone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting mostly of clay. Moderately soft to moderately hard, edges of hand-size fragment break with manual pressure; thicker portion requires moderate hammer blow to break. No reaction with HCl. Color is medium gray. Upon excavation with a backhoe, mudstone breaks up into angular, hand-size and smaller chunks. Lab test data from 1.5-13.0 ft.: 76% fines, 23% sand, 1% gravel; LL = 42%, PI = 19%, Field Moisture = 11.9%. pH = 7.4, Resistivity = 436 ohm/cm, Sulfates = 3,500 ppm, Sulfides = < 1 ppm, Chlorides = 53 ppm. Lab classification is Lean Clay with Sand (CL)s. Note: material originated from mudstone.			
13.0 ft.	**Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: **S**urface: low rounded hills of claystone from the Chinle Formation located 100 ft. north. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-35

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1860140 **E.** 854023 **GROUND ELEVATION:** 4554

APPROXIMATE DIMENSIONS: 20' x 8' x 9.5' DEEP **LOGGED BY:** B. PRUDHOM

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/12/2012 **DATE LOGGED:** 6/12/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SC) Visual Class.	**0.0 - 6.0 ft. Clayey Sand (SC):** About 70% fine to medium sand, 30% fines with medium plasticity, medium to high toughness, no to slow dilatancy and medium dry strength and trace of fine, subangular gravel. Max. size 15 mm. Strong reaction with HCl. In-place condition: hard, homogeneous, dry, moderate brown material with moderate cementation.	0	0	0
Lab sample taken from 0.0-4.5 ft. (SC) Lab Class.	Lab test data from 0.0-4.5 ft.: 57% sand, 35% fines, 8% gravel; LL = 28%, PI = 17%, Field Moisture = 4.3%. pH = 8.86, Resistivity = 780 ohm/cm, Sulfates = 450 ppm, Sulfides = 6 ppm, Chlorides = 17 ppm. Lab classification is Clayey Sand (SC). In-place density of 113.1 lb/ft^3 taken at 4.5 ft. with sand cone apparatus.			
6.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(Mdst) Visual Class.	**6.0 - 9.5 ft. Mudstone (Mdst):** Mudstone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting mostly of clay; locally shaley. Moderately soft to moderately hard, edges of hand-size fragment break with manual pressure; thicker portion requires moderate hammer blow to break. No reaction with HCl. Color is grayish brown. Upon excavation with a backhoe, mudstone breaks up into angular, slabs 8 in. and smaller in size.			
9.5 ft.	**Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: Surface: flat with few bushes on loose sand and platy gravel; low rounded hills of claystone from the Chinle Formation located 100 ft. south. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-36

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1856088 **E.** 853962 **GROUND ELEVATION:** 4511

APPROXIMATE DIMENSIONS: 20' x 4' x 13.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/7/2012 **DATE LOGGED:** 6/7/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM) Visual Class.	**0.0 - 7.0 ft. Silty Sand (SM):** About 85% fine to coarse sand and 15% nonplastic fines. Medium dry strength, slow dilatancy, low toughness. Max. size, coarse sand. Moderate reaction with HCl. In-place condition: soft, homogenous, dry, medium brown material with weak cementation.	0	0	0
7.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(SP-SC) Visual Class.	**7.0 - 13.5 ft. Poorly Graded Sand with Clay (SP-SC):** About 90% predominantly fine to medium sand and 10% fines with medium plasticity, medium dry strength, no dilatancy and medium toughness. Max. size, medium sand. Strong reaction with HCl. In-place condition: very hard, layered, dry, medium brown material with strong cementation. Irregular, 1 in. thick layers of fine gravel occur throughout interval (seen in pit walls).	0	0	0
Lab sample taken from 7.0-13.5 ft. (SC) Lab Class.	Lab test data from 7.0-13.5 ft.: 65% sand, 28% fines, 7% gravel; LL = 33%, PI = 19%, Field Moisture = 6.1%. pH = 8.48, Resistivity = 742 ohm/cm, Sulfates = 2,100 ppm, Sulfides = < 1 ppm, Chlorides = 37 ppm. Lab classification is Clayey Sand (SC).			
13.5 ft.	**Geologic Interpretation:** Quaternary Alluvium			

REMARKS: **S**urface: flat area; Chinle outcrops located 300 ft. northeast. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-37

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: OLD U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1850071 **E.** 856145 **GROUND ELEVATION:** 4468

APPROXIMATE DIMENSIONS: 20' x 4' x 10.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/6/2012 **DATE LOGGED:** 6/6/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM) Visual Class.	**0.0 - 4.5 ft. Silty Sand (SM):** About 75% predominantly fine to medium sand, 20% nonplastic fines and 5% fine, subrounded to subangular, flat gravel. Max. size, 10 mm. Strong reaction with HCl. In-place condition: soft, layered, dry, brown material with weak cementation. Lab test data from 1.0-4.5 ft.: 75% sand, 23% fines, 2% gravel; LL = 33%, PI = 8%, Field Moisture = 3.6%. pH = 8, Resistivity = 742 ohm/cm, Sulfates = 1,300 ppm, Sulfides = < 1 ppm, Chlorides = 28 ppm. Lab classification is Silty Sand (SM). In-place density of 113.2 lb/ft^3 taken at 4.5 ft. with sand cone apparatus.	0	0	0
Lab sample taken from 1.0-4.5 ft. (SM) Lab Class.				
4.5 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(Ss) Visual Class.	**4.5 - 10.5 ft. Sandstone (Ss):** Sandstone consists of predominately fine sand variably cemented with silica; bedding spaced less than 1 to 3 in. apart. Moderately soft, breaks with manual pressure, but excavates slowly; slightly to moderately weathered, contains rust colored grains. No reaction with HCl. Color is very light gray. Upon excavation with a backhoe, sandstone breaks up into angular, hand-size and smaller chunks.			
10.5 ft.	**Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: Surface: flat area near small drainage. No vegetation. Cobbles and boulders (silica concretions) on surface. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated near refusal; backhoe leaking hydraulic fluid.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-38**

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: OLD U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1845472 **E.** 856398 **GROUND ELEVATION:** 4421.5

APPROXIMATE DIMENSIONS: 10' x 4' x 4.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/6/2012 **DATE LOGGED:** 6/6/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP) Visual Class.	**0.0 - 1.0 ft. Poorly Graded Sand (SP):** About 95% predominantly fine to medium sand and 5% nonplastic fines. Max. size, medium sand. Strong reaction with HCl. In-place condition: soft, homogeneous, dry, brown material with no cementation.	0	0	0
1.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(Ss) Visual Class. Lab sample taken from 1.0-4.0 ft. (SM) Lab Class.	**1.0 - 4.0 ft. Sandstone (Ss):** Sandstone consists of predominately fine sand variably cemented with silica; bedding spaced less than 1 to 3 in. apart. Moderately soft, breaks with manual pressure, but excavates very slowly; at 4.0 ft. becomes harder, hand size fragments require heavy hammer blow to break; slightly to moderately weathered, contains rust colored grains. No reaction with HCl. Color is very light gray. Upon excavation with a backhoe, sandstone breaks up into angular, hand-size and smaller chunks. Lab test data from 0.0-4.0 ft.: 71% sand, 28% fines, 1% gravel; Nonplastic, Field Moisture = 8.2%. pH = 7.73, Resistivity = 1,485 ohm/cm, Sulfates = 2,100 ppm, Sulfides = 2 ppm, Chlorides = 240 ppm. Lab classification is Silty Sand (SM). Note: material derived from sandstone.			
4.0 ft.	**Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: Surface: low rounded hills of white Chinle sandstone, many topped with petrified wood fragments. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-39**

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: OLD U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1838834 **E.** 855393 **GROUND ELEVATION:** 4394.5

APPROXIMATE DIMENSIONS: 20' x 4' x 7.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/6/2012 **DATE LOGGED:** 6/6/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SC) Visual Class. Lab sample taken from 0.0-3.5 ft. (SC) Lab Class. **3.5 ft.**	**0.0 - 3.5 ft. Clayey Sand (SC):** About 70% predominantly fine to coarse sand, 25% fines with low plasticity, slow dilatancy and low toughness and 5% fine gravel. Max. size, 10 mm. Strong reaction with HCl. In-place condition: firm, homogeneous, dry, brown material with no cementation. Lab test data from 0.0-3.5 ft.: 69% sand, 25% fines, 6% gravel; LL = 27%, PI = 11%, Field Moisture = 4.3%. pH = 7.89, Resistivity = 195 ohm/cm, Sulfates = 450 ppm, Sulfides = < 1 ppm, Chlorides = 260 ppm. Lab classification is Clayey Sand (SC). **Geologic Interpretation:** Quaternary Alluvium	0	0	0
(Ss) Visual Class. **7.5 ft.**	**3.5 - 7.5 ft. Sandstone (Ss):** Sandstone consists of predominately fine sand moderately cemented with silica; bedding spaced ½ to 2 in. apart. Moderately soft to moderately hard, edges break with manual pressure, larger pieces require moderate hammer blow to break; slightly to moderately weathered. No reaction with HCl. Color is light gray. Upon excavation with a backhoe, sandstone breaks up into angular, hand-size and smaller chunks. **Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: Surface: flat area south of drainage, white Chinle sandstone rounded hills west of highway. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-40

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: OLD U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1834203 **E.** 853922 **GROUND ELEVATION:** 4378

APPROXIMATE DIMENSIONS: 20' x 10' x 13.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/6/2012 **DATE LOGGED:** 6/6/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(CL) Visual Class. Lab sample taken from 0.0-5.0 ft. (CL) Lab Class. **5.0 ft.**	**0.0 - 5.0 ft. Lean Clay (CL):** About 90% fines with low to medium plasticity, low toughness and high dry strength and 10% predominantly fine sand. Max. size, fine sand. Strong reaction with HCl. In-place condition: very hard, homogeneous, moist, medium grayish brown material with moderate cementation. Lab test data from 0.0-5.0 ft.: 74% fines, 24% sand, 2% gravel; LL = 59%, PI = 40%, Field Moisture = 18.6%, Expansion Index = 137. pH = 8.85, Resistivity = 436 ohm/cm, Sulfates = 3,800 ppm, Sulfides = < 1 ppm, Chlorides = 2,300 ppm. Lab classification is Lean Clay (CL). In-place density of 72.9 lb/ft^3 taken at 4.0 ft. with sand cone apparatus. **Geologic Interpretation:** Quaternary Alluvium	0	0	0
(SP) Visual Class. **5.5 ft.**	**5.0 - 5.5 ft. Poorly Graded Sand (SP):** About 95% predominantly medium sand and 5% nonplastic fines.. Max. size, coarse sand. Strong reaction with HCl. In-place condition: hard, homogeneous, dry, brown material with weak cementation. **Geologic Interpretation:** Quaternary Alluvium	0	0	0
(Mdst) Visual Class. **13.0 ft.**	**5.5 - 13.0 ft. Mudstone (Mdst):** Mudstone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting mostly of clay. Moderately soft, hand-size fragment break with manual pressure; moderately weathered. Weak reaction with HCl. Color is medium brownish gray with yellowish brown mottling. Encountered a piece of petrified wood log at 9.5 ft. Upon excavation with a backhoe, mudstone breaks up into angular, hand-size and smaller chunks. **Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: Surface: low area, about 200-300 ft. north of Moenkopi Wash which has cut through mudstone and sandstone. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-41**

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1829414 **E.** 853563 **GROUND ELEVATION:** 4340

APPROXIMATE DIMENSIONS: 20' x 4' x 12.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/6/2012 **DATE LOGGED:** 6/6/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM) Visual Class.	**0.0 - 1.5 ft. Silty Sand (SM):** About 85% predominantly fine to coarse sand, 15% nonplastic fines and trace of fine, subrounded gravel (surface). Max. size, 15 mm. Strong reaction with HCl. In-place condition: firm, homogeneous, dry, brown material with weak cementation.	0	0	0
1.5 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(SC) Visual Class.	**1.5 - 3.0 ft. Clayey Sand (SC):** About 75% predominantly fine to coarse sand and 25% fines with low plasticity. Max. size, coarse sand. Strong reaction with HCl. In-place condition: soft, homogeneous, dry, reddish brown material with weak cementation.	0	0	0
3.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(Mdst) Visual Class. Lab sample taken from 3.0-8.0 ft. (CH) Lab Class.	**3.0 - 8.0 ft. Mudstone (Mdst):** Mudstone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting mostly of clay. Moderately hard, edges of hand-size fragment break with manual pressure; thicker portion requires moderate hammer blow to break. Weak reaction with HCl. Color is medium brownish gray. Upon excavation with a backhoe, mudstone breaks up into angular, hand-size and smaller chunks. Lab test data from 3.0-8.0 ft.: 91% fines, 9% sand, 0% gravel; LL and PI not tested; Field Moisture = 14.7%. pH = 7.09, Resistivity = 752 ohm/cm, Sulfates = 3,900 ppm, Sulfides = < 1 ppm, Chlorides = 720 ppm. Lab classification is Fat Clay (CH). Note material originated from mudstone.			
8.0 ft.	**Geologic Interpretation:** Chinle Formation, Petrified Forest Member			
(Ss) Visual Class.	**8.0 - 12.0 ft. Sandstone (Ss):** Sandstone consists of predominately medium sand weakly cemented with $CaCO_3$; bedding not apparent. Moderately soft, fragments break with manual pressure; intensely weathered, appears hydrothermally altered. Strong reaction with HCl. Color is yellowish greenish brown. Upon excavation with a backhoe, sandstone breaks up into angular, hand-size and smaller chunks.			
12.0 ft.	**Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: Surface: low area, about 200-300 ft. north of Moenkopi Wash which has cut through mudstone and sandstone. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-42

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1824402 **E.** 854270 **GROUND ELEVATION:** 4330

APPROXIMATE DIMENSIONS: 20' x 10' x 14.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/6/2012 **DATE LOGGED:** 6/6/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SC) Visual Class. **7.0 ft.**	**0.0 - 7.0 ft. Clayey Sand (SC):** About 80% predominantly very fine to fine sand and 20% fines with medium plasticity, very high dry strength and low toughness. Max. size, fine sand. Strong reaction with HCl. In-place condition: very soft, homogeneous, dry, tan material with weak cementation. In-place density of 93.5 lb/ft^3 taken at 5.0 ft. with sand cone apparatus. **Geologic Interpretation:** Quaternary Alluvium	0	0	0
(Clst) Visual Class. Lab sample taken from 7.0-14.5 ft. (SC) Lab Class. **14.5 ft.**	**7.0 - 14.5 ft. Clayey Sand (SC):** About 50% predominantly very fine to fine sand, 45% fines with medium plasticity, very high dry strength and low toughness and 5% fine gravel. Max. size, 10 mm. Strong reaction with HCl. In-place condition: hard, homogeneous, dry, tan material with weak cementation. Lab test data from 7.0-14.5 ft.: 49% sand, 47% fines, 4% gravel; LL = 28%, PI = 10%, Field Moisture = 5.9%. pH = 9.11, Resistivity = 1,392 ohm/cm, Sulfates = 36 ppm, Sulfides = 9 ppm, Chlorides = 38 ppm. Lab classification is Clayey Sand (SC). **Geologic Interpretation:** Quaternary Alluvium			

REMARKS: Surface: scattered bushes. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-43**

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1819698 **E.** 854955 **GROUND ELEVATION:** 4351

APPROXIMATE DIMENSIONS: 20' x 4' x 7.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/6/2012 **DATE LOGGED:** 6/6/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SC) Visual Class. Lab sample taken from 0.0-6.0 ft. (SC-SM) Lab Class. **6.0 ft.**	**0.0 - 6.0 ft. Clayey Sand (SC):** About 80% predominantly fine to medium sand, 20% fines with medium plasticity and trace of fine, subrounded to subangular gravel. Max. size 15 mm. Strong reaction with HCl. In-place condition: firm to hard, homogeneous, dry, medium brown material with weak to moderate cementation. Lab test data from 0.0-6.0 ft.: 42% fines, 57% sand, 1% gravel; LL = 25%, PI = 7%, Field Moisture = 5.0%. pH = 8.95, Resistivity = 566 ohm/cm, Sulfates = 97 ppm, Sulfides = 2 ppm, Chlorides = 200 ppm. Lab classification is Silty, Clayey Sand (SC-SM). **Geologic Interpretation:** Quaternary Alluvium	0	0	0
(Mdst) Visual Class. **13.0 ft.**	**6.0 - 13.0 ft. Mudstone (Mdst):** Mudstone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting mostly of clay. Moderately soft to moderately hard, edges of hand-size fragment break with manual pressure; thicker portion requires moderate hammer blow to break, from 1.8 – 3.5 ft. mudstone is soft to moderately soft. No reaction with HCl. Color is grayish red purple with light greenish gray spots and mottling. Mudstone layers are 1-2 in. thick. Upon excavation with a backhoe, mudstone breaks up into angular, hand-size and smaller chunks. **Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: Surface: low area with no drainage outlet, scattered bushes; mudstone from the Chinle Formation located south and north. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-44**

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1813749 **E.** 854273 **GROUND ELEVATION:** 4333.5

APPROXIMATE DIMENSIONS: 20' x 4' x 8.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/5/2012 **DATE LOGGED:** 6/5/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM) Visual Class.	**0.0 - 0.8 ft. Silty Sand (SM):** About 80% predominantly medium to coarse sand, 20% nonplastic fines and a trace of predominantly fine, hard gravel. Max. size 25 mm. Strong reaction with HCl. In-place condition: soft, homogeneous, dry, tan material with no cementation.	0	0	0
0.8 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(Mdst/Ss) Visual Class. Lab sample taken from 0.8-8.5 ft. (SC-SM) Lab Class.	**0.8 - 8.5 ft. Mudstone (Mdst) with Interbedded Sandstone (Ss):** Mudstone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting mostly of clay. From 0.8-4.0 ft. moderately soft to moderately hard and moderately weathered, edges of hand-size fragment break with manual pressure, thicker portion requires moderate hammer blow to break; from 4.0-8.5 ft. moderately hard and slightly weathered. No reaction with HCl. Color is dark brown. Mudstone layers are 1-4 in. thick. Sandstone interbeds are less than 1 to 2 in. thick and consist of predominately fine sand moderately cemented with $CaCo_3$. Sandstone is moderately soft to moderately hard, fragments break with manual pressure. Weak to strong reaction with HCl. Color is medium gray. Concentration of sandstone lenses is greater in the upper half (0.8-4.0 ft.) of pit. Upon excavation with a backhoe, mudstone and sandstone break up into angular, hand-size and smaller chunks. Lab test data from 0.8-8.5 ft.: 57% sand, 42% fines, 1% gravel; LL = 24%, PI = 5%, Field Moisture = 7.2%. pH = 9.44, Resistivity = 742 ohm/cm, Sulfates = 110 ppm, Sulfides = 2 ppm, Chlorides = 700 ppm. Lab classification is Silty, Clayey Sand (SC-SM). Note: material originated from mudstone.			
8.5 ft.	**Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: Surface: scattered bushes on loose sand; low rounded hills of claystone from the Chinle Formation located east beyond the highway ROW. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-45**

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1809488 **E.** 854273 **GROUND ELEVATION:** 4309

APPROXIMATE DIMENSIONS: 20' x 4' x 13.4' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/5/2012 **DATE LOGGED:** 6/5/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP-SM) Visual Class. **1.0 ft.**	**0.0 - 1.0 ft. Poorly Graded Sand with Silt (SP-SM):** About 90% predominantly medium to coarse sand and 10% nonplastic fines and trace of predominantly fine, hard gravel. Max. size 25 mm. Strong reaction with HCl. **Geologic Interpretation:** Quaternary Alluvium	0	0	0
(Mdst/Slst) Visual Class. **4.5 ft.**	**1.0 - 4.5 ft. Mudstone (Mdst) with Interbedded Siltstone (Slst):** Mudstone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting mostly of clay. Moderately soft to moderately hard, edges of hand-size fragment break with manual pressure; thicker portion requires moderate hammer blow to break. No reaction with HCl. Color is mottled dark brownish gray. Mudstone layers are 1-5 in. thick. Siltstone interbeds are less than 1 to 2 in. thick and consist of moderately indurated silt. Moderately soft, fragments break with manual pressure. Weak reaction with HCl on carbonate grains. Color is very light green. Upon excavation with a backhoe, mudstone and siltstone breaks up into angular, hand-size and smaller chunks. **Geologic Interpretation:** Chinle Formation, Petrified Forest Member			
(Mdst) Visual Class. Lab sample taken from 4.5-13.4 ft. (CL)s Lab Class. **13.4 ft.**	**4.5 - 13.4 ft. Mudstone (Mdst):** Mudstone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting of approximately 60% clay, 40% fine sand and a trace of lenticular gravel up to 10 mm long. Moderately soft to moderately hard, fragments break with manual pressure, thicker portion requires moderate hammer blow to break, moderately weathered. No reaction with HCl. Color is medium brownish gray. Upon excavation with a backhoe, mudstone breaks up into angular, hand-size and smaller chunks. Lab test data from 4.5-13.4 ft.: 72% fines, 28% sand, 0% gravel; LL and PI not tested, Field Moisture = 12.2%. pH = 8.22, Resistivity = 306 ohm/cm, Sulfates = 75 ppm, Sulfides = 3 ppm, Chlorides = 450 ppm. Lab classification is Lean Clay with Sand (CL)s. Note: material originated from mudstone. **Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: Surface: scattered bushes. Chinle Formation outcrop east outside of ROW. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-46**

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1803445 **E.** 853625 **GROUND ELEVATION:** 4296

APPROXIMATE DIMENSIONS: 20' x 4' x 8.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/5/2012 **DATE LOGGED:** 6/5/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(Mdst) Visual Class.	**0.0 - 8.0 ft. Mudstone (Mdst) with Interbedded Sandstone (Ss):** Mudstone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting mostly of clay. Moderately soft to moderately hard, edges of hand-size fragment break with manual pressure; thicker portion requires moderate hammer blow to break, from 0.0-0.8 ft. mudstone is moderately soft. No reaction with HCl. Color is medium gray with light greenish gray spots and mottling. Mudstone layers are 1-5 in. thick. Sandstone interbeds are less than 1 to 3 in. thick and consist of predominately fine to medium sand moderately cemented with $CaCo_3$. Sandstone is moderately soft, fragments break with manual pressure. Weak reaction with HCl. Color is very light gray.	0	0	0
Lab sample taken from 0.0-8.0 ft. (CL) Lab Class.	From 0.8-1.3 ft. Sandstone layer composed of predominately fine sand cemented with silica; crystalline Sandstone is hard to very hard, requires heavy hammer blow to break; slightly weathered. No reaction with HCl. Color is very light gray. Upon excavation with a backhoe, mudstone and sandstone break up into angular, hand-size and smaller chunks. Lab test data from 0.0-8.0 ft.: 54% fines, 28% sand, 18% gravel; LL = 41%, PI = 15%, Field Moisture = 7.9%, Expansion Index = 40. pH = 8.35, Resistivity = 807 ohm/cm, Sulfates = 1,500 ppm, Sulfides = < 1 ppm, Chlorides = 620 ppm. Lab classification is Lean Clay (CL). Note: material originated from mudstone.			
8.0 ft.	**Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: **S**urface: scattered bushes. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-47

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1798627 **E.** 853115 **GROUND ELEVATION:** 4254

APPROXIMATE DIMENSIONS: 20' x 4' x 13.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/5/2012 **DATE LOGGED:** 6/5/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken))	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP-SM)b Visual Class. Lab sample taken from 0.0-8.0 ft. (SM) Lab Class. **8.0 ft.**	**0.0 - 8.0 ft. Poorly Graded Sand with Silt and Trace of Boulders (SP-SM)b:** About 80% predominantly medium to coarse sand, 10% nonplastic fines and 10% predominantly fine, hard gravel. Max. size, 25 mm. Strong reaction with HCl. Total sample (by volume): Trace of plus 12 in. hard, subangular boulders; remainder minus 3 in.; maximum size, 1.2 ft. In-place condition: soft to firm, homogeneous, dry, tan material with weak cementation. Gravel layer from 5.0-5.5 ft. Lab test data from 0.0-8.0 ft.: 79% sand, 15% fines, 6% gravel; LL and PI not tested, Field Moisture = 2.4%. pH = 9.42, Resistivity = 733 ohm/cm, Sulfates = 300 ppm, Sulfides = < 1 ppm, Chlorides = 83 ppm. Lab classification is Silty Sand (SM). **Geologic Interpretation:** Quaternary Alluvium	0	0	T
(Mdst) Visual Class. **13.5 ft.**	**8.0 - 13.5 ft. Mudstone (Mdst):** Mudstone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting of approximately 60% clay, 40% fine sand and a trace of lenticular gravel up to 10 mm long. Moderately soft, fragments break with manual pressure, thicker portion requires moderate hammer blow to break, moderately weathered. Strong reaction with HCl. Color is medium gray. Upon excavation with a backhoe, mudstone breaks up into angular, hand-size and smaller chunks. **Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: Surface: scattered bushes on loose sand. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-48

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: U.S. HIGHWAY 89 **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1792253 **E.** 852467 **GROUND ELEVATION:** 4222.5

APPROXIMATE DIMENSIONS: 20' x 4' x 7.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/5/2012 **DATE LOGGED:** 6/5/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SC) Visual Class.	**0.0 - 1.8 ft. Clayey Sand (SC):** About 70% predominantly fine to coarse sand, 30% fines with low plasticity and trace of fine, subrounded gravel. Max. size, 25 mm. Strong reaction with HCl. In-place condition: soft, homogeneous, dry, tan material with weak cementation.	0	0	0
1.8 ft.	**Geologic Interpretation:** Quaternary Alluvium			
(Mdst/Ss) Visual Class.	**1.8 - 7.5 ft. Mudstone (Mdst) with Interbedded Sandstone (Ss):** Mudstone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting mostly of clay. Moderately soft to moderately hard, edges of hand-size fragment break with manual pressure; thicker portion requires moderate hammer blow to break, from 1.8-3.5 ft. mudstone is soft to moderately soft. No reaction with HCl. Color is grayish red purple with light greenish gray spots and mottling. Mudstone layers are 1-2 in. thick. Sandstone interbeds are less than 1 to 2 in. thick and consist of predominately fine to medium sand moderately cemented with $CaCo_3$. Sandstone is moderately soft, fragments break with manual pressure. Concentration of sandstone lenses is greater in the upper half (1.8-3.8 ft.) of pit. Weak reaction with HCl. Color is very light gray. Upon excavation with a backhoe, mudstone and sandstone break up into angular, hand-size and smaller chunks.			
Lab sample taken from 1.8-7.5 ft. s(CL) Lab Class.	Lab test data from 1.8-7.5 ft.: 51% fines, 46% sand, 3% gravel; LL and PI not tested, Field Moisture = 10.0%, Expansion Index = 20. pH = 8.15, Resistivity = 1,021 ohm/cm, Sulfates = 2,100 ppm, Sulfides = < 1 ppm, Chlorides = 390 ppm. Lab classification is Sandy Lean Clay s(CL). Note: material originated from mudstone.			
7.5 ft.	**Geologic Interpretation:** Chinle Formation, Petrified Forest Member			

REMARKS: Surface: scattered bushes on loose sand; low rounded hills of mudstone from the Chinle Formation located east beyond the highway ROW. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-49**

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: COPPER MINE ROAD **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1932123 **E.** 841355 **GROUND ELEVATION:** 5440

APPROXIMATE DIMENSIONS: 14' x 4' x 7.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/18/2012 **DATE LOGGED:** 6/18/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP) Visual Class. Lab sample taken from 0.0-3.2 ft. (SP-SM) Lab Class **3.2 ft.**	**0.0 - 3.2 ft. Poorly Graded Sand (SP):** About 100% predominantly fine to medium sand and a trace of nonplastic fines. Low dry strength, rapid dilatancy and low toughness. Max. size, medium sand. No reaction with HCl. In-place condition: very soft to soft, homogenous, dry, light reddish brown material with no cementation. Lab test data from 0.0-3.2 ft.: 91% sand, 9% fines, 0% gravel; LL and PI not tested, Field Moisture = 1.1%. pH = 8.9, Resistivity = 6,125 ohm/cm, Sulfates = 3 ppm, Sulfides = < 1 ppm, Chlorides = 7 ppm. Lab classification is Poorly Graded Sand with Silt (SP-SM). **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
(Ss) Visual Class. **7.0 ft.**	**3.2 - 7.0 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand moderately cemented with iron oxide and silica; crossbedded, beds are 1/2 to 2 in. thick. Moderately soft to moderately hard, edges of hand-size fragment break with manual pressure, thicker portions require moderate hammer blow to break; moderately weathered. No reaction with HCl, except on $CaCO_3$ coating fractures from 3.2-5.2 ft. Color is light reddish brown. Upon excavation with a backhoe, the sandstone breaks up into platy fragments 6 in. in size and smaller. **Geologic Interpretation:** Navajo Sandstone Formation			

REMARKS: **S**urface: top of small dune, loose sand with scattered Mormon Tea. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-50**

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: COPPER MINE ROAD **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1943021 **E.** 843301 **GROUND ELEVATION:** 5450

APPROXIMATE DIMENSIONS: 10' x 4' x 5.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/18/2012 **DATE LOGGED:** 6/18/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM) Visual Class. Lab sample taken from 0.0-5.0 ft. (SM) Lab Class **5.0 ft.**	**0.0 - 5.0 ft. Silty Sand (SM):** About 85% predominantly fine to medium sand, 15% nonplastic fines and a trace of fine gravel at about 5.0 ft. Low dry strength, rapid dilatancy and low toughness. Max. size, 2 in. Strong reaction with HCl. In-place condition: very soft to soft, homogenous, dry, light reddish brown material with no cementation. Lab test data from 0.0-5.0 ft.: 87% sand, 13% fines, 0% gravel; LL and PI not tested, Field Moisture = 1.4%. pH = 8.34, Resistivity = 8,816 ohm/cm, Sulfates = 2 ppm, Sulfides = < 1 ppm, Chlorides = 7 ppm. Lab classification is Silty Sand (SM). **Geologic Interpretation:** QuaternaryEluvium (wind-blown sand)	0	0	0
(Ss) Visual Class. **5.0 ft.**	**5.0 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand moderately cemented with silica; crossbedded, beds are 1/2 to 2 in. thick. Moderately hard, edges of hand-size fragment break with manual pressure; thicker portions require moderate hammer blow to break; moderately weathered, 2 mm rust spots apparent. No reaction with HCl. Color is very pale orange. Backhoe only grooved surface of sandstone, could not excavate. **Geologic Interpretation:** Navajo Sandstone Formation			

REMARKS: Surface: flat loose sand with scattered grass clumps. Sandstone outcrop about 200 ft. north; land surface drops off 5-10 ft. to the west. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-51

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: COPPER MINE ROAD **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1952941 **E.** 845453 **GROUND ELEVATION:** 5448.5

APPROXIMATE DIMENSIONS: 20' x 4' x 13.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/18/2012 **DATE LOGGED:** 6/18/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP) Visual Class. **4.5 ft.**	**0.0 - 4.5 ft. Poorly Graded Sand (SP):** About 95% predominantly fine sand, 5% nonplastic fines and a trace of fine subrounded to rounded gravel. Low dry strength, rapid dilatancy and low toughness. Max. size, 15 mm. Strong reaction with HCl. In-place condition: soft, homogenous, dry, light brown material with weak cementation. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
(CL) Visual Class. Lab sample taken from 4.5-6.5 ft. s(CL) Lab Class. **6.5 ft.**	**4.5 - 6.5 ft. Lean Clay (CL):** About 90% fines with medium plasticity, medium toughness and high dry strength and 10% predominantly fine sand. Max. size fine sand. Strong reaction with HCl. In-place condition: very hard, homogeneous, slightly moist, medium light gray material with strong cementation. Lab test data from 4.5-6.5 ft.: 61% fines, 39% sand, 0% gravel; LL = 33%, PI = 18%, Field Moisture = 13.5%. pH = 8.84, Resistivity = 817 ohm/cm, Sulfates = 100 ppm, Sulfides = < 1 ppm, Chlorides = 143 ppm. Lab classification is Sandy Lean Clay s(CL). **Geologic Interpretation:** Quaternary Eluvium	0	0	0
(SP) Visual Class. **10.4 ft.**	**6.5 - 10.4 ft. Poorly Graded Sand (SP):** About 95% predominantly fine sand and 5% nonplastic fines. Low dry strength, rapid dilatancy and low toughness. Max. size, fine sand. Strong reaction with HCl. From 6.5-8.0 ft. color is light gray, from 8.0 to 10.4 ft. color is white. In-place condition: soft, homogenous, dry material with weak cementation. **Geologic Interpretation:** Quaternary Eluvium	0	0	0
(Ss) Visual Class. **13.0 ft.**	**10.4 - 13.0 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand weakly cemented with silica; crossbedded, beds are 1/2 to 2 in. thick. Soft to moderately soft, fragment break with manual pressure. No reaction with HCl. Color is very pale orange. Upon excavation with a backhoe, the sandstone breaks up into platy fragments 10 in. in size and smaller. **Geologic Interpretation:** Navajo Sandstone Formation			

REMARKS: Surface: flat with scattered grass and Mormon Tea. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-52

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: COPPER MINE ROAD **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1958219 **E.** 846142 **GROUND ELEVATION:** 5454

APPROXIMATE DIMENSIONS: 15' x 4' x 7.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/18/2012 **DATE LOGGED:** 6/18/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP) Visual Class.	**0.0 - 2.0 ft. Poorly Graded Sand (SP):** About 95% predominantly fine sand and 5% nonplastic fines. Low dry strength, rapid dilatancy and low toughness. Max. size, fine sand. No reaction with HCl. In-place condition: soft, homogenous, dry, light brown material with weak cementation.	0	0	0
2.0 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
(SP)g Visual Class. Lab sample taken from 2.0-3.8 ft. (SP) Lab Class.	**2.0 - 3.8 ft. Poorly Graded Sand with Gravel (SP)g:** About 75% predominantly fine sand, 20% fine to coarse gravel in the form of platy, angular sandstone fragments and 5% nonplastic fines. Low dry strength, rapid dilatancy and low toughness. Max. size, 3 in. No reaction with HCl. In-place condition: soft, homogenous, dry, very pale orange material with weak cementation. Lab test data from 2.0-3.8 ft.: 96% sand, 4% fines, 0% gravel; LL and PI not tested, Field Moisture = 0.6%. pH = 8.82, Resistivity = 9,187 ohm/cm, Sulfates = 6 ppm, Sulfides = < 1 ppm, Chlorides = 8 ppm. Lab classification is Poorly Graded Sand (SP).			
3.8 ft.	**Geologic Interpretation:** Quaternary Eluvium (weathered sandstone)			
(Ss) Visual Class.	**3.8 - 7.0 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand weakly cemented with silica; crossbedded, beds are 1/2 to 2 in. thick. Soft to moderately soft, fragment break with manual pressure. No reaction with HCl. Color is very pale orange. Upon excavation with a backhoe, the sandstone breaks up into platy fragments 4 in. in size and smaller.			
7.0 ft.	**Geologic Interpretation:** Navajo Sandstone Formation			

REMARKS: **S**urface: furrowed sand dunes with scattered grass and Mormon Tea. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-53**

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: COPPER MINE ROAD **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1964315 **E.** 846472 **GROUND ELEVATION:** 5457

APPROXIMATE DIMENSIONS: 15' x 4' x 8.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/18/2012 **DATE LOGGED:** 6/18/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP) Visual Class. **3.0 ft.**	**0.0 - 3.0 ft. Poorly Graded Sand (SP):** About 95% predominantly fine sand and 5% nonplastic fines. Low dry strength, rapid dilatancy and low toughness. Max. size, fine sand. No reaction with HCl. In-place condition: soft, homogenous, dry, brown grading with depth to tan material with weak cementation. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
(SP)g Visual Class. **3.5 ft.**	**3.0 - 3.5 ft. Poorly Graded Sand with Gravel (SP)g:** About 80% predominantly fine sand and 20% fine to coarse gravel in the form of platy, angular sandstone fragments. Low dry strength, rapid dilatancy and low toughness. Max. size, 3 in. No reaction with HCl. In-place condition: soft, homogenous, dry, very pale orange material with weak cementation. **Geologic Interpretation:** Quaternary Eluvium (weathered sandstone)	0	0	0
(Ss) Visual Class. **8.0 ft.**	**3.5 - 8.0 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand moderately cemented with silica; crossbedded, beds are 1/8 to 3 in. thick. Moderately hard, edges of hand-size fragment break with manual pressure; thicker portions require moderate hammer blow to break. No reaction with HCl. Color is very pale orange. Upon excavation with a backhoe, the sandstone breaks up into platy fragments 4 in. in size and smaller. **Geologic Interpretation:** Navajo Sandstone Formation			

REMARKS: Surface: furrowed sand dunes with scattered grass and Mormon Tea. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-54

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: COPPER MINE ROAD **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1968137 **E.** 845058 **GROUND ELEVATION:** 5466

APPROXIMATE DIMENSIONS: 15' x 4' x 6.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/18/2012 **DATE LOGGED:** 6/18/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP) Visual Class.	**0.0 - 2.4 ft. Poorly Graded Sand (SP):** About 95% predominantly fine sand and 5% nonplastic fines. Low dry strength, rapid dilatancy and low toughness. Max. size, fine sand. No reaction with HCl. In-place condition: soft, homogenous, dry, grayish brown material with weak cementation.	0	0	0
2.4 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
(Ss) Visual Class.	**2.4 - 6.5 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand moderately cemented with silicaand iron oxide; crossbedded, beds are 1/8 to 3 in. thick. Moderately hard, edges of hand-size fragment break with manual pressure; thicker portions require moderate hammer blow to break. No reaction with HCl. Color is light gray to yellowish gray (due to limonite staining). Upon excavation with a backhoe, the sandstone breaks up into platy fragments 8 in. in size and smaller.			
6.5 ft.	**Geologic Interpretation:** Navajo Sandstone Formation			

REMARKS: **S**urface: flat; scattered grass and Mormon Tea; sandstone outcrops in roadway located about 70 ft. east. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-55

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: COPPER MINE ROAD **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1987294 **E.** 845104 **GROUND ELEVATION:** 5559

APPROXIMATE DIMENSIONS: 20' x 4' x 14.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/18/2012 **DATE LOGGED:** 6/18/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP) Visual Class. **5.0 ft.**	**0.0 - 5.0 ft. Poorly Graded Sand (SP):** About 95% predominantly fine to medium sand and 5% nonplastic fines. Low dry strength, rapid dilatancy and low toughness. Max. size, medium sand. No reaction with HCl except at 3.0 and 5.0 ft. where CaCO3 forms diffuse layers about 3-5 in. thick.. Color is light brown from 0.0 to 3.0 ft. and tan from 3.0 to 5.0 ft. In-place condition: soft, homogenous, dry material with weak cementation. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
(SP) Visual Class. Lab sample taken from 5.0-14.5 ft. (SP) Lab Class. **14.5 ft.**	**5.0 - 14.5 ft. Poorly Graded Sand (SP):** About 100% fine sand with a trace of nonplastic fines. Low dry strength, rapid dilatancy and low toughness. Max. size, fine sand. No reaction with HCl. In-place condition: soft at top grading to very hard at the bottom of the interval, homogenous, dry, grayish orange material with weak cementation. Lab test data from 5.0-14.5 ft.: 93% sand, 3% fines, 4% gravel; LL and PI not tested, Field Moisture = 1.1%. pH = 9.09, Resistivity = 2,877 ohm/cm, Sulfates = 23 ppm, Sulfides = < 1 ppm, Chlorides = 36 ppm. Lab classification is Poorly Graded Sand (SP). **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0

REMARKS: Surface: loose sand with scattered bushes. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-56

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: COPPER MINE ROAD **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1995421 **E.** 847673 **GROUND ELEVATION:** 5605.5

APPROXIMATE DIMENSIONS: 20' x 4' x 14.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/18/2012 **DATE LOGGED:** 6/18/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP) Visual Class.	**0.0 - 15.0 ft. Poorly Graded Sand (SP):** About 95% predominantly fine to medium sand and 5% nonplastic fines. Low dry strength, rapid dilatancy and low toughness. Max. size, medium sand. No reaction with HCl, except from 1.7 to 2.3 ft., where CaCO3 forms a diffuse layer. Color is light brown from 0.0 to 1.7 ft. and tan from 1.7 to 2.7 ft.	0	0	0
Lab sample taken from 2.7-15.0 ft.	In-place condition: soft, homogenous, dry, light brown material from 0.0 to 2.7 ft., very pale orange from 2.7 to 15.0 ft, weak cementation.			
(SP-SM) Lab Class.	Lab test data from 2.7-15.0 ft.: 93% sand, 7% fines, 0% gravel; LL and PI not tested, Field Moisture = 1.1%. pH = 8.39, Resistivity = 2,320 ohm/cm, Sulfates = 38 ppm, Sulfides = < 1 ppm, Chlorides = 55 ppm. Lab classification is Poorly Graded Sand with Silt (SP-SM).			
15.0 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			

REMARKS: Surface: loose sand with scattered bushes. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-57

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: COPPER MINE ROAD **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 2043381 **E.** 841242 **GROUND ELEVATION:** 5956

APPROXIMATE DIMENSIONS: 20' x 12' x 10.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/19/2012 **DATE LOGGED:** 6/19/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP) Visual Class. Lab sample taken from 0.0-10.0 ft. (SP-SM) Lab Class **10.0 ft.**	**0.0 - 10.0 ft. Poorly Graded Sand (SP):** About 95% predominantly fine sand and 5% nonplastic fines. Low dry strength, rapid dilatancy and low toughness. Max. size, fine sand. No reaction with HCl. In-place condition: very soft, homogenous, dry, tan material with no cementation. Lab test data from 0.0-10.0 ft.: 94% sand, 6% fines, 0% gravel; LL and PI not tested, Field Moisture = 1.4%. pH = 8.84, Resistivity = 13,920 ohm/cm, Sulfates = 1 ppm, Sulfides = < 1 ppm, Chlorides = 7 ppm. Lab classification is Poorly Graded Sand with Silt (SP-SM). **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
(Ss) Visual Class. **10.0 ft.**	**10.0 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand moderately cemented with silica; crossbedded, beds are 1/2 to 2 in. thick. Hard, fragments require moderate to heavy hammer blow to break; slightly weathered. No reaction with HCl. Color is very pale orange. Backhoe only grooved surface of sandstone, could not excavate. **Geologic Interpretation:** Navajo Sandstone Formation			

REMARKS: **S**urface: low area with scattered shrubs; cobbles and boulders up to 2 ft. diameter on surface. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal; pit walls caving.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-58

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: COPPER MINE ROAD **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 2050224 **E.** 838884 **GROUND ELEVATION:** 5993

APPROXIMATE DIMENSIONS: 20' x 10' x 13.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/19/2012 **DATE LOGGED:** 6/19/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP) Visual Class.	**0.0 - 13.0 ft. Poorly Graded Sand (SP):** About 95% predominantly fine sand and 5% nonplastic fines. Low dry strength, rapid dilatancy and low toughness. Max. size, fine sand. No reaction with HCl. In-place condition: very soft, homogenous, dry, tan material with no cementation. Lab test data from 0.0-13.0 ft.: 96% sand, 4% fines, 0% gravel; LL and PI not tested, Field Moisture = 0.5%. pH = 9.2, Resistivity = 16,704 ohm/cm, Sulfates = 4 ppm, Sulfides = < 1 ppm, Chlorides = 11 ppm. Lab classification is Poorly Graded Sand with Silt (SP-SM). In-place density of 101.6 lb/ft^3 taken at 4.5 ft. with sand cone apparatus.	0	0	0
Lab sample taken from 0.0-13.0 ft. (SP-SM) Lab Class				
13.0 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			

REMARKS: Surface: flat with scattered shrubs; sandstone outcrop about 350 ft. east across road. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at reach of equipment; pit walls caving.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-59

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: COPPER MINE ROAD **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 2057408 **E.** 840426 **GROUND ELEVATION:** 5892

APPROXIMATE DIMENSIONS: 10' x 4' x 5.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/19/2012 **DATE LOGGED:** 6/19/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP) Visual Class. Lab sample taken from 0.0-5.5 ft. (SM) Lab Class **5.5 ft.**	**0.0 - 5.5 ft. Poorly Graded Sand (SP):** About 95% predominantly fine sand, 5% nonplastic fines and a trace of fine gravel. Low dry strength, rapid dilatancy and low toughness. Max. size, 1 in. No reaction with HCl. In-place condition: very soft, homogenous, dry, light brown material with weak cementation. Lab test data from 0.0-5.5 ft.: 88% sand, 12% fines, 0% gravel; LL and PI not tested, Field Moisture = 0.7%. pH = 8.0, Resistivity = 12,992 ohm/cm, Sulfates = 1 ppm, Sulfides = < 1 ppm, Chlorides = 7 ppm. Lab classification is Silty Sand (SM). **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
(Ss) Visual Class. **5.5 ft.**	**5.5 ft. Sandstone (Ss):** Unable to retrieve sample; description taken from nearby outcrops. Sandstone consists of predominately fine, subrounded sand moderately cemented with silica; crossbedded, beds are 1/2 to 2 in. thick. Hard, fragments require moderate to heavy hammer blow to break; slightly weathered. No reaction with HCl. Color is very pale orange. Backhoe only grooved surface of sandstone, could not excavate. **Geologic Interpretation:** Navajo Sandstone Formation			

REMARKS: **S**urface: gently sloping east toward road; loose sand with scattered shrubs; sandstone outcrop about 200 ft. east across road. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-60

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: COPPER MINE ROAD **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 2063729 **E.** 839298 **GROUND ELEVATION:** 5871

APPROXIMATE DIMENSIONS: 10' x 4' x 6.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/19/2012 **DATE LOGGED:** 6/19/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP) Visual Class. Lab sample taken from 0.0-6.5 ft. (SP) Lab Class **6.5 ft.**	**0.0 - 6.5 ft. Poorly Graded Sand (SP):** About 95% predominantly fine sand, 5% nonplastic fines and a trace of fine gravel. Low dry strength, rapid dilatancy and low toughness. Max. size, 1 in. No reaction with HCl. In-place condition: very soft, homogenous, dry, light brown material with weak cementation. Lab test data from 0.0-6.5 ft.: 96% sand, 4% fines, 0% gravel; LL and PI not tested, Field Moisture = 0.4%. pH = 9.13, Resistivity = 16,704 ohm/cm, Sulfates = 3 ppm, Sulfides = < 1 ppm, Chlorides = 7 ppm. Lab classification is Poorly Graded Sand (SP). **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
(Ss) Visual Class. **6.5 ft.**	**6.5 ft. Sandstone (Ss):** Unable to retrieve sample; description taken from nearby outcrops. Sandstone consists of predominately fine, subrounded sand moderately cemented with silica; crossbedded, beds ½ to 3 in. thick. Hard, fragments require moderate to heavy hammer blow to break; slightly weathered. No reaction with HCl. Color is very pale orange. Backhoe only grooved surface of sandstone, could not excavate. **Geologic Interpretation:** Navajo Sandstone Formation			

REMARKS: **S**urface: low area with scattered bushes; sandstone outcrops about 200 ft. east and northeast of pit. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-61**

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: COPPER MINE ROAD **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 2068954 **E.** 838733 **GROUND ELEVATION:** 5872

APPROXIMATE DIMENSIONS: 15' x 4' x 7.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/19/2012 **DATE LOGGED:** 6/19/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP)cb Visual Class. Lab sample taken from 0.0-3.5 ft. (SP-SM) Lab Class **3.5 ft.**	**0.0 - 3.5 ft. Poorly Graded Sand with Cobbles and Boulders (SP)cb:** About 85% predominantly fine sand, 10% fine to coarse gravel in the form of platy, angular sandstone fragments and 5% nonplastic fines. Low dry strength, rapid dilatancy and low toughness. Max. size, 1 in. No reaction with HCl. Total sample (by volume): About 10% 3 to 5 in. platy, moderately hard sandstone cobbles; about 5% 5 to 12 in. blocky, moderately hard sandstone cobbles; about 5% plus 12 in. blocky, moderately hard sandstone boulders; remainder minus 3 in.; maximum size, 1.5 ft. In-place condition: soft grading to hard with depth, homogenous, dry, light brown material with weak cementation. Lab test data from 0.0-3.5 ft.: 91% sand, 7% fines, 2% gravel; LL and PI not tested, Field Moisture = 0.6%. pH = 8.92, Resistivity = 13,920 ohm/cm, Sulfates = 3 ppm, Sulfides = < 1 ppm, Chlorides = 7 ppm. Lab classification is Poorly Graded Sand with Silt (SP-SM). **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand and in-place weathering of sandstone)	10	5	5
(Ss) Visual Class. **7.0 ft.**	**3.5 - 7.0 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand moderately cemented with silica; crossbedded, beds ½ to 3 in. thick. Hard, fragments require moderate to heavy hammer blow to break; slightly weathered. No reaction with HCl. Color is very pale orange. Backhoe excavated upper jointed portion, but encountered sandstone surface that could not even groove. **Geologic Interpretation:** Navajo Sandstone Formation			

REMARKS: Surface: gently dipping to north; loose sand with scattered bushes. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-62

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: COPPER MINE ROAD **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 2074220 **E.** 838226 **GROUND ELEVATION:** 5806

APPROXIMATE DIMENSIONS: 20' x 10' x 6.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/19/2012 **DATE LOGGED:** 6/19/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP) Visual Class. Lab sample taken from 0.0-5.5 ft. (SP-SM) Lab Class **5.5 ft.**	**0.0 - 5.5 ft. Poorly Graded Sand (SP):** About 95% predominantly fine sand and 5% nonplastic fines. Low dry strength, rapid dilatancy and low toughness. Max. size, fine sand. No reaction with HCl. In-place condition: very soft to soft, homogenous, dry, light brown material with weak cementation. Lab test data from 0.0-5.5 ft.: 94% sand, 6% fines, 0% gravel; LL and PI not tested, Field Moisture = 0.4%. pH = 7.88, Resistivity = 12,992 ohm/cm, Sulfates = 1 ppm, Sulfides = 2 ppm, Chlorides = 14 ppm. Lab classification is Poorly Graded Sand with Silt (SP-SM). In-place density of 112.0 lb/ft^3 taken at 5.5 ft. with sand cone apparatus. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
(Ss) Visual Class. **6.5 ft.**	**5.5 - 6.5 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand moderately cemented with silica. Hard, fragments require moderate to heavy hammer blow to break; slightly weathered. No reaction with HCl. Color is very pale orange. Backhoe could only excavate 1 ft., grooved sandstone with teeth. **Geologic Interpretation:** Navajo Sandstone Formation			

REMARKS: **S**urface: gently sloping to east; loose sand with scattered bushes; small drainage located north of pit. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-63**

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: COPPER MINE ROAD **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 2080261 **E.** 839292 **GROUND ELEVATION:** 5835

APPROXIMATE DIMENSIONS: 20' x 10' x 10.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/19/2012 **DATE LOGGED:** 6/19/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP) Visual Class. Lab sample taken from 0.0-5.0 ft. (SP-SM) Lab Class **5.0 ft.**	**0.0 - 5.0 ft. Poorly Graded Sand (SP):** About 95% predominantly fine sand and 5% nonplastic fines. Low dry strength, rapid dilatancy and low toughness. Max. size, fine sand. No reaction with HCl. In-place condition: very soft to soft, homogenous, dry, light brown material with weak cementation. Lab test data from 0.0-5.0 ft.: 93% sand, 7% fines, 0% gravel; LL and PI not tested, Field Moisture = 0.8%. pH = 8.57, Resistivity = 8,909 ohm/cm, Sulfates = 5 ppm, Sulfides = 2 ppm, Chlorides = 14 ppm. Lab classification is Poorly Graded Sand with Silt (SP-SM). In-place density of 104.3 lb/ft^3 taken at 4.5 ft. with sand cone apparatus. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
(Ss) Visual Class. **10.0 ft.**	**5.0 - 10.0 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand moderately cemented with $CaCO_3$ and iron oxide; crossbedded, beds are ¼-2 in. thick. Moderately hard, fragments require moderate hammer blow to break; moderately weathered. Strong reaction with HCl. Color is light brown. Upon excavation with a backhoe, the sandstone breaks up into blocky chunks 6 in. in size and smaller. **Geologic Interpretation:** Carmel Formation			

REMARKS: Surface: flat, loose sand with scattered bushes. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-67

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: COPPER MINE ROAD **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 2000911 **E.** 849102 **GROUND ELEVATION:** 5669

APPROXIMATE DIMENSIONS: 15' x 4' x 9.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/18/2012 **DATE LOGGED:** 6/18/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP) Visual Class. Lab sample taken from 0.0-7.0 ft. (SP-SM) Lab Class. **7.0 ft.**	**0.0 - 7.0 ft. Poorly Graded Sand (SP):** About 95% predominantly fine sand, 5% nonplastic fines and a trace of fine, angular gravel. Low dry strength, rapid dilatancy and low toughness. Max. size, 5 mm.. No reaction with HCl. In-place condition: soft, homogenous, dry, light brown material with weak cementation. Lab test data from 0.0-7.0.0 ft.: 94% sand, 6% fines, 0% gravel; LL and PI not tested, Field Moisture = 0.5%. pH = 8.0, Resistivity = 9,094 ohm/cm, Sulfates = 4 ppm, Sulfides = < 1 ppm, Chlorides = 8 ppm. Lab classification is Poorly Graded Sand with Silt (SP-SM). **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
(Ss) Visual Class. **9.0 ft.**	**7.0 - 9.0 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand weakly cemented with silica. Moderately soft, fragments break with manual pressure. No reaction with HCl, except on fracture surfaces coated with $CaCO_3$. Color is grayish orange. Upon excavation with a backhoe, the sandstone breaks up into platy fragments 4 in. and smaller. **Geologic Interpretation:** Navajo Sandstone Formation			

REMARKS: Surface: gently dipping toward small wash; scattered scrub bushes; sandstone outcrop located about 200 ft. southeast. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-68**

FEATURE: WESTERN NAVAJO PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: COPPER MINE ROAD **METHOD OF EXPLORATION:** BACKHOE - 420E CATERPILLAR

COORDINATES: N. 1974019 **E.** 844872 **GROUND ELEVATION:** 5482

APPROXIMATE DIMENSIONS: 10' x 4' x 5.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 6/18/2012 **DATE LOGGED:** 6/18/2012

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP) Visual Class. Lab sample taken from 0.0-3.3 ft. (SP-SM) Lab Class. **3.3 ft.**	**0.0 - 3.3 ft. Poorly Graded Sand (SP):** About 95% predominantly fine sand, 5% nonplastic fines and a trace of fine, rounded gravel. Low dry strength, rapid dilatancy and low toughness. Max. size, 5 mm.. No reaction with HCl. In-place condition: soft, homogenous, dry, light brown material with weak cementation. Lab test data from 0.0-3.3 ft.: 91% sand, 9% fines, 0% gravel; LL and PI not tested, Field Moisture = 1.2%. pH = 8.64, Resistivity = 7,424 ohm/cm, Sulfates = 1 ppm, Sulfides = < 1 ppm, Chlorides = 1 ppm. Lab classification is Poorly Graded Sand with Silt (SP-SM). **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
(Ss) Visual Class. **5.5 ft.**	**3.3 - 5.5 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand moderately cemented with silica; crossbedded, beds are 1/8 to 3 in. thick. Moderately hard, edges of hand-size fragment break with manual pressure; thicker portions require moderate hammer blow to break. No reaction with HCl. Color is light gray to yellowish gray (due to limonite staining). Upon excavation with a backhoe, the sandstone breaks up into platy fragments 1-3 in. in size and smaller. **Geologic Interpretation:** Navajo Sandstone Formation			

REMARKS: Surface: flat; scattered grass and Mormon Tea; sandstone outcrops in roadway located about 70 ft. east. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-69**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: TUBA CITY SPUR **METHOD OF EXPLORATION:** BACKHOE - DEERE 310J

COORDINATES (ARIZONA STATE PLANE): **N.** 1863869 **E.** 872798 **GROUND ELEVATION:** 4626

APPROXIMATE DIMENSIONS: 20' x 4' x 4.5 DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 5/6/2013 **DATE LOGGED:** 5/6/2013

CLASSIFICATION GROUP SYMBOL (describe sample taken))	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(Mdst) Visual Class. Lab sample taken from 0.0-4.5 ft. (CL)s Lab Class . **4.5 ft.**	**0.0 - 4.5 ft. Mudstone (Mdst):** Mudstone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting of approximately 70% clay, and 30% fine sand. Moderately soft to moderately hard, fragments break with manual pressure, thicker portion requires moderate hammer blow to break, moderately weathered. Strong reaction with HCl. Color is medium reddish brown with light gray interbeds. Upon excavation with a backhoe, mudstone breaks up into angular, 1-2 inch-size and smaller chunks. Breaks down into sand and clay particles upon immersion in water. Lab test data from 0.0-4.5 ft.: Lab Classification is Lean Clay with Sand (CL)s derived from Claystone: 69% fines, 31% sand, 0% gravel. Liquid Limit (LL) = 31.0; Plasticity Index (PI) = 14.4. **Geologic Interpretation:** Glen Canyon Group, Kayenta Formation			

REMARKS: **S**urface: flat, no vegetation, scattered concentrations of polished, angular gravels up to 3 in. in diameter. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336
Bureau of Reclamation

LOG OF TEST PIT OR AUGER HOLE

HOLE NO. TP-70

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: TUBA CITY SPUR **METHOD OF EXPLORATION:** BACKHOE - DEERE 310J

COORDINATES (ARIZONA STATE PLANE): **N.** 1864644 **E.** 873906 **GROUND ELEVATION:** 4678

APPROXIMATE DIMENSIONS: 20' x 4' x 13.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 5/7/2013 **DATE LOGGED:** 5/7/2013

CLASSIFICATION GROUP SYMBOL (describe sample taken)	CLASSIFICATION AND DESCRIPTION OF MATERIAL SEE USBR 5000, 5005	% PLUS 3 in (75 mm) BY VOLUME		
		3 – 5 in	5 – 12 in	PLUS 12 in
(SP-SM) Visual Class.	**0.0 - 13.0 ft. Poorly Graded Sand with Silt (SP-SM):** About 90% predominantly fine sand and 10% nonplastic fines with medium to high dry strength, rapid dilatancy and low toughness. Max. size, coarse sand.. Strong reaction with HCl.	0	0	0
Lab sample taken from 10.0-12.0 ft.	In-place condition: very soft consistency becoming firm with depth, homogenous, dry, light brown material with weak to moderate cementation.			
(SP-SM) Lab Class.	Lab test data from 10.0-12.0 ft.: Lab classification is Poorly Graded Sand with Silt (SP-SM): 91% sand, 9% fines, 0% gravel; Nonplastic; Field Moisture = 1.2%. Proctor Test (max. dry density) = 102.1 lbm/ft^3; Optimum Moisture = 15.3%.			
13.0 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			

REMARKS: **S**urface: top of sand dune; scattered scrub; outcrops of older, weakly cemented dunes located 100 ft. north. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-71**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: TUBA CITY SPUR **METHOD OF EXPLORATION:** BACKHOE - DEERE 310J

COORDINATES (ARIZONA STATE PLANE): N. 1865606 **E.** 875773 **GROUND ELEVATION:** 4706

APPROXIMATE DIMENSIONS: 20' x 8' x 9.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 5/7/2013 **DATE LOGGED:** 5/7/2013

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM) Visual Class.	**0.0 - 9.0 ft. Silty Sand (SM):** About 75% predominantly fine sand, 25% nonplastic fines with medium dry strength, rapid dilatancy and low toughness; trace of fine to coarse, angular gravel. Max. size, 40 mm. Strong reaction with HCl. 4.5 to 5.4 ft. gravelly layer composed of up to 30% fine to coarse, angular gravel.	0	0	0
Lab sample taken from 0.0-9.5 ft.	In-place condition: very soft consistency becoming firm with depth, homogenous, dry, light brown material with weak cementation.			
(SM) Lab Class.	Lab test data from 0.0-9.0 ft.: Lab classification is Silty Sand (SM): 69% sand, 22% fines, 9% gravel; Nonplastic; Field Moisture = 1.9%. Proctor Test (max. dry density) = 121.4 lbm/ft^3; Optimum Moisture = 10.8%. In-place density taken at 4.8 ft. with sand cone apparatus = 108.7 lbm/ft^3.			
9.0 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
(Mdst) Visual Class.	**9.0 - 9.5 ft. Mudstone (Mdst):** Mudstone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting of approximately 70% clay, and 30% fine sand. Moderately soft to moderately hard, fragments break with manual pressure, thicker portion requires moderate hammer blow to break, moderately weathered. Strong reaction with HCl. Color is medium gray. Upon excavation with a backhoe, mudstone breaks up into angular, 1-2 inch-size and smaller chunks; could not excavate beyond 9.5 ft.. Breaks down into sand and clay particles upon exposure to water. 9.3-9.4 ft. white, fine grained, intensely weathered, soft sandstone layer.			
9.5 ft.	**Geologic Interpretation:** Glen Canyon Group, Kayenta Formation (silty facies)			

REMARKS: Surface: loose sand; scattered scrub. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-72

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: TUBA CITY SPUR **METHOD OF EXPLORATION:** BACKHOE - DEERE 310J

COORDINATES (ARIZONA STATE PLANE): **N.** 1866916 **E.** 877543 **GROUND ELEVATION:** 4803

APPROXIMATE DIMENSIONS: 20' x 8' x 12.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 5/7/2013 **DATE LOGGED:** 5/7/2013

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP-SM) Visual Class.	**0.0 - 12.0 ft. Poorly Graded Sand with Silt (SP-SM):** About 90% predominantly fine to coarse sand, 10% nonplastic fines with low to medium dry strength, rapid dilatancy and low toughness. Max. size, coarse sand. Strong reaction with HCl. 10.5-12.0 ft. scattered fragments of sandstone up to 2 inches in size. In-place condition: very soft consistency becoming firm with depth, homogenous, dry, tan material with weak cementation.	0	0	0
Lab sample taken from 0.0-12.0 ft. (SM) Lab Class.	Lab test data from 0.0-12.0 ft.: Lab classification is Silty Sand (SM): 87% sand, 13% fines, 0% gravel; Nonplastic; Field Moisture = 1.3%. Proctor Test (max. dry density) = 106.1 lbm/ft^3; Optimum Moisture = 13.5%. In-place density taken at 5.0 ft. with sand cone apparatus = 102.6 lbm/ft^3.			
12.0 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			

REMARKS: **S**urface: loose sand; scattered scrub Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-73

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: TUBA CITY SPUR **METHOD OF EXPLORATION:** BACKHOE - DEERE 310J

COORDINATES (ARIZONA STATE PLANE): **N.** 1868709 **E.** 880201 **GROUND ELEVATION:** 5061

APPROXIMATE DIMENSIONS: 20' x 4' x 3.8' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 5/7/2013 **DATE LOGGED:** 5/7/2013

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP-SM) Visual Class.	**0.0 - 2.5 ft. Poorly Graded Sand with Silt (SP-SM):** About 90% predominantly fine sand, 10% nonplastic fines with medium dry strength, rapid dilatancy and low toughness; trace of fine to coarse, angular gravel (sandstone fragments). Max. size, 30 mm. Strong reaction with HCl. In-place condition: firm consistency, homogenous, dry, light reddish brown material with weak cementation.	0	0	0
2.5 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
(Mdst & Ss) Visual Class.	**2.5 - 3.8 ft. Mudstone with Interbedded Sandstone (Mdst & Ss):** Mudstone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting of approximately 60% clay, and 40% fine sand. Moderately hard, fragments break with moderate hammer blow, moderately weathered. Unfractured. Strong reaction with HCl. Sandstone is fine- to medium-grained, very soft and intensely weathered and occurs as 2- to 3-inch thick lenses within the mudstone. Color is medium purplish gray (mudstone) with light gray bands (sandstone). Upon excavation with a backhoe, mudstone breaks up into angular, 1-2 inch-size and smaller chunks.			
3.8 ft.	**Geologic Interpretation:** Glen Canyon Group, Kayenta-Navajo transition zone (Jkn)			

REMARKS: **S**urface: loose sand; scattered small scrub and grass. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-74

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: TUBA CITY SPUR **METHOD OF EXPLORATION:** BACKHOE - DEERE 310J

COORDINATES (ARIZONA STATE PLANE): **N.** 1869104 **E.** 881687 **GROUND ELEVATION:** 5079

APPROXIMATE DIMENSIONS: 20' x 4' x 2.4' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 5/7/2013 **DATE LOGGED:** 5/7/2013

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP-SM) Visual Class.	**0.0 - 0.9 ft. Poorly Graded Sand with Silt (SP-SM):** About 90% predominantly fine sand, 10% nonplastic fines with medium dry strength, rapid dilatancy and low toughness; trace of fine to coarse, angular gravel (sandstone fragments). Max. size, 30 mm. Localized calcium carbonate concentrations present as white patches. Strong reaction with HCl. In-place condition: firm consistency, homogenous, dry, light reddish brown material with weak cementation.	0	0	0
0.9 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
(Ss) Visual Class.	**0.9 - 2.4 ft. Sandstone (Ss):** Sandstone is fine grained, intensely weathered becoming intensely to moderately weathered at 2.4 ft.; very soft, gouges easily with geologic pick, breaks with manual pressure. Strong reaction with HCl. From 0.9 to 1.4 ft. an intensely fractured, very hard chert layer is present. Color is medium dark purple. Upon excavation with a backhoe, sandstone breaks up into angular, 1-2 inch-size and smaller chunks. Could not dig beyond 2.4 ft.			
2.4 ft.	**Geologic Interpretation:** Glen Canyon Group, Kayenta-Navajo transition zone (Jkn)			

REMARKS: **S**urface: loose sand; scattered small scrub and grass. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-75

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: TUBA CITY SPUR **METHOD OF EXPLORATION:** BACKHOE - DEERE 310J

COORDINATES (ARIZONA STATE PLANE): **N.** 1870153 **E.** 883455 **GROUND ELEVATION:** 5098

APPROXIMATE DIMENSIONS: 20' x 4' x 8.7' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 5/7/2013 **DATE LOGGED:** 5/7/2013

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM) Visual Class.	**0.0 - 8.6 ft. Silty Sand (SM):** About 70% predominantly fine sand and 30% nonplastic fines. Low dry strength, rapid dilatancy and low toughness. Max. size, coarse sand.. No reaction with HCl.	0	0	0
Lab sample taken from 0.0-4.8 ft.	In-place condition: very hard consistency, homogenous, dry, light brown material with strong cementation.			
(SM) Lab Class.	Lab test data from 0.0-4.8 ft.: 68% sand, 32% fines, 0% gravel; Nonplastic; Field Moisture = 2.7%. Lab classification is Silty Sand (SM).			
8.6 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
(Ss) Visual Class.	**8.6 - 8.7 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand moderately cemented with silica; crossbedded, beds are 1/8 to 3 in. thick. Moderately hard, edges of hand-size fragment break with manual pressure; thicker portions require moderate hammer blow to break. Moist, no reaction with HCl. Color is light gray to yellowish gray (due to limonite staining). Upon excavation with a backhoe, the sandstone breaks up into platy fragments 1-3 in. in size and smaller.			
8.7 ft.	**Geologic Interpretation:** Glen Canyon Group, Navajo Sandstone Formation			

REMARKS: **S**urface: sand dunes; scattered grass; sandstone outcrops in trail located about 70 ft. east. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-76**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: TUBA CITY SPUR **METHOD OF EXPLORATION:** BACKHOE - DEERE 310J

COORDINATES (ARIZONA STATE PLANE): **N.** 1871536 **E.** 886275 **GROUND ELEVATION:** 5172

APPROXIMATE DIMENSIONS: 20' x 4' x 6.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 5/7/2013 **DATE LOGGED:** 5/7/2013

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM) Visual Class. Lab sample taken from 0.0-6.0 ft. (SM) Lab Class. **6.0 ft.**	**0.0 - 6.0 ft. Silty Sand (SM):** About 70% predominantly fine sand and 30% nonplastic fines. Low dry strength, rapid dilatancy and low toughness. Max. size, coarse sand.. No reaction with HCl. In-place condition: very soft consistency, homogenous, dry, light brown material with no cementation. Lab test data from 0.0-6.0 ft.: Lab classification is Silty Sand (SM): 69% sand, 31% fines, 0% gravel; Nonplastic; Field Moisture = 3.1%. Proctor Test (max. dry density) = 114.1 lbm/ft^3; Optimum Moisture = 11.0%. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
(Ss) Visual Class. **6.5 ft.**	**6.0 - 6.5 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand cemented with calcium carbonate. Moderately weathered and moderately soft, fragment break with manual pressure. Moderate reaction with HCl. Color is white to tan with some limonite in matrix. Upon excavation with a backhoe, the sandstone breaks up into platy fragments 1-3 in. in size and smaller. Could not excavate below 6.5 ft. **Geologic Interpretation:** Glen Canyon Group, Navajo Sandstone Formation			

REMARKS: **S**urface: sand dunes with scattered grass. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-77

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: TUBA CITY SPUR **METHOD OF EXPLORATION:** BACKHOE - DEERE 310J

COORDINATES (ARIZONA STATE PLANE): **N.** 1872879 **E.** 888920 **GROUND ELEVATION:** 5208

APPROXIMATE DIMENSIONS: 20' x 4' x 9.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 5/8/2013 **DATE LOGGED:** 5/8/2013

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM) Visual Class.	**0.0 - 5.5 ft. Silty Sand (SM):** About 85% predominantly fine to coarse sand and 15% nonplastic fines. Rapid dilatancy and low toughness. Max. size, coarse sand.. Strong reaction with HCl. In-place condition: very hard consistency, homogenous, dry, tan material with strong cementation.	0	0	0
Lab sample taken from 0.0-5.5 ft. (SM) Lab Class.	Lab test data from 0.0-5.5 ft.: Lab classification is Silty Sand (SM): 85% sand, 15% fines, 0% gravel; Liquid Limit (LL) = 20.6; Plasticity Index (PI) = 2.3; Field Moisture = 2.2%. Proctor Test (max. dry density) = 118.5 lbm/ft^3; Optimum Moisture = 11.3%.			
5.5 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
(Ss) Visual Class.	**5.5 - 9.0 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand cemented with silica. Moderately weathered and soft, fragments crumble with manual pressure. No reaction with HCl. Color is light brown grading to light gray and white at about 9.0 ft. Upon excavation with a backhoe, the sandstone breaks down into sand and fine gravel-size fragments. Could not excavate below 9.0 ft.			
9.0 ft.	**Geologic Interpretation:** Glen Canyon Group, Navajo Sandstone Formation			

REMARKS: **S**urface: flat sand dunes with scattered shrubs and grass. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-78**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: TUBA CITY SPUR **METHOD OF EXPLORATION:** BACKHOE - DEERE 310J

COORDINATES (ARIZONA STATE PLANE): **N.** 1874179 **E.** 891755 **GROUND ELEVATION:** 5194

APPROXIMATE DIMENSIONS: 20' x 4' x 6.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 5/8/2013 **DATE LOGGED:** 5/8/2013

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM) Visual Class. Lab sample taken from 0.0-6.0 ft. (SM) Lab Class. **6.0 ft.**	**0.0 - 6.0 ft. Silty Sand (SM):** About 70% predominantly fine to coarse sand and 30% nonplastic fines. High dry strength, slow to rapid dilatancy and low toughness. Max. size, coarse sand.. Strong reaction with HCl. In-place condition: soft consistency, homogenous, dry, tan material with weak cementation. Lab test data from 0.0-6.0 ft.: Lab classification is Silty Sand (SM): 69% sand, 31% fines, 0% gravel; Liquid Limit (LL) = 18.4; Plasticity Index (PI) = 2.4; Field Moisture = 4.1%. Proctor Test (max. dry density) = 122.2 lbm/ft^3; Optimum Moisture = 10.0%. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
(Ss) Visual Class. **6.0 ft.**	**6.0 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand cemented with silica. Moderately weathered and soft, fragments crumble with manual pressure. No reaction with HCl. Color is light brown. Upon excavation with a backhoe, the sandstone breaks down into sand and fine gravel-size fragments. Backhoe could only scrape surface of sandstone, characteristics assumed similar to TP-77. **Geologic Interpretation:** Glen Canyon Group, Navajo Sandstone Formation			

REMARKS: **S**urface: flat area beside sand dune with scattered shrubs and grass. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-79

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: TUBA CITY SPUR **METHOD OF EXPLORATION:** BACKHOE - DEERE 310J

COORDINATES (ARIZONA STATE PLANE): **N.** 1876060 **E.** 893201 **GROUND ELEVATION:** 5204

APPROXIMATE DIMENSIONS: 20' x 8' x 11.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 5/8/2013 **DATE LOGGED:** 5/8/2013

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM) Visual Class.	**0.0 - 7.7 ft. Silty Sand (SM):** About 85% predominantly fine to coarse sand and 15% nonplastic fines. High dry strength, rapid dilatancy and low toughness. Max. size, coarse sand. Weak reaction with HCl. In-place condition: very soft consistency, homogenous, dry, light brown material with weak cementation.	0	0	0
Lab sample taken from 0.0-7.7 ft. (SM) Lab Class.	Lab test data from 0.0-7.7 ft.: Lab classification is Silty Sand (SM): 88% sand, 12% fines, 0% gravel; Nonplastic; Field Moisture = 1.5%. Proctor Test (max. dry density) = 107.2 lbm/ft^3; Optimum Moisture = 13.9%. In-place density taken at 5.0 ft. with sand cone apparatus = 107.8 lbm/ft^3.			
7.7 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
(Ss) Visual Class.	**7.7 - 11.0 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand cemented with silica. Moderately weathered and soft, fragments crumble with manual pressure. No reaction with HCl. Color is light brown. Upon excavation with a backhoe, the sandstone breaks down into gravel-size fragments about 1 inch in diameter.			
11.0 ft.	**Geologic Interpretation:** Glen Canyon Group, Navajo Sandstone Formation			

REMARKS: **S**urface: active sand dune with scattered tumbleweeds. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-80

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: TUBA CITY SPUR **METHOD OF EXPLORATION:** BACKHOE - DEERE 310J

COORDINATES (ARIZONA STATE PLANE): **N.** 1876464 **E.** 894308 **GROUND ELEVATION:** 5208

APPROXIMATE DIMENSIONS: 20' x 8' x 9.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 5/8/2013 **DATE LOGGED:** 5/8/2013

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SM) Visual Class.	**0.0 - 6.0 ft. Silty Sand (SM):** About 80% predominantly fine to coarse sand and 20% nonplastic fines. High dry strength, rapid dilatancy and low toughness. Max. size, coarse sand. Strong reaction with HCl. In-place condition: very hard consistency, homogenous, dry, tan material with strong cementation.	0	0	0
Lab sample taken from 0.0-6.0 ft. (SM) Lab Class.	Lab test data from 0.0-6.0 ft.: Lab classification is Silty Sand (SM): 78% sand, 22% fines, 0% gravel; Nonplastic; Field Moisture = 1.9%. Proctor Test (max. dry density) = 106.6 lbm/ft^3; Optimum Moisture = 13.2%. In-place density taken at 5.0 ft. with sand cone apparatus = 108.7 lbm/ft^3.			
6.0 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
(Ss) Visual Class.	**6.0 - 9.0 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand cemented with calcium carbonate. Moderately weathered and soft, fragments crumble with manual pressure. Laminated to very thinly bedded, bedding planes range from ¼ to 1 in. apart; flaggy. Strong reaction with HCl; calcium carbonate concentrated along bedding surfaces. Color is light brown. Upon excavation with a backhoe, the sandstone breaks down into platy gravel-size fragments; although soft, backhoe could not excavate where the sandstone is not thinly bedded; refusal at 9.0 ft.			
9.0 ft.	**Geologic Interpretation:** Glen Canyon Group, Navajo Sandstone Formation			

REMARKS: **S**urface: sand dune with scattered shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-81**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: TUBA CITY SPUR **METHOD OF EXPLORATION:** BACKHOE - DEERE 310J

COORDINATES (ARIZONA STATE PLANE): **N.** 1876700 **E.** 900034 **GROUND ELEVATION:** 5161

APPROXIMATE DIMENSIONS: 20' x 8' x 9.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 5/8/2013 **DATE LOGGED:** 5/8/2013

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(SP) Visual Class.	**0.0 - 9.5 ft. Poorly Graded Sand (SP):** About 95% predominantly fine to medium sand and 5% nonplastic fines. High dry strength, rapid dilatancy and low toughness. Max. size, medium sand. Strong reaction with HCl. In-place condition: very soft consistency, homogenous, dry becoming moist at about 6 ft, tan material with weak cementation.	0	0	0
Lab sample taken from 0.0-9.5 ft. (SP-SM) Lab Class.	Lab test data from 0.0-9.5 ft.: Lab classification is Poorly Graded Sand with Silt (SP-SM): 95% sand, 5% fines, 0% gravel; Nonplastic; Field Moisture = 1.0%. Proctor Test (max. dry density) = 105.4 lbm/ft^3; Optimum Moisture = 14.9%. In-place density taken at 5.0 ft. with sand cone apparatus = 99.4 lbm/ft^3.			
9.5 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
(Ss) Visual Class.	**9.5 ft. Sandstone (Ss):** Description based on sandstone outcrop located 70 ft. southwest in wind swept bowl not exposed 9 months earlier during initial site selection. Sandstone consists of predominately fine, subrounded sand cemented with calcium carbonate. Moderately weathered and very soft, fragments crumble with manual pressure. Laminated to very thinly bedded, bedding planes range from ¼ to 1 in. apart. Strong reaction with HCl. Color is light brown. Backhoe could not excavate below 9.5 ft.			
9.5 ft.	**Geologic Interpretation:** Glen Canyon Group, Navajo Sandstone Formation			

REMARKS: **S**urface: active sand dune with scattered grass and tumbleweeds. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from topography model. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-201**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1847260 **E.** 916290 **GROUND ELEVATION:** 5089

APPROXIMATE DIMENSIONS: 15' x 6' x 12.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 4/19/2016 **DATE LOGGED:** 4/19/2016

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class.	**0.0 - 6.5 ft. Silty Sand (SM):** About 85% predominantly fine to coarse sand, 15% nonplastic fines with low dry strength, rapid dilatancy and low toughness. Max. size, coarse sand. Strong reaction with HCl. In-place condition: very soft consistency with firm clumps, homogenous, dry, no to weak cementation. Color is reddish tan.	0	0	0
Lab sample taken from 0.0-5.5 ft. SM Lab Class.	Lab test data from 0.0-5.5 ft.: Lab classification is Silty Sand (SM): 85% sand, 15% fines. Nonplastic; Field Moisture = 1.9%. Proctor Test (max. dry density) = 109.3 lbm/ft^3; Optimum Moisture = 13.2%. In-Place Density taken at 5.5 ft. with sand cone apparatus = 98.5 lbm/ft^3.			
6.5 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
Ss Visual Class.	**6.5 - 12.5 ft. Sandstone (Ss):** Sandstone consists of predominantly fine, subrounded sand moderately cemented with silica; crossbedded, beds are 1/8 to 3 in. thick. Soft to moderately soft, edges of hand-size fragments break with light manual pressure; thicker portions require heavy manual pressure to break. No reaction with HCl. Color is very light gray to white (N8 to N9).			
12.5 ft.	**Geologic Interpretation:** Navajo Sandstone Formation (Jn)			

REMARKS: **S**urface: slightly sloping, loose sand within ADOT ROW covered with scattered grasses. Outcrop of white sandstone (Navajo Sandstone Formation) across road in wind-blown depression. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-202**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1841915 **E.** 917156 **GROUND ELEVATION:** 5177

APPROXIMATE DIMENSIONS: 15' x 4' x 9' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 4/19/2016 **DATE LOGGED:** 4/19/2016

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SP-SM Visual Class.	**0.0 - 3.5 ft. Poorly Graded Sand with Silt (SP-SM):** About 90% predominantly fine to coarse sand, 10% nonplastic fines with low dry strength, rapid dilatancy and low toughness, trace of fine to coarse gravel. Max. size, 1.5 in. Strong reaction with HCl. In-place condition: very soft consistency, homogenous, dry, no cementation. Color is reddish tan. Lab test data from 0.0-3.5 ft.: Lab classification is Poorly Graded Sand with Silt (SP-SM): 94% sand, 6% fines, trace of gravel. Nonplastic; Field Moisture = 0.9%. Proctor Test (max. dry density) = 110.4 lbm/ft^3; Optimum Moisture = 12.7%. Corrosion Potential Testing 0.0-3.5 ft.: pH = 8.8, Resistivity = 3,802 ohm/cm.	0	0	0
Lab sample taken from 0.0-3.5 ft. SP-SM Lab Class.				
3.5 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
SP Visual Class.	**3.5 - 7.0 ft. Poorly Graded Sand (SP):** About 95% predominantly fine sand, 5% nonplastic fines. Max. size, fine sand. No reaction with HCl. In-place condition: very soft consistency, homogenous, dry, no cementation. Color is white.	0	0	0
7.0 ft.	**Geologic Interpretation:** Quaternary Colluvium derived from in-place weathering of the underlying sandstone.			
Ss Visual Class.	**7.0 - 9.0 ft. Sandstone (Ss):** Sandstone consists of predominantly fine, subrounded sand moderately cemented with silica; crossbedded, beds are 1/8 to 1 in. thick. Soft to moderately soft, edges of hand-size fragments break with light manual pressure; thicker portions require heavy manual pressure to break. No reaction with HCl. Color is very light gray to white (N8 to N9). Although sandstone can be broken with manual pressure in hand specimen, backhoe met refusal.			
9.0 ft.	**Geologic Interpretation:** Navajo Sandstone Formation (Jn)			

REMARKS: **S**urface: slightly sloping loose sand within ADOT ROW covered with scattered grasses. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-203**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1837010 **E.** 917194 **GROUND ELEVATION:** 5318

APPROXIMATE DIMENSIONS: 15' x 6' x 13' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 4/19/2016 **DATE LOGGED:** 4/19/2016

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class.	**0.0 - 13.0 ft. Silty Sand (SM):** About 80% predominantly fine to coarse sand, 20% nonplastic fines with low dry strength, rapid dilatancy and low toughness, trace of fine to coarse gravel from 5.5 to 13.0 ft. Max. size, 2 in. Strong reaction with HCl. In-place condition: very soft to soft consistency, dry, weak cementation. Irregularly shaped layer of angular to rounded, fine to coarse gravel occurs from about 2.3 to 3.5 ft. Color is reddish tan.	0	0	0
Lab sample taken from 0.0-5.5 ft. SM Lab Class.	Lab test data from 0.0-5.5 ft.: Lab classification is Silty Sand (SM): 79% sand, 21% fines, trace of gravel. Nonplastic; Field Moisture = 1.7%. Proctor Test (max. dry density) = 115.2 lbm/ft^3; Optimum Moisture = 10.6%. In-Place Density taken at 5.5 ft. with sand cone apparatus = 105.7 lbm/ft^3.			
13.0 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			

REMARKS: **S**urface: slightly sloping, loose sand within ADOT ROW covered with scattered grasses. Outcrop of white sandstone (Navajo Sandstone Formation) in drainage about 100 ft. downstream along road. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-204**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1833069 **E.** 917350 **GROUND ELEVATION:** 5478

APPROXIMATE DIMENSIONS: 15' x 4' x 11.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 4/19/2016 **DATE LOGGED:** 4/19/2016

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class. Lab sample taken from 0.0-7.0 ft. SM Lab Class. **7.0 ft.**	**0.0 - 7.0 ft. Silty Sand (SM):** About 80% predominantly fine to coarse sand, 20% nonplastic fines with low dry strength, rapid dilatancy and low toughness, trace of gravel. Max. size, 1.5 in. Strong reaction with HCl. In-place condition: very soft to soft consistency, homogenous, dry, no cementation. Color is reddish tan. Lab test data from 0.0-7.0 ft.: Lab classification is Silty Sand (SM): 81% sand, 17% fines, 2% gravel. Nonplastic; Field Moisture = 1.9%. Proctor Test (max. dry density) = 115.4 lbm/ft^3; Optimum Moisture = 8.6%. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
SP Visual Class. **9.5 ft.**	**7.0 - 9.5 ft. Poorly Graded Sand (SP):** About 95% predominantly fine sand, 5% nonplastic fines. Max. size, fine sand. Strong reaction with HCl. In-place condition: soft consistency, homogenous, dry, no cementation. Color is white. **Geologic Interpretation:** Quaternary Colluvium derived from in-place weathering of the underlying sandstone.	0	0	0
Ss Visual Class. **11.5 ft.**	**9.5 - 11.5 ft. Sandstone (Ss):** Sandstone consists of predominantly fine, subrounded sand moderately cemented with silica; crossbedded, beds are 1/8 to 1 in. thick. Soft to moderately soft, edges of hand-size fragments break with light manual pressure; thicker portions require heavy manual pressure to break. No reaction with HCl. Color is very light gray to white (N8 to N9). Although sandstone can be broken with manual pressure in hand specimen, backhoe met refusal. **Geologic Interpretation:** Navajo Sandstone Formation (Jn)			

REMARKS: **S**urface: level, loose sand within ADOT ROW covered with scattered grasses. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-205**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1831382 **E.** 922235 **GROUND ELEVATION:** 5381

APPROXIMATE DIMENSIONS: 15' x 6' x 13.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 4/19/2016 **DATE LOGGED:** 4/19/2016

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class.	**0.0 - 11.0 ft. Silty Sand (SM):** About 80% predominantly fine to coarse sand, 20% nonplastic fines with low dry strength, rapid dilatancy and low toughness. Max. size, coarse sand. Strong reaction with HCl. In-place condition: very soft to firm consistency, homogenous, dry, weak to moderate cementation. A few localized pockets of uncemented, fine gravel present. Color is reddish tan to tan.	0	0	0
Lab sample taken from 0.0-4.6 ft. SM Lab Class.	Lab test data from 0.0-11.0 ft.: Lab classification is Silty Sand (SM): 85% sand, 15% fines. Nonplastic; Field Moisture = 1.5%. Proctor Test (max. dry density) = 109.1 lbm/ft^3; Optimum Moisture = 13.3%. In-Place Density taken at 4.6 ft. with sand cone apparatus = 105.6 lbm/ft^3.			
11.0 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
Ss Visual Class.	**11.0 - 13.0 ft. Sandstone (Ss):** Sandstone consists of predominantly fine, subrounded sand moderately cemented with silica; crossbedded, beds are 1/8 to 3 in. thick. Soft, fragments break with light manual pressure. Moderate reaction with HCl. Color is very light gray to white (N8 to N9).			
13.0 ft.	**Geologic Interpretation:** Navajo Sandstone Formation (Jn)			

REMARKS: **S**urface: level ground, loose sand within ADOT ROW covered with scattered grasses. Outcrop of white sandstone (Navajo Sandstone Formation) across road in wind-blown depression. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** **TP-206**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1830016 **E.** 926196 **GROUND ELEVATION:** 5405

APPROXIMATE DIMENSIONS: 15' x 3' x 15' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 4/19/2016 **DATE LOGGED:** 4/19/2016

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class.	**0.0 - 15.0 ft. Silty Sand (SM):** About 80% predominantly fine to coarse sand, 20% nonplastic fines with low dry strength, rapid dilatancy and low toughness. Max. size, coarse sand. Strong reaction with HCl. In-place condition: very soft to soft consistency, homogenous, dry, weak cementation. Color is tan.	0	0	0
Lab sample taken from 0.0-15.0 ft. SM Lab Class.	Lab test data from 0.0-15.0 ft.: Lab classification is Silty Sand (SM): 78% sand, 22% fines. Nonplastic; Field Moisture = 3.5%. Proctor Test (max. dry density) = 115.7 lbm/ft^3; Optimum Moisture = 13.7%. Corrosion Potential Testing 0.0-5.0 ft.: pH = 8.8, Resistivity = 2,735 ohm/cm.			
15.0 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			

REMARKS: **S**urface: flat ground, loose sand within ADOT ROW covered with scattered grasses. Located 30 feet upstream of manmade drainage. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336
Bureau of Reclamation

LOG OF TEST PIT OR AUGER HOLE

HOLE NO. TP-207

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1828460 **E.** 930731 **GROUND ELEVATION:** 5447

APPROXIMATE DIMENSIONS: 15' x 6' x 14' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 4/19/2016 **DATE LOGGED:** 4/19/2016

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class.	**0.0 - 14.0 ft. Silty Sand (SM):** About 70% predominantly fine to coarse sand, 30% nonplastic fines with low dry strength, rapid dilatancy and low toughness. Max. size, coarse sand. Strong reaction with HCl. In-place condition: very soft to firm consistency, homogenous, dry, weak cementation. Color is reddish tan.	0	0	0
Lab sample taken from 0.0-5.3 ft. SM Lab Class.	Lab test data from 0.0-5.3 ft.: Lab classification is Silty Sand (SM): 67% sand, 33% fines. Nonplastic; Field Moisture = 4.1%. Proctor Test (max. dry density) = 117.3 lbm/ft^3; Optimum Moisture = 13.6%. In-Place Density taken at 5.3 ft. with sand cone apparatus = 97.8 lbm/ft^3.			
14.0 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			

REMARKS: **S**urface: flat ground, loose sand within ADOT ROW covered with scattered grasses. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-208**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1827412 **E.** 936926 **GROUND ELEVATION:** 5624

APPROXIMATE DIMENSIONS: 15' x 3' x 7.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 4/19/2016 **DATE LOGGED:** 4/19/2016

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class. Lab sample taken from 0.0-5.0 ft. SM Lab Class. **5.0 ft.**	**0.0 - 5.0 ft. Silty Sand (SM):** About 80% predominantly fine to coarse sand, 20% nonplastic fines with low dry strength, rapid dilatancy and low toughness, trace of fine to coarse gravel. Max. size, 1 in. Strong reaction with HCl. In-place condition: very soft to soft consistency, homogenous, dry, weak cementation. Color is reddish tan. Lab test data from 0.0-5.0 ft.: Lab classification is Silty Sand (SM): 78% sand, 21% fines, 1% gravel. Nonplastic; Field Moisture = 2.2%. Proctor Test (max. dry density) = 117.0 lbm/ft^3; Optimum Moisture = 10.5 %. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
SP Visual Class. **6.5 ft.**	**5.0 - 6.5 ft. Poorly Graded Sand (SP):** About 95% predominantly fine sand, 5% nonplastic fines. Max. size, fine sand. Strong reaction with HCl. In-place condition: soft consistency, homogenous, dry, no cementation. Color is white. **Geologic Interpretation:** Quaternary Colluvium derived from in-place weathering of the underlying sandstone.	0	0	0
Ss Visual Class. **7.5 ft.**	**6.5 - 7.5 ft. Sandstone (Ss):** Sandstone consists of predominantly fine, subrounded sand moderately cemented with silica; crossbedded, beds are 1/8 to 1 in. thick. Soft to moderately soft, edges of hand-size fragments break with light manual pressure; thicker portions require heavy manual pressure to break. Strong reaction with HCl. Color is very light gray to white (N8 to N9). Although sandstone can be broken with manual pressure in hand specimen, backhoe met refusal. **Geologic Interpretation:** Navajo Sandstone Formation (Jn)			

REMARKS: **S**urface: level, loose sand within ADOT ROW covered with scattered grasses. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-209

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1826225 **E.** 942223 **GROUND ELEVATION:** 5654

APPROXIMATE DIMENSIONS: 15' x 3' x 8' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 4/20/2016 **DATE LOGGED:** 4/20/2016

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class. Lab sample taken from 0.0-4.5 ft. SM Lab Class. **4.5 ft.**	**0.0 - 4.5 ft. Silty Sand (SM):** About 80% predominantly fine to coarse sand, 20% nonplastic fines with low dry strength, rapid dilatancy and low toughness, trace of gravel. Max. size, 1.5 in. Strong reaction with HCl. In-place condition: very soft to soft consistency, homogenous, dry, weak cementation. Color is reddish tan. Lab test data from 0.0-4.5 ft.: Lab classification is **Silty Sand (SM):** 77% sand, 23% fines, trace of gravel. Nonplastic; Field Moisture = 2.4%. Proctor Test (max. dry density) = 118.3 lbm/ft^3; Optimum Moisture = 11.5%. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
SP Visual Class. **5.0 ft.**	**4.5 - 5.0 ft. Poorly Graded Sand (SP):** About 95% predominantly fine sand, 5% nonplastic fines. Max. size, fine sand. Strong reaction with HCl. In-place condition: soft consistency, homogenous, dry, no cementation. Color is white. **Geologic Interpretation:** Quaternary Colluvium derived from in-place weathering of the underlying sandstone.	0	0	0
Ss Visual Class. **8.0 ft.**	**5.0 - 8.0 ft. Sandstone (Ss):** Sandstone consists of predominantly fine, subrounded sand moderately cemented with silica; crossbedded, beds are 1/8 to 1 in. thick. Soft to moderately soft, edges of hand-size fragments break with light manual pressure; thicker portions require heavy manual pressure to break. No reaction with HCl except strong reaction on powdery coatings on some bedding joints. Color is very light gray to white (N8 to N9). Although sandstone can be broken with manual pressure in hand specimen, backhoe met refusal. **Geologic Interpretation:** Navajo Sandstone Formation (Jn)			

REMARKS: **S**urface: level, loose sand within ADOT ROW covered with scattered grasses. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-210**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1825050 **E.** 947389 **GROUND ELEVATION:** 5734

APPROXIMATE DIMENSIONS: 15' x 6' x 9.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 4/20/2016 **DATE LOGGED:** 4/20/2016

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class. Lab sample taken from 0.0-6.0 ft. SM Lab Class. **6.0 ft.**	**0.0 - 6.0 ft. Silty Sand (SM):** About 75% predominantly fine to coarse sand, 25% nonplastic fines with low dry strength, rapid dilatancy and low toughness. Max. size, coarse sand. Strong reaction with HCl. In-place condition: very soft to firm consistency, homogenous, dry, weak cementation. Color is reddish tan. Lab test data from 0.0-6.0 ft.: Lab classification is Silty Sand (SM): 81% sand, 19% fines. Nonplastic; Field Moisture = 1.6%. Proctor Test (max. dry density) = 120.4 lbm/ft^3; Optimum Moisture = 9.3%. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
Ss Visual Class. **9.0 ft.**	**6.0 - 9.0 ft. Sandstone (Ss):** Sandstone consists of predominantly fine, subrounded sand moderately cemented with silica; crossbedded, beds are 1/8 to 1 in. thick. Soft, fragments break with light manual pressure. No reaction with HCl, except strong reaction on $CaCO_3$ coatings on bedding planes. Color is very light gray to white (N8 to N9). **Geologic Interpretation:** Carmel Formation (Jsc)			

REMARKS: **S**urface: level ground, loose sand within ADOT ROW covered with scattered grasses. Outcrop of white sandstone (Navajo Sandstone Formation) across road in wind-blown depression. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-211**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1823850 **E.** 952522 **GROUND ELEVATION:** 5797

APPROXIMATE DIMENSIONS: 15' x 3' x 8' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 4/20/2016 **DATE LOGGED:** 4/20/2016

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
s(CL) Visual Class.	**0.0 - 3.0 ft. Sandy Lean Clay s(CL):** About 60% fines with medium plasticity, low dry strength, slow dilatancy and low toughness. 40% predominantly fine to coarse sand, trace of fine to coarse, rounded to subrounded gravel. Max. size, 2 in. Strong reaction with HCl. In-place condition: very hard consistency, homogenous, dry, moderate to strong cementation. Color is reddish tan. Lab test data from 0.0-3.0 ft.:	0	0	0
Lab sample taken from 0.0-3.0 ft. s(CL) Lab Class.	Lab classification is Sandy Lean Clay s(CL): 53% fines, 47% sand, trace of gravel. Liquid Limit (LL) = 21.4; Plasticity Index (PI) = 10.2; Field Moisture = 6.1%. Proctor Test (max. dry density) = 116.7 lbm/ft^3; Optimum Moisture = 11.5%. Corrosion Potential Testing 0.0-3.0 ft.: pH = 8.5, Resistivity = 2,068 ohm/cm.			
3.0 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
Sltst Visual Class.	**3.0 - 3.5 ft. Siltstone (Sltst):** Siltstone consists of silt to very fine sand cemented with $CaCO_3$; thinly bedded, beds are 1/8 to 1/2 in. thick. Soft, fragments break with light manual pressure. Strong reaction with HCl. Color is light brownish gray (5YR 6/1).			
Ss Visual Class.	**3.5 - 8.0 ft. Sandstone (Ss):** Sandstone consists of predominantly fine sand moderately cemented with $CaCO_3$; bedding is 1/2 to 2 in. thick. Soft, fragments break with light manual pressure. Moderate reaction with HCl, except strong reaction on $CaCO_3$ coating bedding planes. Color is pale yellowish orange (10 YR 8/6).			
8.0 ft.	**Geologic Interpretation:** Dakota Formation (Kd)			

REMARKS: **S**urface: level ground, loose sand within ADOT ROW covered with scattered grasses. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-212

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1822048 **E.** 957517 **GROUND ELEVATION:** 5848

APPROXIMATE DIMENSIONS: 15' x 3' x 5.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 4/20/2016 **DATE LOGGED:** 4/20/2016

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class. Lab sample taken from 0.0-2.0 ft. SM Lab Class. **2.0 ft.**	**0.0 - 2.0 ft. Silty Sand (SM):** About 60% predominantly fine to medium sand, 40% nonplastic fines with low dry strength, rapid dilatancy and low toughness, trace of fine to coarse gravel. Max. size, 2 in. Strong reaction with HCl. In-place condition: very soft to firm consistency, homogenous, dry, weak cementation. Color is reddish tan. Lab test data from 0.0-2.0 ft.: Lab classification is Silty Sand (SM): 56% sand, 43% fines, 1% gravel. Liquid Limit (LL) = 19.6; Plasticity Index (PI) = 3.9; Field Moisture = 4.2%. Proctor Test (max. dry density) = 119.6 lbm/ft^3; Optimum Moisture = 12.1%. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
Ss Visual Class. **5.5 ft.**	**2.0 - 5.5 ft. Sandstone (Ss):** Sandstone consists of silt to predominantly fine sand moderately cemented with $CaCO_3$; bedding is 1/2 to 2 in. thick. Moderately weathered, moderately soft to moderately hard; thin fragments break with manual pressure, thicker fragments require light hammer blow to break. Strong reaction with HCl. Color is mottled dark yellowish orange and pale yellowish orange (10YR 6/6 and 10 YR 8/6). **Geologic Interpretation:** Dakota Formation (Kd)			

REMARKS: **S**urface: level ground, loose sand within ADOT ROW covered with scattered grasses. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-213**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1819729 **E.** 962262 **GROUND ELEVATION:** 5872

APPROXIMATE DIMENSIONS: 15' x 6' x 7' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 4/20/2016 **DATE LOGGED:** 4/20/2016

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
s(CL) Visual Class. Lab sample taken from 0.0-6.0 ft. s(CL) Lab Class. **7.0 ft.**	**0.0 - 7.0 ft. Sandy Lean Clay s(CL):** About 55% fines with high plasticity, high dry strength, slow dilatancy and low toughness. 45% predominantly fine to coarse sand. Max. size, coarse sand. Strong reaction with HCl. In-place condition: very hard consistency, homogenous, dry, strong cementation. Color is medium brown. Lab test data from 0.0-6.0 ft.: Lab classification is Sandy Lean Clay s(CL): 53% fines, 47% sand. Liquid Limit (LL) = 24.7; Plasticity Index (PI) = 14.0; Field Moisture = 5.5%. Proctor Test (max. dry density) = 117.8 lbm/ft^3; Optimum Moisture = 12.9%. **Geologic Interpretation:** Quaternary Colluvium	0	0	0

REMARKS: **S**urface: low spot along road - evidence of standing water within ADOT ROW. Covered with scattered grasses. Bottom of pit at 5 ft. was too hard too level and dig to perform in-place density with a sand cone. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-215

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1816406 **E.** 969051 **GROUND ELEVATION:** 5973

APPROXIMATE DIMENSIONS: 15' x 3' x 9' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 4/20/2016 **DATE LOGGED:** 4/20/2016

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class.	**0.0 - 2.0 ft. Silty Sand (SM):** About 75% predominantly fine to medium sand, 25% nonplastic fines with low dry strength, rapid dilatancy and low toughness. Max. size, medium sand. Strong reaction with HCl. In-place condition: very soft to firm consistency, homogenous, dry, weak cementation. Color is reddish tan.	0	0	0
2.0 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
s(CL) Visual Class.	**2.0 - 5.0 ft. Sandy Lean Clay s(CL):** About 55% fines with high plasticity, high dry strength, slow dilatancy and low toughness. 45% predominantly fine to coarse sand. Max. size, coarse sand. Strong reaction with HCl. In-place condition: very hard consistency, homogenous, dry, strong cementation. Color is medium brown.	0	0	0
5.0 ft.	**Geologic Interpretation:** Quaternary Colluvium (derived from underlying sandstone)			
Cgl Visual Class.	**5.0 - 6.5 ft. Sandy Conglomerate:** Conglomerate consists of about 70% fine to coarse, subrounded gravel and 30% fine to coarse sand weakly cemented with calcium carbonate. Very intensely weathered to decomposed and very soft, material breaks into component parts when excavated. Strong reaction with HCl.			
Ss Visual Class.	**6.5 - 9.0 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand cemented with silica. Intensely weathered and soft, fragments crumble with manual pressure. Becomes slightly harder with depth. No reaction with HCl. Color is grayish orange (10YR 7/4). The conglomerate and sandstone are part of the sequence mapped as Tsy deposited on top of the Mancos Shale Formation.			
9.0 ft.	**Geologic Interpretation:** Pliocene to Mid-Miocene Deposits (Tsy)			

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-216**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1814140 **E.** 973710 **GROUND ELEVATION:** 5994

APPROXIMATE DIMENSIONS: 15' x 6' x 12' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/5/2015 **DATE LOGGED:** 10/5/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class. Lab sample taken from 0.0-6.0 ft. SM Lab Class. **6.0 ft.**	**0.0 - 6.0 ft. Silty Sand (SM):** About 65% predominantly fine to coarse sand, 35% nonplastic fines with high dry strength, rapid dilatancy and low toughness, trace of gravel. Max. size, 1 inch. Strong reaction with HCl. In-place condition: hard consistency, homogenous, dry, weak cementation. Thin stringers (1/16 to 1/8 inch thick) of $CaCO_3$ present. Color is yellowish brown. Lab test data from 0.0-6.0 ft.: Lab classification is Silty Sand (SM): 64% sand, 36% fines, trace of gravel. Nonplastic; Field Moisture = 4.7%. Proctor Test (max. dry density) = 121.5 lbm/ft^3; Optimum Moisture = 10.9%. In-Place Density taken at 4.0 ft. with sand cone apparatus = 101.6 lbm/ft^3. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
Ss Visual Class. **12.0 ft.**	**6.0 - 12.0 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand cemented with silica. Intensely weathered and soft, fragments crumble with manual pressure. Becomes slightly harder with depth. No reaction with HCl. Color is grayish orange (10YR 7/4). A few rounded gravels present in the last bucket. The sandstone is part of the conglomerate and sandstone sequence mapped as Tsy and deposited on top of the Mancos Shale Formation **Geologic Interpretation:** Pliocene to Mid-Miocene Deposits (Tsy)			

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-217**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1811752 **E.** 978601 **GROUND ELEVATION:** 6056

APPROXIMATE DIMENSIONS: 15' x 3' x 12' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/5/2015 **DATE LOGGED:** 10/5/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
s(ML) Visual Class.	**0.0 - 3.0 ft. Sandy Silt s(ML):** About 50% nonplastic fines with high dry strength, rapid dilatancy and low toughness, 50% predominantly fine to coarse sand, trace of gravel. Max. size, 3/4 inch. Strong reaction with HCl. In-place condition: hard consistency, homogenous, dry, Thin stringers (1/16 to 1/8 inch thick) of $CaCO_3$ present. Color is yellowish brown.	0	0	0
Lab sample taken from 0.0-3.0 ft. s(ML) Lab Class.	Lab test data from 0.0-3.0 ft.: Lab classification is Sandy Silt s(ML): 51% fines, 49% sand, trace of gravel. Liquid Limit (LL) = 21.1; Plasticity Index (PI) = 2.3; Field Moisture = 4.7%. Proctor Test (max. dry density) = 121.8 lbm/ft^3; Optimum Moisture = 11.7%.			
3.0 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
Ss Visual Class. \	**3.0 - 12.0 ft. Sandstone (Ss):** Sandstone consists of predominately coarse sand partially cemented with $CaCO_3$. $CaCO_3$ makes up to 30% of the material by volume. Intensely weathered and soft, most fragments crumble with manual pressure. Becomes slightly harder with depth. Strong reaction with HCl. Color is grayish orange (10YR 7/4) to grayish pink (5R 8/2). Rounded to angular gravels up to 3-inches in diameter present in excavated material, but not seen in sandstone fragments. Interval easily excavated by backhoe. The sandstone is part of the conglomerate and sandstone sequence mapped as Tsy and deposited on top of the Mancos Shale Formation			
12.0 ft.	**Geologic Interpretation:** Pliocene to Mid-Miocene Deposits (Tsy)			

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-218**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1809445 **E.** 983347 **GROUND ELEVATION:** 6111

APPROXIMATE DIMENSIONS: 15' x 3' x 6.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/5/2015 **DATE LOGGED:** 10/5/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class. . **3.0 ft.**	**0.0 - 3.0 ft. Silty Sand (SM):** About 60% predominantly fine to coarse sand, 40% nonplastic fines with high dry strength, rapid dilatancy and low toughness, trace of gravel. Max. size, 1 inch. Strong reaction with HCl. In-place condition: hard consistency, homogenous, dry, weak cementation. Thin stringers (1/16 to 1/8 inch thick) of $CaCO_3$ present. Color is yellowish brown. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
Sh Visual Class. **6.5 ft.**	**3.0 - 6.5 ft. Shale (Sh):** Shale with interbedded siltstone. Shale is a very fine-grained, clastic sedimentary rock composed of silt- to clay-sized particles. The shale is intensely weathered and soft, fragments crumble with manual pressure. Laminated, bedding less than 3/8 inch thick and fissile. Color is light brownish gray (5YR 6/1). Encountered siltstone layers at about 5 feet; siltstone is very fine-grained, moderately soft to moderately hard, some fragments break with heavy manual pressure. Very thinly bedded, bedding ½ to 1 inch thick. Color is pale grayish orange (10YR 8/4). **Geologic Interpretation:** Mancos Shale (Km)			

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336
Bureau of Reclamation

LOG OF TEST PIT OR AUGER HOLE

HOLE NO. TP-219

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1806903 **E.** 988537 **GROUND ELEVATION:** 6122

APPROXIMATE DIMENSIONS: 15' x 6' x 11' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/5/2015 **DATE LOGGED:** 10/5/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	CLASSIFICATION AND DESCRIPTION OF MATERIAL SEE USBR 5000, 5005	% PLUS 3 in (75 mm) BY VOLUME		
		3 – 5 in	5 – 12 in	PLUS 12 in
SC Visual Class. Lab sample taken from 0.0-6.0 ft. SC Lab Class. **3.0 ft.**	**0.0 - 3.0 ft. Clayey Sand (SC):** About 60% predominantly fine to coarse sand, 40% fines with low plasticity, high dry strength, slow dilatancy and low toughness, trace of gravel. Max. size, 1 inch. Strong reaction with HCl. In-place condition: firm consistency, homogenous, dry, weak cementation. Color is reddish brown. Lab test data from 0.0-3.0 ft.: Lab classification is Clayey Sand (SC): 60% sand, 40% fines, trace of gravel. Liquid Limit (LL) = 20.0; Plasticity Index (PI) = 8.1; Field Moisture = 4.3%. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
SM Visual Class. Lab sample taken from 3.0-6.0 ft. SM Lab Class. **6.0 ft.**	**3.0 - 6.0 ft. Silty Sand (SM):** About 70% fine to coarse sand, 20% nonplastic fines with high dry strength, rapid dilatancy and low toughness, 10% predominantly fine to coarse gravel. Max. size, 1 inch. Strong reaction with HCl. In-place condition: hard consistency, homogenous, dry, strong cementation. Thin stringers (1/16 to 1/8 inch thick) of $CaCO_3$ present. From about 4 to 6 feet, material is strongly cemented with caliche ($CaCO_3$). Color is reddish brown. Lab test data from 3.0-6.0 ft.: Lab classification is Silty Sand (SM): 74% sand, 18% fines, 8% gravel. Nonplastic. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
Ss Visual Class. **11.0 ft.**	**6.0 - 11.0 ft. Sandstone (Ss):** Sandstone consists of fine to predominantly coarse, subrounded sand, fine to coarse gravel and a trace of fine cobbles weakly cemented with $CaCO_3$. Intensely weathered and soft, fragments crumble with manual pressure. Becomes slightly harder with depth. No reaction with HCl. Color is grayish orange (10YR 7/4). The sandstone is part of the conglomerate and sandstone sequence mapped as Tsy and deposited on top of the Mancos Shale Formation **Geologic Interpretation:** Pliocene to Mid-Miocene Deposits (Tsy)			

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-220**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1803966 **E.** 992953 **GROUND ELEVATION:** 6071

APPROXIMATE DIMENSIONS: 15' x 6' x 12.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/5/2015 **DATE LOGGED:** 10/5/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class. Lab sample taken from 0.0-4.0 ft. SM Lab Class. **7.5 ft.**	**0.0 - 7.5 ft. Silty Sand (SM):** About 85% predominantly fine to coarse sand and 15% nonplastic fines with high dry strength, rapid dilatancy and low toughness. Max. size, coarse sand. Strong reaction with HCl. In-place condition: loose at the surface becoming firm consistency with depth, homogenous, dry, no to weak cementation. Color is light reddish brown. Lab test data from 0.0-4.0 ft.: Lab classification is Silty Sand (SM): 87% sand, 13% fines. Nonplastic; Field Moisture = 2.4%. Proctor Test (max. dry density) = 116.9 lbm/ft^3; Optimum Moisture = 9.8%. In-Place Density taken at 3.8 ft. with sand cone apparatus = 104.1 lbm/ft^3. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
Sh Visual Class. **12.0 ft.**	**7.5 - 12.0 ft. Shale (Sh):** Shale is a very fine-grained, clastic sedimentary rock composed of silt- to clay-sized particles. The shale is moderately weathered and soft, fragments crumble with manual pressure. Laminated, bedding less than 3/8 inch thick and fissile. Color is light bluish gray (5B 7/1) to light brownish gray (5YR 6/1). $CaCO_3$ crystals and thin stringers present, especially in the upper 3 feet. **Geologic Interpretation:** Mancos Shale (Km)			

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-221**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1800098 **E.** 997756 **GROUND ELEVATION:** 5944

APPROXIMATE DIMENSIONS: 15' x 3' x 10.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/6/2015 **DATE LOGGED:** 10/6/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class. Lab sample taken from 4.0-7.5 ft. SM Lab Class. **7.5 ft.**	**0.0 - 7.5 ft. Silty Sand (SM):** About 85% predominantly fine to coarse sand and 15% nonplastic fines with high dry strength, rapid dilatancy and low toughness. Max. size, coarse sand. Strong reaction with HCl. In-place condition: loose at the surface becoming firm consistency with depth, homogenous, dry, no to weak cementation. Color is light reddish brown. Lab test data from 4.0-7.5 ft.: Lab classification is Silty Sand (SM): 85% sand, 15% fines. Nonplastic; Field Moisture = 1.8%. Proctor Test (max. dry density) = 117.4 lbm/ft^3; Optimum Moisture = 12.9%. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
Sh Visual Class. **10.5 ft.**	**7.5 - 10.5 ft. Shale (Sh):** Shale with interbedded siltstone. Shale is a very fine-grained, clastic sedimentary rock composed of silt- to clay-sized particles. The shale is moderately weathered and soft, fragments crumble with manual pressure. Laminated, bedding less than 3/8 inch thick and fissile. Color is medium light gray (N6). Interbedded siltstone is very fine-grained, moderately soft to moderately hard, some fragments break with heavy manual pressure others require light hammer blow to break. Very thinly bedded, bedding ½ to 1 inch thick. Color is pinkish gray (5YR 8/1). **Geologic Interpretation:** Mancos Shale (Km)			

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-222

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1797435 **E.** 1001113 **GROUND ELEVATION:** 6071

APPROXIMATE DIMENSIONS: 15' x 3' x 12.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/6/2015 **DATE LOGGED:** 10/6/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class.	**0.0 - 11.0 ft. Silty Sand (SM):** About 80% predominantly fine to coarse sand, 20% nonplastic fines with high dry strength, rapid dilatancy and low toughness, trace of gravel. Max. size, 1 inch. Strong reaction with HCl. In-place condition: loose at the surface developing a very hard consistency with depth, homogenous, dry, no cementation at surface becoming strongly cemented with depth. From 3.5 to 4.5 ft. and 10.0 to 11.0 ft. material is well cemented with caliche ($CaCO_3$) and hard to dig. Color is light reddish brown.	0	0	0
Lab sample taken from 4.0-10.0 ft. SM Lab Class.	Lab test data from 4.0-10.0 ft.: Lab classification is Silty Sand (SM): 82% sand, 11% fines, trace of gravel. Nonplastic; Field Moisture = 2.7%. Proctor Test (max. dry density) = 118.0 lbm/ft^3; Optimum Moisture = 10.4%.			
11.0 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
Sh Visual Class.	**11.0 - 12.0 ft. Shale (Sh):** Shale with interbedded siltstone. Shale is a very fine-grained, clastic sedimentary rock composed of silt- to clay-sized particles. The shale is moderately weathered and soft, fragments crumble with manual pressure. Laminated, bedding less than 3/8 inch thick and fissile. Color is medium light gray (N6). Interbedded siltstone is very fine-grained, moderately soft to moderately hard, some fragments break with heavy manual pressure others require light hammer blow to break. Very thinly bedded, bedding ½ to 1 inch thick. Color is pinkish gray (5YR 8/1).			
12.0 ft.	**Geologic Interpretation:** Mancos Shale (Km)			

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at reach of equipment, but material becoming hard to excavate.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-224**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1787227 **E.** 1006297 **GROUND ELEVATION:** 6309

APPROXIMATE DIMENSIONS: 15' x 6' x 10.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/6/2015 **DATE LOGGED:** 10/6/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class.	**0.0 - 4.8 ft. Silty Sand (SM):** About 80% predominantly fine to coarse sand, 20% nonplastic fines with high dry strength, rapid dilatancy and low toughness, trace of gravel. Max. size, 1 inch. Strong reaction with HCl. In-place condition: loose at the surface developing a very hard consistency with depth, homogenous, dry, no cementation at surface becoming strongly cemented with depth. From 3.5 to 4.5 ft. and 10.0 to 11.0 ft. material is well cemented with caliche ($CaCO_3$) and hard to dig. Color is light reddish brown.	0	0	0
Lab sample taken from 0.0-4.8 ft. SM Lab Class.	Lab test data from 0.0-4.8 ft.: Lab classification is Silty Sand (SM): 86% sand, 14% fines. Nonplastic; Field Moisture = 4.3%. Proctor Test (max. dry density) = 118.4 lbm/ft^3; Optimum Moisture = 9.4%. In-Place Density taken at 4.0 ft. with sand cone apparatus = 117.6 lbm/ft^3. Corrosion Potential Testing 0.0-4.8 ft.: pH = 8.7, Resistivity = 8,224 ohm/cm.			
4.8 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
Mdst Visual Class.	**4.8 - 10.0 ft. Mudstone (Mdst):** Mudstone with interbedded siltstone. Mudstone is a very fine-grained, clastic sedimentary rock composed of silt- to clay-sized particles. Mudstone is moderately weathered and soft, fragments crumble with manual pressure. Bedding not apparent. Color is medium light gray (N6).			
10.0 ft.	**Geologic Interpretation:** Mesaverde Group, Toreva Formation, Middle Member (Kmv)			

REMARKS: **S**urface: slight slope within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-225

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1789535 **E.** 1011513 **GROUND ELEVATION:** 6332

APPROXIMATE DIMENSIONS: 15' x 3' x 11.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/6/2015 **DATE LOGGED:** 10/6/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class. Lab sample taken from 0.0-8.0 ft. SM Lab Class. **8.0 ft.**	**0.0 - 8.0 ft. Silty Sand (SM):** About 80% predominantly fine to coarse sand, 20% nonplastic fines with high dry strength, rapid dilatancy and low toughness, trace of gravel. Max. size, 1 inch. From 0.0-4.0 ft. no reaction with HCl; from 4.0-4.5 ft. strong reaction with HCl. In-place condition: loose at the surface developing a very hard consistency with depth, homogenous, dry, no cementation at surface becoming strongly cemented with depth. From 4.0-4.5 ft. material is well cemented with caliche ($CaCO_3$) and hard to dig. Color is reddish brown. Lab test data from 0.0-8.0 ft.: Lab classification is Silty Sand (SM): 84% sand, 16% fines, trace of gravel. Nonplastic; Field Moisture = 2.2%. Proctor Test (max. dry density) = 117.1 lbm/ft^3; Optimum Moisture = 10.6%. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
Mdst Visual Class. **11.0 ft.**	**8.0 - 11.0 ft. Mudstone (Mdst):** Mudstone is a very fine-grained, clastic sedimentary rock composed of silt- to clay-sized particles. Mudstone is moderately weathered and soft, fragments crumble with manual pressure. Bedding not apparent. From 8.0-8.5 ft. mudstone is laced with $CaCO_3$ veins up to ¾ inch thick. Strong reaction with HCl. Color is medium light gray (N6). **Geologic Interpretation:** Mesaverde Group, Toreva Formation, Middle Member (Kmv)			

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-226

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1794496 **E.** 1014129 **GROUND ELEVATION:** 6295

APPROXIMATE DIMENSIONS: 15' x 3' x 10.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/6/2015 **DATE LOGGED:** 10/6/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class.	**0.0 - 5.5 ft. Silty Sand (SM):** About 80% predominantly fine to coarse sand, 20% nonplastic fines with high dry strength, rapid dilatancy and low toughness, trace of gravel. Max. size, 1 inch. From 0.0-2.5 ft. no reaction with HCl; from 2.5-5.5 ft. strong reaction with HCl. In-place condition: loose at the surface developing a very hard consistency with depth, homogenous, dry, no cementation at surface becoming strongly cemented with depth. From 2.5-5.5 ft. material is well cemented with caliche ($CaCO_3$). Color is reddish brown.	0	0	0
5.5 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
Ss Visual Class.	**5.5 - 6.0 ft. Sandstone (Ss):** Sandstone consists of predominately coarse sand partially cemented with $CaCO_3$. Very intensely weathered and very soft, fragments crumble with manual pressure. Strong reaction with HCl. Color is grayish orange (10YR 7/4).			
6.0 ft.	**Geologic Interpretation:** Mesaverde Group, Toreva Formation, Middle Member (Kmv)			
Mdst Visual Class.	**6.0 - 10.5 ft. Mudstone (Mdst):** Mudstone is a very fine-grained, clastic sedimentary rock composed of silt- to clay-sized particles. Mudstone is moderately weathered and soft, fragments crumble with manual pressure. Bedding not apparent. From 9.5-10.5 ft. mudstone is iron oxide stained and rusty colored. Color is medium light gray (N6).			
10.5 ft.	**Geologic Interpretation:** Mesaverde Group, Toreva Formation, Middle Member (Kmv)			

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-227

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1806635 **E.** 1015140 **GROUND ELEVATION:** 6133

APPROXIMATE DIMENSIONS: 15' x 3' x 12.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/6/2015 **DATE LOGGED:** 10/6/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class.	**0.0 - 6.0 ft. Silty Sand (SM):** About 80% predominantly fine to coarse sand, 20% nonplastic fines with high dry strength, rapid dilatancy and low toughness, trace of gravel. Max. size, 3/4 inch. Strong reaction with HCl. In-place condition: loose at the surface developing a very hard consistency with depth, homogenous, dry, no cementation at surface becoming strongly cemented with depth. From 3.0-6.0 ft. material is well cemented with caliche ($CaCO_3$). Color is reddish brown.	0	0	0
6.0 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
Sh Visual Class.	**6.0 - 12.0 ft. Shale (Sh):** Shale with interbedded siltstone. Shale is a very fine-grained, clastic sedimentary rock composed of silt- to clay-sized particles. The shale is intensely weathered and soft, fragments crumble with manual pressure. Laminated, bedding less than 3/8 inch thick and fissile. Color is grayish orange (10YR 7/4). Interbedded siltstone is very fine-grained, moderately soft to moderately hard, some fragments break with heavy manual pressure. Very thinly bedded, bedding is 1/4 to ½ to inch thick. Color is pale grayish orange (10YR 8/4). Corrosion Potential Testing 6.0-10.0 ft.: pH = 8.0, Resistivity = 423ohm/cm.			
12.0 ft.	**Geologic Interpretation:** Mancos Shale (Km)			

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-228

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1810581 **E.** 1021665 **GROUND ELEVATION:** 5917

APPROXIMATE DIMENSIONS: 15' x 3' x 9.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/6/2015 **DATE LOGGED:** 10/6/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class.	**0.0 - 6.0 ft. Silty Sand (SM):** About 80% predominantly fine to coarse sand, 20% nonplastic fines with high dry strength, rapid dilatancy and low toughness, trace of gravel. Max. size, 3/4 inch. Strong reaction with HCl. In-place condition: loose at the surface developing a very hard consistency with depth, homogenous, dry, no cementation at surface becoming strongly cemented with depth. From 3.0-6.0 ft. material is well cemented with caliche ($CaCO_3$). Color is light reddish brown.	0	0	0
6.0 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
Ss Visual Class.	**6.0 - 9.0 ft. Sandstone (Ss):** Sandstone consists of predominately fine, subrounded sand cemented with silica and iron oxide. Moderately weathered and soft to moderately soft, fragments break with manual pressure. Becomes slightly harder with depth. No reaction with HCl. Bedding not discernible in pit walls, but probably 1-3 inches thick (seen in outcrop). Iron oxide stained. Color is pale grayish orange (10YR 8/4).			
9.0 ft.	**Geologic Interpretation:** Dakota Sandstone (Kd)			

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at refusal.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-229**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1810017 **E.** 1027195 **GROUND ELEVATION:** 5845

APPROXIMATE DIMENSIONS: 15' x 3' x 11.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/6/2015 **DATE LOGGED:** 10/6/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SC-SM Visual Class.	**0.0 - 4.0 ft. Silty Clayey Sand (SC-SM):** About 55% predominantly fine to coarse sand, 45% fines with low plasticity, high dry strength, slow dilatancy and low toughness, trace of gravel. Max. size, 1 inch. Strong reaction with HCl. In-place condition: loose at the surface developing a very hard consistency with depth, homogenous, dry, no cementation at surface becoming strongly cemented with depth. From 3.0-6.0 ft. material is well cemented with caliche ($CaCO_3$). Color is light brown.	0	0	0
Lab sample taken from 0.0-4.0 ft. SC-SM Lab Class.	Lab test data from 0.0-4.0 ft.: Lab classification is Silty Clayey Sand (SM): 53% sand, 47% fines, trace of gravel. Liquid Limit (LL) = 21.8; Plasticity Index (PI) = 5.4; Field Moisture = 5.2%. Proctor Test (max. dry density) = 118.2 lbm/ft^3; Optimum Moisture = 12.3%.			
4.0 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			
Sh Visual Class.	**4.0 - 11.5 ft. Shale (Sh):** Shale with interbedded siltstone, sandstone and coal. Shale is a very fine-grained, clastic sedimentary rock composed of silt- to clay-sized particles. The shale is intensely weathered and soft, fragments crumble with manual pressure. Laminated, bedding less than 3/8 inch thick and fissile. Color is medium dark gray (N4). Interbedded siltstone is very fine-grained, moderately soft to moderately hard, some fragments break with heavy manual pressure. Very thinly bedded, bedding is 1/4 to ½ to inch thick. Color is grayish orange (10YR 7/4). Sandstone consists of predominately fine sand cemented with $CaCO_3$. Moderately weathered and soft to moderately soft, fragments break with manual pressure. Color is pale grayish orange (10YR 8/4). Coal occurs as very thin, intermittent layers.			
11.5 ft.	**Geologic Interpretation:** Dakota Sandstone, Middle Carbonaceous Member (Kd)			

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-230**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1811265 **E.** 1035896 **GROUND ELEVATION:** 5704

APPROXIMATE DIMENSIONS: 15' x 3' x 11.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/6/2015 **DATE LOGGED:** 10/6/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
s(CL) Visual Class.	**0.0 - 11.0 ft. Sandy Lean Clay s(CL):** About 55% fines with medium plasticity, high dry strength, slow dilatancy and low toughness, 45% predominantly fine to coarse sand. Max. size, coarse sand. Strong reaction with HCl. In-place condition: loose at the surface developing a very hard consistency with depth, homogenous, dry, no cementation at surface becoming strongly cemented with depth. Material becomes sandier near the bottom of the excavation. Color is pinkish gray.	0	0	0
Lab sample taken from 0.0-6.0 ft. s(CL) Lab Class.	Lab test data from 0.0-6.0 ft.: Lab classification is Sandy Lean Clay s(CL): 52% fines, 48% sand. Liquid Limit (LL) = 24.7; Plasticity Index (PI) = 13.2; Field Moisture = 6.6%. Proctor Test (max. dry density) = 119.6 lbm/ft^3; Optimum Moisture = 12.8%.			
11.0 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-231**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1812147 **E.** 1040084 **GROUND ELEVATION:** 5733

APPROXIMATE DIMENSIONS: 15' x 6' x 12.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/6/2015 **DATE LOGGED:** 10/6/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class. Lab sample taken from 0.0-4.5 ft. SM Lab Class. **12.0 ft.**	**0.0 - 12.0 ft. Silty Sand (SM):** About 55% predominantly fine to coarse sand, 45% nonplastic fines with high dry strength, rapid dilatancy and low toughness. Max. size, coarse sand. Strong reaction with HCl. In-place condition: loose at the surface developing a very hard consistency with depth, homogenous, dry, no cementation at surface becoming variably cemented with depth. Color is very pale brown. Lab test data from 0.0-4.5 ft.: Lab classification is Silty Sand (SM): 55% sand, 45% fines. Nonplastic; Field Moisture = 3.6%. Proctor Test (max. dry density) = 116.5 lbm/ft^3; Optimum Moisture = 12.9%. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-232**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1813646 **E.** 1047135 **GROUND ELEVATION:** 5712

APPROXIMATE DIMENSIONS: 15' x 6' x 13.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/7/2015 **DATE LOGGED:** 10/7/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SC/CL Visual Class.	**0.0 - 13.0 ft. Clayey Sand (SC/CL):** About 50% predominantly fine to coarse sand, 50% fines with medium to low plasticity, high dry strength, slow dilatancy and medium toughness, trace of fine to coarse gravel. Max. size, 1 inch. Strong reaction with HCl. At about 8.0 ft. encountered a discontinuous layer of sandstone cobbles from 0.3-1.0 ft. in diameter . In-place condition: loose at the surface developing a very hard consistency with depth, homogenous, dry, no cementation at surface becoming weakly cemented with depth; easily excavated. Color is very pale brown.	0	0	0
Lab sample taken from 0.0-4.5 ft. SC/CL Lab Class.	Lab test data from 0.0-4.5 ft.: Lab classification is Clayey Sand (SC/CL): 51% sand, 49% fines, trace of gravel. Liquid Limit (LL) = 22.3; Plasticity Index (PI) = 9.3; Field Moisture = 4.3%. Proctor Test (max. dry density) = 118.9 lbm/ft^3; Optimum Moisture = 12.4%. In-Place Density taken at 4.5 ft. with sand cone apparatus = 90.8 lbm/ft^3.			
13.0 ft.	**Geologic Interpretation:** Quaternary Alluvium			

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-233

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1814825 **E.** 1052585 **GROUND ELEVATION:** 5711

APPROXIMATE DIMENSIONS: 15' x 3' x 11.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/7/2015 **DATE LOGGED:** 10/7/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
s(CL) Visual Class. Lab sample taken from 0.0-7.0 ft. s(CL) Lab Class. **11.0 ft.**	**0.0 - 11.0 ft. Sandy Lean Clay s(CL):** About 65% fines with medium to low plasticity, high dry strength, slow dilatancy and medium toughness, 35% predominantly fine to coarse sand, trace of fine gravel. Max. size, 1/2 inch. Strong reaction with HCl. In-place condition: loose at the surface developing a very hard consistency with depth, homogenous, dry, no cementation at surface becoming strongly cemented with depth. From 5.5- 6.0 ft. $CaCO_3$ veinlets up to 1/8 inch present. Below 7.0 ft, caliche ($CaCO_3$). Color is very pale brown. Lab test data from 0.0-7.0 ft.: Lab classification is Sandy Lean Clay s(CL): 64% fines, 36% sand, trace of gravel. Liquid Limit (LL) = 23.6; Plasticity Index (PI) = 12.1; Field Moisture = 5.3%. Proctor Test (max. dry density) = 115.1 lbm/ft^3; Optimum Moisture = 13.8%. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** **TP-234**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1814962 **E.** 1058343 **GROUND ELEVATION:** 5724

APPROXIMATE DIMENSIONS: 15' x 3' x 13.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/7/2015 **DATE LOGGED:** 10/7/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
(CL)s Visual Class. Lab sample taken from 0.0-13.0 ft. (CL)s Lab Class. **13.0 ft.**	**0.0 - 13.0 ft. Lean Clay with Sand (CL)s:** About 75% fines with medium to low plasticity, high dry strength, slow dilatancy and medium toughness, 25% predominantly fine to coarse sand. Max. size, coarse sand. Strong reaction with HCl. In-place condition: loose at the surface developing a very hard consistency with depth, homogenous, dry, no cementation at surface becoming strongly cemented with depth. Color is very pale brown. Lab test data from 0.0-13.0 ft.: Lab classification is Lean Clay with Sand (CL)s): 76% fines, 25% sand. Liquid Limit (LL) = 33.8; Plasticity Index (PI) = 21.1; Field Moisture = 9.0%. Proctor Test (max. dry density) = 109.9 lbm/ft^3; Optimum Moisture = 16.4%. **Geologic Interpretation:** Quaternary Alluvium	0	0	0

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-235

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1810550 **E.** 1061867 **GROUND ELEVATION:** 5775

APPROXIMATE DIMENSIONS: 15' x 6' x 15.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/7/2015 **DATE LOGGED:** 10/7/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class.	**0.0 - 15.0 ft. Silty Sand (SM):** About 75% predominantly fine to coarse sand, 25% nonplastic fines with high dry strength, rapid dilatancy and low toughness, trace of fine to coarse gravel. Max. size, 1 inch. Strong reaction with HCl. In-place condition: loose at the surface developing a very hard consistency with depth, homogenous, dry, no cementation at surface becoming moderately cemented with depth. Color is very pale brown.	0	0	0
Lab sample taken from 0.0-5.0 ft. SM Lab Class.	Lab test data from 0.0-5.0 ft.: Lab classification is Silty Sand (SM): 78% sand, 22% fines, trace of gravel. Nonplastic; Field Moisture = 2.3%. Proctor Test (max. dry density) = 121.0 lbm/ft^3; Optimum Moisture = 12.6%. In-Place Density taken at 4.0 ft. with sand cone apparatus = 100.4 lbm/ft^3. Corrosion Potential Testing 6.0-10.0 ft.: pH = 8.5, Resistivity = 2,181ohm/cm.			
15.0 ft.	**Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)			

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO. TP-236**

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1806198 **E.** 1064620 **GROUND ELEVATION:** 5956

APPROXIMATE DIMENSIONS: 15' x 3' x 13.5' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/7/2015 **DATE LOGGED:** 10/7/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SP-SM Visual Class. Lab sample taken from 0.0-7.0 ft. SP-SM Lab Class. **8.0 ft.**	**0.0 - 8.0 ft. Poorly Graded Sand with Silt (SP-SM):** About 90% predominantly fine to coarse sand and 10% nonplastic fines with high dry strength, rapid dilatancy and low toughness, trace of fine to coarse gravel. Max. size, 1 inch. No reaction with HCl. In-place condition: loose, soft consistency, homogenous, dry, no cementation. Color is light reddish brown. Lab test data from 0.0-7.0 ft.: Lab classification is Poorly Graded Sand with Silt (SP-SM): 88% sand, 12% fines, trace of gravel. Nonplastic. Proctor Test (max. dry density) = 109.9 lbm/ft^3; Optimum Moisture = 10.2%. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
Sh Visual Class. **13.5 ft.**	**8.0 - 13.5 ft. Shale (Sh):** Shale with interbedded siltstone and sandstone. Shale is a very fine-grained, clastic sedimentary rock composed of silt- to clay-sized particles. The shale is intensely weathered and very soft, fragments crumble with manual pressure. Bedding is not discernible; resembles mudstone. Color is grayish orange (10YR 7/4). Siltstone is very fine-grained, moderately soft, fragments break with heavy manual pressure. Very thinly bedded, bedding is 1/4 to ½ to inch thick. Surfaces are iron oxide stained. Color is light grayish brown (5YR 6/1). Sandstone is fine grained, intensely weathered and soft to moderately soft, fragments break with manual pressure. Color is very pale orange (10YR 8/2). **Geologic Interpretation:** Mancos Shale (Km)			

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at reach of equipment.

[1] Report to the nearest 0.1 foot (0.03 meter)

7-1336 Bureau of Reclamation	**LOG OF TEST PIT OR AUGER HOLE**	**HOLE NO.** TP-237

FEATURE: NORTH CENTRAL ARIZONA PIPELINE **PROJECT:** NORTH CENTRAL ARIZONA WATER SUPPLY STUDY

AREA DESIGNATION: HOPI SEGMENT **METHOD OF EXPLORATION:** BACKHOE - DEERE 310K

COORDINATES (AZ STATE PLANE CENTRAL ZONE NAD83): **N.** 1802004 **E.** 1067286 **GROUND ELEVATION:** 5967

APPROXIMATE DIMENSIONS: 15' x 3' x 12.0' DEEP **LOGGED BY:** M. MILLER

DEPTH WATER ENCOUNTERED[1]: DRY **DATE:** 10/7/2015 **DATE LOGGED:** 10/7/2105

CLASSIFICATION GROUP SYMBOL (describe sample taken)	**CLASSIFICATION AND DESCRIPTION OF MATERIAL** SEE USBR 5000, 5005	**% PLUS 3 in (75 mm) BY VOLUME**		
		3 – 5 in	**5 – 12 in**	**PLUS 12 in**
SM Visual Class.	**0.0 - 12.0 ft. Silty Sand (SM):** About 85% predominantly fine to coarse sand and 15% nonplastic fines with rapid dilatancy and low toughness, trace of fine to coarse gravel. Max. size, 1 inch. No reaction with HCl. In-place condition: loose, soft consistency, homogenous, dry, no cementation. Color is light reddish brown. Lab test data from 0.0-12.0 ft.: Lab classification is Silty Sand (SM): 85% sand, 115% fines, trace of gravel. Nonplastic; Field Moisture = 1.7%. Proctor Test (max. dry density) = 112.1 lbm/ft^3; Optimum Moisture = 11.6%. **Geologic Interpretation:** Quaternary Eluvium (wind-blown sand)	0	0	0
Lab sample taken from 0.0-12.0 ft. SM Lab Class.				
12.0 ft.				

REMARKS: **S**urface: flat area within ADOT ROW covered with scattered grasses and small shrubs. Coordinates obtained from GPS (NAD83 Arizona State Plane, Central Zone, International Foot). Elevation obtained from Google Earth. Colors refer to Munsell Rock Color Chart. Test pit terminated at reach of equipment.

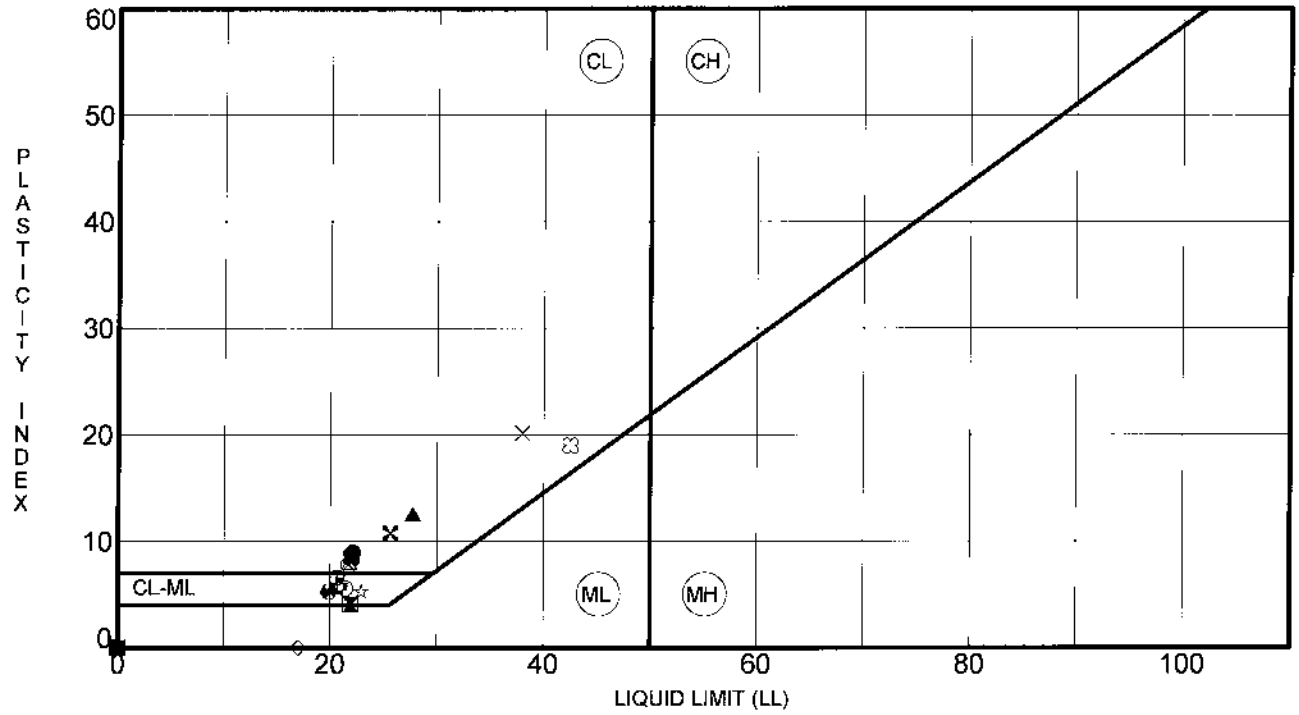
[1] Report to the nearest 0.1 foot (0.03 meter)

Table G-3. North Central Arizona Pipeline - Corrosion Potential.

TEST PIT	SAMPLE INTERVAL (ft)	pH	RESISTIVITY (Ohm-Cm)	SULFATES (SO4) (ppm)	SULFIDE (ppm)	CHLORIDE (CL) (ppm)	UNIFIED SOIL CLASSIFICATION SYMBOL	GEOLOGIC UNIT	CORROSIVITY RATING
TP-01	0.0 - 8.0	8.8	6,218	14	2	17	SM	Qe	moderately
TP-02	0.0 - 12.0	8.5	473	1,400	< 1	120	(SM)g	Qal	extremely
TP-03	4.0 - 13.0	9.0	3,712	25	< 1	62	(SP-SM)g	Qal	corrosive
TP-04	4.0 - 13.0	8.1	483	530	< 1	170	(GC-GM)s	Qal	extremely
TP-05	2.0 - 12.0	8.5	1,021	30	< 1	92	(CL)s	Qal	highly
TP-06	4.0 - 10.4	8.9	2,784	34	3	24	SM	Qal	highly
TP-07	0.0 - 14.0	8.7	1,021	160	2	100	SC-SM	Qal	highly
TP-08	2.0 - 7.0	8.7	1,856	110	6	55	(SC)g	Qal	highly
TP-09	6.0 - 10.0	8.2	659	1,500	< 1	160	(SC-SM)g	Qal	extremely
TP-10	0.0 - 9.0	8.5	2,042	400	< 1	140	(SC-SM)g	Qal	highly
TP-11	0.0 - 6.0	7.3	854	1,700	< 1	72	(SC)g	Qal	extremely
TP-12	3.8 - 11.5	7.7	1,856	51	< 1	57	SC	Qal	highly
TP-13	0.0 - 4.5	8.5	1,949	22	2	60	SC-SM	Qal	highly
TP-14	0.0 - 10.0	8.3	1,949	18	2	24	SM	Qal	highly
TP-15	0.0 - 5.5	8.8	2,042	30	< 1	23	SC-SM	Qal	highly
TP-16	0.0 - 3.5	8.5	2,227	11	4	22	s(CL)	Qal	highly
TP-18	2.5 - 9.0	7.3	752	73	3	74	Mudstone	TRcp	extremely
TP-19	0.0 - 8.0	8.5	928	210	2	420	(SC)g	Qal	extremely
TP-20	0.0 - 8.5	8.4	1,856	29	< 1	66	SC-SM	Qal	highly
TP-21	3.0 - 5.0	9.7	3,526	96	3	67	(SW-SC)g	Qal	corrosive
TP-21	8.0 - 15.0	8.8	2,877	14	< 1	46	s(CL)	Qal	highly
TP-22	6.0 - 14.0	10.2	780	NT	NT	NT	(SW-SC)g	Qal	extremely
TP-23	0.0 - 6.0	9.3	2,227	22	2	26	SM	Qal	highly
TP-23	6.0 - 8.0	9.8	1,949	12	3	17	(SC)g	Qal	highly
TP-24	5.0 - 15.0	9.1	1,578	80	2	34	(SP-SM)g	Qal	highly
TP-25	8.0 - 12.0	7.3	4,640	7	< 1	17	SC-SM	Qal	corrosive
TP-26	3.5 - 10.5	8.8	1,578	7	5	22	Sandstone	TRcp	highly
TP-27	0.0 - 5.0	9.7	2,042	33	< 1	33	SP-SM	Qal	highly
TP-28	0.0 - 14.0	8.7	510	28	2	28	(SM)g	Qal	extremely
TP-29	0.5 - 10.0	8.9	2,970	210	< 1	2,400	Mudstone	TRcp	highly
TP-30	2.0 - 14.0	7.8	408	86	< 1	180	Mudstone	TRcp	extremely
TP-31	0.0 - 3.0	8.9	371	1,800	4	268	Sandstone	TRcp	extremely
TP-32	0.0 - 14.0	8.9	1,670	NT	NT	NT	(SM)g	Qal	highly
TP-33	0.0 - 2.0	8.9	1,021	180	6	49	SC-SM	Qal	highly
TP-34	1.5 - 13.0	7.4	436	3,500	< 1	53	Mudstone	TRcp	extremely
TP-35	0.0 - 4.5	8.9	780	450	6	17	SC	Qal	extremely
TP-36	7.0 - 13.5	8.5	742	2,100	< 1	37	SC	Qal	extremely
TP-37	1.0 - 4.5	8.0	742	1,300	< 1	28	SM	Qal	extremely
TP-38	1.0 - 4.0	7.7	1,485	2,100	2	240	Sandstone	TRcp	highly
TP-39	0.0 - 3.5	7.9	195	450	< 1	260	SC	Qal	extremely

TP-40	0.0 - 5.0	8.9	436	3,800	< 1	2,300	(CH)s	Qal	extremely
TP-41	3.0 - 8.0	7.1	752	3,900	< 1	720	Mudstone	TRcp	extremely
TP-42	7.0 - 14.5	9.1	1,392	36	9	38	SC	Qal	highly
TP-43	0.0 - 6.0	9.0	566	97	2	200	SC-SM	Qal	extremely
TP-44	0.8 - 8.5	9.4	742	110	2	700	Mudstone	TRcp	extremely
TP-45	0.0 - 14.0	8.2	306	75	3	450	Mudstone	TRcp	extremely
TP-46	0.0 - 8.0	8.4	807	1,500	< 1	620	Mudstone	TRcp	extremely
TP-47	0.0 - 8.0	9.4	733	300	< 1	83	SM	Qal	extremely
TP-48	1.8 - 7.5	8.2	1,021	2,100	< 1	390	Mudstone	TRcp	highly
TP-49	0.0 - 3.2	8.9	6,125	3	< 1	7	SP-SM	Qe	moderately
TP-50	0.0 - 5.0	8.3	8,816	2	< 1	7	SM	Qe	moderately
TP-51	4.5 - 6.5	8.8	817	100	< 1	143	s(CL)	Qe	extremely
TP-52	2.0 - 8.0	8.8	9,187	6	< 1	8	SP	Qe	moderately
TP-55	5.0 - 14.5	9.1	2,877	23	< 1	36	SP	Qe	highly
TP-56	2.0 - 15.0	8.4	2,320	38	< 1	55	SP-SM	Qe	highly
TP-57	0.0 - 10.0	8.8	13,920	1	< 1	7	SP-SM	Qe	mildly
TP-58	0.0 - 13.0	9.2	16,704	4	< 1	11	SP	Qe	mildly
TP-59	0.0 - 5.5	8.0	12,992	1	< 1	7	SM	Qe	mildly
TP-60	0.0 - 6.5	9.1	16,704	3	< 1	7	SP	Qe	mildly
TP-61	0.0 - 3.5	8.9	13,920	3	< 1	7	SP-SM	Qe	mildly
TP-62	0.0 - 5.5	7.9	12,992	1	2	14	SP-SM	Qe	mildly
TP-63	0.0 - 5.0	8.6	8,909	5	2	14	SP-SM	Qe	moderately
TP-67	0.0 - 7.0	8.0	9,094	4	< 1	8	SP-SM	Qe	moderately
TP-68	0.0 - 3.3	8.6	7,424	1	< 1	7	SP-SM	Qe	moderately
TP-202	0.0-3.5	8.8	3,802	NT	NT	NT	SP-SM	Qe	corrosive
TP-206	0.0-5.0	8.8	2,735	NT	NT	NT	SM	Qe	highly
TP-211	0.0-3.0	8.5	2,068	NT	NT	NT	s(CL)	Qe	highly
TP-224	0.0-4.8	8.7	8,224	NT	NT	NT	SM	Qe	moderately
TP-227	6.0-10.0	8.0	423	NT	NT	NT	Shale	Km	extremely
TP-235	6.0-10.0	8.5	2,181	NT	NT	NT	SM	Qe	highly

Soil Resistivity (ohm cm)	Corrosivity Rating
>20,000	Essentially non-corrosive
10,000 to 20,000	Mildly corrosive
5,000 to 10,000	Moderately corrosive
3,000 to 5,000	Corrosive
1,000 to 3,000	Highly corrosive
<1,000	Extremely corrosive



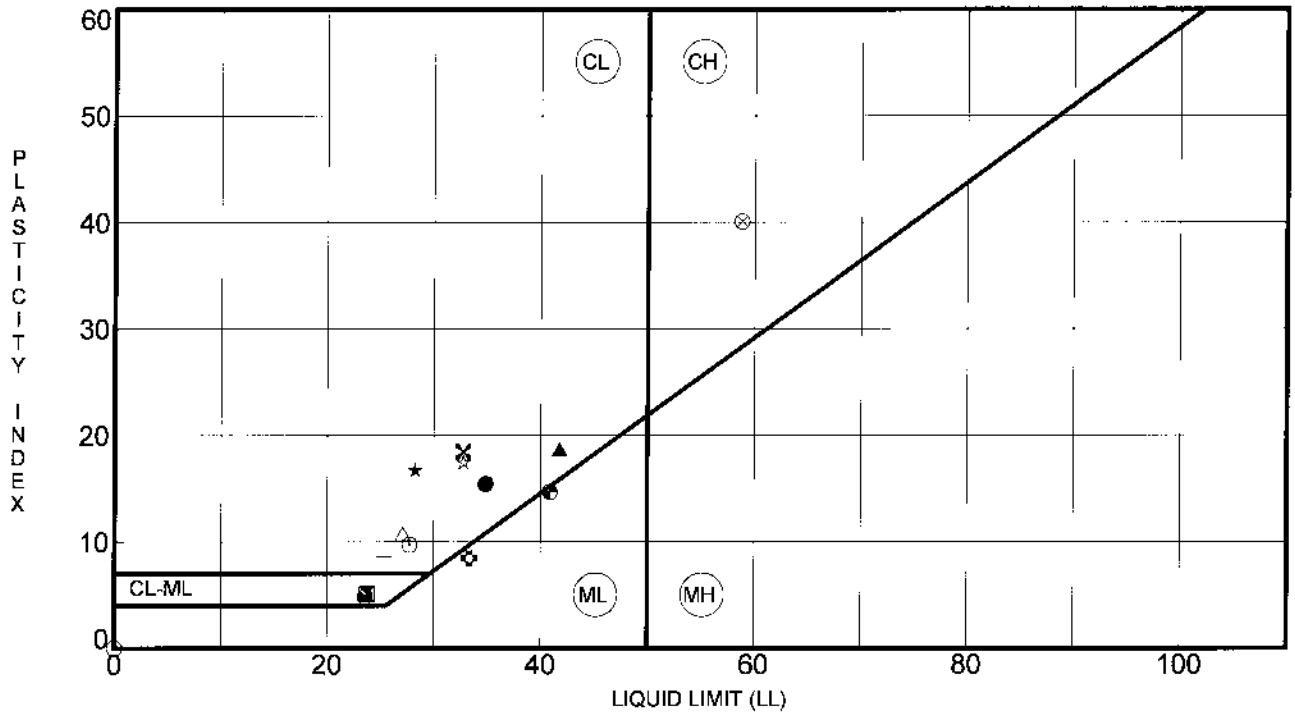
Specimen Identification		LL	PL	PI	Fines	Classification
●	TP-02 0.0	NP	NP	NP	36.9	SILTY SAND with GRAVEL SM
⊠	TP-04 4.0	22	18	4	14.6	SILTY, CLAYEY GRAVEL with SAND GC-GM
▲	TP-05 2.0	28	15	13	72.1	LEAN CLAY with SAND CL
★	TP-07 0.0	20	15	5	42.3	SILTY, CLAYEY SAND SC-SM
×	TP-08 2.0	26	15	11	37.0	CLAYEY SAND with GRAVEL SC
✿	TP-09 6.0	21	15	6	27.9	SILTY, CLAYEY SAND with GRAVEL SC-SM
○	TP-10 0.0	21	16	6	30.2	SILTY, CLAYEY SAND with GRAVEL SC-SM
△	TP-11 0.0	22	14	8	38.5	CLAYEY SAND with GRAVEL SC
⊗	TP-12 3.8	22	14	8	30.2	CLAYEY SAND SC
◐	TP-13 0.0	21	14	7	38.6	SILTY, CLAYEY SAND SC-SM
▭	TP-14 0.0	NP	NP	NP	15.3	SILTY SAND SM
⊖	TP-15 0.0	20	15	5	23.4	SILTY, CLAYEY SAND SC-SM
◕	TP-19 0.0	22	13	9	18.7	CLAYEY SAND with GRAVEL SC
☆	TP-20 0.0	23	18	5	28.0	SILTY, CLAYEY SAND SC-SM
⊠	TP-21 8.0	42	24	19	68.1	CLAYSTONE (SANDY LEAN CLAY CL)
■	TP-23 0.0	NP	NP	NP	30.7	SILTY SAND SM
◆	TP-23 6.0	22	13	9	17.6	CLAYEY SAND with GRAVEL SC
◇	TP-25 8.0	17	NP	NP	19.3	SILTY SAND SM
⊠	TP-29 3.0	38	18	20	73.0	CLAYSTONE (LEAN CLAY with SAND CL)
✱	TP-30 2.0	22	14	8	78.3	LEAN CLAY with SAND CL

PROJECT Cameron Water Line - Page to Cameron
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ATTERBERG LIMITS' RESULTS

SPEEDIE AND ASSOCIATES

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Specimen Identification			LL	PL	PI	Fines	Classification
●	TP-31	0.0	35	19	15	29.0	CLAYEY SAND SC
⊠	TP-33	0.0	24	19	5	22.9	SILTY, CLAYEY SAND SC-SM
▲	TP-34	1.5	42	23	19	76.1	CLAYSTONE (LEAN CLAY with SAND CL)
★	TP-35	0.0	28	11	17	34.6	CLAYEY SAND SC
×	TP-36	0.0	33	14	18	28.1	CLAYEY SAND SC
✡	TP-37	1.0	33	25	8	22.8	SILTY SAND SM
○	TP-38	1.0	NP	NP	NP	27.8	SILTY SAND SM
△	TP-39	0.0	27	16	11	25.4	CLAYEY SAND SC
⊗	TP-40	0.0	59	19	40	70.8	FAT CLAY with SAND CH
⊕	TP-42	7.0	28	18	10	47.0	CLAYEY SAND SC
❐	TP-43	0.0	25	18	8	41.6	SILTY, CLAYEY SAND SC-SM
⊖	TP-44	0.0	24	19	5	41.5	SILTY, CLAYEY SAND SC-SM
◒	TP-46	0.0	41	26	15	53.9	CLAYSTONE (SANDY SILT with GRAVEL ML)
☆	TP-51	4.5	33	15	18	61.4	SANDY LEAN CLAY CL

PROJECT **Cameron Water Line - Page to Cameron** JOB NO. **120751TF**
DATE **6/18/12**

ATTERBERG LIMITS' RESULTS

SPEEDIE AND ASSOCIATES

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CORROSIVE TEST DATA

SOIL BORING or TEST PIT NUMBER	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE INTERVAL (ft)	PERCENT FINER #200 SIEVE	pH	RESISTIVITY (Ohm-Centimeters)	SULFATE (SO4) (ppm)	CHLORIDE (CL) (ppm)	REDOX (millivolts)	SULFIDE (ppm)	UNIFIED SOIL CLASSIFICATION	SPECIMEN DESCRIPTION
TP-01	BS-1	BULK	0.0 - 8.0	14.5	8.82	6217.6	14	17	NT	2	SC-SM	SILTY, CLAYEY SAND
TP-02	BS-1	BULK	0.0 - 12.0	36.9	8.48	473.3	1400	120	NT	<1	SM	SILTY SAND with GRAVEL
TP-03	BS-1	BULK	4.0 - 13.0	8.5	9	3712	25	62	NT	<1	SP-SM-SC	POORLY GRADED SAND with SILT, CLAY, and GRAVEL
TP-04	BS-1	BULK	4.0 - 13.0	14.6	8.1	482.6	530	170	NT	<1	GC-GM	SILTY, CLAYEY GRAVEL with SAND
TP-05	BS-1	BULK	2.0 - 12.0	72.1	8.45	1020.8	30	92	NT	<1	CL	LEAN CLAY with SAND
TP-06	BS-1	BULK	4.0 - 10.4	14.7	8.88	2784	34	24	NT	3	SC-SM	SILTY, CLAYEY SAND
TP-07	BS-1	BULK	0.0 - 14.0	42.3	8.68	1020.8	160	100	NT	2	SC-SM	SILTY, CLAYEY SAND
TP-08	BS-1	BULK	2.0 - 7.0	37.0	8.7	1856	110	55	NT	6	SC	CLAYEY SAND with GRAVEL
TP-09	BS-1	BULK	6.0 - 10.0	27.9	8.22	658.9	1500	160	NT	<1	SC-SM	SILTY, CLAYEY SAND with GRAVEL
TP-10	BS-1	BULK	0.0 - 9.0	30.2	8.48	2041.6	400	140	NT	<1	SC-SM	SILTY, CLAYEY SAND with GRAVEL
TP-11	BS-1	BULK	0.0 - 6.0	38.5	7.26	853.8	1700	72	NT	<1	SC	CLAYEY SAND with GRAVEL
TP-12	BS-1	BULK	3.8 - 11.5	30.2	7.66	1856	51	57	NT	<1	SC	CLAYEY SAND
TP-13	BS-1	BULK	0.0 - 4.5	38.6	8.5	1948.8	22	60	NT	2	SC-SM	SILTY, CLAYEY SAND
TP-14	BS-1	BULK	0.0 - 10.0	15.3	8.32	1948.8	18	24	NT	2	SM	SILTY SAND
TP-15	BS-1	BULK	0.0 - 5.5	23.4	8.8	2041.6	30	23	NT	<1	SC-SM	SILTY, CLAYEY SAND

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CORROSIVE TEST DATA

SOIL BORING or TEST PIT NUMBER	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE INTERVAL (ft)	PERCENT FINER #200 SIEVE	pH	RESISTIVITY (Ohm-Centimeters)	SULFATE (SO4) (ppm)	CHLORIDE (CL) (ppm)	REDOX (millivolts)	SULFIDE (ppm)	UNIFIED SOIL CLASSIFICATION	SPECIMEN DESCRIPTION
TP-16	BS-1	BULK	0.0 - 3.5	51.5	8.48	2227.2	11	22	NT	4	CL	CLAYSTONE (SANDY LEAN CLAY)
TP-18	BS-1	BULK	2.5 - 9.0	94.2	7.25	751.7	73	74	NT	3	CL	CLAYSTONE (LEAN CLAY)
TP-19	BS-1	BULK	0.0 - 8.0	18.7	8.54	928	210	420	NT	2	SC	CLAYEY SAND with GRAVEL
TP-20	BS-1	BULK	0.0 - 8.5	28.0	8.41	1856	29	66	NT	<1	SC-SM	SILTY, CLAYEY SAND
TP-21	BS-1	BULK	3.0 - 5.0	4.6	9.7	3526.4	96	67	NT	3	SW-SM-SC	WELL-GRADED SAND with SILT, CLAY, and GRAVEL
TP-21	BS-2	BULK	8.0 - 15.0	68.1	8.83	2876.8	14	46	NT	<1	CL	(CLAYSTONE) SANDY LEAN CLAY
TP-22	BS-1	BULK	6.0 - 14.0	11.7	10.16	779.5	NT	NT	NT	NT	SW-SM-SC	WELL-GRADED SAND with SILT, CLAY, and GRAVEL
TP-23	BS-1	BULK	0.0 - 6.0	30.7	9.29	2227.2	22	26	NT	2	SM	SILTY SAND
TP-23	BS-2	BULK	6.0 - 8.0	17.6	9.83	1948.8	12	17	NT	3	SC	CLAYEY SAND with GRAVEL
TP-24	BS-1	BULK	5.0 - 15.0	6.6	9.11	1577.6	80	34	NT	2	SP-SM-SC	POORLY GRADED SAND with SILT, CLAY, and GRAVEL
TP-25	BS-1	BULK	8.0 - 12.0	19.3	7.31	4640	7	17	NT	<1	SM	SILTY SAND
TP-26	BS-1	BULK	3.5 - 10.5	12.2	8.8	1577.6	7	22	NT	5	SC-SM	SILTY, CLAYEY SAND
TP-27	BS-1	BULK	0.0 - 5.0	10.2	9.7	2041.6	33	33	NT	<1	SP-SM-SC	POORLY GRADED SAND with SILT and CLAY
TP-28	BS-1	BULK	0.0 - 14.0	14.6	8.71	510.4	28	28	NT	2	SC-SM	SILTY, CLAYEY SAND with GRAVEL
TP-29	BS-1	BULK	0.5 - 10.0	73.0	8.85	2969.6	210	2400	NT	<1	CL	CLAYSTONE (LEAN CLAY with SAND)

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CORROSIVE TEST DATA

SOIL BORING or TEST PIT NUMBER	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE INTERVAL (ft)	PERCENT FINER #200 SIEVE	pH	RESISTIVITY (Ohm-Centimeters)	SULFATE (SO4) (ppm)	CHLORIDE (CL) (ppm)	REDOX (millivolts)	SULFIDE (ppm)	UNIFIED SOIL CLASSIFICATION	SPECIMEN DESCRIPTION
TP-30	BS-1	BULK	2.0 - 14.0	78.3	7.84	408.3	86	180	NT	<1	CL	LEAN CLAY with SAND
TP-31	BS-1	BULK	0.0 - 3.0	29.0	8.9	371.2	1800	268	NT	4	SC	CLAYEY SAND
TP-32	BS-1	BULK	0.0 - 14.0	13.1	8.91	1670.4	NT	NT	NT	NT	SC-SM	SILTY, CLAYEY SAND with GRAVEL
TP-33	BS-1	BULK	0.0 - 2.0	22.9	8.91	1020.8	180	49	NT	6	SC-SM	SILTY, CLAYEY SAND
TP-34	BS-1	BULK	1.5 - 13.0	76.1	7.4	436.2	3500	53	NT	<1	CL	CLAYSTONE (LEAN CLAY with SAND)
TP-35	BS-1	BULK	0.0 - 4.5	34.6	8.86	779.5	450	17	NT	6	SC	CLAYEY SAND
TP-36	BS-1	BULK	7.0 - 13.5	28.1	8.48	742.4	2100	37	NT	<1	SC	CLAYEY SAND
TP-37	BS-1	BULK	1.0 - 4.5	22.8	8	742.4	1300	28	NT	<1	SM	SILTY SAND
TP-38	BS-1	BULK	1.0 - 4.0	27.8	7.73	1484.8	2100	240	NT	2	SM	SILTY SAND
TP-39	BS-1	BULK	0.0 - 3.5	25.4	7.89	194.9	450	260	NT	<1	SC	CLAYEY SAND
TP-40	BS-1	BULK	0.0 - 5.0	70.8	8.85	436.2	3800	2300	NT	<1	CH	FAT CLAY with SAND
TP-41	BS-1	BULK	3.0 - 8.0	90.8	7.09	751.7	3900	720	NT	<1	CH	CLAYSTONE (FAT CLAY)
TP-42	BS-1	BULK	7.0 - 14.5	47.0	9.11	1392	36	38	NT	9	SC	CLAYEY SAND
TP-43	BS-1	BULK	0.0 - 6.0	41.6	8.95	566.1	97	200	NT	2	SC-SM	SILTY, CLAYEY SAND
TP-44	BS-1	BULK	0.8 - 8.5	41.5	9.44	742.4	110	700	NT	2	SC-SM	SILTY, CLAYEY SAND
TP-45	BS-1	BULK	0.0 - 14.0	71.7	8.22	306.2	75	450	NT	3	CL	CLAYSTONE (LEAN CLAY with SAND)

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CORROSIVE TEST DATA

SOIL BORING or TEST PIT NUMBER	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE INTERVAL (ft)	PERCENT FINER #200 SIEVE	pH	RESISTIVITY (Ohm-Centimeters)	SULFATE (SO4) (ppm)	CHLORIDE (CL) (ppm)	REDOX (millivolts)	SULFIDE (ppm)	UNIFIED SOIL CLASSIFICATION	SPECIMEN DESCRIPTION
TP-46	BS-1	BULK	0.0 - 8.0	53.9	8.35	807.4	1500	620	NT	<1	ML	CLAYSTONE (SANDY SILT with GRAVEL)
TP-47	BS-1	BULK	0.0 - 8.0	14.8	9.42	733.1	300	83	NT	<1	SC-SM	SILTY, CLAYEY SAND
TP-48	BS-1	BULK	1.8 - 7.5	50.8	8.15	1020.8	2100	390	NT	<1	CL	CLAYSTONE (SANDY LEAN CLAY)
TP-49	373697	BULK	0.0 - 3.2	9.0	8.9	6124.8	3	7	NT	<1	SP-SM-SC	POORLY GRADED SAND with SILT and CLAY
TP-50	BS-1	BULK	0.0 - 5.0	13.5	8.34	8816	2	7	NT	<1	SC-SM	SILTY, CLAYEY SAND
TP-51	BS-1	BULK	4.5 - 6.5	61.4	8.84	816.6	100	143	NT	<1	CL	SANDY LEAN CLAY
TP-52	BS-1	BULK	2.0 - 8.0	3.7	8.82	9187.2	6	8	NT	<1	SP	POORLY GRADED SAND
TP-55	BS-1	BULK	5.0 - 14.5	3.4	9.09	2876.8	23	36	NT	<1	SP	POORLY GRADED SAND
TP-56	BS-1	BULK	2.0 - 15.0	6.6	8.39	2320	38	55	NT	<1	SP-SM-SC	POORLY GRADED SAND with SILT and CLAY
TP-57	BS-1	BULK	0.0 - 10.0	5.5	8.84	13920	1	7	NT	<1	SP-SM-SC	POORLY GRADED SAND with SILT and CLAY
TP-58	BS-1	BULK	0.0 - 13.0	3.6	9.2	16704	4	11	NT	<1	SP	POORLY GRADED SAND
TP-59	BS-1	BULK	0.0 - 5.5	12.2	8	12992	1	7	NT	<1	SC-SM	SILTY, CLAYEY SAND
TP-60	BS-1	BULK	0.0 - 6.5	3.6	9.13	16704	3	7	NT	<1	SP	POORLY GRADED SAND
TP-61	BS-1	BULK	0.0 - 3.5	6.6	8.92	13920	3	7	NT	<1	SP-SM-SC	POORLY GRADED SAND with SILT and CLAY
TP-62	BS-1	BULK	0.0 - 5.5	5.6	7.88	12992	1	14	NT	2	SP-SM-SC	POORLY GRADED SAND with SILT and CLAY
TP-63	BS-1	BULK	0.0 - 5.0	6.8	8.57	8908.8	5	14	NT	2	SP-SM-SC	POORLY GRADED SAND with SILT and CLAY

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CORROSIVE TEST DATA

SOIL BORING or TEST PIT NUMBER	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE INTERVAL (ft)	PERCENT FINER #200 SIEVE	pH	RESISTIVITY (Ohm-Centimeters)	SULFATE (SO4) (ppm)	CHLORIDE (CL) (ppm)	REDOX (millivolts)	SULFIDE (ppm)	UNIFIED SOIL CLASSIFICATION	SPECIMEN DESCRIPTION
TP-67	BS-1	BULK	0.0 - 7.0	6.2	8	9094.4	4	8	NT	<1	SP-SM-SC	POORLY GRADED SAND with SILT and CLAY
TP-68	BS-1	BULK	0.0 - 3.3	8.9	8.64	7424	1	7	NT	<1	SP-SM-SC	POORLY GRADED SAND with SILT and CLAY

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DAILY FIELD REPORT

PROJECT:	Cameron Water Line	**DATE:**	June 5, 2012
LOCATION:	Hwy 89, Page to Cameron Cameron, AZ	**WEATHER CONDITIONS:**	Clear/Windy
CLIENT:	Apache Underground & Excavating	**REPRESENTATIVE:**	Mark Gardner
CONTRACTOR:	Apache Underground & Excavating	**REPRESENTATIVE:**	James Gillespie

Summary for: A. Arp-Romero **Number of Trips:** 1

- ☐ Soil Density Testing
- ☐ AC Density Testing
- ☐ Concrete Testing
- ☐ Pick Up Concrete
- ☒ Pick Up Soil Sample
- ☒ Other: Test Pit Obs./Sampling 7.0

Progress of Work:

The writer arrived on site at request of the client to obtain samples from test pits. The contractor excavated test pits 44, 45, 46, 47 and 48 today. Bulk samples from each test pit were obtained and transported to Speedie and Associates laboratory for testing. Refer to the Tabulation of Test Data and Physical Properties of Soils and Aggregates Reports for testing results. In addition, the writer met with the project geologist throughout the day and discussed the testing to be performed. Field density testing is scheduled to be performed on selected test pits on June 6th.

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S&A PROJECT NO. 120751TF

CLIENT PROJECT NO.

SHEET 1 of 1

DAILY FIELD REPORT

PROJECT:	Cameron Water Line	**DATE:**	June 6, 2012
LOCATION:	Hwy 89, Page to Cameron Cameron, AZ	**WEATHER CONDITIONS:**	Clear/Windy
CLIENT:	Apache Underground & Excavating	**REPRESENTATIVE:**	Mark Gardner
CONTRACTOR:	Apache Underground & Excavating	**REPRESENTATIVE:**	James Gillespie

Summary for: A. Arp-Romero **Number of Trips:** 1

- ☒ Soil Density Testing
- ☐ AC Density Testing
- ☐ Concrete Testing
- ☐ Pick Up Concrete
- ☒ Pick Up Soil Sample
- 9.0
- ☒ Other: Test Pit Obs./Sampling

Progress of Work:

The writer arrived on site at request of the client to obtain samples from test pits and to perform field density testing. The contractor excavated test pits 37, 38, 39, 40, 41, 42, and 43 today. Bulk samples from each test pit were obtained and transported to Speedie and Associates laboratory for testing. Refer to the Tabulation of Test Data and Physical Properties of Soils and Aggregates Reports for testing results. While on site, the writer performed field density testing at test pits 37, 40, and 42. Density testing was performed by the sand cone method and nuclear guage method. Refer to Sand Cone Field Density Test Daily Report and Field Density Test Daily Report for test results.

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S&A PROJECT NO. 120751TF

CLIENT PROJECT NO.

SHEET 1 of 1

DAILY FIELD REPORT

PROJECT:	Cameron Water Line	**DATE:**	June 12, 2012
LOCATION:	Hwy 89, Page to Cameron Cameron, AZ	**WEATHER CONDITIONS:**	Clear/Windy
CLIENT:	Apache Underground & Excavating	**REPRESENTATIVE:**	Mark Gardner
CONTRACTOR:	Apache Underground & Excavating	**REPRESENTATIVE:**	James Gillespie

Summary for: A. Griffiths **Number of Trips:** 1

5.0	☒	Soil Density Testing	☐	Concrete Testing		☒	Pick Up Soil Sample
	☐	AC Density Testing	☐	Pick Up Concrete	4.5	☒	Other: Test Pit Obs./Sampling

Progress of Work:

The writer arrived on site at request of the client to obtain samples from test pits and to perform field density testing. The contractor excavated test pits 35, 33, 31, 29A, and 24 today. Bulk samples from each test pit were obtained and transported to Speedie and Associates laboratory for testing. Refer to the Tabulation of Test Data and Physical Properties of Soils and Aggregates Reports for testing results. While on site, the writer performed field density testing at test pits 35, 31, 29A, and 24 by the sand cone method. Refer to Sand Cone Field Density Test Daily Report for specific testing locations and results.

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S&A PROJECT NO. 120751TF

CLIENT PROJECT NO.

SHEET 1 of 1

DAILY FIELD REPORT

PROJECT:	Cameron Water Line	**DATE:**	June 13, 2012
LOCATION:	Hwy 89, Page to Cameron Cameron, AZ	**WEATHER CONDITIONS:**	Clear/Windy
CLIENT:	Apache Underground & Excavating	**REPRESENTATIVE:**	Mark Gardner
CONTRACTOR:	Apache Underground & Excavating	**REPRESENTATIVE:**	James Gillespie

Summary for: A. Griffiths **Number of Trips:** 1

6.0	☒	Soil Density Testing	☐	Concrete Testing		☒	Pick Up Soil Sample
	☐	AC Density Testing	☐	Pick Up Concrete	5.5	☒	Other: Test Pit Obs./Sampling

Progress of Work:

The writer arrived on site at request of the client to obtain samples from test pits and to perform field density testing. The contractor excavated test pits 23, 22, 21, 20, 19, 11, and 9 today. Bulk samples from each test pit were obtained and transported to Speedie and Associates laboratory for testing. Refer to the Tabulation of Test Data and Physical Properties of Soils and Aggregates Reports for testing results. While on site, the writer performed field density testing at test pits 23, 22, 21, 20, and 11 by the sand cone method. Refer to Sand Cone Field Density Test Daily Report for specific testing locations and results.

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S&A PROJECT NO. 120751TF

CLIENT PROJECT NO.

SHEET 1 of 1

DAILY FIELD REPORT

PROJECT:	Cameron Water Line	**DATE:**	June 14, 2012
LOCATION:	Hwy 89, Page to Cameron Cameron, AZ	**WEATHER CONDITIONS:**	Clear/Windy
CLIENT:	Apache Underground & Excavating	**REPRESENTATIVE:**	Mark Gardner
CONTRACTOR:	Apache Underground & Excavating	**REPRESENTATIVE:**	James Gillespie

Summary for: A. Griffiths **Number of Trips:** 1

3.0	☒ Soil Density Testing	☐ Concrete Testing		☒ Pick Up Soil Sample	
	☐ AC Density Testing	☐ Pick Up Concrete	7.5	☒ Other: Test Pit Obs./Sampling	

Progress of Work:

The writer arrived on site at request of the client to obtain samples from test pits and to perform field density testing. The contractor excavated test pits 4, 3, 2, 1, 5, 6, and 7 today. Bulk samples from each test pit were obtained and transported to Speedie and Associates laboratory for testing. Refer to the Tabulation of Test Data and Physical Properties of Soils and Aggregates Reports for testing results. While on site, the writer performed field density testing at test pits 4, 2, and 7 by the sand cone method. Refer to Sand Cone Field Density Test Daily Report for specific testing locations and results.

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S&A PROJECT NO. 120751TF

CLIENT PROJECT NO.

SHEET 1 of 1

DAILY FIELD REPORT

PROJECT:	Cameron Water Line	**DATE:**	June 19, 2012
LOCATION:	Hwy 89, Page to Cameron Cameron, AZ	**WEATHER CONDITIONS:**	Clear/Windy
CLIENT:	Apache Underground & Excavating	**REPRESENTATIVE:**	Mark Gardner
CONTRACTOR:	Apache Underground & Excavating	**REPRESENTATIVE:**	James Gillespie

Summary for: A. Griffiths **Number of Trips:** 1

3.5	☒ Soil Density Testing	☐ Concrete Testing	☒ Pick Up Soil Sample		
	☐ AC Density Testing	☐ Pick Up Concrete	8.0	☒ Other: Test Pit Obs./Sampling	

Progress of Work:

The writer arrived on site at request of the client to obtain samples from test pits and to perform field density testing. The contractor excavated test pits 57, 58, 59, 60, 61, 62, and 63 today. Bulk samples were obtained from each test pit. The writer also retrieved samples obtained by the contractor from excavations performed the previous day at test pits 49, 50, 51, 52, 55, 67, and 68. All samples were transported tot eh Speedie & Associates laboratory in Flagstaff for testing. Refer to the Tabulation of Test Data report and Physical Properties of Soils and Aggregates Reports for testing results.

While on site, the writer performed field density testing at test pits 58, 62, and 63 by the sand cone method. Refer to Sand Cone Field Density Test Daily Report for specific testing locations and results.

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SAND CONE FIELD DENSITY TEST DAILY REPORT

Project: Cameron Water Line **Project Number:** 120751TF **Date:** June 6, 2012

Location: Hwy 89, Page to Cameron, Cameron, AZ **Technician:** A. Arp-Romero

Client: Apache Underground & Excavating

Contractor: Apache Underground & Excavating **Person Notified:** J. Gillespie

Test	Task	Test Location	Elevation	S.G. -#4 Material	% Rock	Optimum Moisture *	Maximum Dry Density *	Wet Density	% Moisture	Dry Density	% Comp.	Required Comp.	Test Results
1	19	Test Pit #42	EG-5'	2.65	0.0	N/A	N/A	98.2	5.0	93.5			
2	19	Test Pit #40	EG-4'	2.65	0.0	N/A	N/A	86.2	18.2	72.9			
3	19	Test Pit #37	EG-4.5'	2.65	21.1	N/A	N/A	116.3	2.7	113.2			

Remarks:

Elevation		TASK Test Area			Test Element		
FB-Bottom of Footing	FF-Finished Floor	1-Building Pad	7-Apron	13-Storm Sewer Trench	A-Foundation Over Ex Backfill	G-Select Cap	M-Pipe Line/Conduit Bedding
FS-Finished Subgrade		2-Parking Lot	8-Curb/Gutter	14-Elec Conduit Trench	B-Subgrade Prep	H-Underslab Base Course	N-Pipe Line/Conduit Shading
FG-Finished Grade		3-Driveway	9-Sidewalk	15-Irrigation Trench	C-Engineered Fill	I-Pavement Agg. Base Course	O-Trench Backfill
FP-Finished Pavement		4-Landscape Area	10-Water Line Trench	16-Gas Trench	D-Structural Backfill	J-AC Pavement-Base Lift	P-Embankment
BOP-Bottom of Pipe		5-Transformer Pad	11-Fire Line Trench	17-Retaining Wall Backfill	E-Lime Stabilizated Subgrade	K-AC Pavement-Intermed Lift	Q-
TOP-Top of Pipe		6-Roadway	12-Sanitary Sewer Trench	18-RCBC 19-Other Trench	F-Non/Low Expansion Cap	L-AC Pavement-Surface Lift	R-

* = Rock Corrected Value

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FIELD DENSITY TEST DAILY REPORT

Project: Cameron Water Line
Project Number: 120751TF
Date: June 6, 2012
Location: Hwy 89, Page to Cameron, Cameron, AZ
Technician: A. Arp-Romero
Client: Apache Underground & Excavating
Serial Number: 16217
Contractor: Apache Underground & Excavating
Person Notified: James Gillespie

Test	Task	Test Location	Elevation	Material	% Rock	Optimum Moisture *	Maximum Dry Density *	Wet Density	% Moisture	Dry Density	% Comp.	Required Comp.	Test Results
1	19	Test Pit #42	EG -5'	373074	0	N/A	N/A	94.5	4.7	90.3	######	N/A	#####
2	19	Test Pit #40	EG-4'	373072	0	N/A	N/A	97.4	20.6	80.8	######	N/A	#####
3	19	Test Pit #37	EG-4.5'	373351	0	N/A	N/A	109.1	2.7	106.2	######	N/A	#####

Remarks:

TASK

Elevation		Test Area			Test Element		
FB-Bottom of Footing	FF-Finished Floor	1-Building Pad	8-Curb/Gutter	15-Irrigation Trench	A-Foundation Over Ex Backfill	H-Underslab Base Course	O-Trench Backfill
FS-Finished Subgrade		2-Parking Lot	9-Sidewalk	16-Gas trench	B-Subgrade Prep	I-Pavement Agg. Base Course	P-Embankment
FG-Finished Grade		3-Driveway	10-Water Line Trench	17-Retaining Wall Backfill	C-Engineered Fill	J-AC Pavement-Base Lift	
FP-Finished Pavement		4-Landscape Area	11-Fire Line Trench	18-RCBC	D-Structural Backfill	K-AC Pavement-Intermed Lift	
BOP-Bottom of Pipe		5-Transformer Pad	12-Sanitary Sewer Trench	19-Other Trench	E-Lime Stabiltzated Subgrade	L-AC Pavement-Surface Lift	
TOP-Top of Pipe		6-Roadway	13-Storm Sewer Trench		F-Non/Low Expansion Cap	M-Pipe Line/Conduit Bedding	
SL-Spring Line		7-Apron	14-Electric Conduit Trench		G-Select Cap	N-Pipe Line/Conduit Shading	

* = Rock Corrected Value

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SAND CONE FIELD DENSITY TEST DAILY REPORT

Project: Cameron Water Line **Project Number:** 120751TF **Date:** June 12, 2012

Location: Hwy 89, Page to Cameron, Cameron, AZ **Technician:** A. Griffiths

Client: Apache Underground & Excavating

Contractor: Apache Underground & Excavating **Person Notified:** J. Gillespie

Test	Task	Test Location	Elevation	S.G. +#4 Material	% Rock	Optimum Moisture *	Maximum Dry Density *	Wet Density	% Moisture	Dry Density	% Comp.	Required Comp.	Test Results
1	19	Test Pit #35	EG -4.5'	2.65	16.3	N/A	N/A	115.4	2.0	113.1			
2	19	Test Pit #31	EG -4.0'	2.65	1.2	N/A	N/A	121.9	4.4	116.8			
3	19	Test Pit #29	EG -3.0'	2.65	0.0	N/A	N/A	115.5	0.0	115.5			
4	19	Test Pit #24	EG -3.5'	2.65	31.8	N/A	N/A	124.9	0.9	123.7			

Remarks: Moisture testing was not performed for Test Pit #29A. Material was a claystone.

Elevation		TASK Test Area				Test Element		
FB-Bottom of Footing	FF-Finished Floor	1-Building Pad	7-Apron	13-Storm Sewer Trench		A-Foundation Over Ex Backfill	G-Select Cap	M-Pipe Line/Conduit Bedding
FS-Finished Subgrade		2-Parking Lot	8-Curb/Gutter	14-Elec Conduit Trench		B-Subgrade Prep	H-Underslab Base Course	N-Pipe Line/Conduit Shading
FG-Finished Grade		3-Driveway	9-Sidewalk	15-Irrigation Trench		C-Engineered Fill	I-Pavement Agg. Base Course	O-Trench Backfill
FP-Finished Pavement		4-Landscape Area	10-Water Line Trench	16-Gas Trench		D-Structural Backfill	J-AC Pavement-Base Lift	P-Embankment
BOP-Bottom of Pipe		5-Transformer Pad	11-Fire Line Trench	17-Retaining Wall Backfill		E-Lime Stabilizated Subgrade	K-AC Pavement-Intermed Lift	Q-
TOP-Top of Pipe		6-Roadway	12-Sanitary Sewer Trench	18-RCBC	19-Other Trench	F-Non/Low Expansion Cap	L-AC Pavement-Surface Lift	R-

* = Rock Corrected Value

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SAND CONE FIELD DENSITY TEST DAILY REPORT

Project: Cameron Water Line **Project Number:** 120751TF **Date:** June 13, 2012

Location: Hwy 89, Page to Cameron, Cameron, AZ **Technician:** A. Griffiths

Client: Apache Underground & Excavating

Contractor: Apache Underground & Excavating **Person Notified:** J. Gillespic

Test	Task	Test Location	Elevation	S.G. +#4 Material	% Rock	Optimum Moisture *	Maximum Dry Density *	Wet Density	% Moisture	Dry Density	% Comp.	Required Comp.	Test Results
1	19	Test Pit #23	EG -4.0'	2.65	0.0	N/A	N/A	101.8	1.7	100.1			
2	19	Test Pit #22	EG -4.0'	2.65	30.6	N/A	N/A	121.5	0.5	120.9			
3	19	Test Pit #21	EG -3.0'	2.65	19.5	N/A	N/A	127.7	0.4	127.2			
4	19	Test Pit #20	EG -5.0'	2.65	12.5	N/A	N/A	106.5	0.3	106.2			
5	19	Test Pit #11	EG -4.2'	2.65	27.2	N/A	N/A	98.9	1.4	97.6			

Remarks:

TASK

Elevation		Test Area			Test Element		
FB-Bottom of Footing	FF-Finished Floor	1-Building Pad	7-Apron	13-Storm Sewer Trench	A-Foundation Over Ex Backfill	G-Select Cap	M-Pipe Line/Conduit Bedding
FS-Finished Subgrade		2-Parking Lot	8-Curb/Gutter	14-Elec Conduit Trench	B-Subgrade Prep	H-Underslab Base Course	N-Pipe Line/Conduit Shading
FG-Finished Grade		3-Driveway	9-Sidewalk	15-Irrigation Trench	C-Engineered Fill	I-Pavement Agg. Base Course	O-Trench Backfill
FP-Finished Pavement		4-Landscape Area	10-Water Line Trench	16-Gas Trench	D-Structural Backfill	J-AC Pavement-Base Lift	P-Embankment
BOP-Bottom of Pipe		5-Transformer Pad	11-Fire Line Trench	17-Retaining Wall Backfill	E-Lime Stabilizated Subgrade	K-AC Pavement-Intermed Lift	Q-
TOP-Top of Pipe		6-Roadway	12-Sanitary Sewer Trench	18-RCBC 19-Other Trench	F-Non/Low Expansion Cap	L-AC Pavement-Surface Lift	R-

* = Rock Corrected Value

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SAND CONE FIELD DENSITY TEST DAILY REPORT

Project: Cameron Water Line **Project Number:** 120751TF **Date:** June 14, 2012

Location: Hwy 89, Page to Cameron, Cameron, AZ **Technician:** A. Griffiths

Client: Apache Underground & Excavating

Contractor: Apache Underground & Excavating **Person Notified:** J. Gillespie

Test	Task	Test Location	Elevation	S.G. -#4 Material	% Rock	Optimum Moisture *	Maximum Dry Density *	Wet Density	% Moisture	Dry Density	% Comp.	Required Comp.	Test Results
1	19	Test Pit #4	EG -3.8'	2.65	37.4	N/A	N/A	92.4	1.1	91.4			
2	19	Test Pit #2	EG -3.5'	2.65	5.1	N/A	N/A	99.2	0.9	98.4			
3	19	Test Pit #7	EG -3.5'	2.65	11.3	N/A	N/A	104.9	0.8	104.0			

Remarks:

Elevation		TASK Test Area			Test Element		
FB-Bottom of Footing	FF-Finished Floor	1-Building Pad	7-Apron	13-Storm Sewer Trench	A-Foundation Over Ex Backfill	G-Select Cap	M-Pipe Line/Conduit Bedding
FS-Finished Subgrade		2-Parking Lot	8-Curb/Gutter	14-Elec Conduit Trench	B-Subgrade Prep	H-Underslab Base Course	N-Pipe Line/Conduit Shading
FG-Finished Grade		3-Driveway	9-Sidewalk	15-Irrigation Trench	C-Engineered Fill	I-Pavement Agg. Base Course	O-Trench Backfill
FP-Finished Pavement		4-Landscape Area	10-Water Line Trench	16-Gas Trench	D-Structural Backfill	J-AC Pavement-Base Lift	P-Embankment
BOP-Bottom of Pipe		5-Transformer Pad	11-Fire Line Trench	17-Retaining Wall Backfill	E-Lime Stabilizated Subgrade	K-AC Pavement-Intermed Lift	Q-
TOP-Top of Pipe		6-Roadway	12-Sanitary Sewer Trench	18-RCBC 19-Other Trench	F-Non/Low Expansion Cap	L-AC Pavement-Surface Lift	R-

* = Rock Corrected Value

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SAND CONE FIELD DENSITY TEST DAILY REPORT

Project: Cameron Water Line **Project Number:** 120751TF **Date:** June 19, 2012

Location: Hwy 89, Page to Cameron, Cameron, AZ **Technician:** A. Griffiths

Client: Apache Underground & Excavating

Contractor: Apache Underground & Excavating **Person Notified:** J. Gillespie

Test	Task	Test Location	Elevation	S.G. +#4 Material	% Rock	Optimum Moisture *	Maximum Dry Density *	Wet Density	% Moisture	Dry Density	% Comp.	Required Comp.	Test Results
1	19	Test Pit #63	EG -4.5'	2.65	13.2	N/A	N/A	105.6	1.3	104.3			
2	19	Test Pit #62	EG -5.5'	2.65	0.8	N/A	N/A	112.0	0.0	112.0			
3	19	Test Pit #58	EG -4.5'	2.65	0.0	N/A	N/A	101.6	0.0	101.6			

Remarks:

Elevation		TASK Test Area			Test Element		
FB-Bottom of Footing	FF-Finished Floor	1-Building Pad	7-Apron	13-Storm Sewer Trench	A-Foundation Over Ex Backfill	G-Select Cap	M-Pipe Line/Conduit Bedding
FS-Finished Subgrade		2-Parking Lot	8-Curb/Gutter	14-Elec Conduit Trench	B-Subgrade Prep	H-Undersfab Base Course	N-Pipe Line/Conduit Shading
FG-Finished Grade		3-Driveway	9-Sidewalk	15-Irrigation Trench	C-Engineered Fill	I-Pavement Agg. Base Course	O-Trench Backfill
FP-Finished Pavement		4-Landscape Area	10-Water Line Trench	16-Gas Trench	D-Structural Backfill	J-AC Pavement-Base Lift	P-Embankment
BOP-Bottom of Pipe		5-Transformer Pad	11-Fire Line Trench	17-Retaining Wall Backfill	E-Lime Stabilizated Subgrade	K-AC Pavement-Intermed Lift	Q-
TOP-Top of Pipe		6-Roadway	12-Sanitary Sewer Trench	18-RCBC 19-Other Trench	F-Non/Low Expansion Cap	L-AC Pavement-Surface Lift	R-

* = Rock Corrected Value

Reviewed By

SPEEDIE AND ASSOCIATES

LABORATORY REPORT

Physical Properties of Soils and Aggregates

Client: Apache Underground & Excavating, LLC
Attention: Mark Gardner
6141 Crimson Oak Dr.
Lakeside, AZ 85929

Project No. 120751TF
Lab No. 373309
Report Date: 07-16-12

Project: Cameron Water Line
Location: Hwy 89 Page to Cameron
Material: Claystone (Lean Clay) Sampled By: Client Date: 06-11-12
Source: TP-18 Submitted By: C. Jones Date: 06-11-12
Supplier: Native Authorized By: Client Date: 06-11-12
Sample Location: 2.5' to 9.0'

Expansion Index (ASTM D4829)

Sample Properties

Before Test		After Test	
Wet Density (pcf)	110.2	Wet Density (pcf)	120.9
Dry Density (pcf)	97.4	Dry Density (pcf)	92.8
Moisture Content	13.2%	Moisture Content	30.2%
Degree of Saturation	48.8%	Degree of Saturation	100.2%

Measured Expansion Index (EI_M) = 49

Calculated Expansion Index @ 50% Saturation (EI_{50}) = 48

Expansion Index Classification:

E.I.	Potential Expansion
0-20	Very Low
21-50	Low
51-90	Medium
91-130	High
>130	Very High

Laboratory test results reported herein apply only to the specific sample on which the test was run. The above services and report were performed pursuant to the terms and conditions of the agreement or proposal, if any, between SA and client. SA warrants that this work was performed under the appropriate standard of care, including the skill and judgement that is reasonably expected from similarly situated professionals. No other warranty, guaranty, or representation, either express or implied is included or intended.

Reviewed by _____
Laboratory Manager

SPEEDIE AND ASSOCIATES

LABORATORY REPORT

Physical Properties of Soils and Aggregates

Client: Apache Underground & Excavating, LLC
Attention: Mark Gardner
6141 Crimson Oak Dr.
Lakeside, AZ 85929

Project No. 120751TF
Lab No. 373122
Report Date: 07-16-12

Project: Cameron Water Line
Location: Hwy 89 Page to Cameron
Material: Lean Clay with Sand — Sampled By: Client — Date: 06-07-12
Source: TP-30 — Submitted By: C. Jones — Date: 06-11-12
Supplier: Native — Authorized By: Client — Date: 06-07-12
Sample Location: 2.0' to 14.0'

Expansion Index (ASTM D4829)

Sample Properties

Before Test		After Test	
Wet Density (pcf)	110.1	Wet Density (pcf)	115.5
Dry Density (pcf)	94.1	Dry Density (pcf)	83.4
Moisture Content	17.0%	Moisture Content	38.6%
Degree of Saturation	58.1%	Degree of Saturation	102.0%

Measured Expansion Index (EI_M) = 129

Calculated Expansion Index @ 50% Saturation (EI_{50}) = 139

Expansion Index Classification:

E.I.	Potential Expansion
0-20	Very Low
21-50	Low
51-90	Medium
91-130	High
>130	Very High

Laboratory test results reported herein apply only to the specific sample on which the test was run. The above services and report were performed pursuant to the terms and conditions of the agreement or proposal, if any, between SA and client. SA warrants that this work was performed under the appropriate standard of care, including the skill and judgement that is reasonably expected from similarly situated professionals. No other warranty, guaranty, or representation, either express or implied is included or intended.

Reviewed by _____
Laboratory Manager

SPEEDIE AND ASSOCIATES

LABORATORY REPORT

Physical Properties of Soils and Aggregates

Client: Apache Underground & Excavating, LLC
Attention: Mark Gardner
6141 Crimson Oak Dr.
Lakeside, AZ 85929

Project No. 120751TF
Lab No. 373072
Report Date: 07-16-12

Project: Cameron Water Line
Location: Hwy 89 Page to Cameron
Material: Fat Clay with Sand — Sampled By: A. Arp-Romero — Date: 06-06-12
Source: TP-40 — Submitted By: C. Jones — Date: 06-11-12
Supplier: Native — Authorized By: Client — Date: 06-06-12
Sample Location: 0.0' to 5.0'

Expansion Index (ASTM D4829)

Sample Properties

Before Test		After Test	
Wet Density (pcf)	111.9	Wet Density (pcf)	115.2
Dry Density (pcf)	96.4	Dry Density (pcf)	84.8
Moisture Content	16.0%	Moisture Content	35.9%
Degree of Saturation	57.8%	Degree of Saturation	98.2%

Measured Expansion Index (EI_M) = 137

Calculated Expansion Index @ 50% Saturation (EI_{50}) = 147

Expansion Index Classification:

E.I.	Potential Expansion
0-20	Very Low
21-50	Low
51-90	Medium
91-130	High
>130	Very High

Laboratory test results reported herein apply only to the specific sample on which the test was run. The above services and report were performed pursuant to the terms and conditions of the agreement or proposal, if any, between SA and client. SA warrants that this work was performed under the appropriate standard of care, including the skill and judgement that is reasonably expected from similarly situated professionals. No other warranty, guaranty, or representation, either express or implied is included or intended.

Reviewed by _____
Laboratory Manager

SPEEDIE AND ASSOCIATES

LABORATORY REPORT

Physical Properties of Soils and Aggregates

Client: Apache Underground & Excavating, LLC
Attention: Mark Gardner
6141 Crimson Oak Dr.
Lakeside, AZ 85929

Project No. 120751TF
Lab No. 373073
Report Date: 07-16-12

Project: Cameron Water Line
Location: Hwy 89 Page to Cameron
Material: Claystone (Fat Clay) Sampled By: A. Arp-Romero Date: 06-06-12
Source: TP-41 Submitted By: C. Jones Date: 06-11-12
Supplier: Native Authorized By: Client Date: 06-06-12
Sample Location: 3.0' to 8.0'

Expansion Index (ASTM D4829)

Sample Properties

Before Test		After Test	
Wet Density (pcf)	112.4	Wet Density (pcf)	116.2
Dry Density (pcf)	97.1	Dry Density (pcf)	87.0
Moisture Content	15.7%	Moisture Content	33.6%
Degree of Saturation	57.7%	Degree of Saturation	96.8%

Measured Expansion Index (EI_M) = 117
Calculated Expansion Index @ 50% Saturation (EI_{50}) = 126

Comments: 43% rock in sample.

Expansion Index Classification:

E.I.	Potential Expansion
0-20	Very Low
21-50	Low
51-90	Medium
91-130	High
>130	Very High

Laboratory test results reported herein apply only to the specific sample on which the test was run. The above services and report were performed pursuant to the terms and conditions of the agreement or proposal, if any, between SA and client. SA warrants that this work was performed under the appropriate standard of care, including the skill and judgement that is reasonably expected from similarly situated professionals. No other warranty, guaranty, or representation, either express or implied is included or intended.

Reviewed by _____
Laboratory Manager

SPEEDIE AND ASSOCIATES

LABORATORY REPORT

Physical Properties of Soils and Aggregates

Client: Apache Underground & Excavating, LLC
Attention: Mark Gardner
6141 Crimson Oak Dr.
Lakeside, AZ 85929

Project No. 120751TF
Lab No. 372907
Report Date: 07-16-12

Project: Cameron Water Line
Location: Hwy 89 Page to Cameron
Material: Claystone (Sandy Silt with Gravel) Sampled By: A. Arp-Romero Date: 06-05-12
Source: TP-46 Submitted By: C. Jones Date: 06-11-12
Supplier: Native Authorized By: Client Date: 06-05-12
Sample Location: 0.0' to 0.8'

Expansion Index (ASTM D4829)

Sample Properties

Before Test		After Test	
Wet Density (pcf)	118.7	Wet Density (pcf)	126.8
Dry Density (pcf)	106.7	Dry Density (pcf)	102.6
Moisture Content	11.3%	Moisture Content	23.6%
Degree of Saturation	52.5%	Degree of Saturation	99.1%

Measured Expansion Index (EI_M) = 40

Calculated Expansion Index @ 50% Saturation (EI_{50}) = 42

Expansion Index Classification:

E.I.	Potential Expansion
0-20	Very Low
21-50	Low
51-90	Medium
91-130	High
>130	Very High

Laboratory test results reported herein apply only to the specific sample on which the test was run. The above services and report were performed pursuant to the terms and conditions of the agreement or proposal, if any, between SA and client. SA warrants that this work was performed under the appropriate standard of care, including the skill and judgement that is reasonably expected from similarly situated professionals. No other warranty, guaranty, or representation, either express or implied is included or intended.

Reviewed by _____
Laboratory Manager

SPEEDIE AND ASSOCIATES

LABORATORY REPORT

Physical Properties of Soils and Aggregates

Client: Apache Underground & Excavating, LLC
Attention: Mark Gardner
6141 Crimson Oak Dr.
Lakeside, AZ 85929

Project No. 120751TF
Lab No. 372905
Report Date: 07-16-12

Project: Cameron Water Line
Location: Hwy 89 Page to Cameron
Material: Claystone (Sandy Lean Clay) Sampled By: A. Arp-Romero Date: 06-05-12
Source: TP-48 Submitted By: C. Jones Date: 06-11-12
Supplier: Native Authorized By: Client Date: 06-05-12
Sample Location: 1.8' to 7.5'

Expansion Index (ASTM D4829)

Sample Properties

Before Test		After Test	
Wet Density (pcf)	120.6	Wet Density (pcf)	129.6
Dry Density (pcf)	108.4	Dry Density (pcf)	106.2
Moisture Content	11.3%	Moisture Content	22.0%
Degree of Saturation	55.0%	Degree of Saturation	101.5%

Measured Expansion Index (EI_M) = 20

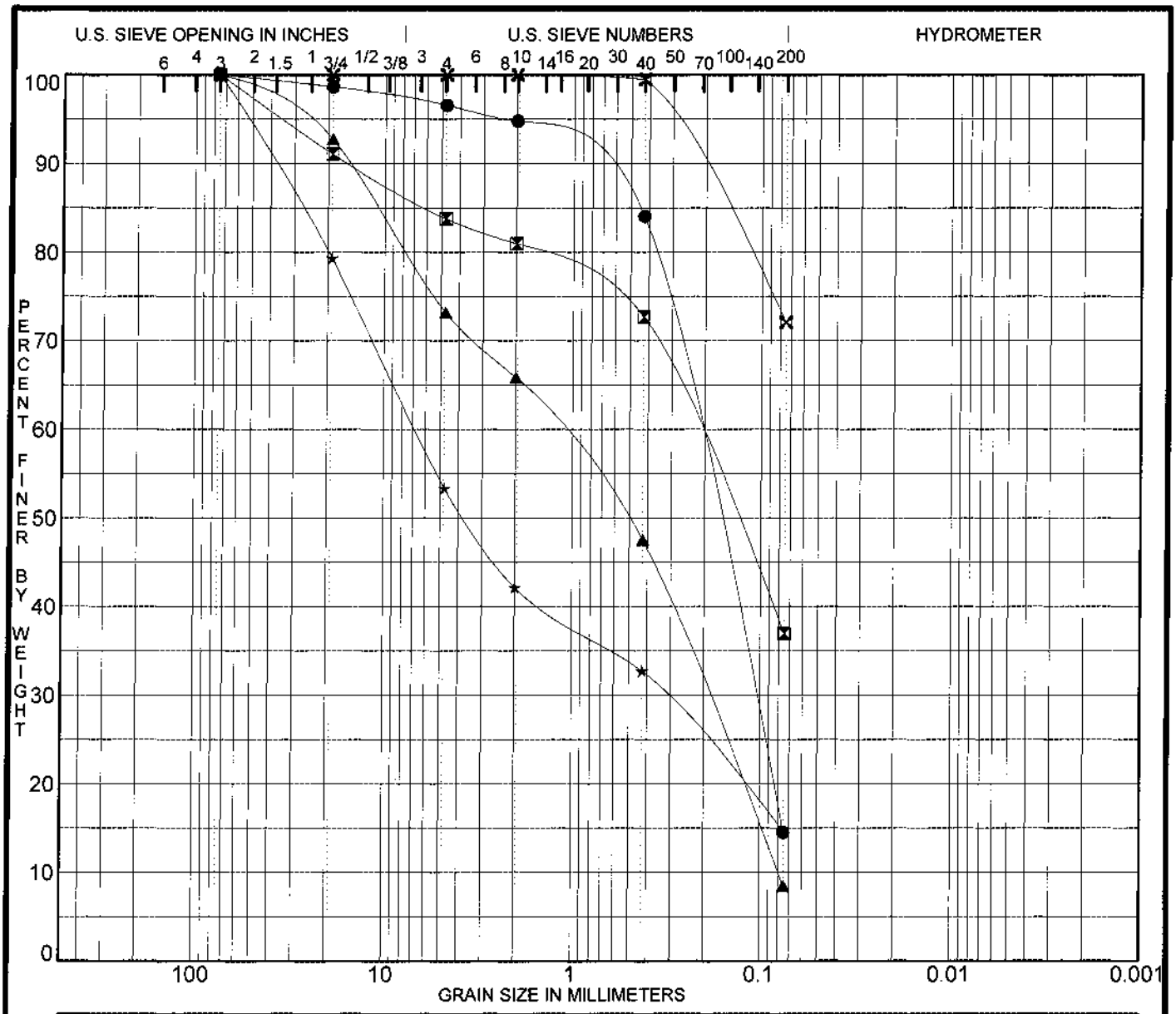
Calculated Expansion Index @ 50% Saturation (EI_{50}) = 23

Expansion Index Classification:

E.I.	Potential Expansion
0-20	Very Low
21-50	Low
51-90	Medium
91-130	High
>130	Very High

Laboratory test results reported herein apply only to the specific sample on which the test was run. The above services and report were performed pursuant to the terms and conditions of the agreement or proposal, if any, between SA and client. SA warrants that this work was performed under the appropriate standard of care, including the skill and judgement that is reasonably expected from similarly situated professionals. No other warranty, guaranty, or representation, either express or implied is included or intended.

Reviewed by _____
Laboratory Manager



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	TP-01	0.0	SILTY, CLAYEY SAND SC-SM		NT	NT	NT		
⊠	TP-02	0.0	SILTY SAND with GRAVEL SM		NP	NP	NP		
▲	TP-03	4.0	POORLY GRADED SAND with SILT, CLAY, and GRAVEL SP-SM-SC		NT	NT	NT	0.39	15.2
★	TP-04	4.0	SILTY, CLAYEY GRAVEL with SAND GC-GM		22	18	4		
✕	TP-05	2.0	LEAN CLAY with SAND CL		28	15	13		

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	TP-01	0.0	75.00	0.23	0.110		3.4	82.0	14.5	
⊠	TP-02	0.0	75.00	0.23			16.2	46.8	36.9	
▲	TP-03	4.0	75.00	1.22	0.195	0.0803	26.8	64.7	8.5	
★	TP-04	4.0	75.00	6.77	0.327		46.6	38.7	14.6	
✕	TP-05	2.0	75.00				0.0	27.9	72.1	

PROJECT Cameron Water Line - Page to Cameron

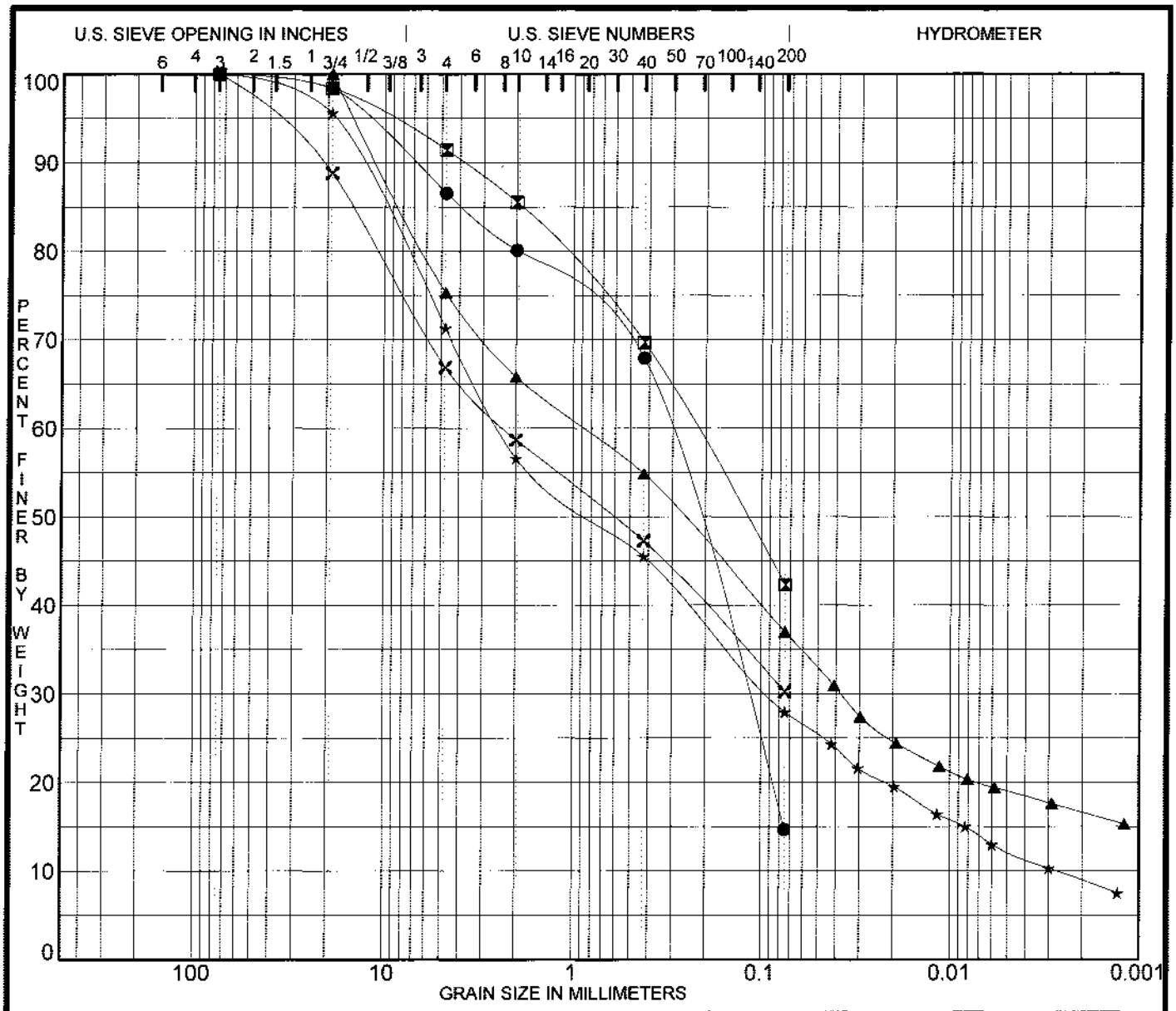
JOB NO. 120751TF

DATE 6/14/12

GRADATION CURVES

SPEEDIE AND ASSOCIATES

{GRSZLSZ 120751TF.GPJ 7/19/12



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	TP-06	4.0	SILTY, CLAYEY SAND SC-SM		NT	NT	NT		
⧓	TP-07	0.0	SILTY, CLAYEY SAND SC-SM		20	15	5		
▲	TP-08	2.0	CLAYEY SAND with GRAVEL SC		26	15	11		
★	TP-09	6.0	SILTY, CLAYEY SAND with GRAVEL SC-SM		21	15	6	1.26	891.2
✕	TP-10	0.0	SILTY, CLAYEY SAND with GRAVEL SC-SM		21	16	6		

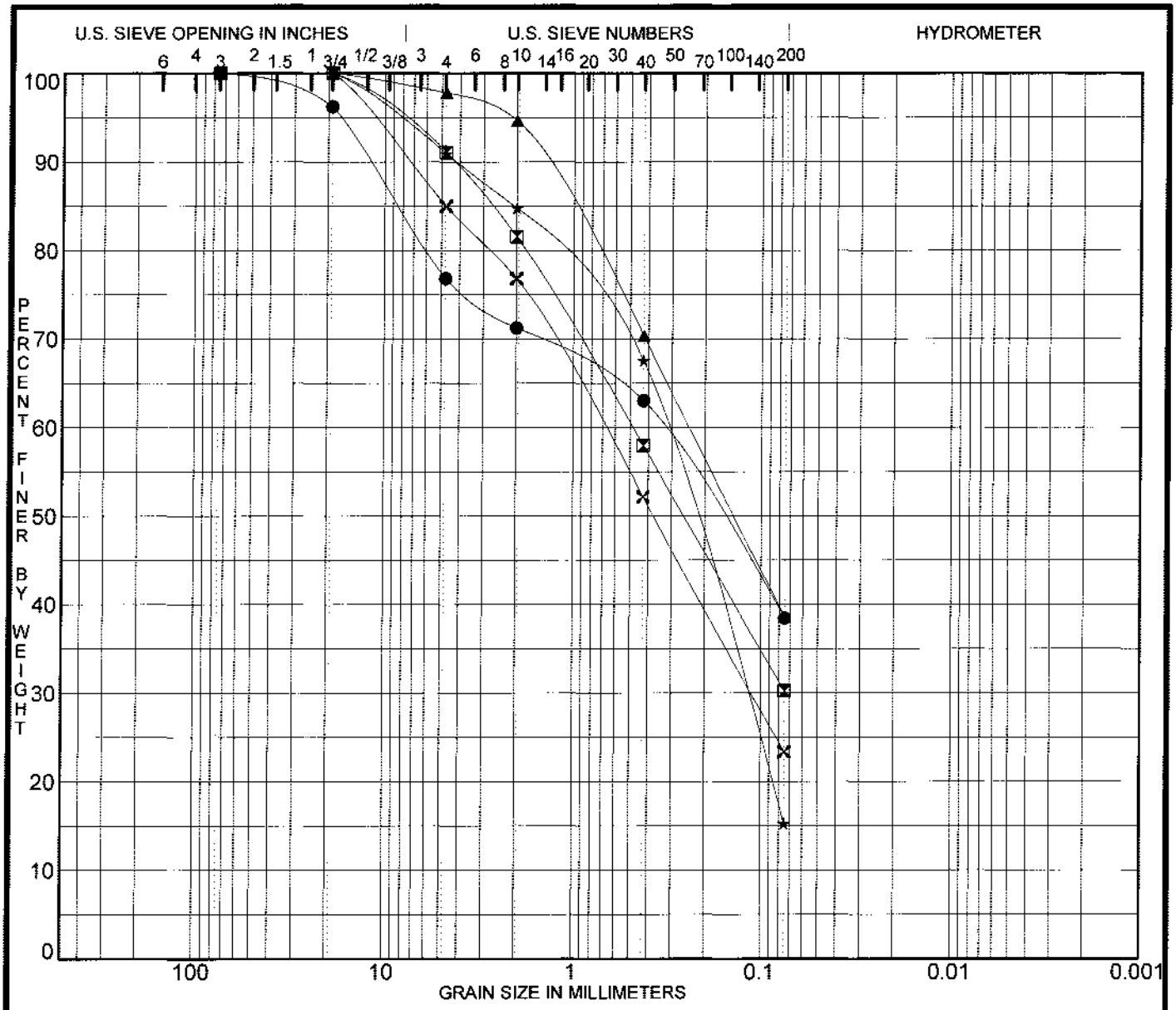
Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	TP-06	4.0	75.00	0.33	0.124		13.5	71.9	14.7	
⧓	TP-07	0.0	75.00	0.23			8.6	49.1	42.3	
▲	TP-08	2.0	75.00	0.88	0.038		24.7	38.3	18.0	19.0
★	TP-09	6.0	75.00	2.44	0.092	0.0027	28.7	43.4	15.7	12.3
✕	TP-10	0.0	75.00	2.30			33.1	36.7	30.2	

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GRADATION CURVES

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COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	TP-11	0.0	CLAYEY SAND with GRAVEL SC		22	14	8		
⊠	TP-12	3.8	CLAYEY SAND SC		22	14	8		
▲	TP-13	0.0	SILTY, CLAYEY SAND SC-SM		21	14	7		
★	TP-14	0.0	SILTY SAND SM		NP	NP	NP		
✕	TP-15	0.0	SILTY, CLAYEY SAND SC-SM		20	15	5		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	TP-11	0.0	75.00	0.34			23.1	38.4	38.5	
⊠	TP-12	3.8	75.00	0.49			8.9	60.9	30.2	
▲	TP-13	0.0	75.00	0.24			2.2	59.2	38.6	
★	TP-14	0.0	75.00	0.33	0.122		9.1	75.7	15.3	
✕	TP-15	0.0	75.00	0.70	0.112		15.0	61.6	23.4	

PROJECT **Cameron Water Line - Page to Cameron**

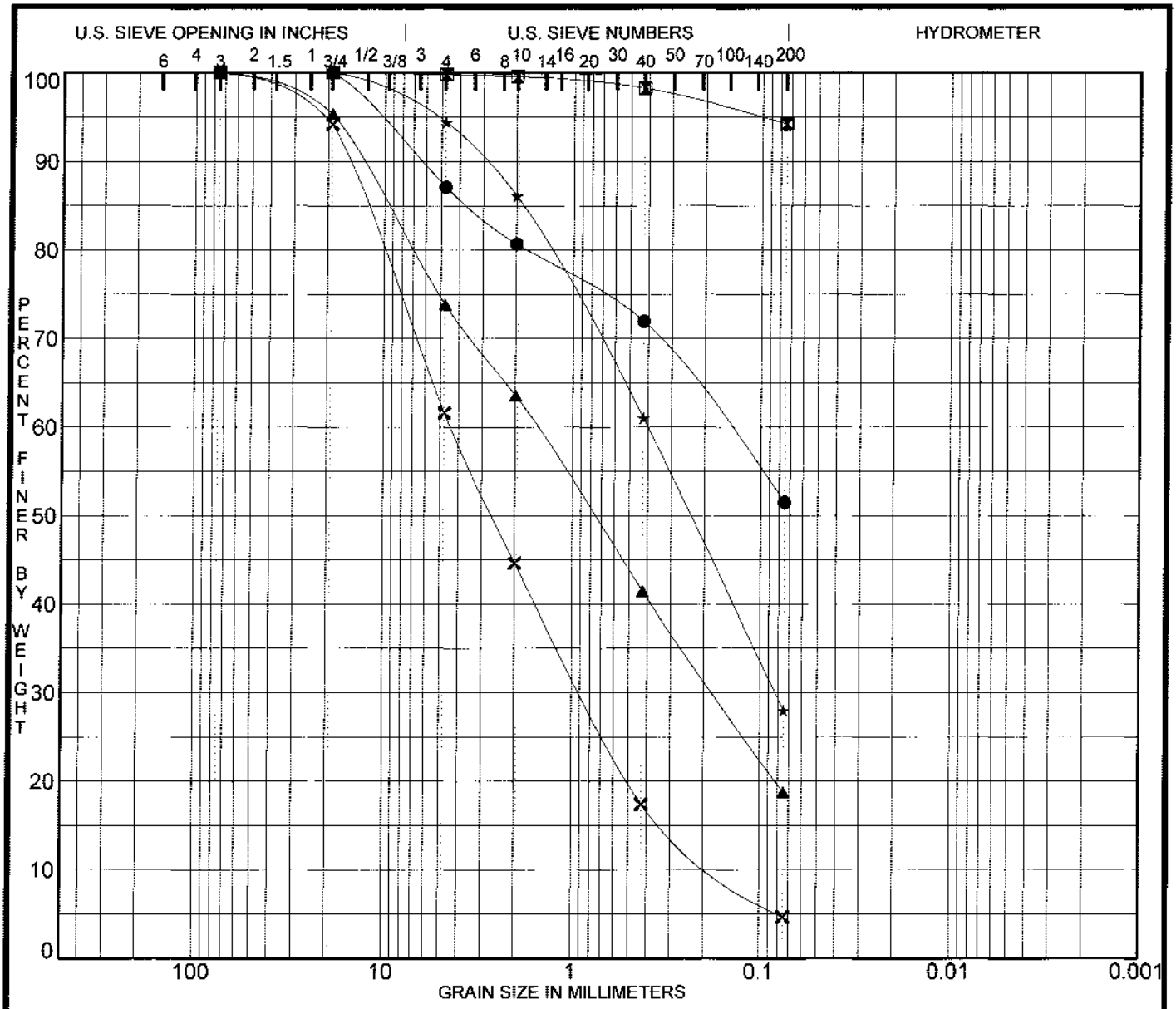
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DATE **6/11/12**

GRADATION CURVES

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COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	TP-16	0.0	CLAYSTONE (SANDY LEAN CLAY CL)		NT	NT	NT		
⊠	TP-18	2.5	CLAYSTONE (LEAN CLAY CL)		NT	NT	NT		
▲	TP-19	0.0	CLAYEY SAND with GRAVEL SC		22	13	9		
★	TP-20	0.0	SILTY, CLAYEY SAND SC-SM		23	18	5		
✕	TP-21	3.0	WELL-GRADED SAND with SILT, CLAY, and GRAVEL SW-SM-SC		NT	NT	NT	1.11	28.1

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	TP-16	0.0	75.00	0.15			12.9	35.6	51.5	
⊠	TP-18	2.5	75.00				0.2	5.6	94.2	
▲	TP-19	0.0	75.00	1.56	0.177		26.1	55.1	18.7	
★	TP-20	0.0	75.00	0.40	0.083		5.5	66.5	28.0	
✕	TP-21	3.0	75.00	4.37	0.871	0.1556	38.4	57.0	4.6	

PROJECT **Cameron Water Line - Page to Cameron**

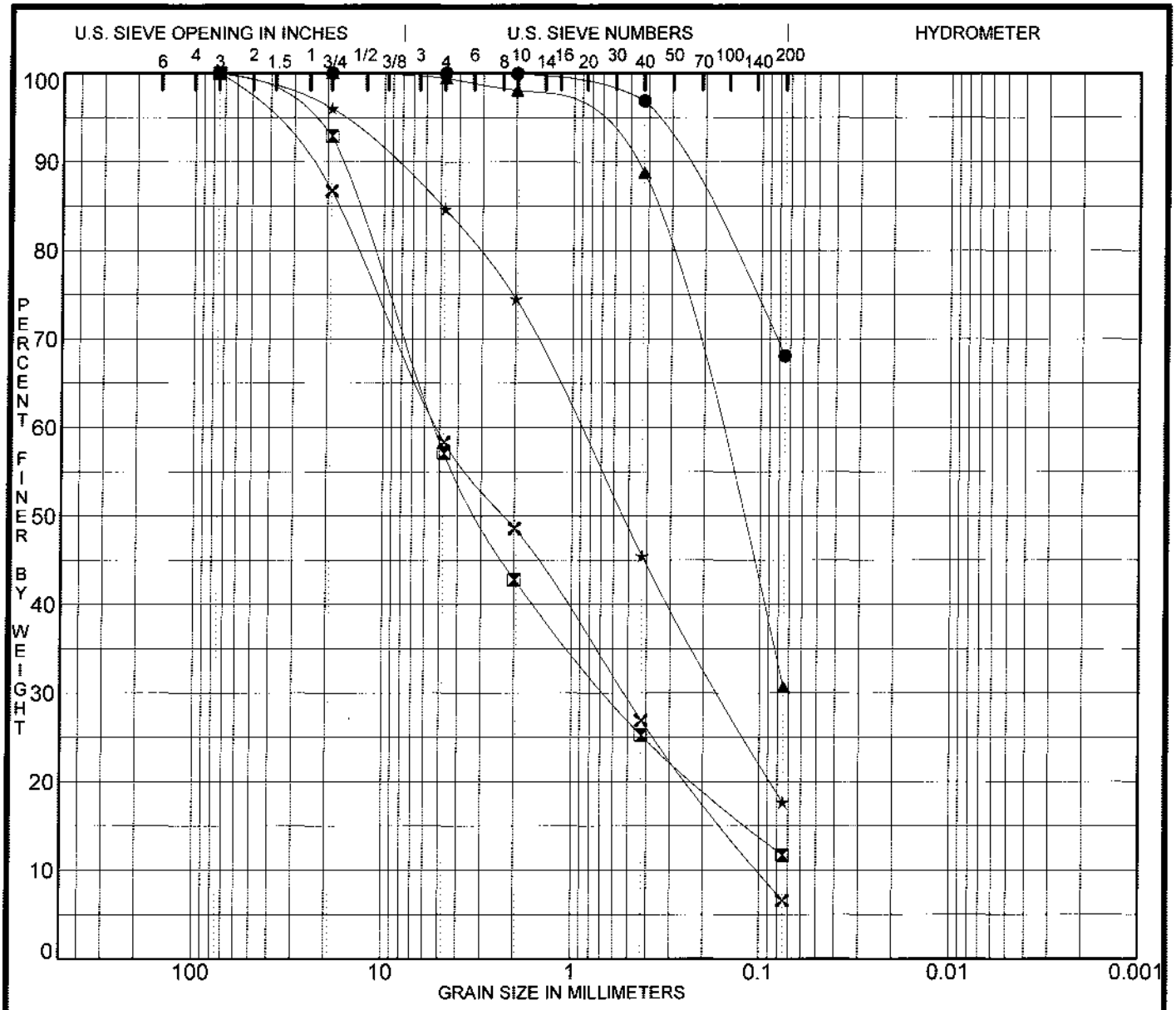
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DATE **6/13/12**

GRADATION CURVES

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COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	TP-21	8.0	CLAYSTONE (SANDY LEAN CLAY CL)		42	24	19		
⊠	TP-22	6.0	WELL-GRADED SAND with SILT, CLAY, and GRAVEL SW-SM-SC		NT	NT	NT	1.31	88.3
▲	TP-23	0.0	SILTY SAND SM		NP	NP	NP		
★	TP-23	6.0	CLAYEY SAND with GRAVEL SC		22	13	9		
✕	TP-24	5.0	POORLY GRADED SAND with SILT, CLAY, and GRAVEL SP-SM-SC		NT	NT	NT	0.54	51.3

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	TP-21	8.0	75.00				0.0	31.9	68.1	
⊠	TP-22	6.0	75.00	5.32	0.647		42.9	45.4	11.7	
▲	TP-23	0.0	75.00	0.18			0.6	68.7	30.7	
★	TP-23	6.0	75.00	0.92	0.162		15.4	67.0	17.6	
✕	TP-24	5.0	75.00	5.15	0.530	0.1004	41.6	51.8	6.6	

PROJECT **Cameron Water Line - Page to Cameron**

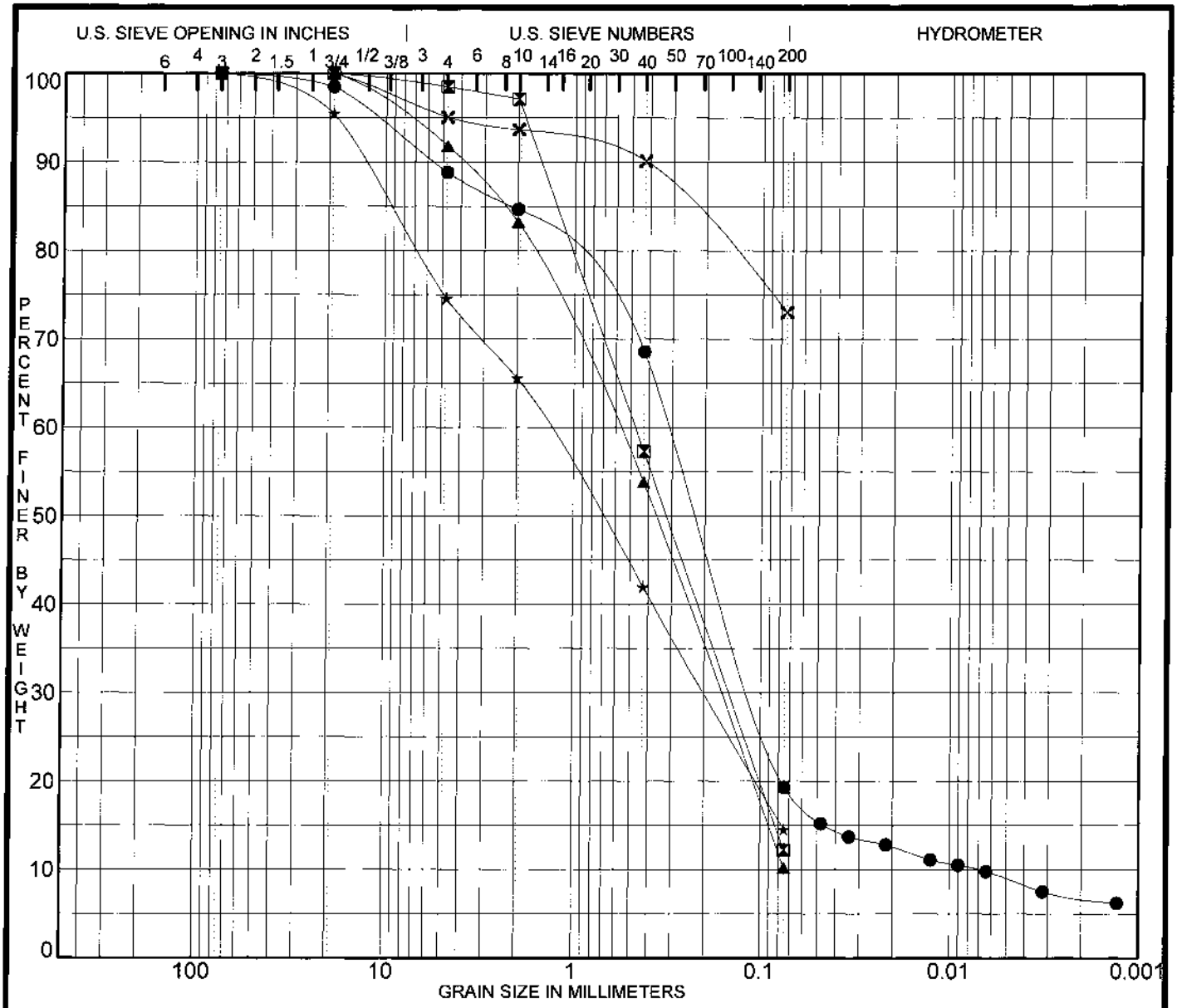
JOB NO. **120751TF**

DATE **6/12/12**

GRADATION CURVES

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COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	TP-25	8.0	SILTY SAND SM		17	NP	NP	5.38	44.5
⧓	TP-26	3.5	SILTY, CLAYEY SAND SC-SM		NT	NT	NT	0.68	6.9
▲	TP-27	0.0	POORLY GRADED SAND with SILT and CLAY SP-SM-SC		NT	NT	NT	0.62	7.9
★	TP-28	0.0	SILTY, CLAYEY SAND with GRAVEL SC-SM		NT	NT	NT		
✕	TP-29	0.5	CLAYSTONE (LEAN CLAY with SAND CL)		38	18	20		

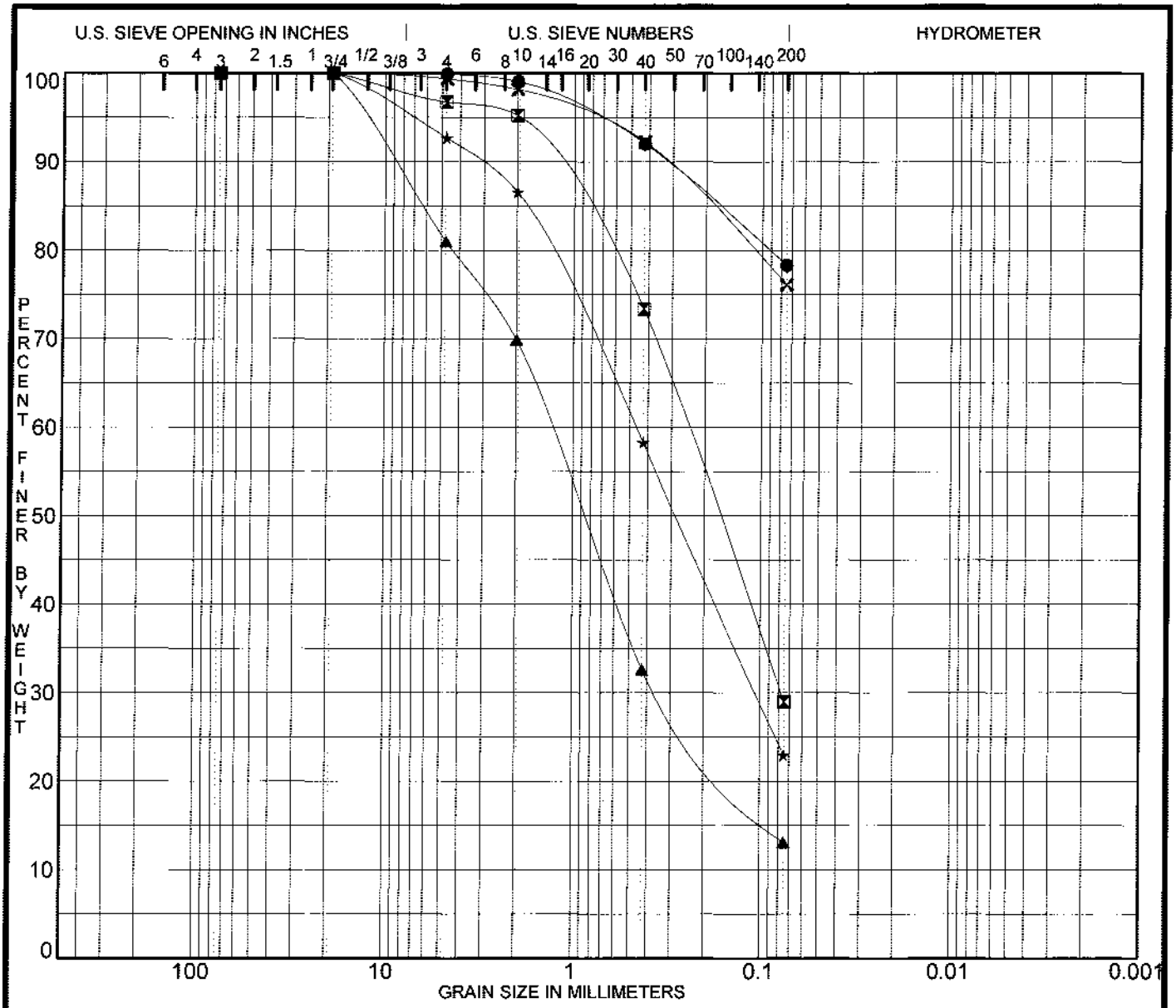
	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	TP-25	8.0	75.00	0.31	0.109	0.0071	11.2	69.5	10.3	9.0
⧓	TP-26	3.5	75.00	0.47	0.149		1.5	86.3	12.2	
▲	TP-27	0.0	75.00	0.59	0.165		8.2	81.6	10.2	
★	TP-28	0.0	75.00	1.39	0.199		25.4	60.0	14.6	
✕	TP-29	0.5	75.00				4.9	22.0	73.0	

PROJECT **Cameron Water Line - Page to Cameron** JOB NO. **120751TF**
DATE **6/12/12**

GRADATION CURVES

SPEEDIE AND ASSOCIATES

{GRSZLSZ 120751TF.GPJ 7/19/12}



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	TP-30	2.0	LEAN CLAY with SAND CL		22	14	8		
⊠	TP-31	0.0	CLAYEY SAND SC		35	19	15		
▲	TP-32	0.0	SILTY, CLAYEY SAND with GRAVEL SC-SM		NT	NT	NT		
★	TP-33	0.0	SILTY, CLAYEY SAND SC-SM		24	19	5		
✕	TP-34	1.5	CLAYSTONE (LEAN CLAY with SAND CL)		42	23	19		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	TP-30	2.0	75.00				0.1	21.6	78.3	
⊠	TP-31	0.0	75.00	0.25	0.078		3.3	67.7	29.0	
▲	TP-32	0.0	75.00	1.33	0.337		19.0	67.9	13.1	
★	TP-33	0.0	75.00	0.47	0.106		7.3	69.7	22.9	
✕	TP-34	1.5	75.00				0.7	23.3	76.1	

PROJECT **Cameron Water Line - Page to Cameron**

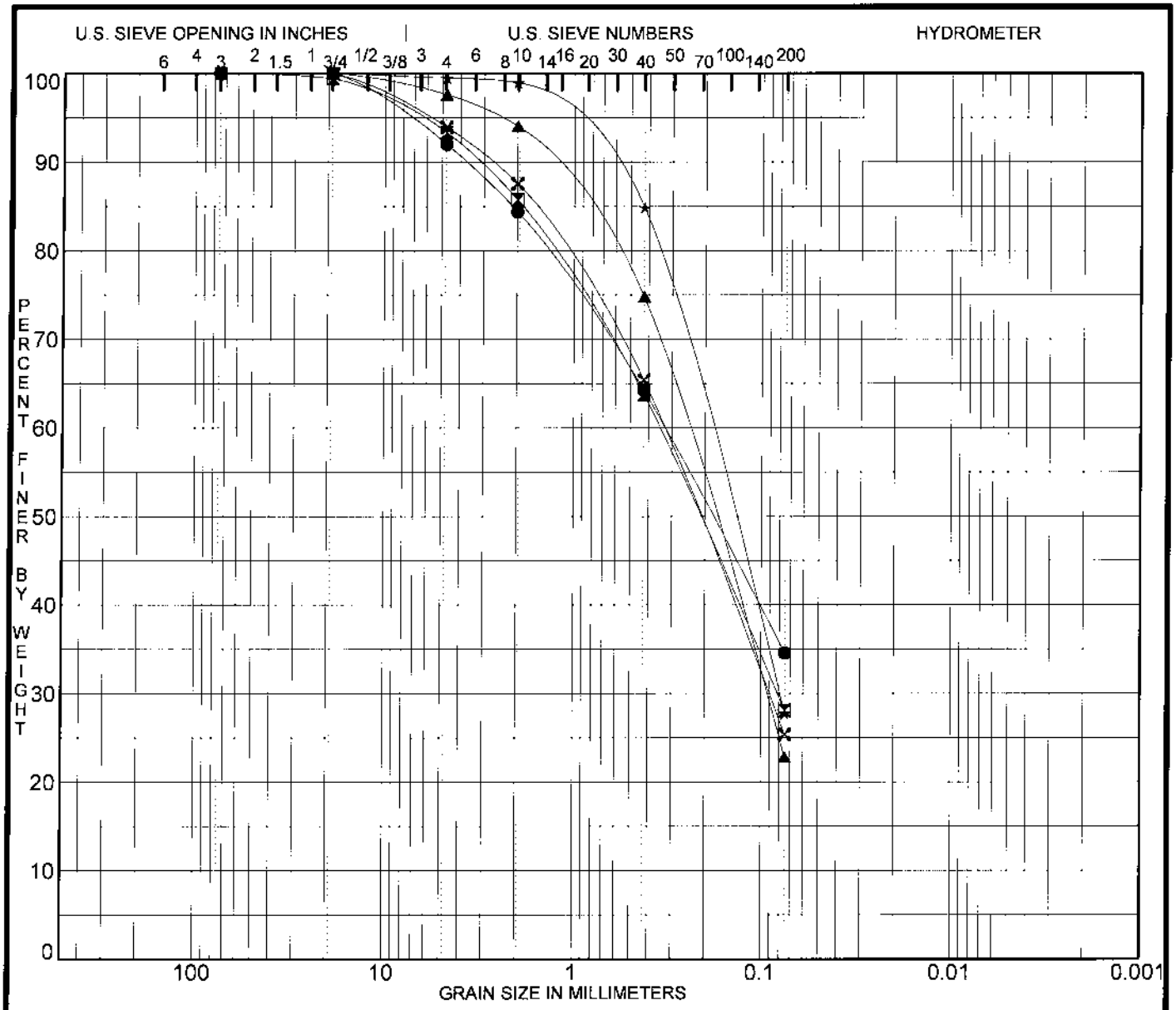
JOB NO. **120751TF**

DATE **6/7/12**

GRADATION CURVES

SPEEDIE AND ASSOCIATES

{GRSZLSZ 120751TF.GPJ 7/19/12}



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	TP-35	0.0	CLAYEY SAND SC		28	11	17		
⧗	TP-36	7.0	CLAYEY SAND SC		33	14	18		
▲	TP-37	1.0	SILTY SAND SM		33	25	8		
★	TP-38	1.0	SILTY SAND SM		NP	NP	NP		
✕	TP-39	0.0	CLAYEY SAND SC		27	16	11		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	TP-35	0.0	75.00	0.33			8.0	57.4	34.6	
⧗	TP-36	7.0	75.00	0.35	0.082		6.7	65.3	28.1	
▲	TP-37	1.0	75.00	0.26	0.095		2.4	74.8	22.8	
★	TP-38	1.0	75.00	0.20	0.080		0.5	71.7	27.8	
✕	TP-39	0.0	75.00	0.34	0.092		6.1	68.6	25.4	

PROJECT **Cameron Water Line - Page to Cameron**

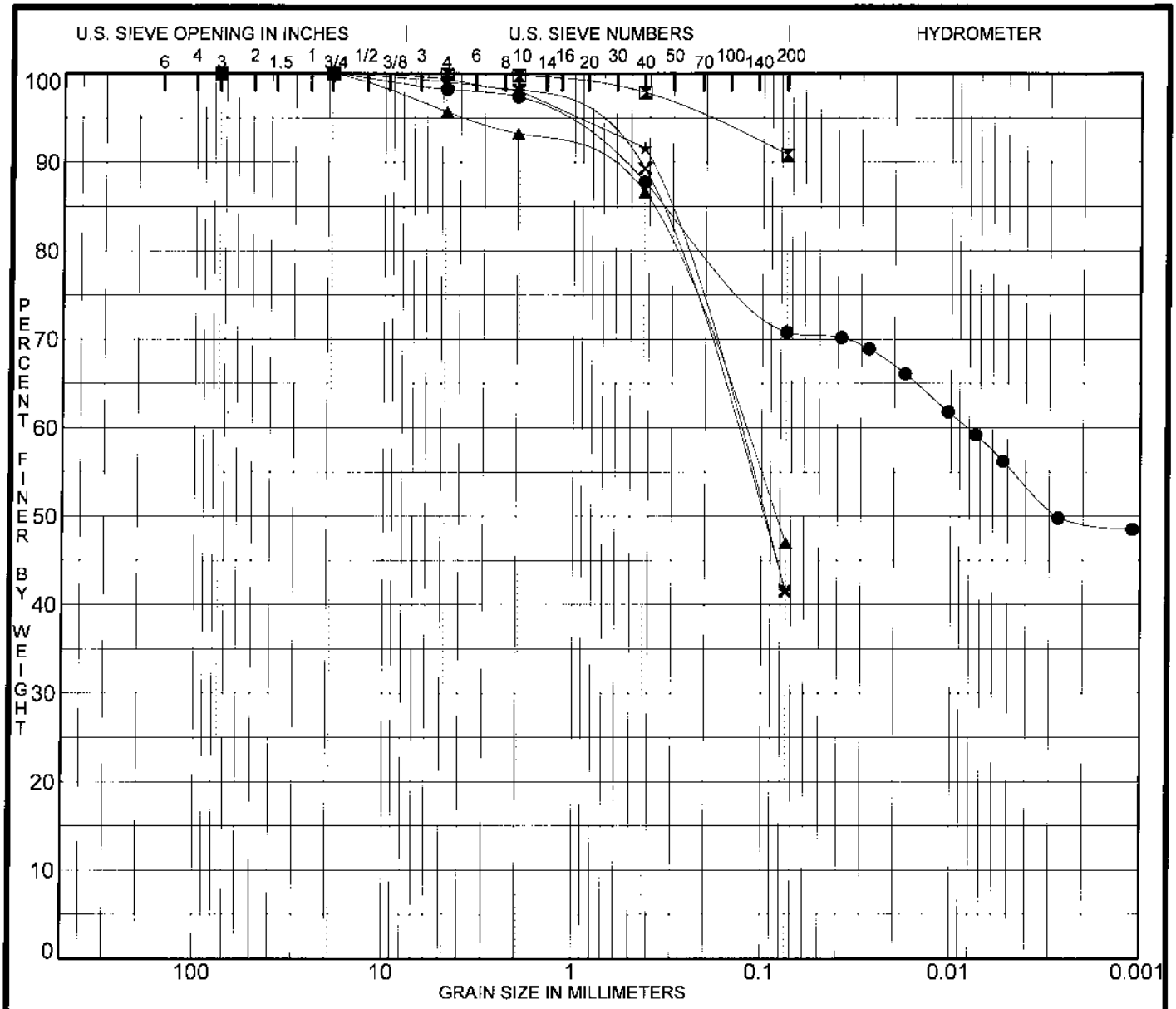
JOB NO. **120751TF**

DATE **6/6/12**

GRADATION CURVES

SPEEDIE AND ASSOCIATES

{GRSZLSZ 120751TF.GPJ 7/19/12}



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	TP-40	0.0	FAT CLAY with SAND CH		59	19	40		
⧗	TP-41	3.0	CLAYSTONE (FAT CLAY CH)		NT	NT	NT		
▲	TP-42	7.0	CLAYEY SAND SC		28	18	10		
★	TP-43	0.0	SILTY, CLAYEY SAND SC-SM		25	18	8		
✕	TP-44	0.8	SILTY, CLAYEY SAND SC-SM		24	19	5		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	TP-40	0.0	75.00	0.01			1.8	27.4	15.1	55.6
⧗	TP-41	3.0	75.00				0.1	9.0	90.8	
▲	TP-42	7.0	75.00	0.13			4.3	48.7	47.0	
★	TP-43	0.0	75.00	0.14			0.7	57.8	41.6	
✕	TP-44	0.8	75.00	0.15			1.0	57.5	41.5	

PROJECT **Cameron Water Line - Page to Cameron**

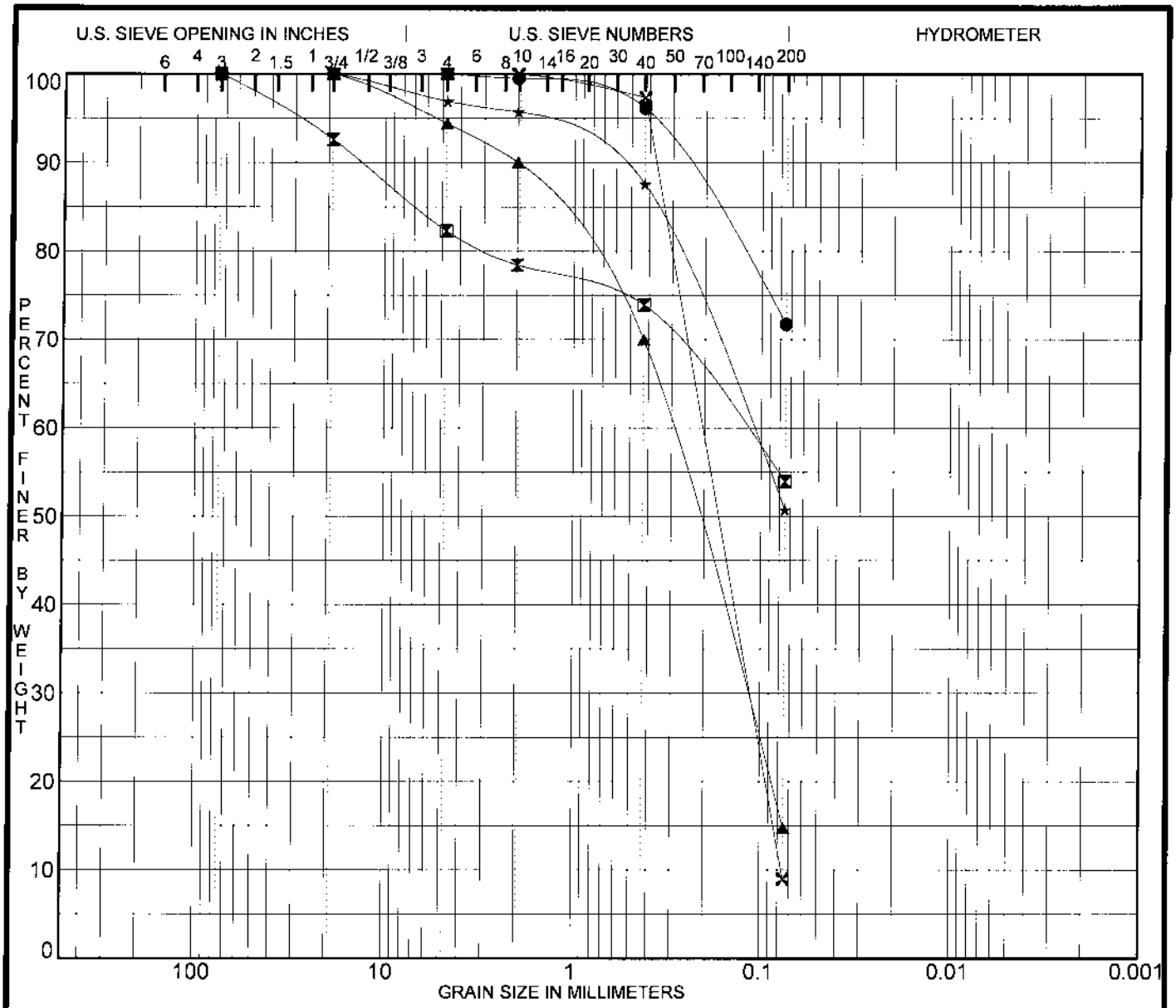
JOB NO. **120751TF**

DATE **6/5/12**

GRADATION CURVES

SPEEDIE AND ASSOCIATES

(GRSZLSZ 120751TF.GPJ 7/19/12)



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	TP-45	0.0	CLAYSTONE (LEAN CLAY with SAND CL)		NT	NT	NT		
⧗	TP-46	0.0	CLAYSTONE (SANDY SILT with GRAVEL ML)		41	26	15		
▲	TP-47	0.0	SILTY, CLAYEY SAND SC-SM		NT	NT	NT		
★	TP-48	1.8	CLAYSTONE (SANDY LEAN CLAY CL)		NT	NT	NT		
✕	TP-49	0.0	POORLY GRADED SAND with SILT and CLAY SP-SM-SC		NT	NT	NT	0.82	2.7

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	TP-45	0.0	75.00				0.0	28.3	71.7	
⧗	TP-46	0.0	75.00	0.13			17.7	28.3	53.9	
▲	TP-47	0.0	75.00	0.31	0.121		5.6	79.6	14.8	
★	TP-48	1.8	75.00	0.12			3.1	46.2	50.8	
✕	TP-49	0.0	75.00	0.20	0.113	0.0765	0.0	91.0	9.0	

PROJECT **Cameron Water Line - Page to Cameron**

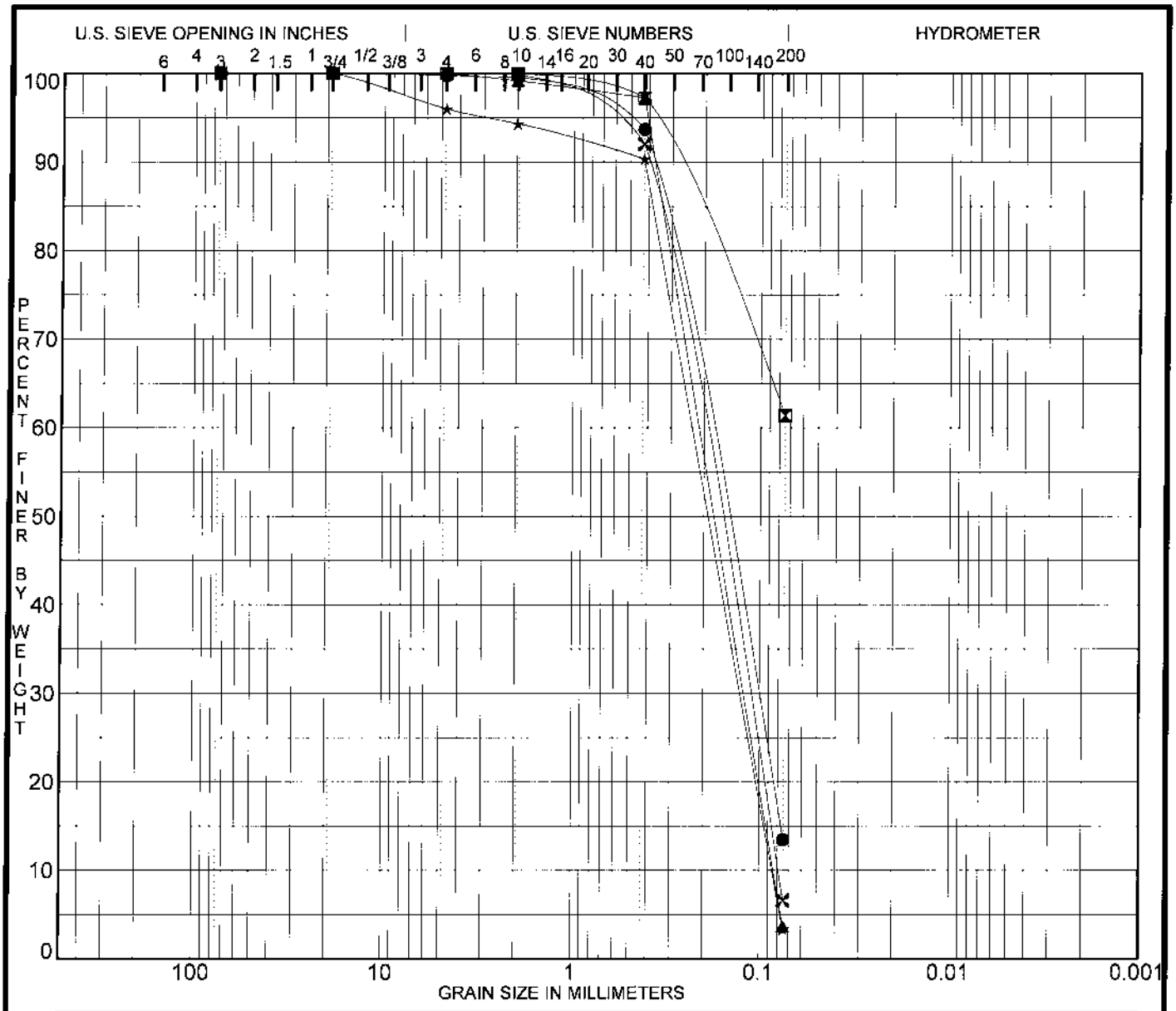
JOB NO. **120751TF**

DATE **6/18/12**

GRADATION CURVES

SPEEDIE AND ASSOCIATES

(GRSZLSZ 120751TF.GPJ 7/19/12)



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	TP-50	0.0	SILTY, CLAYEY SAND SC-SM		NT	NT	NT		
⊠	TP-51	4.5	SANDY LEAN CLAY CL		33	15	18		
▲	TP-52	2.0	POORLY GRADED SAND SP		NT	NT	NT	0.83	2.5
★	TP-55	5.0	POORLY GRADED SAND SP		NT	NT	NT	0.82	2.7
✕	TP-56	2.0	POORLY GRADED SAND with SILT and CLAY SP-SM-SC		NT	NT	NT	0.82	2.8

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	TP-50	0.0	75.00	0.21	0.107		0.2	86.3	13.5	
⊠	TP-51	4.5	75.00				0.0	38.6	61.4	
▲	TP-52	2.0	75.00	0.21	0.122	0.0843	0.1	96.2	3.7	
★	TP-55	5.0	75.00	0.23	0.127	0.0856	4.0	92.6	3.4	
✕	TP-56	2.0	75.00	0.22	0.121	0.0804	0.0	93.4	6.6	

PROJECT **Cameron Water Line - Page to Cameron**

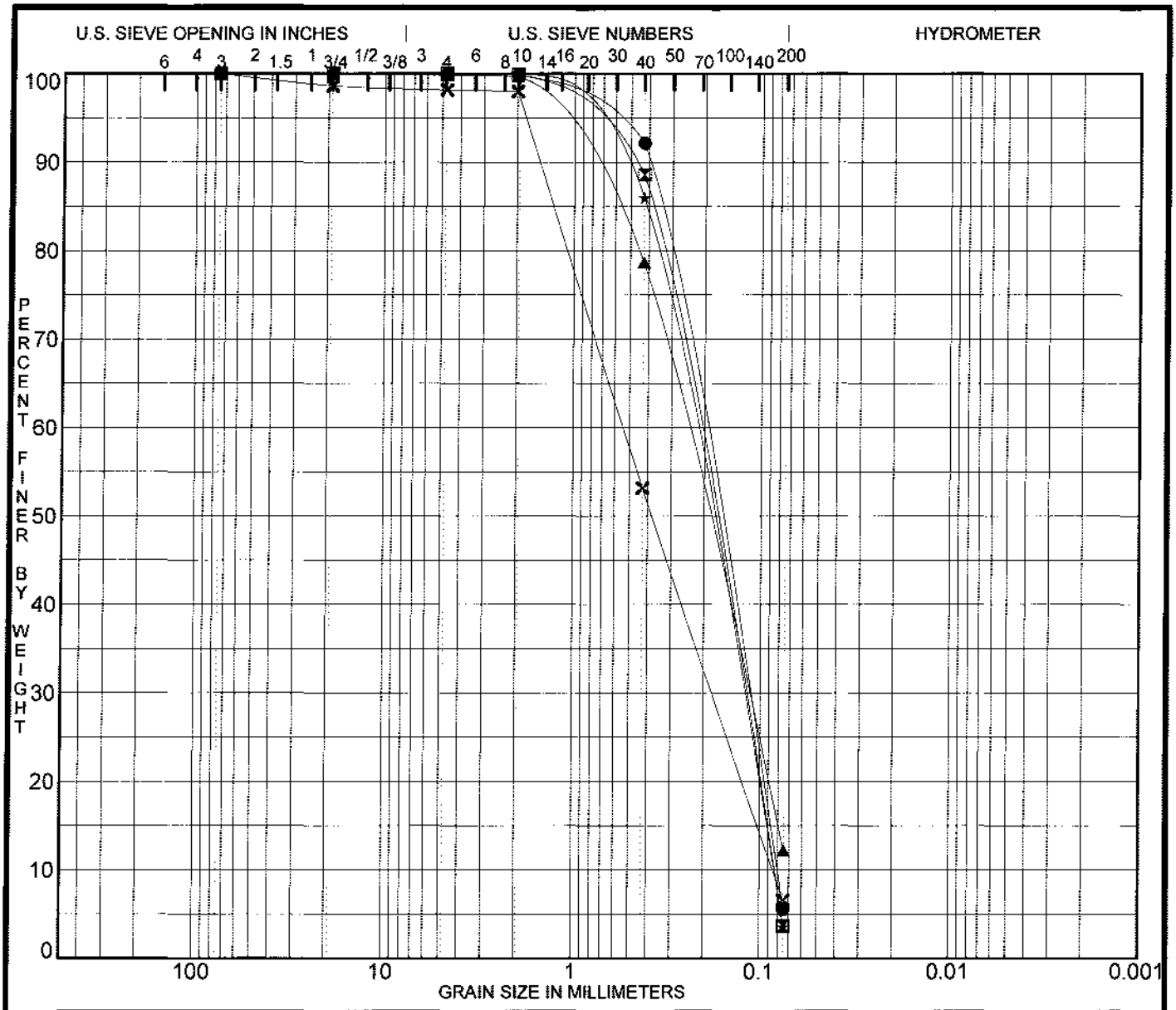
JOB NO. **120751TF**

DATE **6/18/12**

GRADATION CURVES

SPEEDIE AND ASSOCIATES

{GRSZLSZ 120751TF.GPJ 7/19/12}



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	MC%	LL	PL	PI	Cc	Cu
●	TP-57	0.0	POORLY GRADED SAND with SILT and CLAY SP-SM-SC		NT	NT	NT	0.82	2.7
⧗	TP-58	0.0	POORLY GRADED SAND SP		NT	NT	NT	0.82	2.8
▲	TP-59	0.0	SILTY, CLAYEY SAND SC-SM		NT	NT	NT	0.77	3.7
★	TP-60	0.0	POORLY GRADED SAND SP		NT	NT	NT	0.81	2.9
✕	TP-61	0.0	POORLY GRADED SAND with SILT and CLAY SP-SM-SC		NT	NT	NT	0.70	6.3

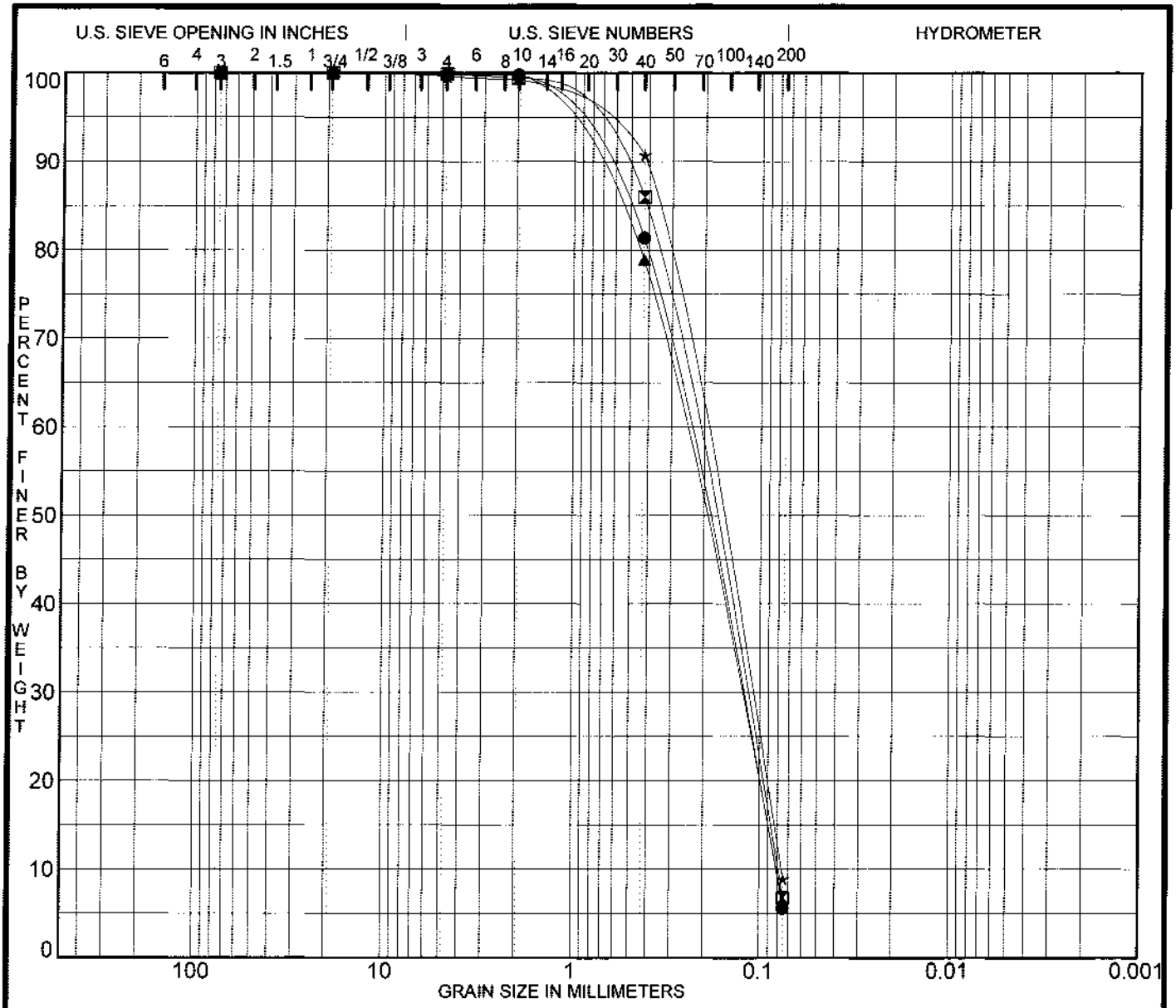
Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	TP-57	0.0	75.00	0.22	0.122	0.0820	0.0	94.5	5.5	
⧗	TP-58	0.0	75.00	0.24	0.129	0.0854	0.0	96.4	3.6	
▲	TP-59	0.0	75.00	0.26	0.119		0.2	87.7	12.2	
★	TP-60	0.0	75.00	0.25	0.131	0.0858	0.0	96.4	3.6	
✕	TP-61	0.0	75.00	0.54	0.179	0.0852	1.8	91.6	6.6	

PROJECT **Cameron Water Line - Page to Cameron** JOB NO. **120751TF**
DATE **6/19/12**

GRADATION CURVES

SPEEDIE AND ASSOCIATES

{GRSZLSZ 120751TF.GPJ 7/19/12}



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	TP-62	0.0	POORLY GRADED SAND with SILT and CLAY SP-SM-SC		NT	NT	NT	0.80	3.1
⊠	TP-63	0.0	POORLY GRADED SAND with SILT and CLAY SP-SM-SC		NT	NT	NT	0.80	3.0
▲	TP-67	0.0	POORLY GRADED SAND with SILT and CLAY SP-SM-SC		NT	NT	NT	0.79	3.3
★	TP-68	0.0	POORLY GRADED SAND with SILT and CLAY SP-SM-SC		NT	NT	NT	0.81	2.9

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	TP-62	0.0	75.00	0.26	0.131	0.0830	0.2	94.2	5.6	
⊠	TP-63	0.0	75.00	0.24	0.125	0.0805	0.1	93.1	6.8	
▲	TP-67	0.0	75.00	0.27	0.132	0.0821	0.1	93.7	6.2	
★	TP-68	0.0	75.00	0.22	0.117	0.0768	0.4	90.7	8.9	

PROJECT **Cameron Water Line - Page to Cameron**

JOB NO. **120751TF**

DATE **6/18/12**

GRADATION CURVES

SPEEDIE AND ASSOCIATES

{GRSZLSZ 120751TF.GPJ 7/19/12}

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line PROJECT NO.: 120751TF

LOCATION: Page to Cameron DATE: 6/14/12

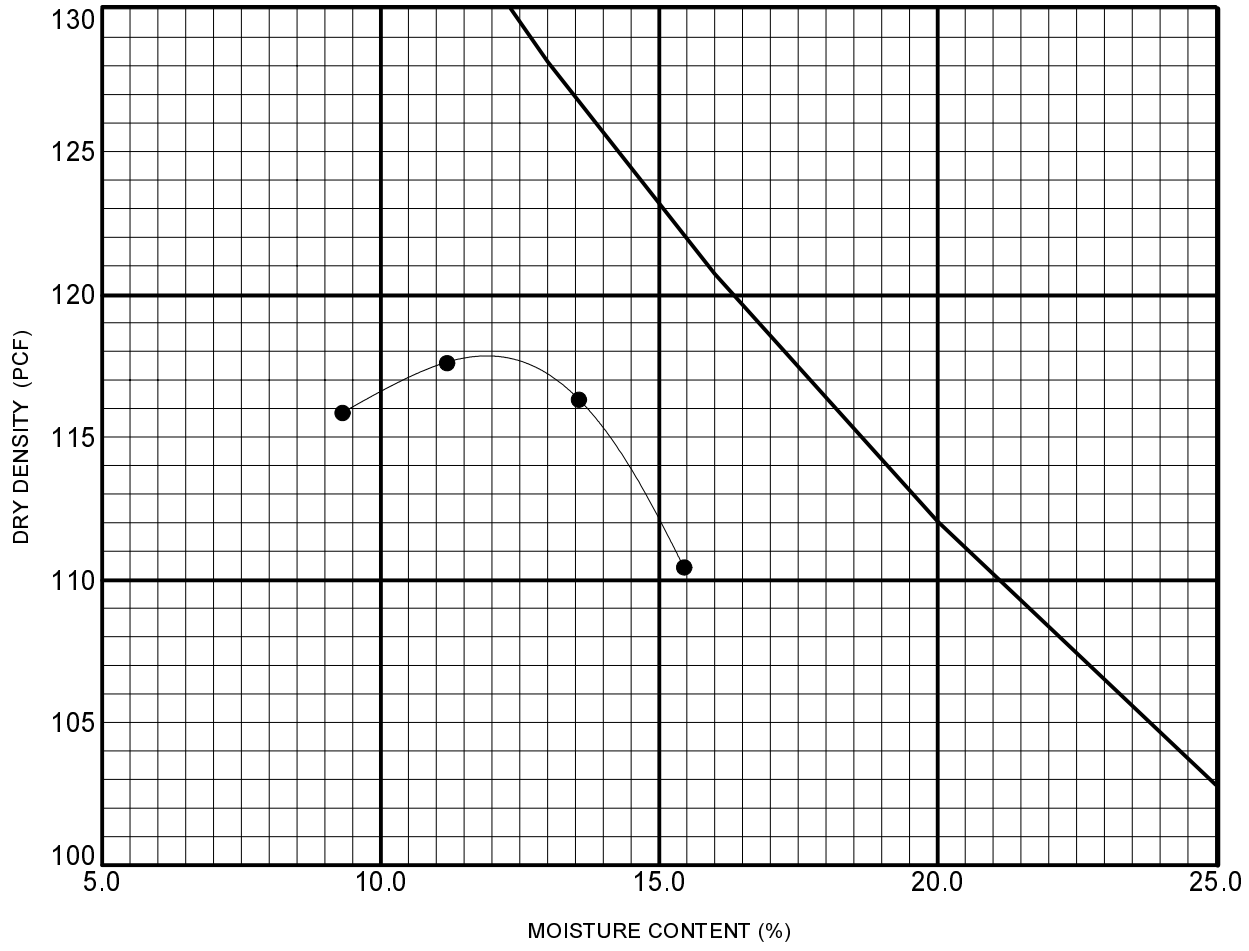
BORING NO.: TP-01 SAMPLE NO.: BS-1 SAMPLE DEPTH: 0 to 8 LABORATORY NO.: 373442

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT PLASTIC LIMIT: NT PLASTICITY INDEX: NT

CLASSIFICATION: SC-SM ASTM SOIL DESCRIPTION: SILTY, CLAYEY SAND

MAXIMUM DRY DENSITY: **117.9 PCF** OPTIMUM MOISTURE CONTENT: **11.8%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.:** 120751TF

LOCATION: Page to Cameron **DATE:** 6/14/12

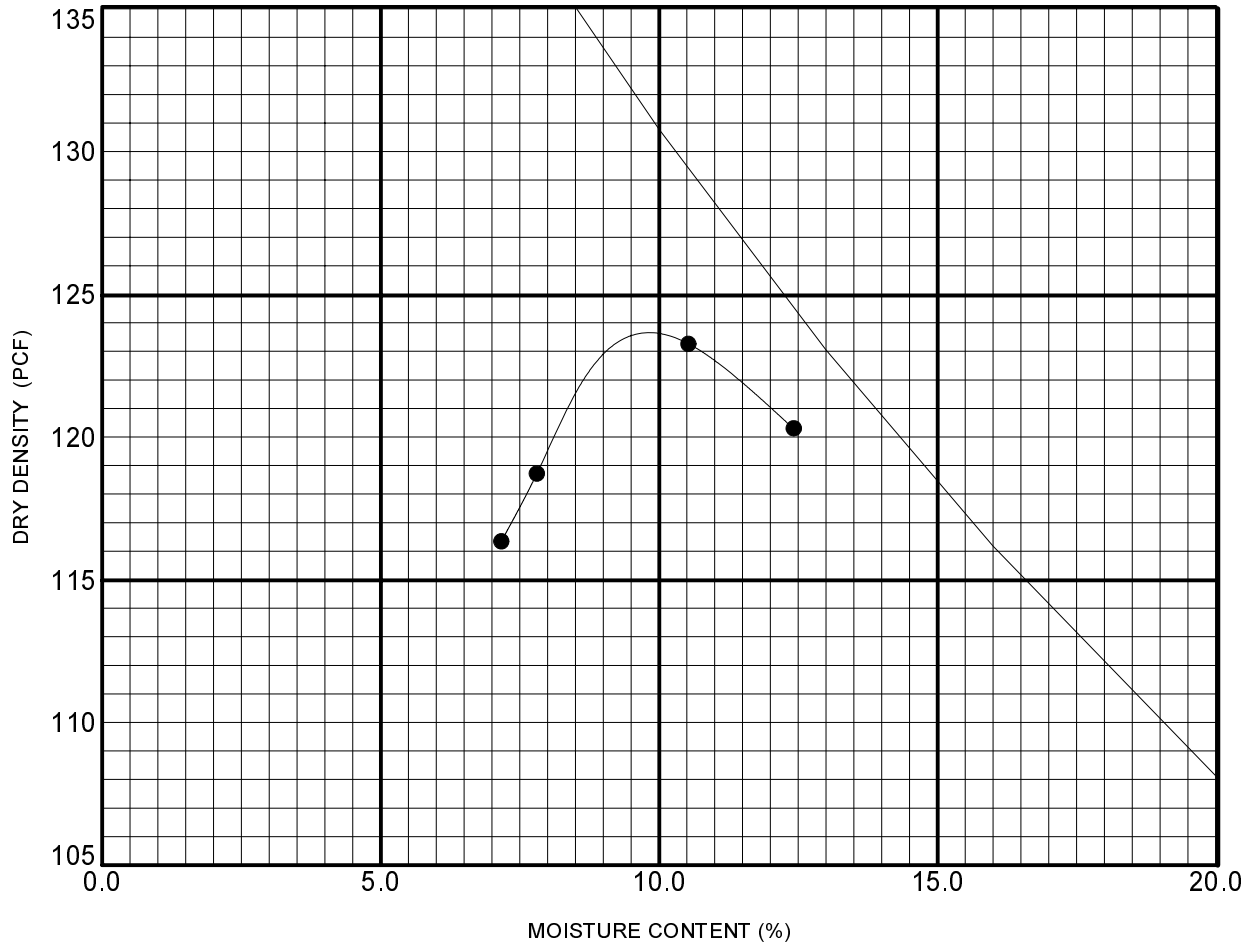
BORING NO.: TP-02 **SAMPLE NO.:** BS-1 **SAMPLE DEPTH:** 0 to 12 **LABORATORY NO.:** 373441

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NP **PLASTIC LIMIT:** NP **PLASTICITY INDEX:** NP

CLASSIFICATION: SM **ASTM SOIL DESCRIPTION:** SILTY SAND with GRAVEL

MAXIMUM DRY DENSITY: **123.7 PCF** OPTIMUM MOISTURE CONTENT: **9.8%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/6/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.:** 120751TF

LOCATION: Page to Cameron **DATE:** 6/14/12

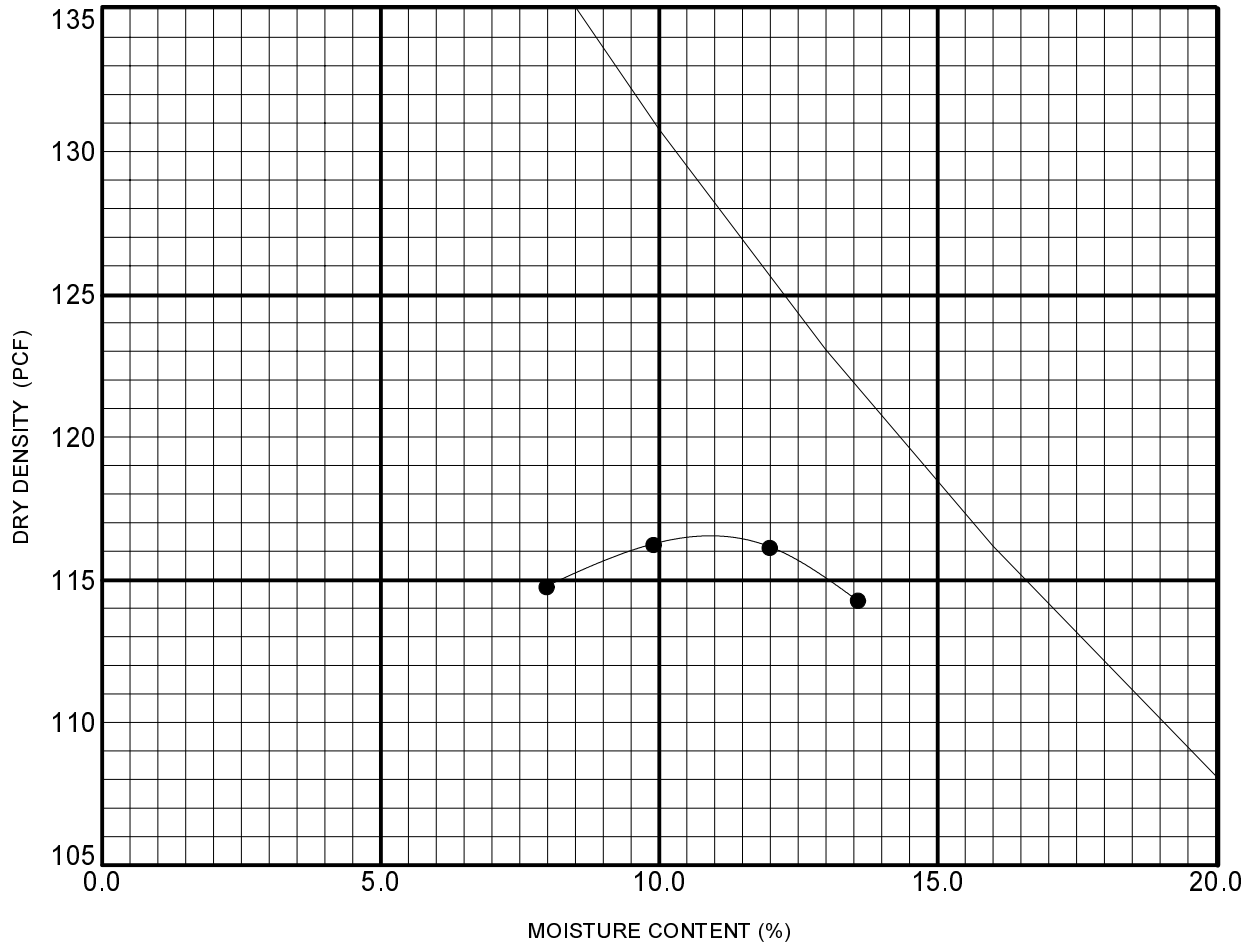
BORING NO.: TP-03 **SAMPLE NO.:** BS-1 **SAMPLE DEPTH:** 4 to 13 **LABORATORY NO.:** 373440

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT **PLASTIC LIMIT:** NT **PLASTICITY INDEX:** NT

CLASSIFICATION: SP-SM-SC **ASTM SOIL DESCRIPTION:** POORLY GRADED SAND with SILT, CLAY and GRAVEL

MAXIMUM DRY DENSITY: **116.5 PCF** OPTIMUM MOISTURE CONTENT: **10.8%**



SPEEDIE AND ASSOCIATES

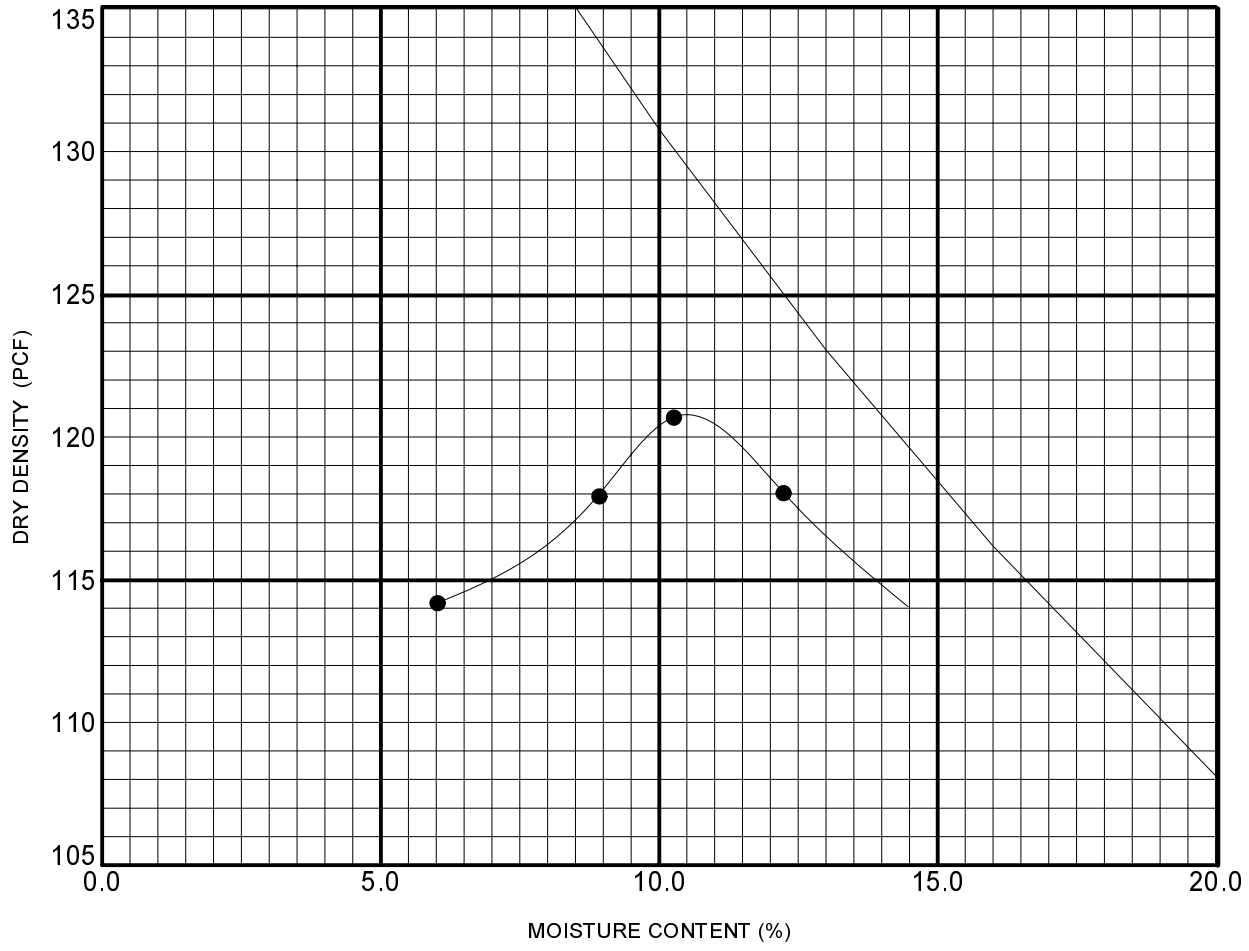
GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT:	**Cameron Water Line**		**PROJECT NO.: 120751TF**
LOCATION:	**Page to Cameron**		**DATE: 6/14/12**
BORING NO.: TP-04	**SAMPLE NO.: BS-1**	**SAMPLE DEPTH: 4 to 13**	**LABORATORY NO.: 373439**
METHOD OF COMPACTION:	**D698A**		
LIQUID LIMIT:	**22**	**PLASTIC LIMIT: 18**	**PLASTICITY INDEX: 4**
CLASSIFICATION:	**GC-GM**	**ASTM SOIL DESCRIPTION:**	**SILTY, CLAYEY GRAVEL with SAND**

MAXIMUM DRY DENSITY: **120.9 PCF**

OPTIMUM MOISTURE CONTENT: **10.5%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/6/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.:** 120751TF

LOCATION: Page to Cameron **DATE:** 6/14/12

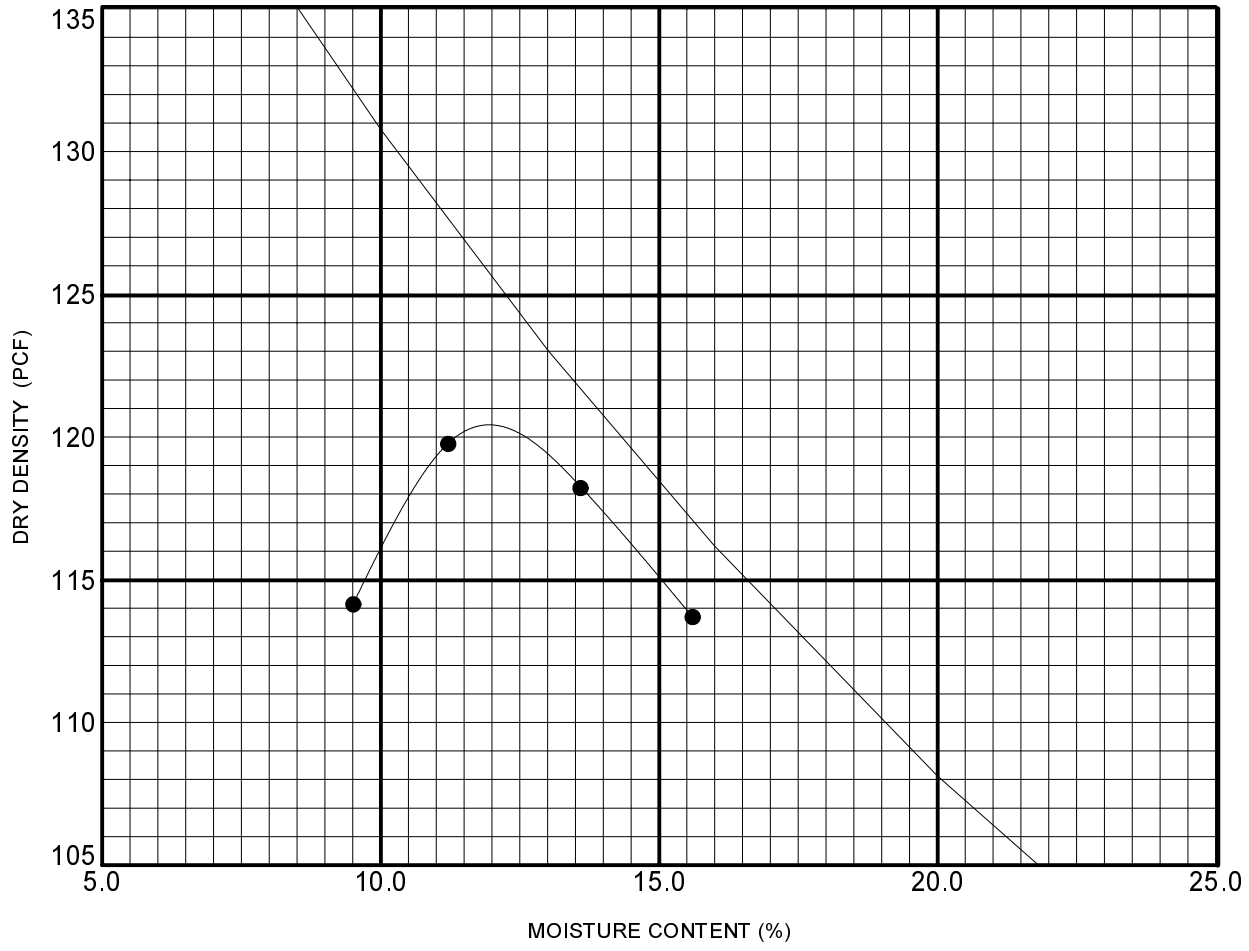
BORING NO.: TP-05 **SAMPLE NO.:** BS-1 **SAMPLE DEPTH:** 2 to 12 **LABORATORY NO.:** 373443

METHOD OF COMPACTION: D698A

LIQUID LIMIT: 28 **PLASTIC LIMIT:** 15 **PLASTICITY INDEX:** 13

CLASSIFICATION: CL **ASTM SOIL DESCRIPTION:** LEAN CLAY with SAND

MAXIMUM DRY DENSITY: **120.4 PCF** OPTIMUM MOISTURE CONTENT: **11.9 %**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/6/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line PROJECT NO.: 120751TF

LOCATION: Page to Cameron DATE: 6/14/12

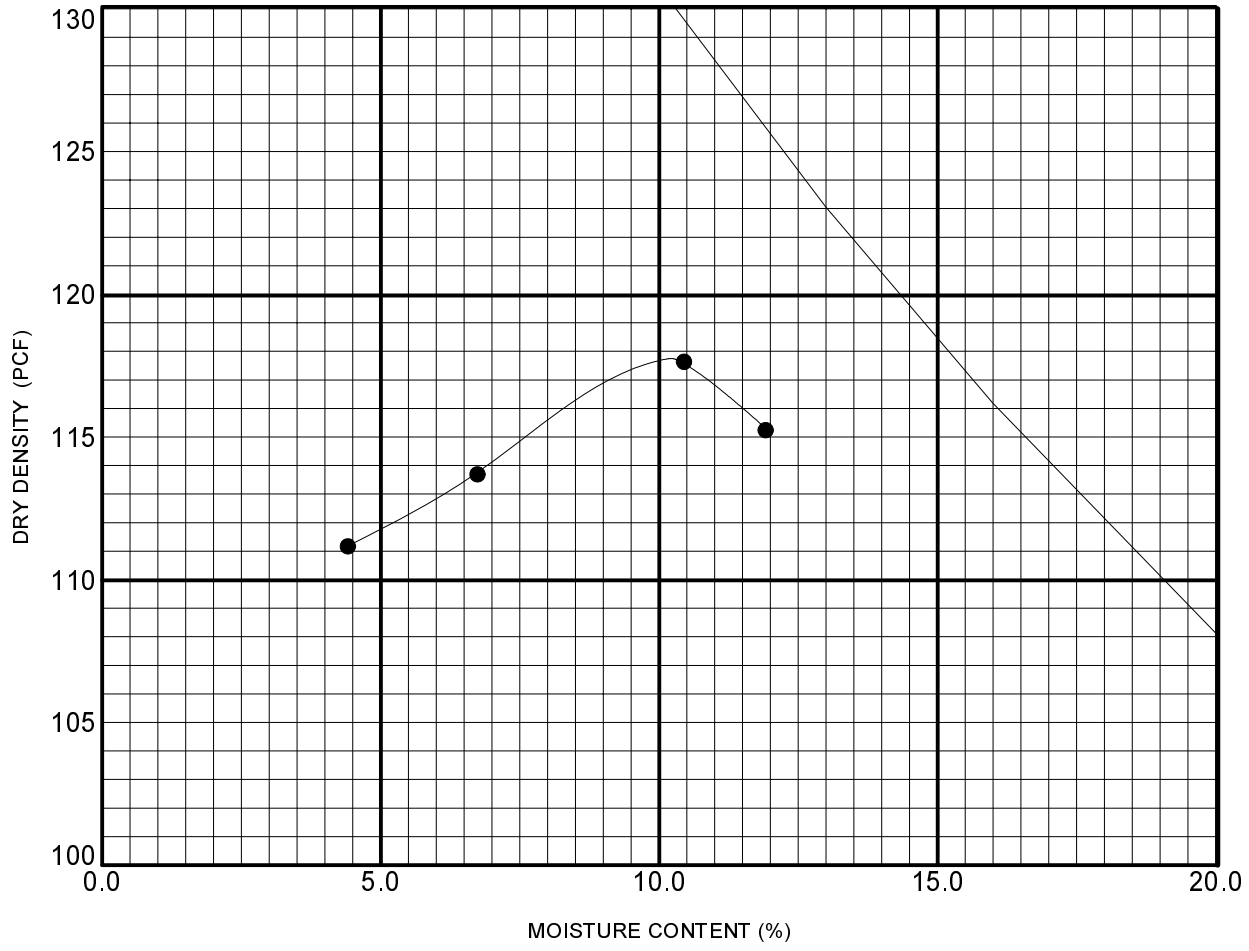
BORING NO.: TP-06 SAMPLE NO.: BS-1 SAMPLE DEPTH: 4 to 10.4 LABORATORY NO.: 373444

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT PLASTIC LIMIT: NT PLASTICITY INDEX: NT

CLASSIFICATION: SC-SM ASTM SOIL DESCRIPTION: SILTY, CLAYEY SAND

MAXIMUM DRY DENSITY: **117.8 PCF** OPTIMUM MOISTURE CONTENT: **10.3%**



SPEEDIE AND ASSOCIATES

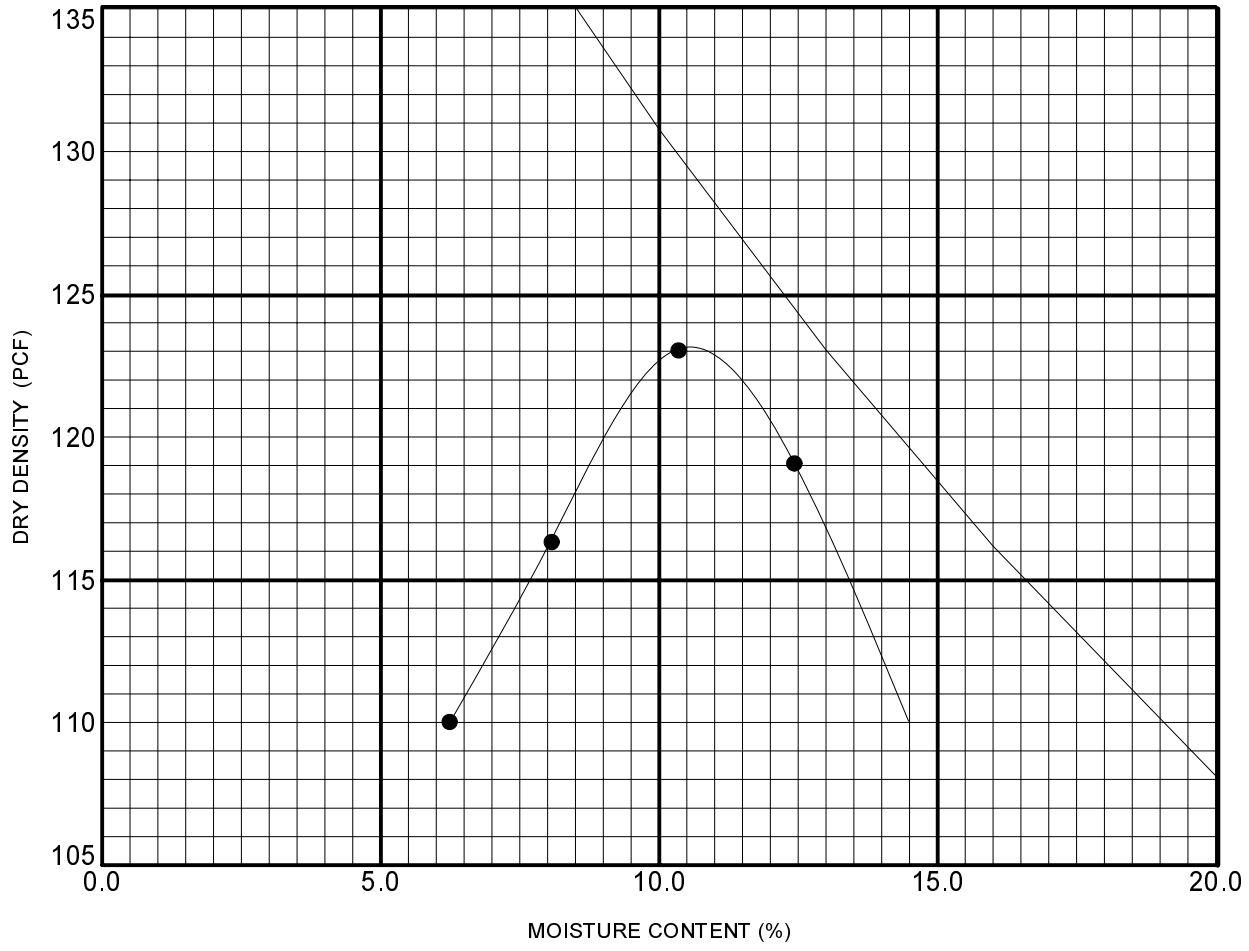
GEOTECH PROCTOR 120751TF.GPJ 7/6/12

MOISTURE-DENSITY RELATIONS

PROJECT:	**Cameron Water Line**		**PROJECT NO.: 120751TF**
LOCATION:	**Page to Cameron**		**DATE: 6/14/12**
BORING NO.: TP-07	**SAMPLE NO.: BS-1**	**SAMPLE DEPTH: 0 to 14**	**LABORATORY NO.: 373445**
METHOD OF COMPACTION:	**D698A**		
LIQUID LIMIT:	**20**	**PLASTIC LIMIT: 15**	**PLASTICITY INDEX: 5**
CLASSIFICATION:	**SC-SM**	**ASTM SOIL DESCRIPTION:**	**SILTY, CLAYEY SAND**

MAXIMUM DRY DENSITY: **123.1 PCF**

OPTIMUM MOISTURE CONTENT: **10.6 %**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/6/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.:** 120751TF

LOCATION: Page to Cameron **DATE:**

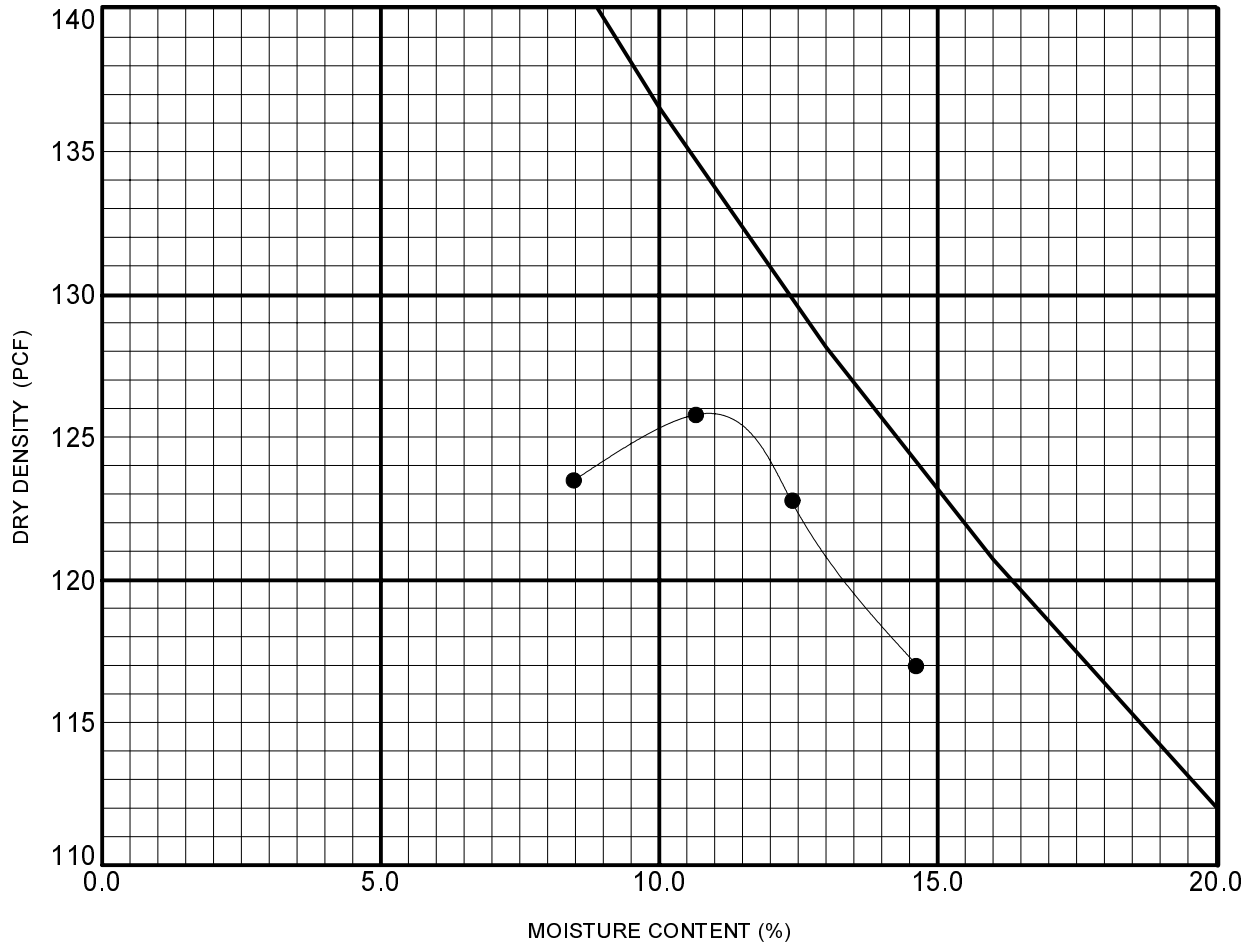
BORING NO.: TP-08 **SAMPLE NO.:** BS-1 **SAMPLE DEPTH:** 2 to 7 **LABORATORY NO.:** 373284

METHOD OF COMPACTION: D698A

LIQUID LIMIT: 26 **PLASTIC LIMIT:** 15 **PLASTICITY INDEX:** 11

CLASSIFICATION: SC **ASTM SOIL DESCRIPTION:** CLAYEY SAND with GRAVEL

MAXIMUM DRY DENSITY: **125.8 PCF** OPTIMUM MOISTURE CONTENT: **11.0%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/6/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.:** 120751TF

LOCATION: Page to Cameron **DATE:** 6/13/12

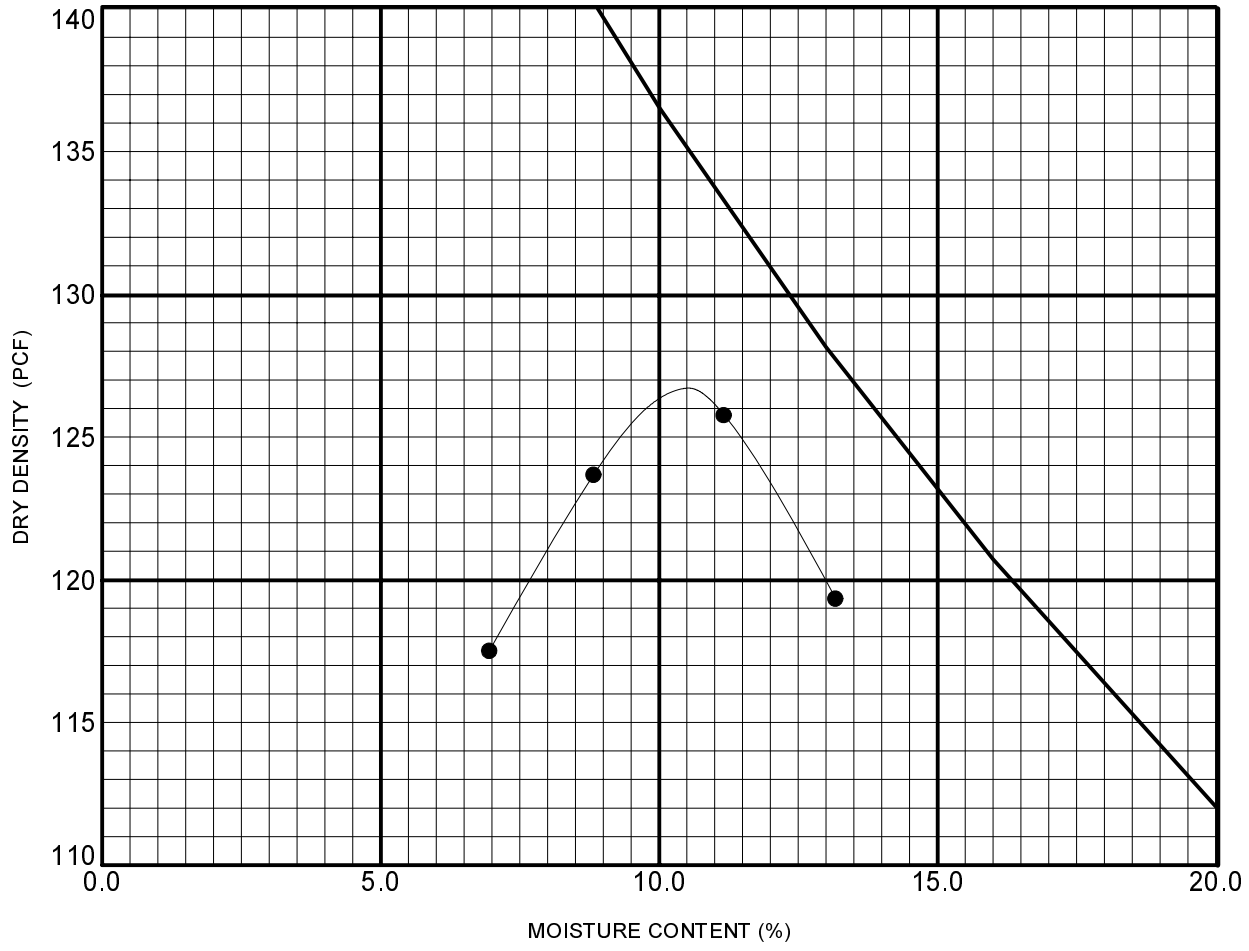
BORING NO.: TP-09 **SAMPLE NO.:** BS-1 **SAMPLE DEPTH:** 6 to 10 **LABORATORY NO.:** 373438

METHOD OF COMPACTION: D698A

LIQUID LIMIT: 21 **PLASTIC LIMIT:** 15 **PLASTICITY INDEX:** 6

CLASSIFICATION: SC-SM **ASTM SOIL DESCRIPTION:** SILTY, CLAYEY SAND with GRAVEL

MAXIMUM DRY DENSITY: **126.8 PCF** OPTIMUM MOISTURE CONTENT: **10.5%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/6/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line PROJECT NO.: 120751TF

LOCATION: Page to Cameron DATE:

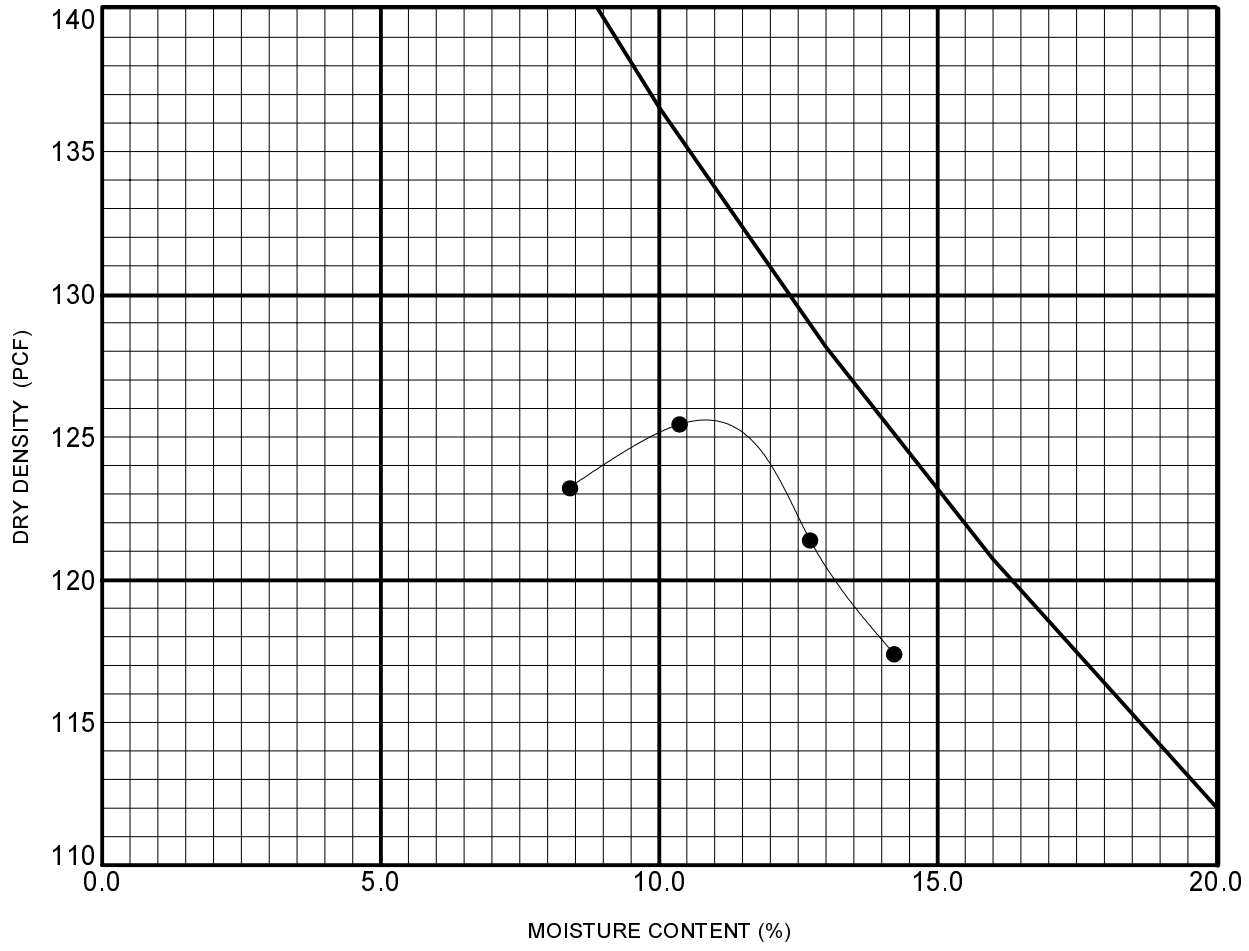
BORING NO.: TP-10 SAMPLE NO.: BS-1 SAMPLE DEPTH: 0 to 9 LABORATORY NO.: 373285

METHOD OF COMPACTION: D698A

LIQUID LIMIT: 21 PLASTIC LIMIT: 16 PLASTICITY INDEX: 6

CLASSIFICATION: SC-SM ASTM SOIL DESCRIPTION: SILTY, CLAYEY SAND with GRAVEL

MAXIMUM DRY DENSITY: **125.5 PCF** OPTIMUM MOISTURE CONTENT: **10.7%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line PROJECT NO.: 120751TF

LOCATION: Page to Cameron DATE: 6/13/12

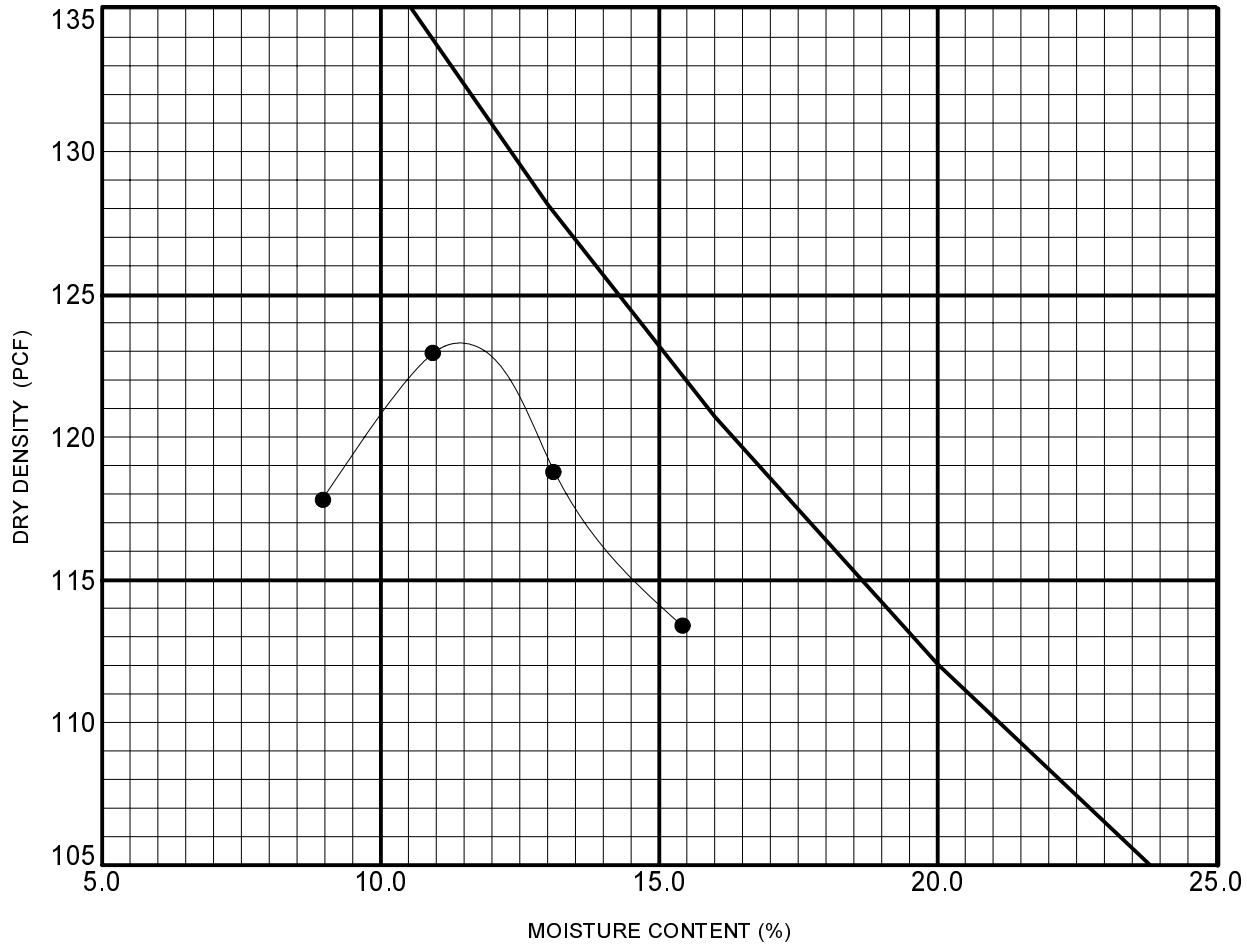
BORING NO.: TP-11 SAMPLE NO.: BS-1 SAMPLE DEPTH: 0 to 6.0 LABORATORY NO.: 373437

METHOD OF COMPACTION: D698A

LIQUID LIMIT: 22 PLASTIC LIMIT: 14 PLASTICITY INDEX: 8

CLASSIFICATION: SC ASTM SOIL DESCRIPTION: CLAYEY SAND with GRAVEL

MAXIMUM DRY DENSITY: **123.3 PCF** OPTIMUM MOISTURE CONTENT: **11.4%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line PROJECT NO.: 120751TF

LOCATION: Page to Cameron DATE: 6/11/12

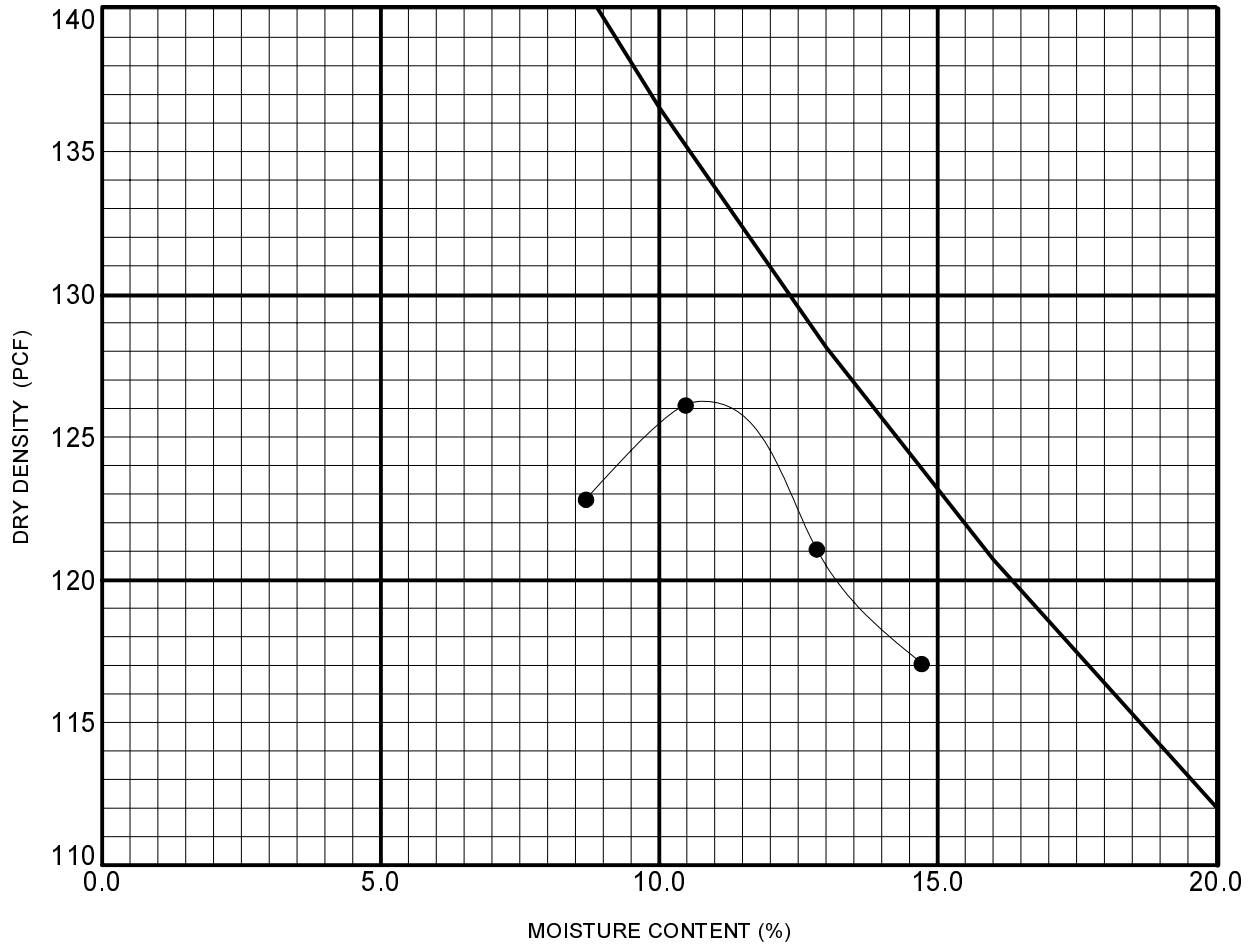
BORING NO.: TP-12 SAMPLE NO.: BS-1 SAMPLE DEPTH: 3.8 to 11.5 LABORATORY NO.: 373287

METHOD OF COMPACTION: D698A

LIQUID LIMIT: 22 PLASTIC LIMIT: 14 PLASTICITY INDEX: 8

CLASSIFICATION: SC ASTM SOIL DESCRIPTION: CLAYEY SAND

MAXIMUM DRY DENSITY: **126.2 PCF** OPTIMUM MOISTURE CONTENT: **10.8%**



SPEEDIE AND ASSOCIATES

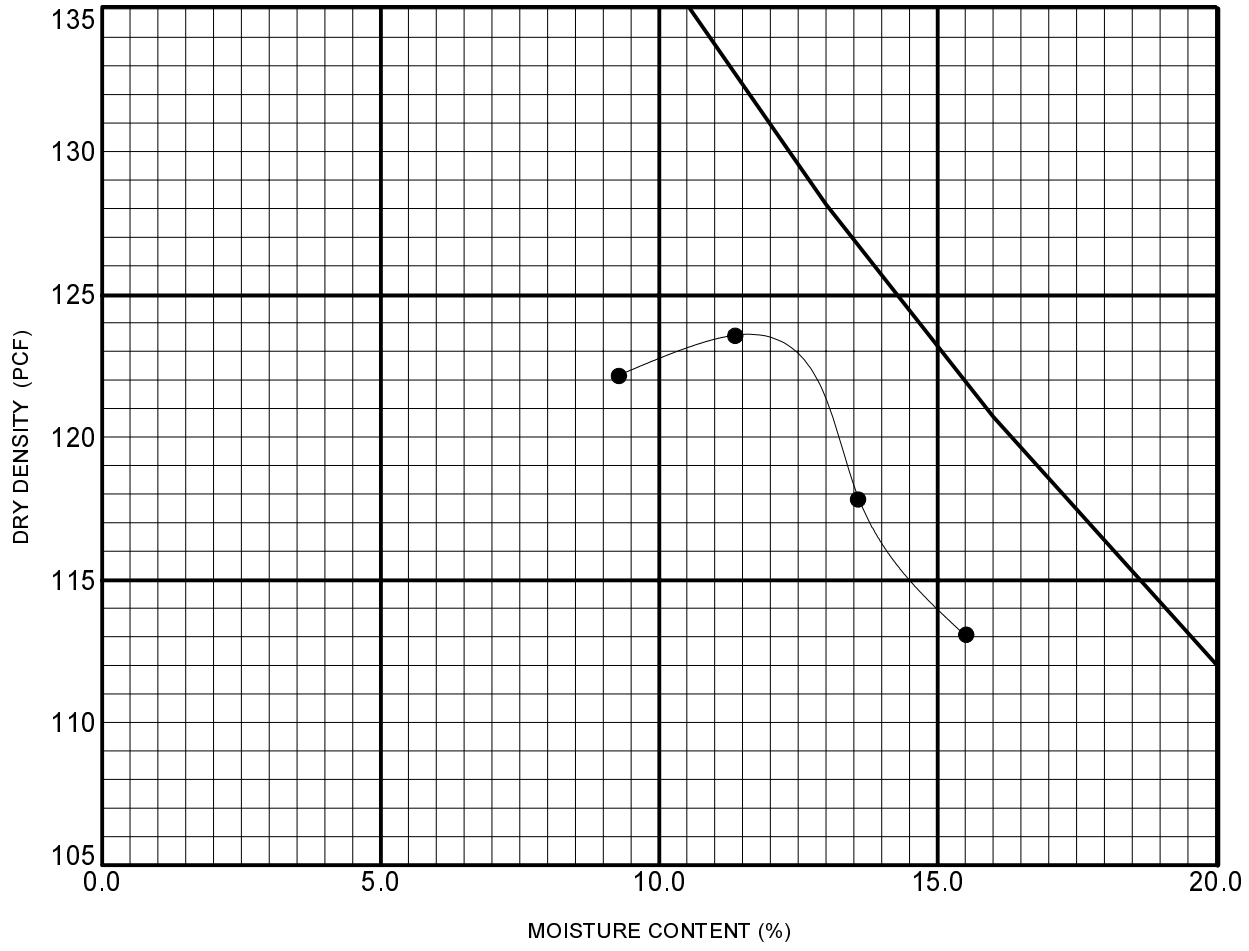
GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT:	**Cameron Water Line**		**PROJECT NO.: 120751TF**
LOCATION:	**Page to Cameron**		**DATE: 6/11/12**
BORING NO.: TP-13	**SAMPLE NO.: BS-1**	**SAMPLE DEPTH: 0 to 4.5**	**LABORATORY NO.: 373288**
METHOD OF COMPACTION:	**D698A**		
LIQUID LIMIT:	**21**	**PLASTIC LIMIT: 14**	**PLASTICITY INDEX: 7**
CLASSIFICATION:	**SC-SM**	**ASTM SOIL DESCRIPTION:**	**SILTY, CLAYEY SAND**

MAXIMUM DRY DENSITY: **123.7 PCF**

OPTIMUM MOISTURE CONTENT: **11.7 %**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/11/12**

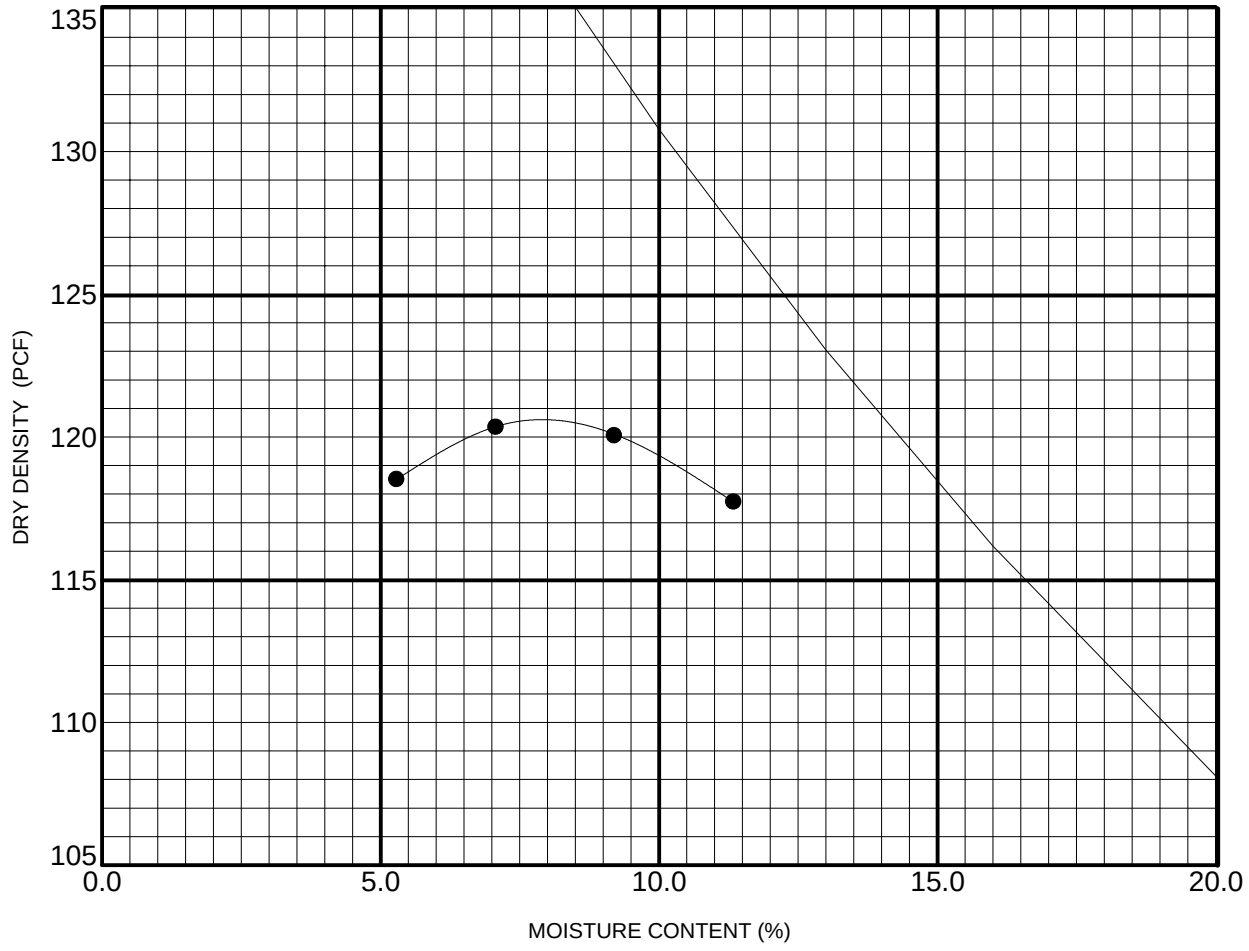
BORING NO.: TP-14 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 0 to 10** **LABORATORY NO.: 373289**

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT **PLASTIC LIMIT:** NT **PLASTICITY INDEX:** NT

CLASSIFICATION: SC-SM **ASTM SOIL DESCRIPTION:** SILTY, CLAYEY SAND

MAXIMUM DRY DENSITY: **120.7 PCF** OPTIMUM MOISTURE CONTENT: **7.8%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/11/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/11/12**

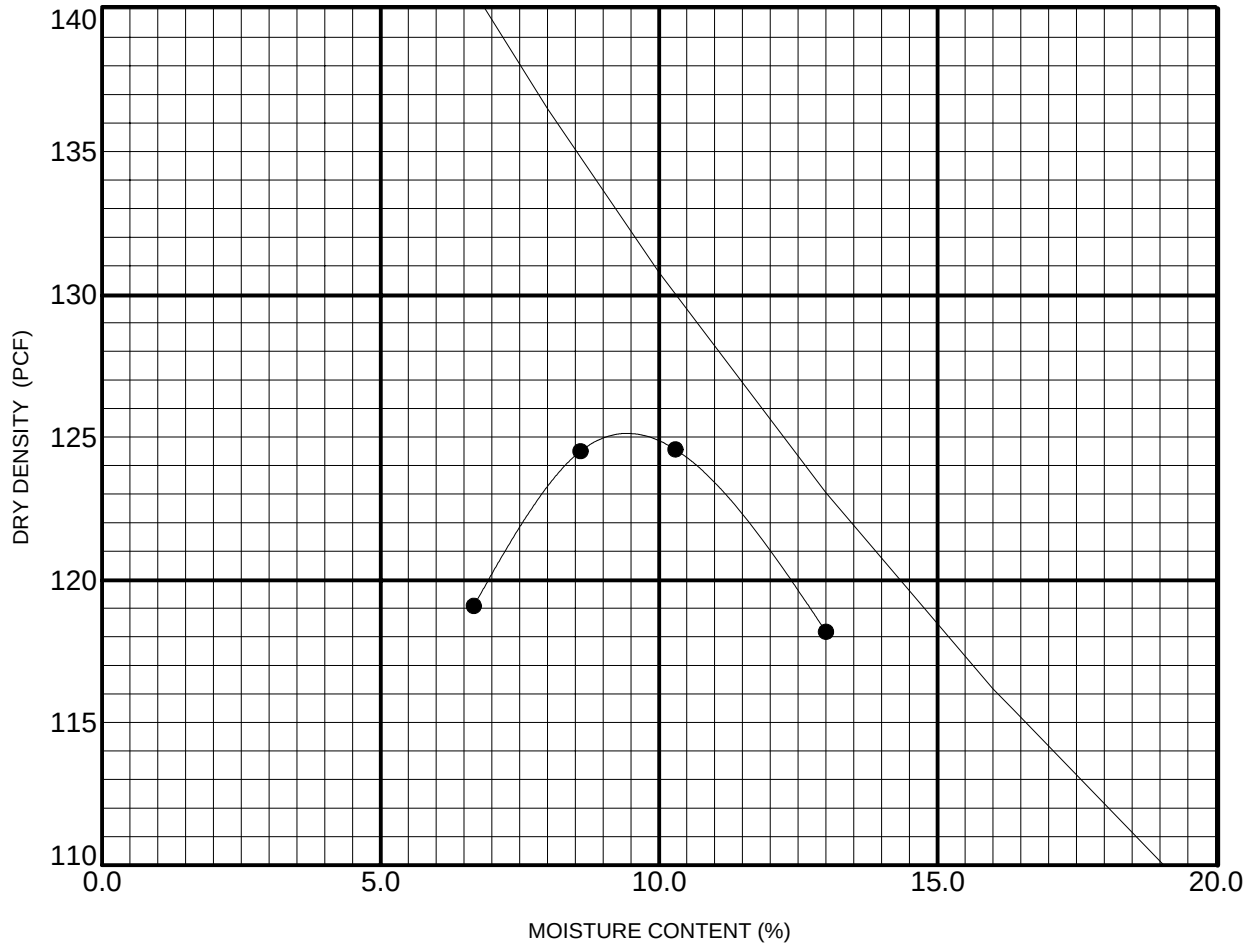
BORING NO.: TP-15 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 0 to 5.5** **LABORATORY NO.: 373290**

METHOD OF COMPACTION: D698A

LIQUID LIMIT: 20 **PLASTIC LIMIT:** 15 **PLASTICITY INDEX:** 5

CLASSIFICATION: SC-SM **ASTM SOIL DESCRIPTION:** SILTY, CLAYEY SAND

MAXIMUM DRY DENSITY: **125.1 PCF** OPTIMUM MOISTURE CONTENT: **9.4 %**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE:**

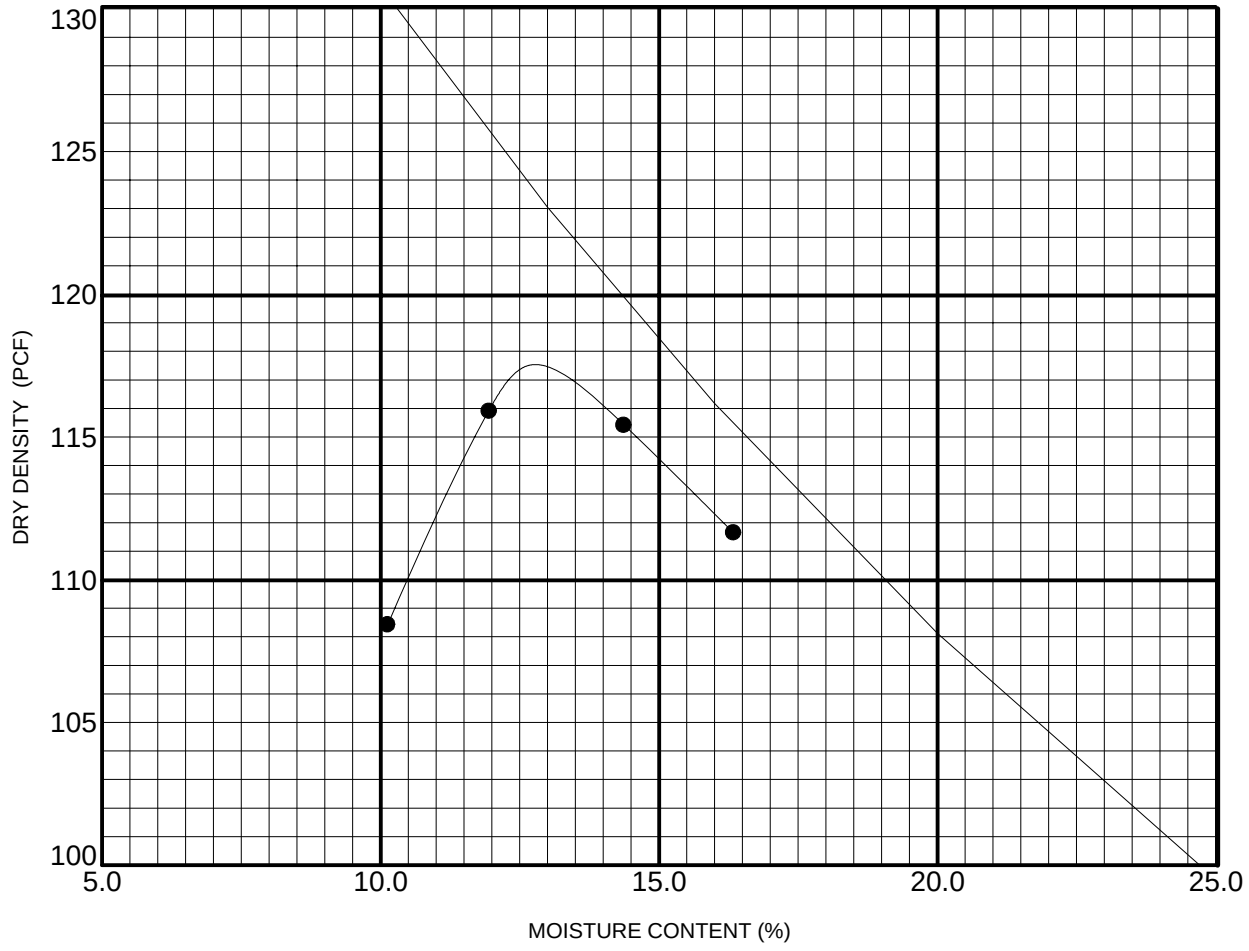
BORING NO.: TP-16 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 0 to 3.5** **LABORATORY NO.: 373291**

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT **PLASTIC LIMIT:** NT **PLASTICITY INDEX:** NT

CLASSIFICATION: CL **ASTM SOIL DESCRIPTION:** CLAYSTONE (SANDY LEAN CLAY)

MAXIMUM DRY DENSITY: **117.6 PCF** OPTIMUM MOISTURE CONTENT: **12.7%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE:**

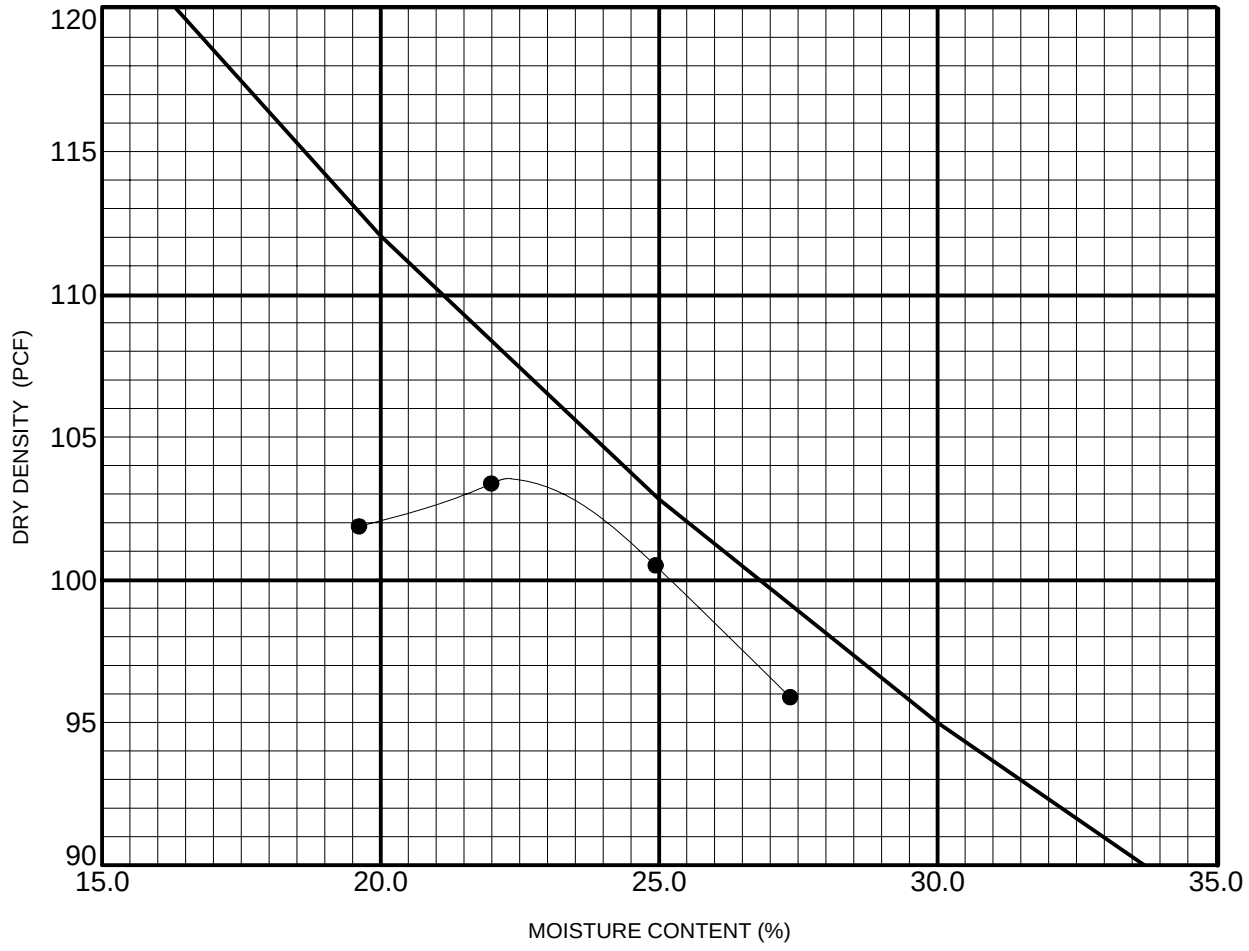
BORING NO.: TP-18 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 2.5 to 9** **LABORATORY NO.: 373309**

METHOD OF COMPACTION: **D698A**

LIQUID LIMIT: **NT** **PLASTIC LIMIT:** **NT** **PLASTICITY INDEX:** **NT**

CLASSIFICATION: **CL** **ASTM SOIL DESCRIPTION:** **CLAYSTONE (LEAN CLAY)**

MAXIMUM DRY DENSITY: **103.6 PCF** OPTIMUM MOISTURE CONTENT: **22.3%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/13/12**

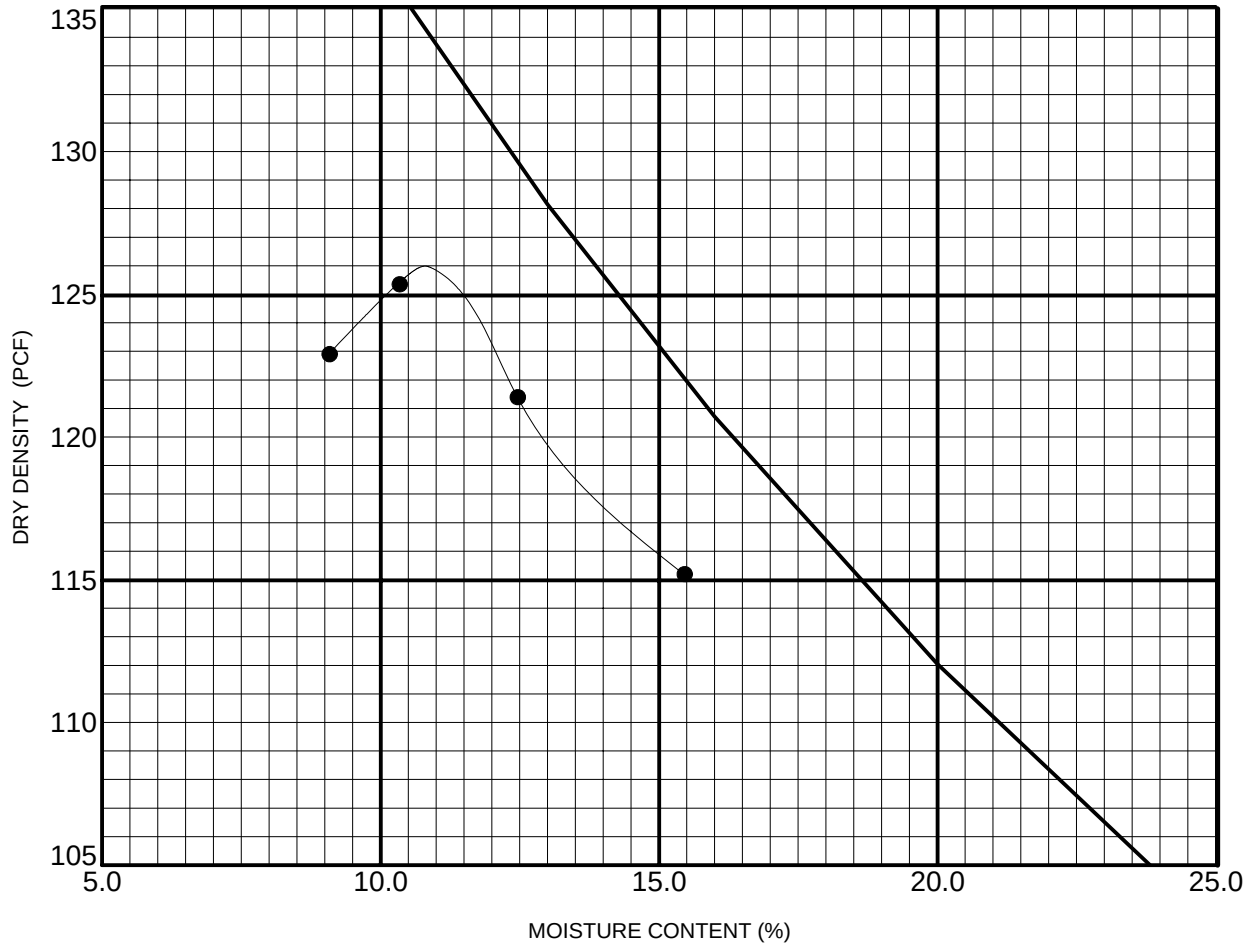
BORING NO.: TP-19 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 0 to 8** **LABORATORY NO.: 373436**

METHOD OF COMPACTION: D698A

LIQUID LIMIT: 22 **PLASTIC LIMIT:** 13 **PLASTICITY INDEX:** 9

CLASSIFICATION: SC **ASTM SOIL DESCRIPTION:** CLAYEY SAND with GRAVEL

MAXIMUM DRY DENSITY: **126.0 PCF** OPTIMUM MOISTURE CONTENT: **10.8%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/13/12**

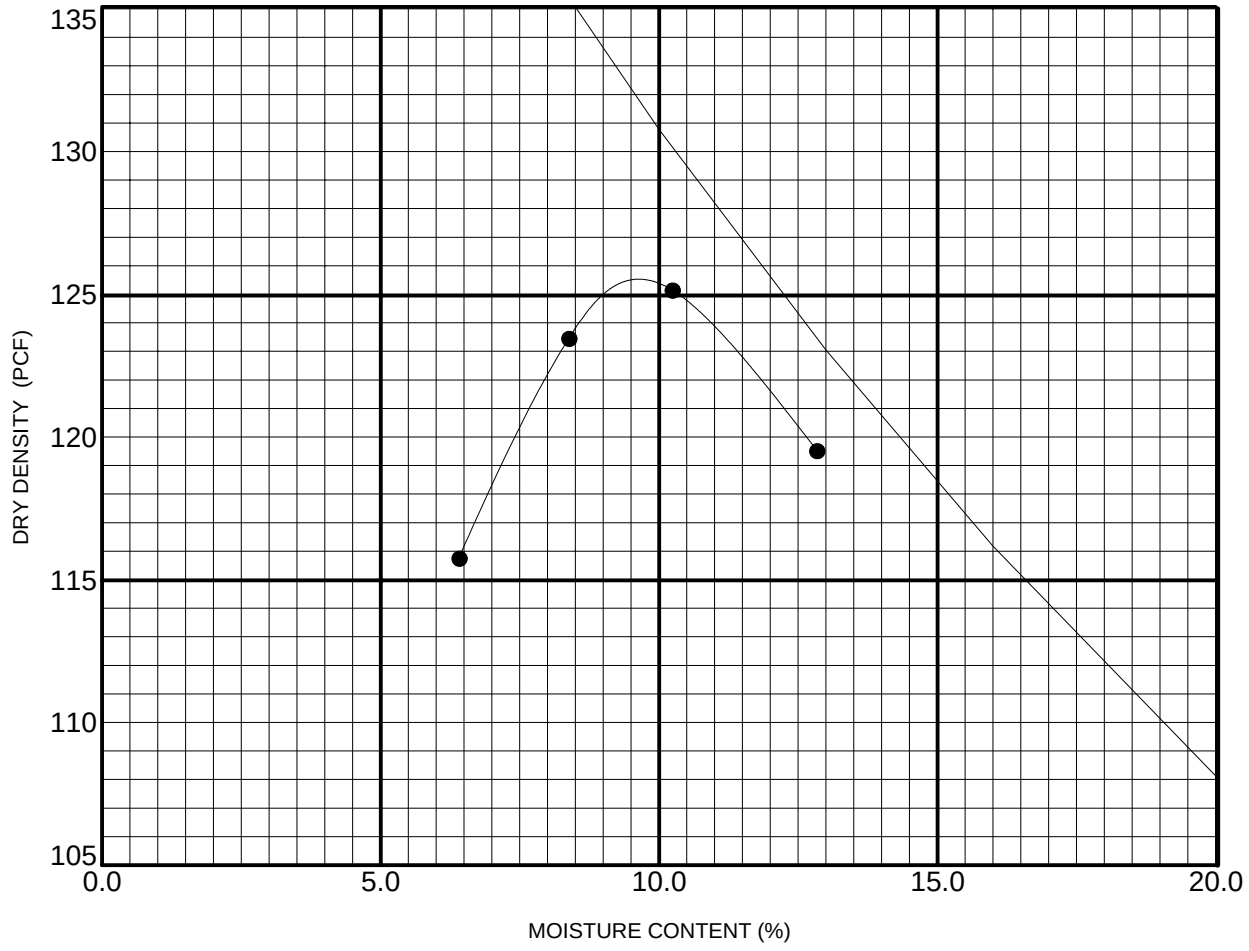
BORING NO.: TP-20 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 0 to 8.5** **LABORATORY NO.: 373435**

METHOD OF COMPACTION: D698A

LIQUID LIMIT: 23 **PLASTIC LIMIT:** 18 **PLASTICITY INDEX:** 5

CLASSIFICATION: SC-SM **ASTM SOIL DESCRIPTION:** SILTY, CLAYEY SAND

MAXIMUM DRY DENSITY: **125.6 PCF** OPTIMUM MOISTURE CONTENT: **9.6%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/13/12**

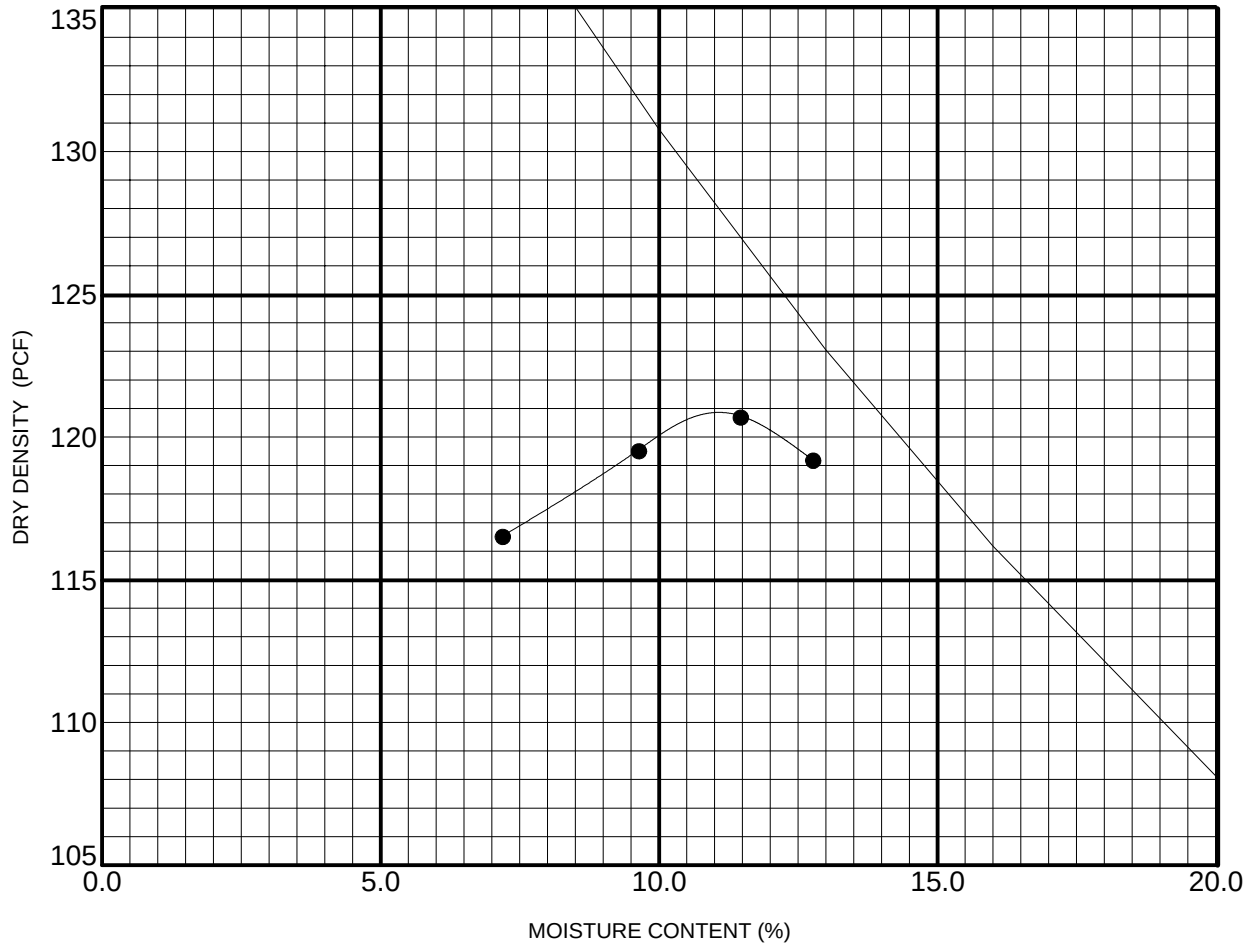
BORING NO.: TP-21 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 3 to 5** **LABORATORY NO.: 373433**

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT **PLASTIC LIMIT:** NT **PLASTICITY INDEX:** NT

CLASSIFICATION: SW-SM-SC **ASTM SOIL DESCRIPTION:** WELL-GRADED SAND with SILT, CLAY, and GRAVEL

MAXIMUM DRY DENSITY: **120.9 PCF** OPTIMUM MOISTURE CONTENT: **11.1%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/13/12**

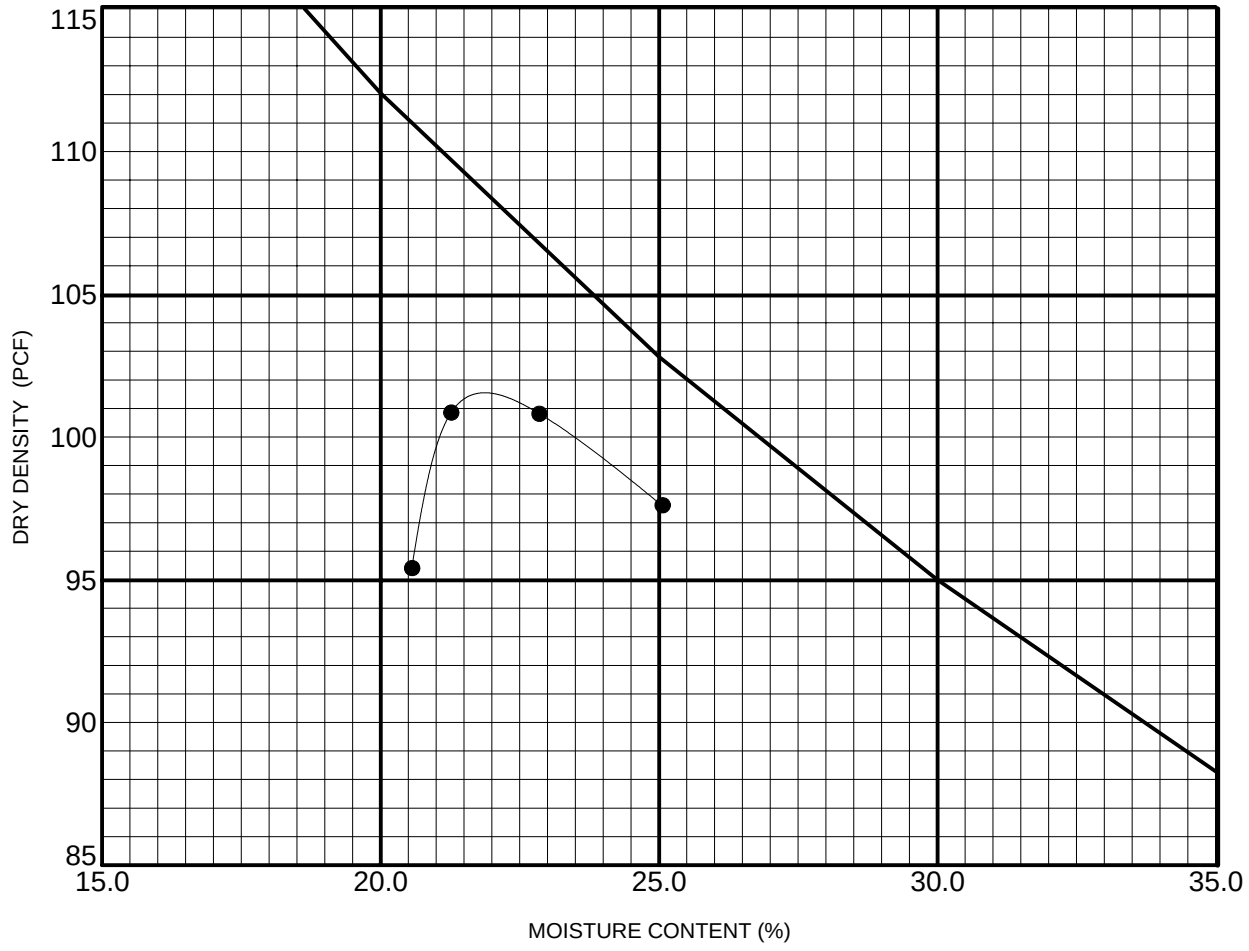
BORING NO.: TP-21 **SAMPLE NO.: BS-2** **SAMPLE DEPTH: 8 to 15** **LABORATORY NO.: 373434**

METHOD OF COMPACTION: **D698A**

LIQUID LIMIT: **42** **PLASTIC LIMIT:** **24** **PLASTICITY INDEX:** **19**

CLASSIFICATION: **CL** **ASTM SOIL DESCRIPTION:** **CLAYSTONE (SANDY LEAN CLAY)**

MAXIMUM DRY DENSITY: **101.5 PCF** OPTIMUM MOISTURE CONTENT: **21.8 %**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/13/12**

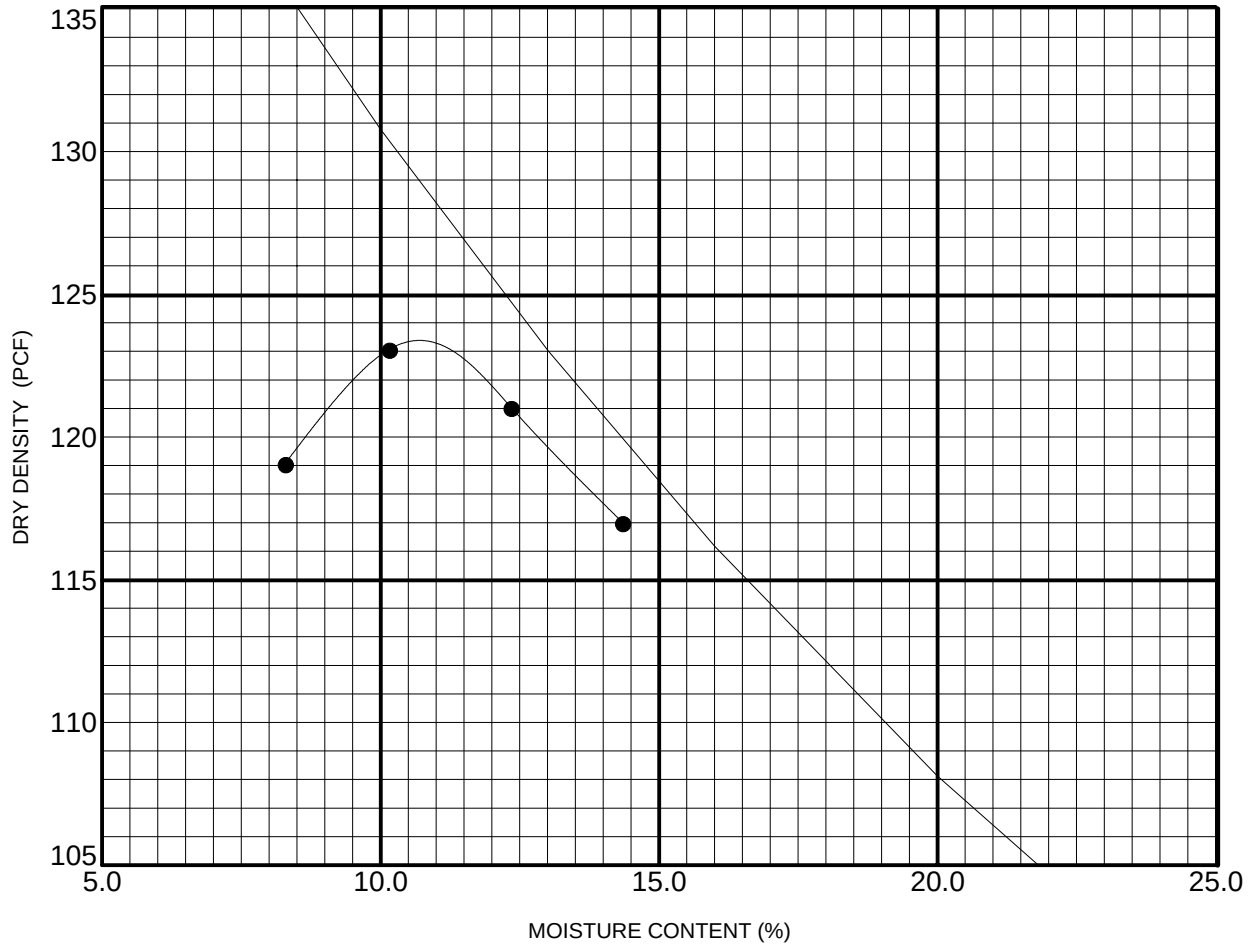
BORING NO.: TP-22 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 6 to 14** **LABORATORY NO.: 373432**

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT **PLASTIC LIMIT:** NT **PLASTICITY INDEX:** NT

CLASSIFICATION: SW-SM-SC **ASTM SOIL DESCRIPTION:** WELL-GRADED SAND with SILT, CLAY and GRAVEL

MAXIMUM DRY DENSITY: **123.3 PCF** OPTIMUM MOISTURE CONTENT: **10.7%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/13/12**

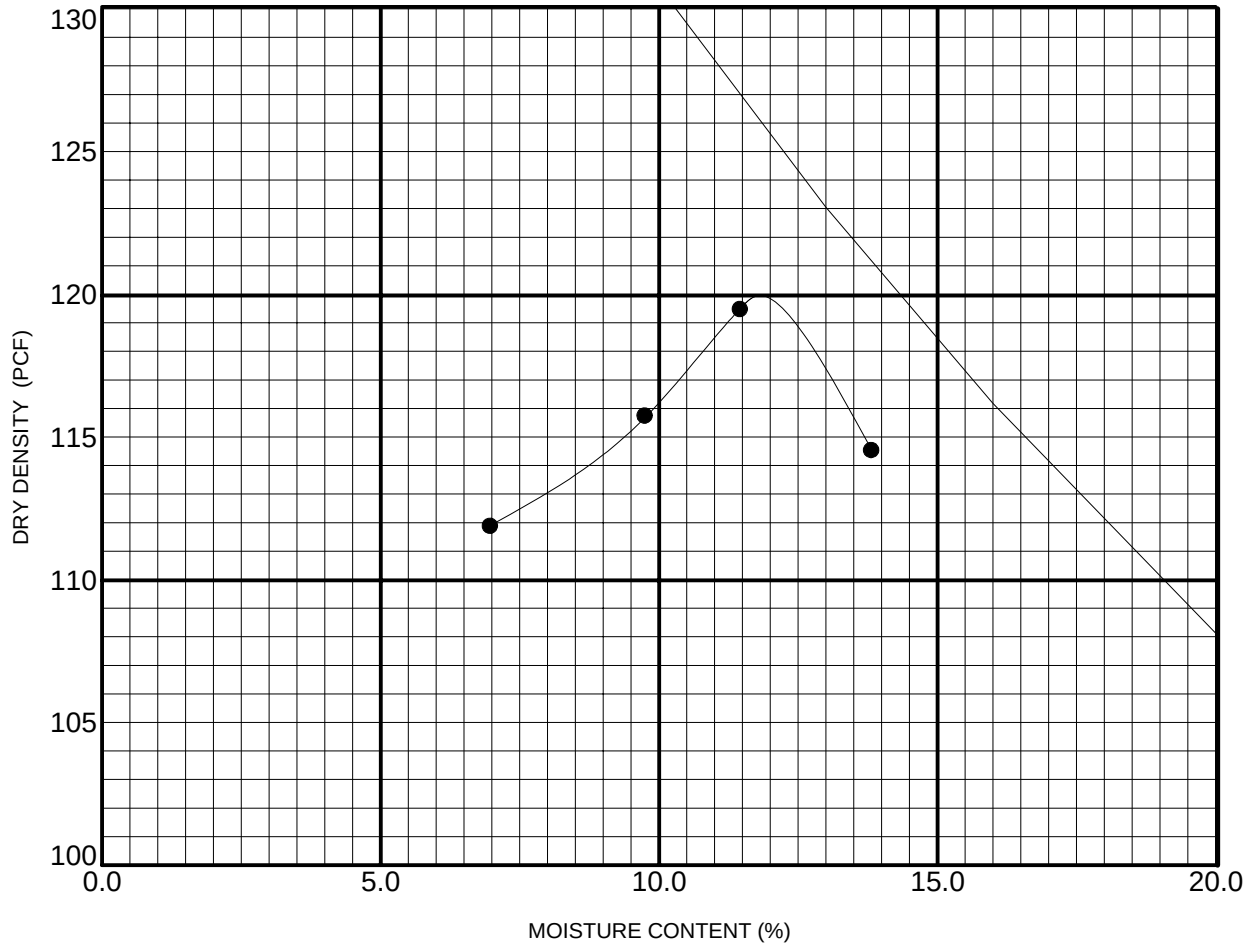
BORING NO.: TP-23 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 0 to 6** **LABORATORY NO.: 373430**

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NP **PLASTIC LIMIT:** NP **PLASTICITY INDEX:** NP

CLASSIFICATION: SM **ASTM SOIL DESCRIPTION:** SILTY SAND

MAXIMUM DRY DENSITY: **120.0 PCF** OPTIMUM MOISTURE CONTENT: **11.7%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/13/12**

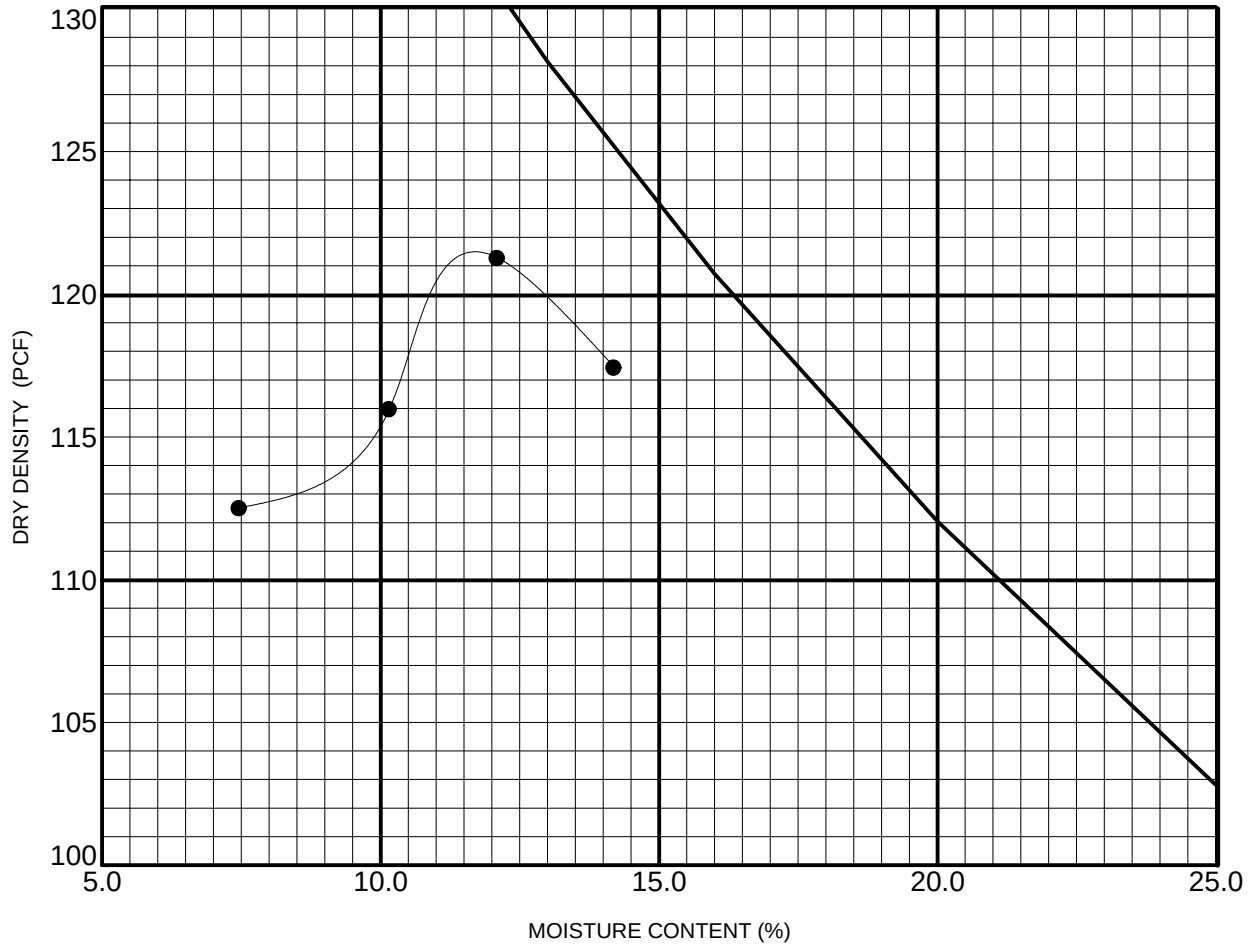
BORING NO.: TP-23 **SAMPLE NO.: BS-2** **SAMPLE DEPTH: 6 to 8** **LABORATORY NO.: 373431**

METHOD OF COMPACTION: D698A

LIQUID LIMIT: 22 **PLASTIC LIMIT:** 13 **PLASTICITY INDEX:** 9

CLASSIFICATION: SC **ASTM SOIL DESCRIPTION:** CLAYEY SAND with GRAVEL

MAXIMUM DRY DENSITY: **121.5 PCF** OPTIMUM MOISTURE CONTENT: **11.7%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/12/12**

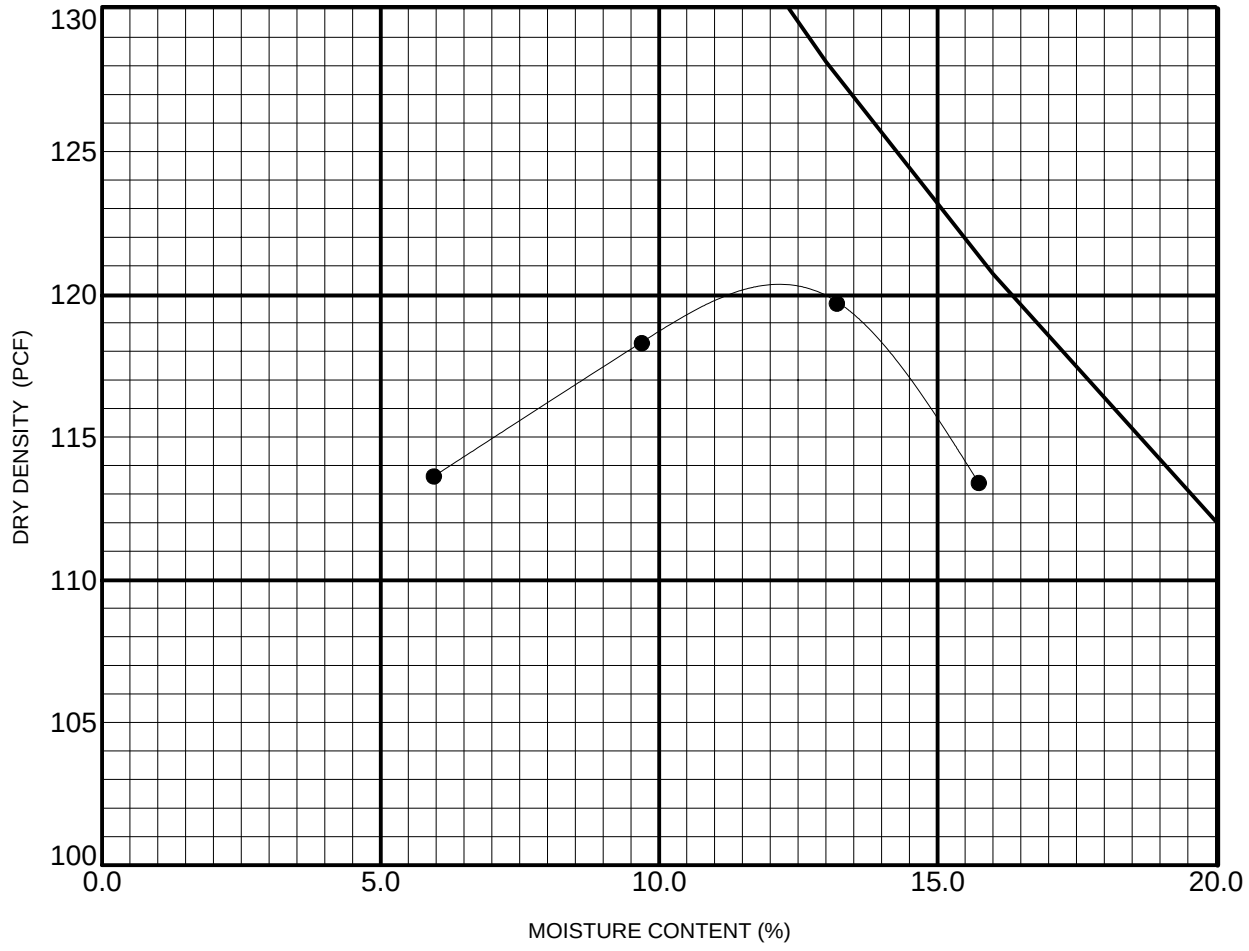
BORING NO.: TP-24 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 5 to 15.0** **LABORATORY NO.: 373429**

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT **PLASTIC LIMIT:** NT **PLASTICITY INDEX:** NT

CLASSIFICATION: SP-SM-SC **ASTM SOIL DESCRIPTION:** POORLY GRADED SAND with SILT, CLAY and GRAVEL

MAXIMUM DRY DENSITY: **120.2 PCF** OPTIMUM MOISTURE CONTENT: **12.2%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/7/12**

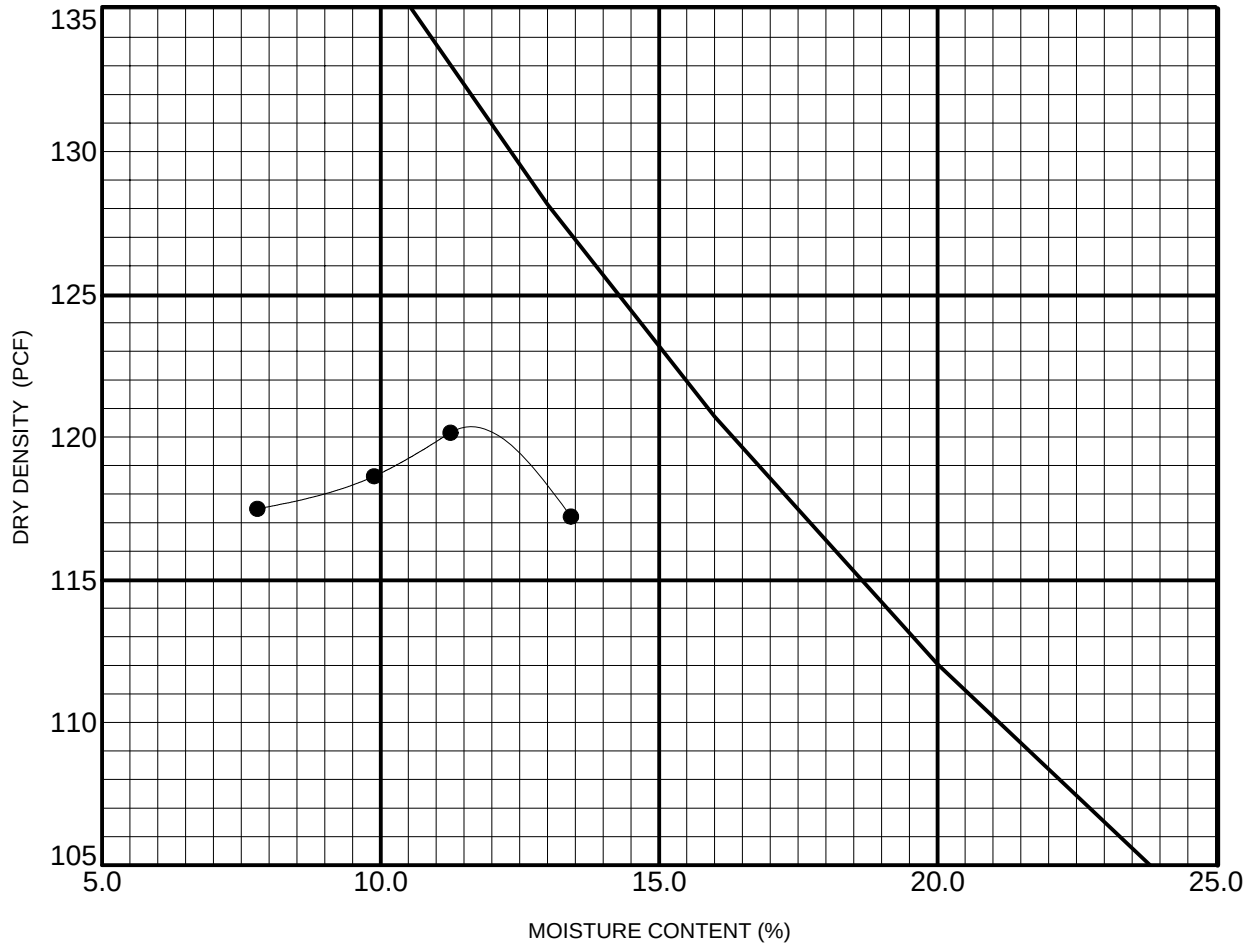
BORING NO.: TP-25 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 8 to 12** **LABORATORY NO.: 373111**

METHOD OF COMPACTION: **D698A**

LIQUID LIMIT: **NT** **PLASTIC LIMIT:** **NT** **PLASTICITY INDEX:** **NT**

CLASSIFICATION: **SC-SM** **ASTM SOIL DESCRIPTION:** **SILTY, CLAYEY SAND**

MAXIMUM DRY DENSITY: **120.3 PCF** OPTIMUM MOISTURE CONTENT: **11.7%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/7/12**

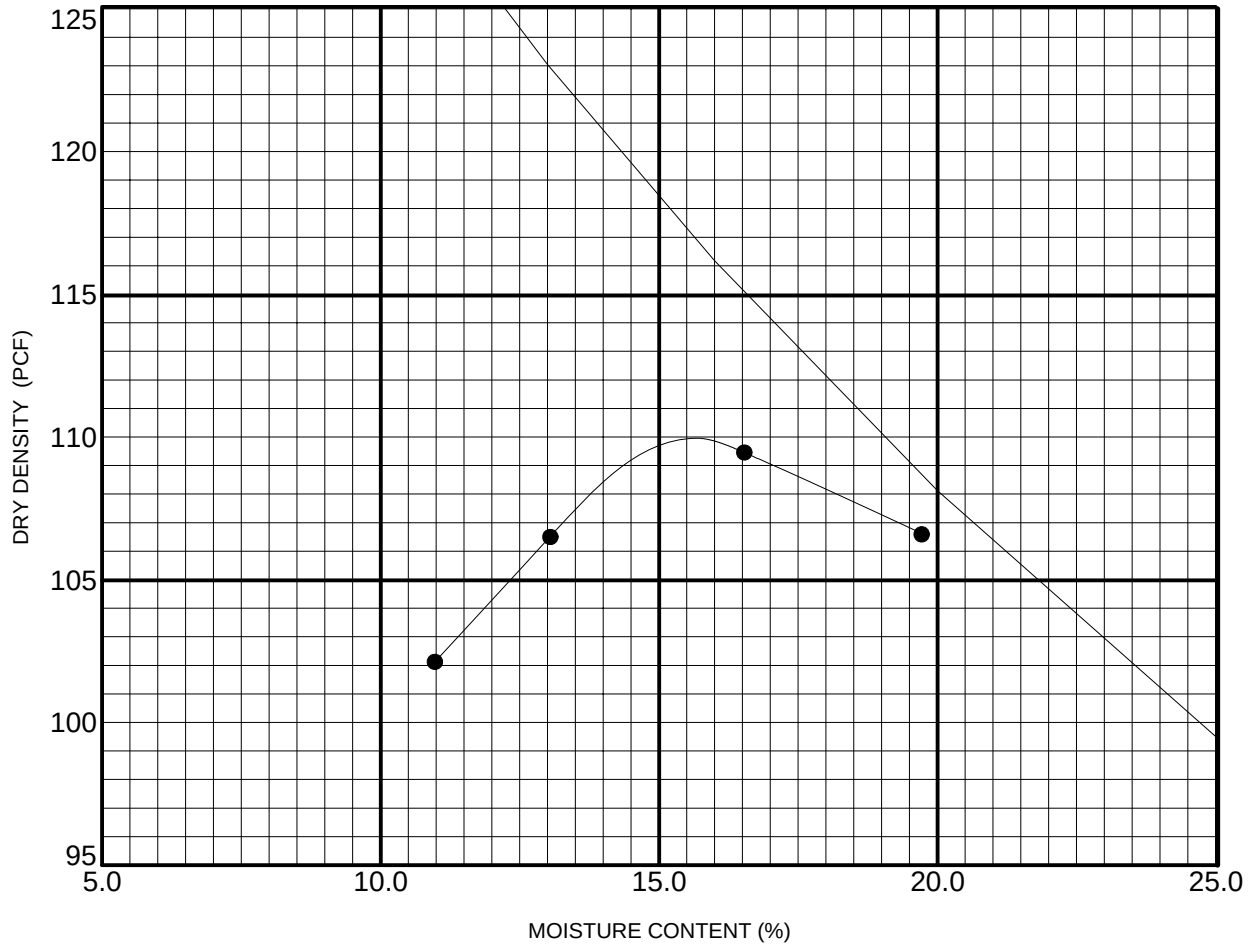
BORING NO.: TP-26 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 3.5 to 10.5** **LABORATORY NO.: 373114**

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT **PLASTIC LIMIT:** NT **PLASTICITY INDEX:** NT

CLASSIFICATION: SC-SM **ASTM SOIL DESCRIPTION:** SILTY, CLAYEY SAND

MAXIMUM DRY DENSITY: **110.0 PCF** OPTIMUM MOISTURE CONTENT: **15.6%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/7/12**

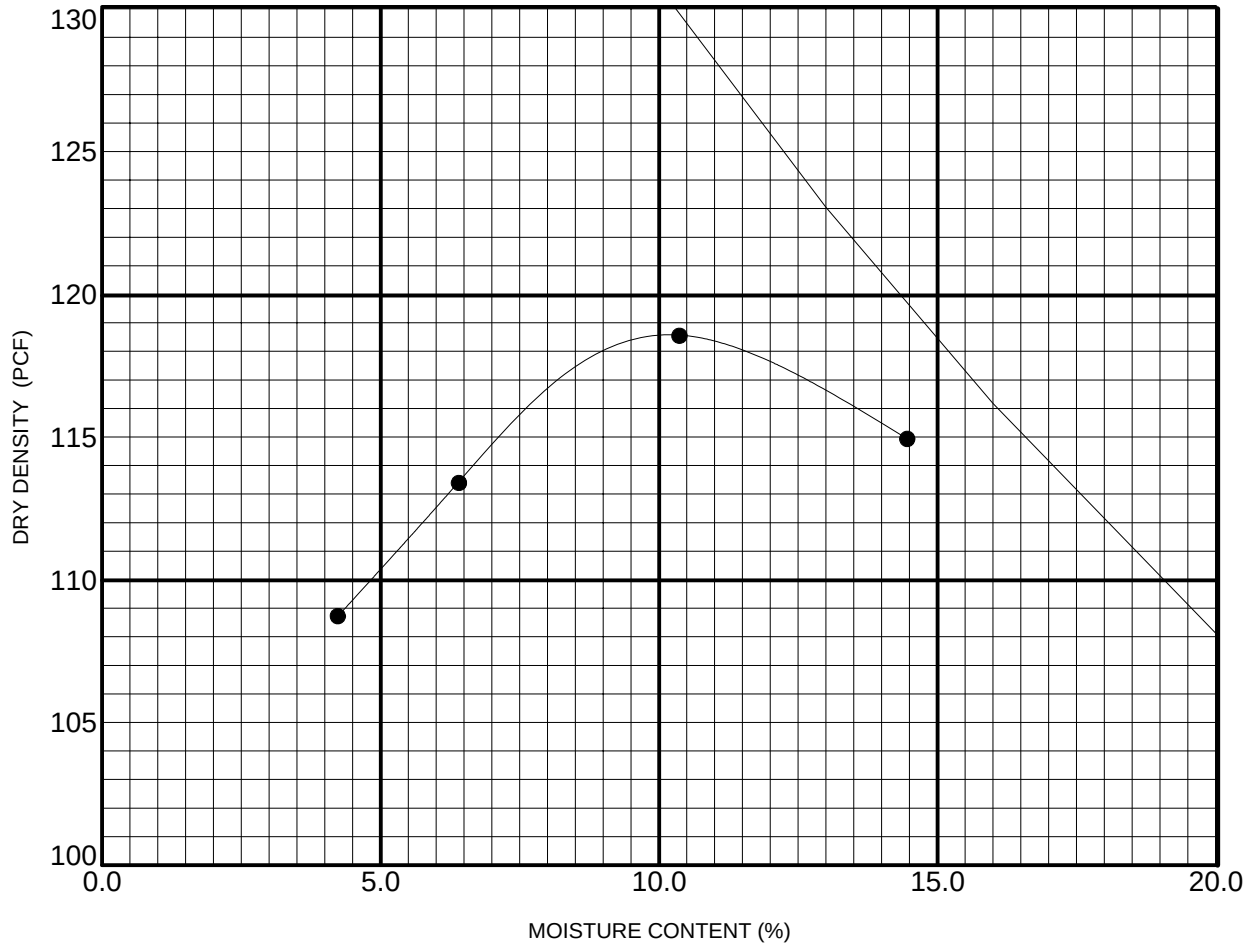
BORING NO.: TP-27 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 0 to 5** **LABORATORY NO.: 373117**

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT **PLASTIC LIMIT:** NT **PLASTICITY INDEX:** NT

CLASSIFICATION: SP-SM-SC **ASTM SOIL DESCRIPTION:** POORLY GRADED SAND with SILT and CLAY

MAXIMUM DRY DENSITY: **118.5 PCF** OPTIMUM MOISTURE CONTENT: **10.3%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/7/12**

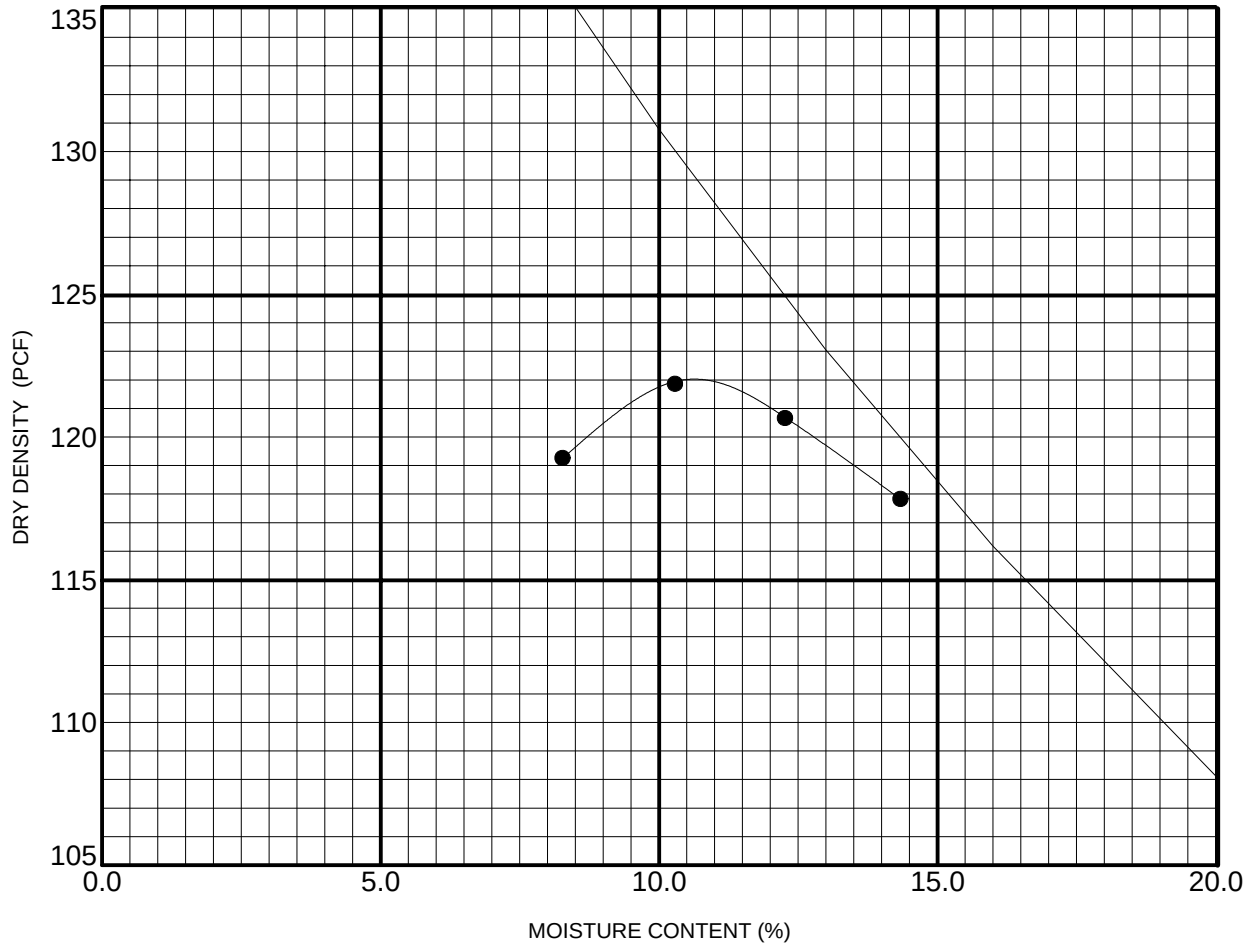
BORING NO.: TP-28 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 0 to 14** **LABORATORY NO.: 373120**

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT **PLASTIC LIMIT:** NT **PLASTICITY INDEX:** NT

CLASSIFICATION: SC-SM **ASTM SOIL DESCRIPTION:** SILTY, CLAYEY SAND with GRAVEL

MAXIMUM DRY DENSITY: **122.0 PCF** OPTIMUM MOISTURE CONTENT: **10.6%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/12/12**

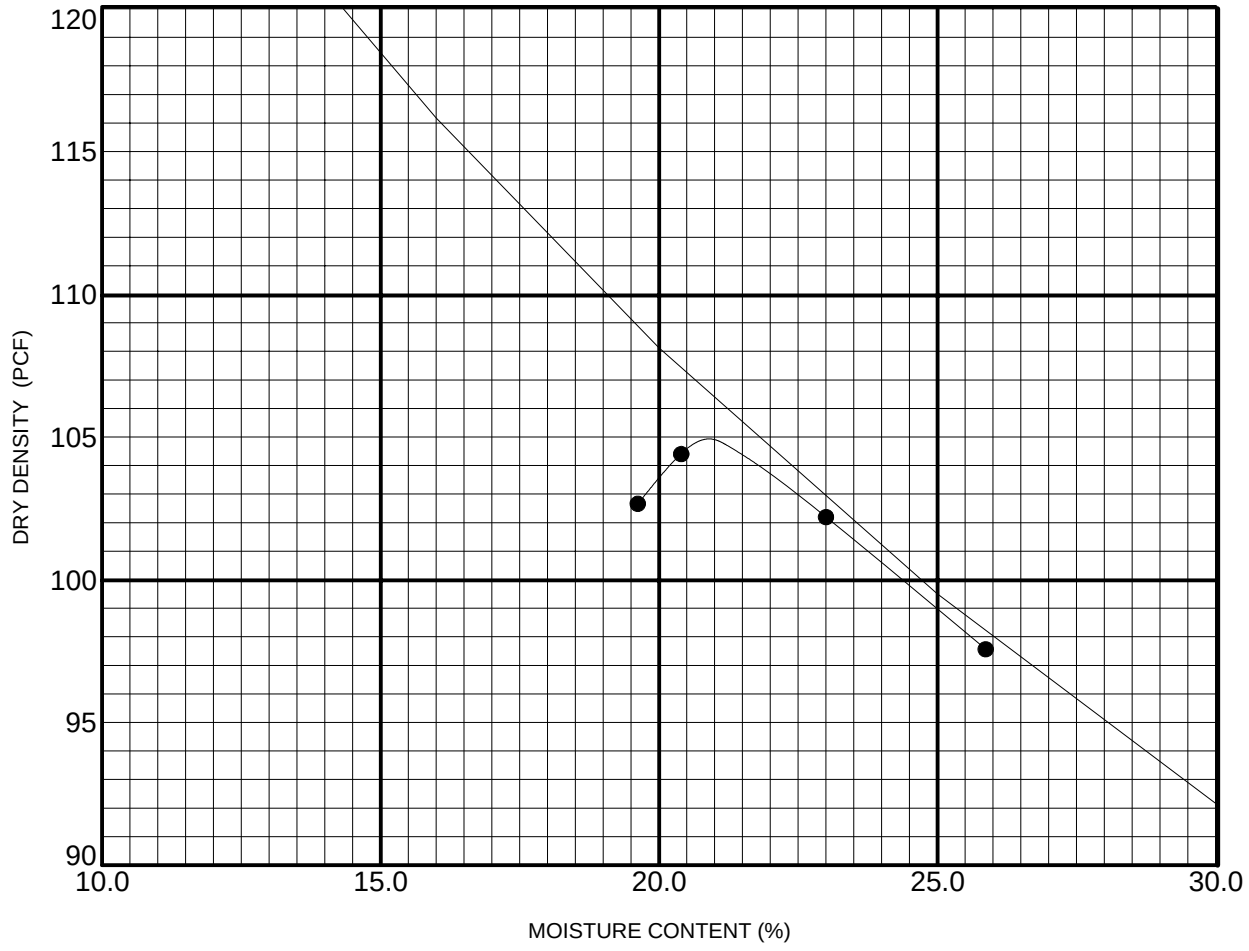
BORING NO.: TP-29 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 0.5 to 10.0** **LABORATORY NO.: 373428**

METHOD OF COMPACTION: D698A

LIQUID LIMIT: 38 **PLASTIC LIMIT:** 18 **PLASTICITY INDEX:** 20

CLASSIFICATION: CL **ASTM SOIL DESCRIPTION:** CLAYSTONE (LEAN CLAY with SAND)

MAXIMUM DRY DENSITY: **104.9 PCF** OPTIMUM MOISTURE CONTENT: **20.9%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/11/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/7/12**

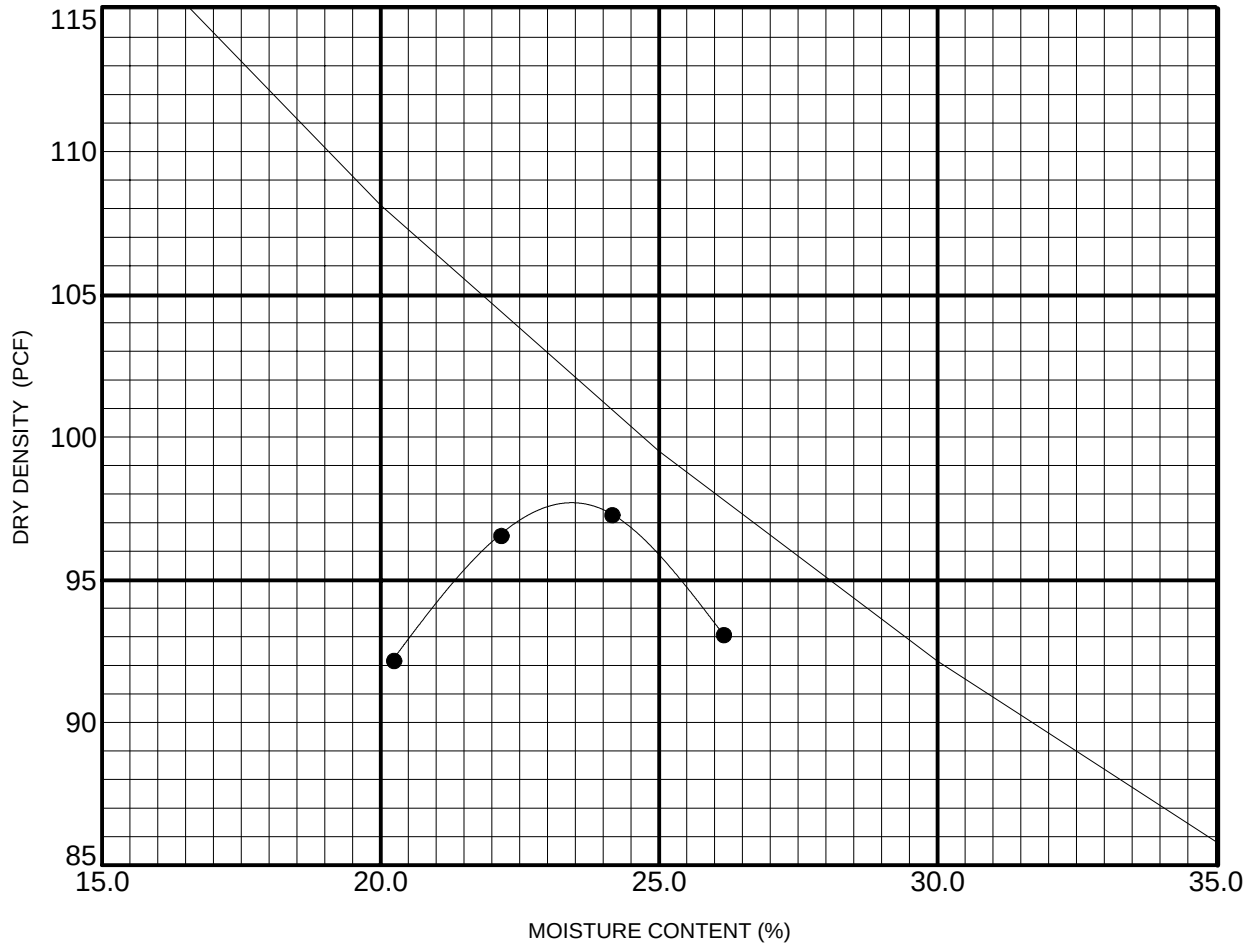
BORING NO.: TP-30 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 2 to 14** **LABORATORY NO.: 373122**

METHOD OF COMPACTION: D698A

LIQUID LIMIT: 22 **PLASTIC LIMIT:** 14 **PLASTICITY INDEX:** 8

CLASSIFICATION: CL **ASTM SOIL DESCRIPTION:** LEAN CLAY with SAND

MAXIMUM DRY DENSITY: **97.8 PCF** OPTIMUM MOISTURE CONTENT: **23.4%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/12/12**

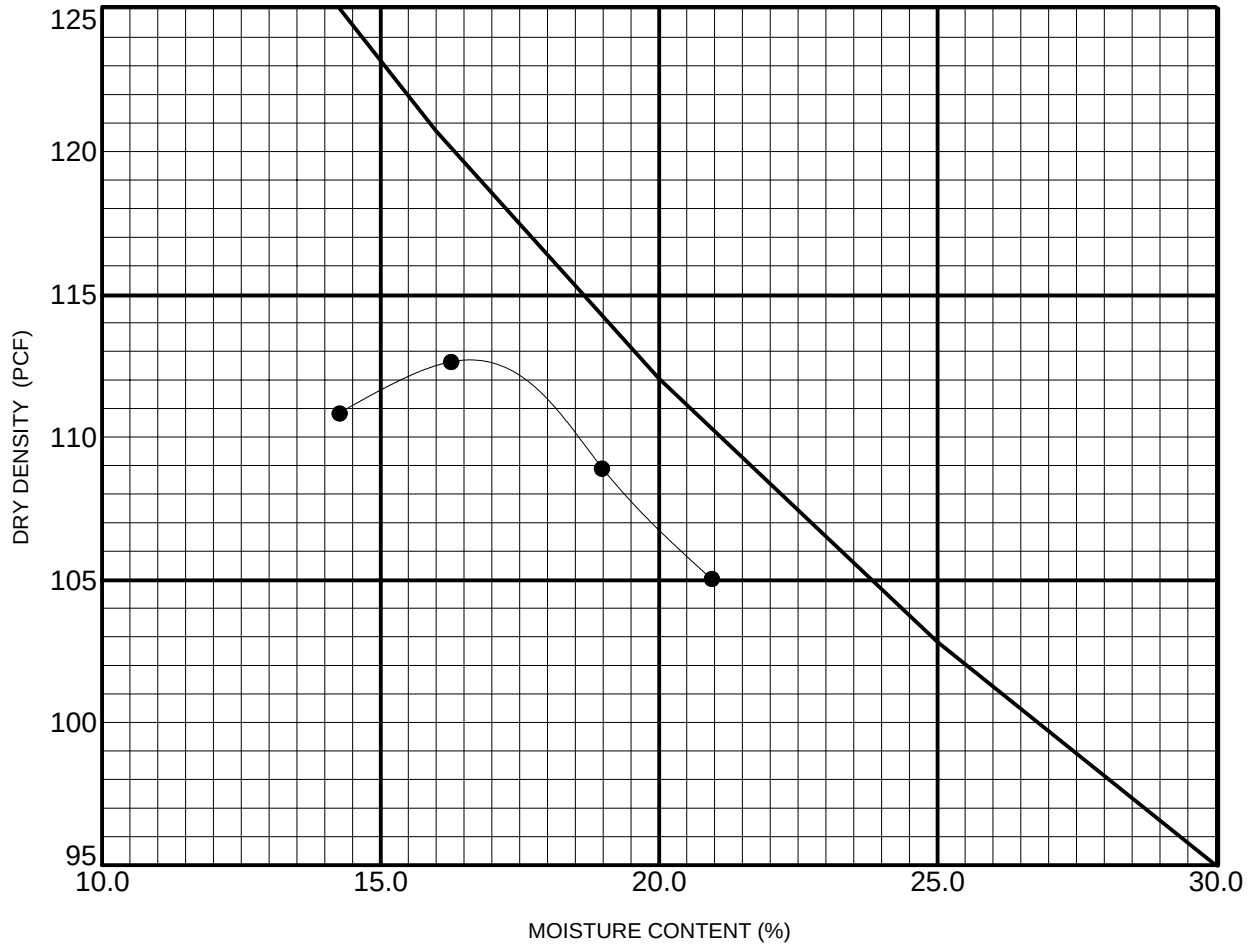
BORING NO.: TP-31 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 0 to 3.0** **LABORATORY NO.: 373427**

METHOD OF COMPACTION: D698A

LIQUID LIMIT: 35 **PLASTIC LIMIT:** 19 **PLASTICITY INDEX:** 15

CLASSIFICATION: SC **ASTM SOIL DESCRIPTION:** CLAYEY SAND

MAXIMUM DRY DENSITY: **112.8 PCF** OPTIMUM MOISTURE CONTENT: **16.6%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/7/12**

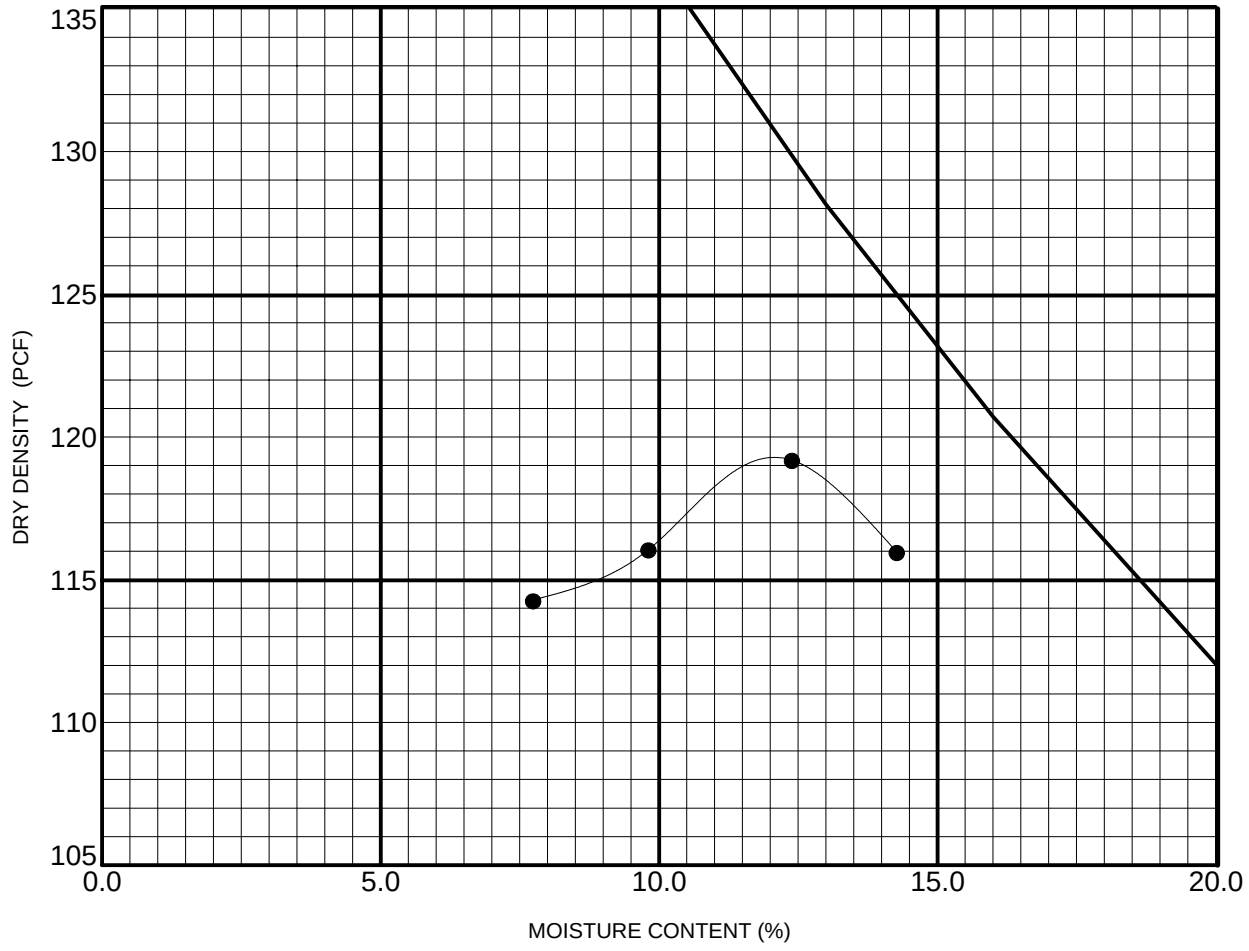
BORING NO.: TP-32 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 0 to 14** **LABORATORY NO.: 373124**

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT **PLASTIC LIMIT:** NT **PLASTICITY INDEX:** NT

CLASSIFICATION: SC-SM **ASTM SOIL DESCRIPTION:** SILTY, CLAYEY SAND with GRAVEL

MAXIMUM DRY DENSITY: **119.2 PCF** OPTIMUM MOISTURE CONTENT: **12.1%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/12/12**

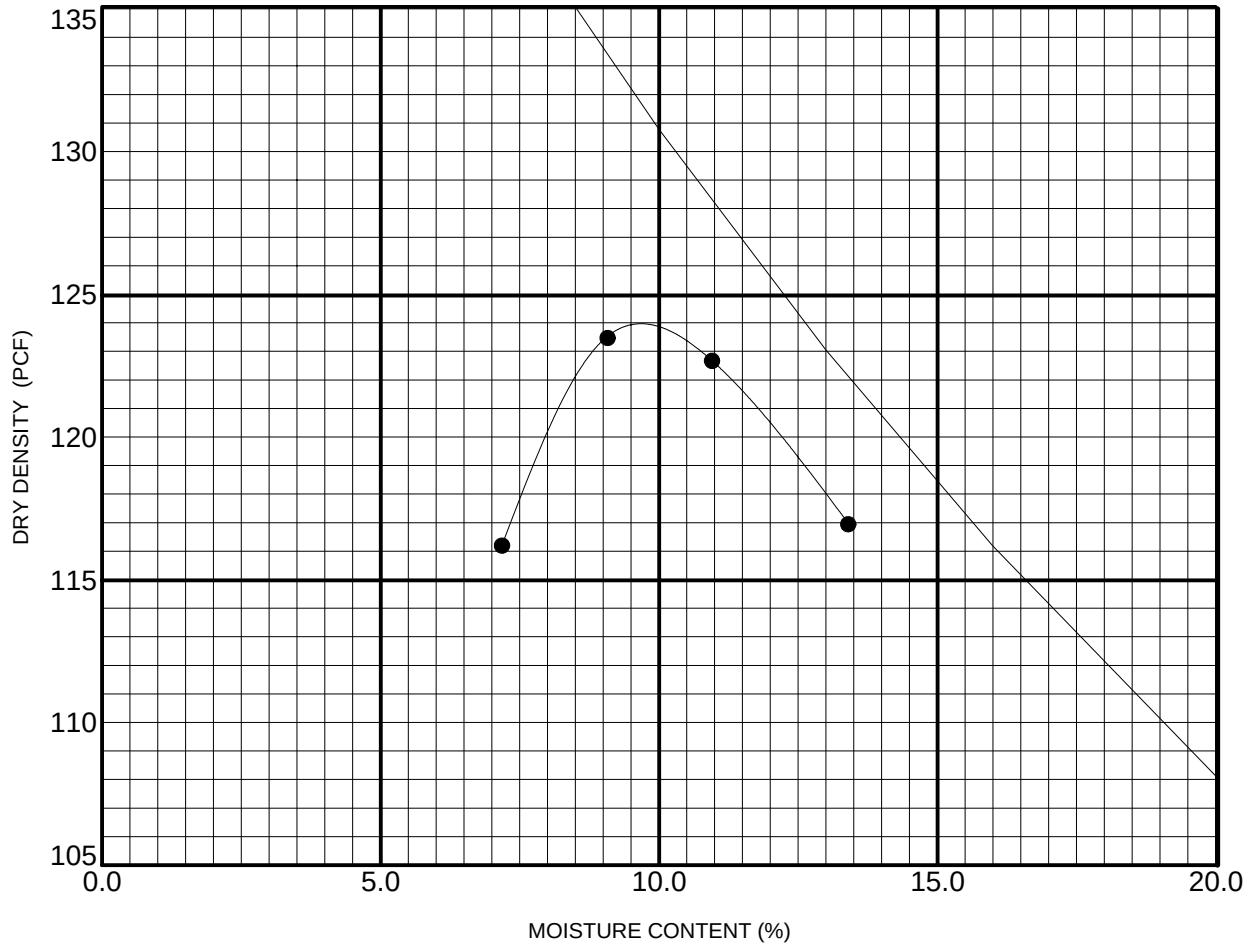
BORING NO.: TP-33 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 0 to 2** **LABORATORY NO.: 373426**

METHOD OF COMPACTION: D698A

LIQUID LIMIT: 24 **PLASTIC LIMIT:** 19 **PLASTICITY INDEX:** 5

CLASSIFICATION: SC-SM **ASTM SOIL DESCRIPTION:** SILTY, CLAYEY SAND

MAXIMUM DRY DENSITY: **124.0 PCF** OPTIMUM MOISTURE CONTENT: **9.7%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/11/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/7/12**

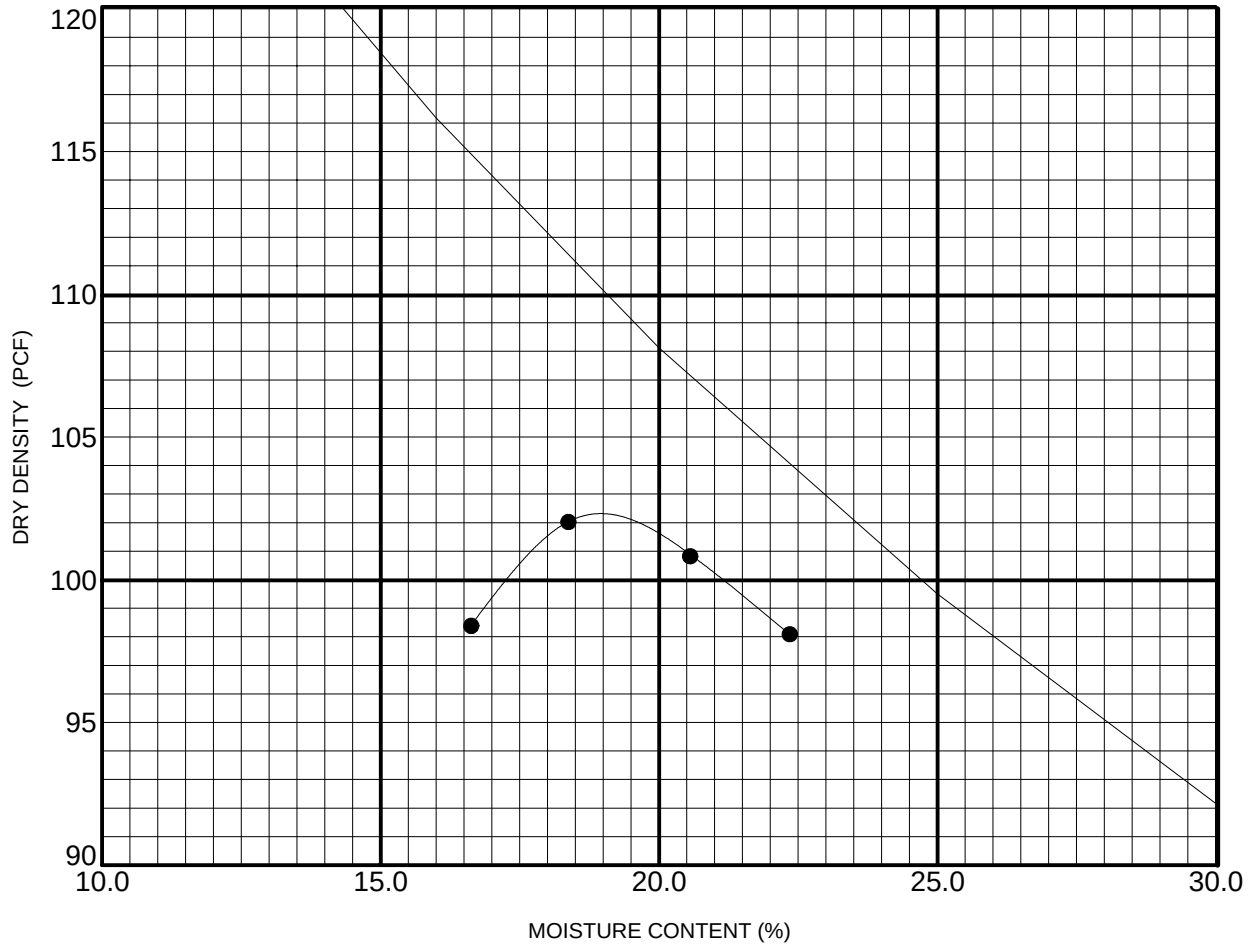
BORING NO.: TP-34 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 1.5 to 13** **LABORATORY NO.: 373126**

METHOD OF COMPACTION: **D698A**

LIQUID LIMIT: **42** **PLASTIC LIMIT:** **23** **PLASTICITY INDEX:** **19**

CLASSIFICATION: **CL** **ASTM SOIL DESCRIPTION:** **CLAYSTONE (LEAN CLAY with SAND)**

MAXIMUM DRY DENSITY: **102.3 PCF** OPTIMUM MOISTURE CONTENT: **19.0%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line PROJECT NO.: 120751TF

LOCATION: Page to Cameron DATE: 6/12/12

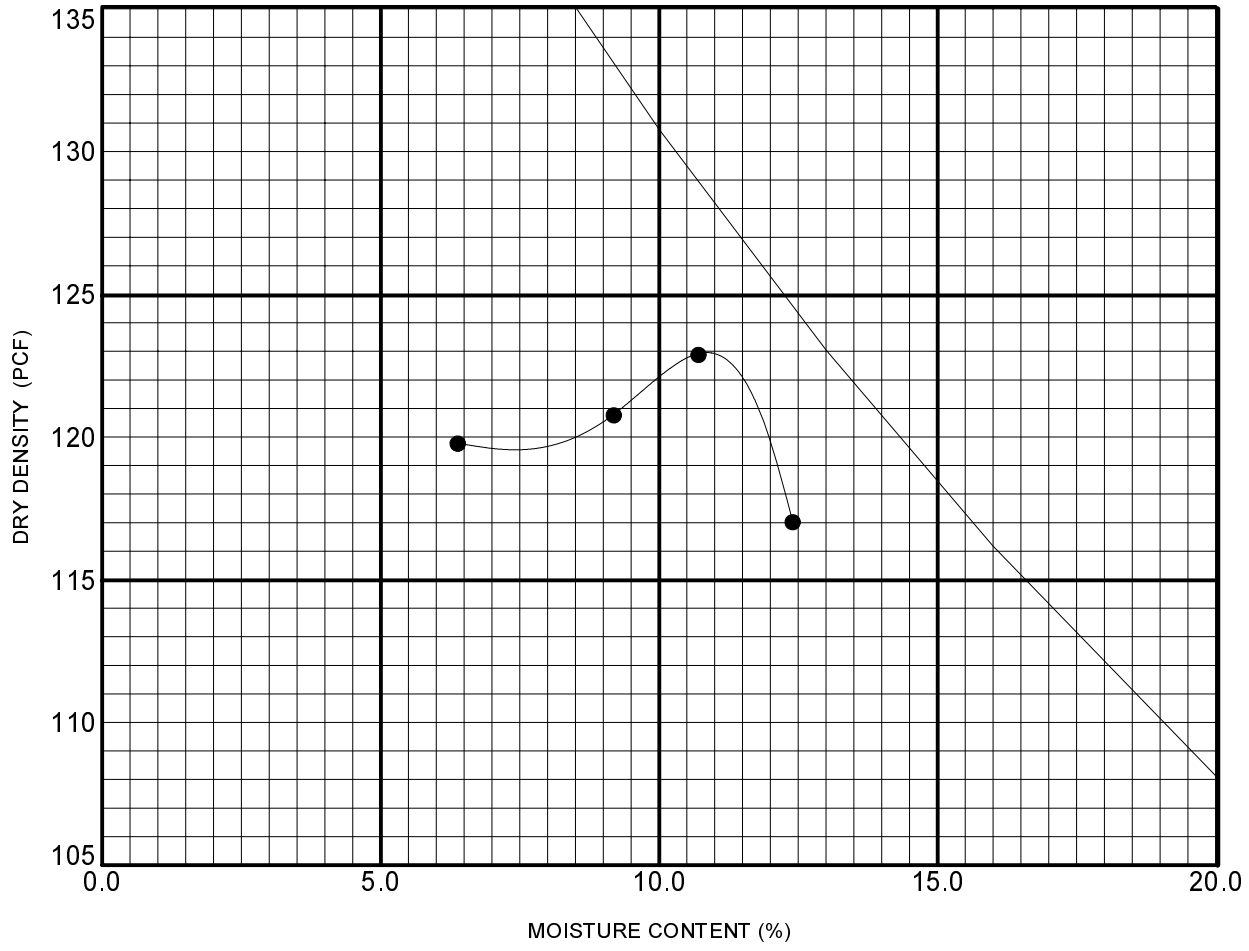
BORING NO.: TP-35 SAMPLE NO.: BS-1 SAMPLE DEPTH: 0 to 4.5 LABORATORY NO.: 373425

METHOD OF COMPACTION: D698A

LIQUID LIMIT: 28 PLASTIC LIMIT: 11 PLASTICITY INDEX: 17

CLASSIFICATION: SC ASTM SOIL DESCRIPTION: CLAYEY SAND

MAXIMUM DRY DENSITY: **123.0 PCF** OPTIMUM MOISTURE CONTENT: **10.8%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/11/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/7/12**

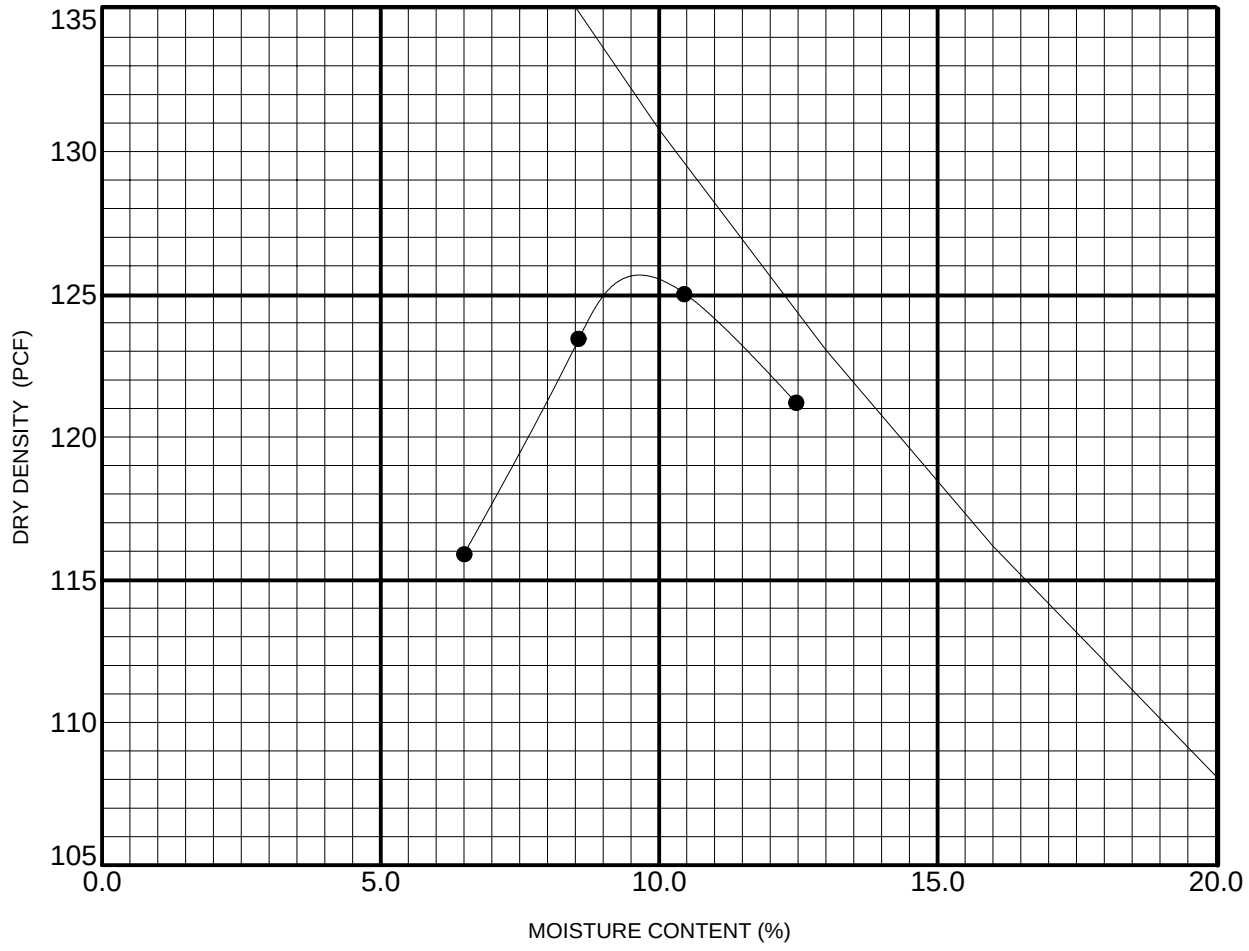
BORING NO.: TP-36 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 7 to 13.5** **LABORATORY NO.: 373127**

METHOD OF COMPACTION: D698A

LIQUID LIMIT: 33 **PLASTIC LIMIT:** 14 **PLASTICITY INDEX:** 18

CLASSIFICATION: SC **ASTM SOIL DESCRIPTION:** CLAYEY SAND

MAXIMUM DRY DENSITY: **125.8 PCF** OPTIMUM MOISTURE CONTENT: **9.7%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/6/12**

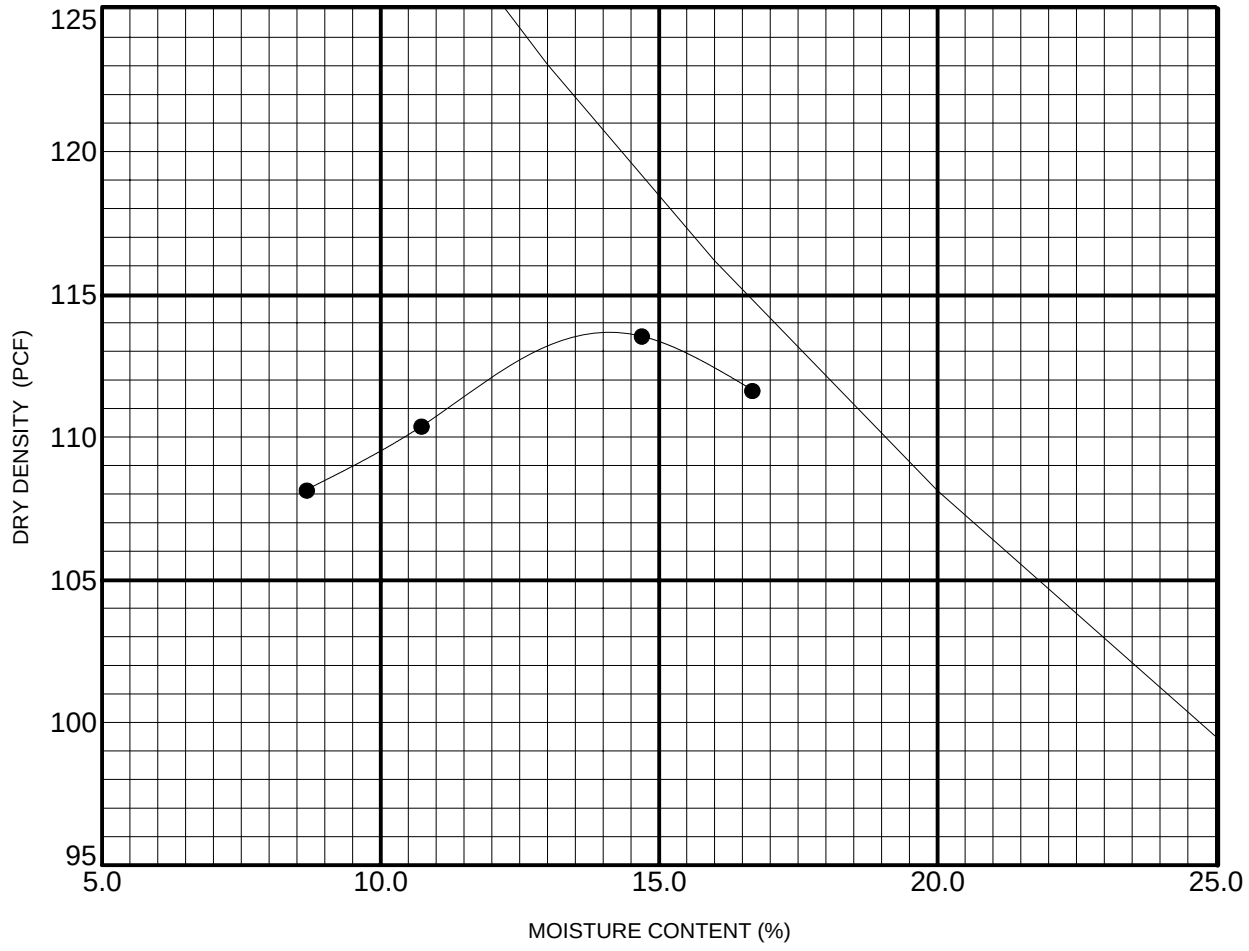
BORING NO.: TP-37 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 1 to 4.5** **LABORATORY NO.: 373351**

METHOD OF COMPACTION: **D698A**

LIQUID LIMIT: **33** **PLASTIC LIMIT:** **25** **PLASTICITY INDEX:** **8**

CLASSIFICATION: **SM** **ASTM SOIL DESCRIPTION:** **SILTY SAND**

MAXIMUM DRY DENSITY: **113.8 PCF** OPTIMUM MOISTURE CONTENT: **14.1%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.: 120751TF**

LOCATION: Page to Cameron **DATE: 6/6/12**

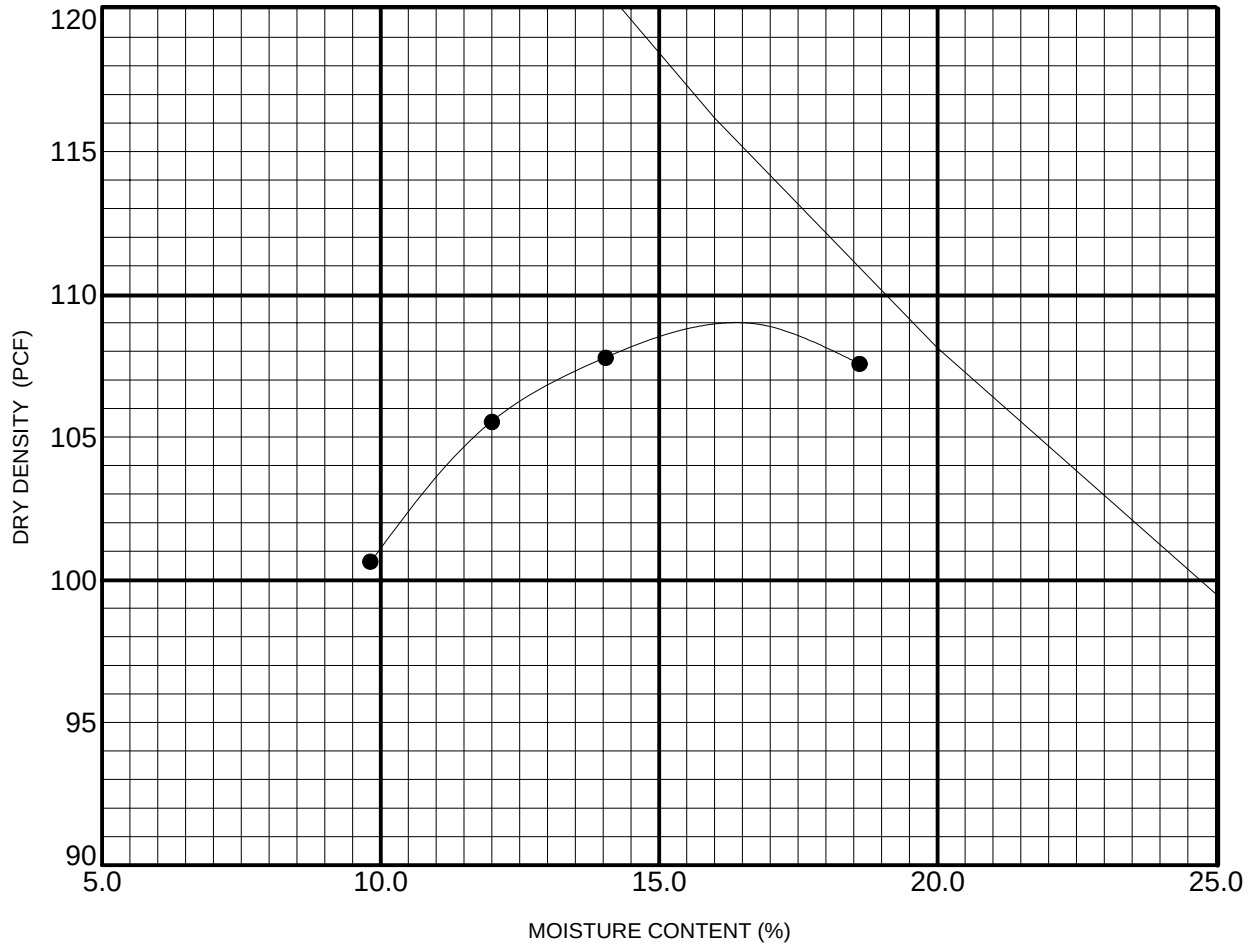
BORING NO.: TP-38 **SAMPLE NO.: BS-1** **SAMPLE DEPTH: 1 to 4** **LABORATORY NO.: 373070**

METHOD OF COMPACTION: **D698A**

LIQUID LIMIT: **NP** **PLASTIC LIMIT:** **NP** **PLASTICITY INDEX:** **NP**

CLASSIFICATION: **SM** **ASTM SOIL DESCRIPTION:** **SILTY SAND**

MAXIMUM DRY DENSITY: **109.0 PCF** OPTIMUM MOISTURE CONTENT: **16.4%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line — PROJECT NO.: 120751TF

LOCATION: Page to Cameron — DATE: 6/6/12

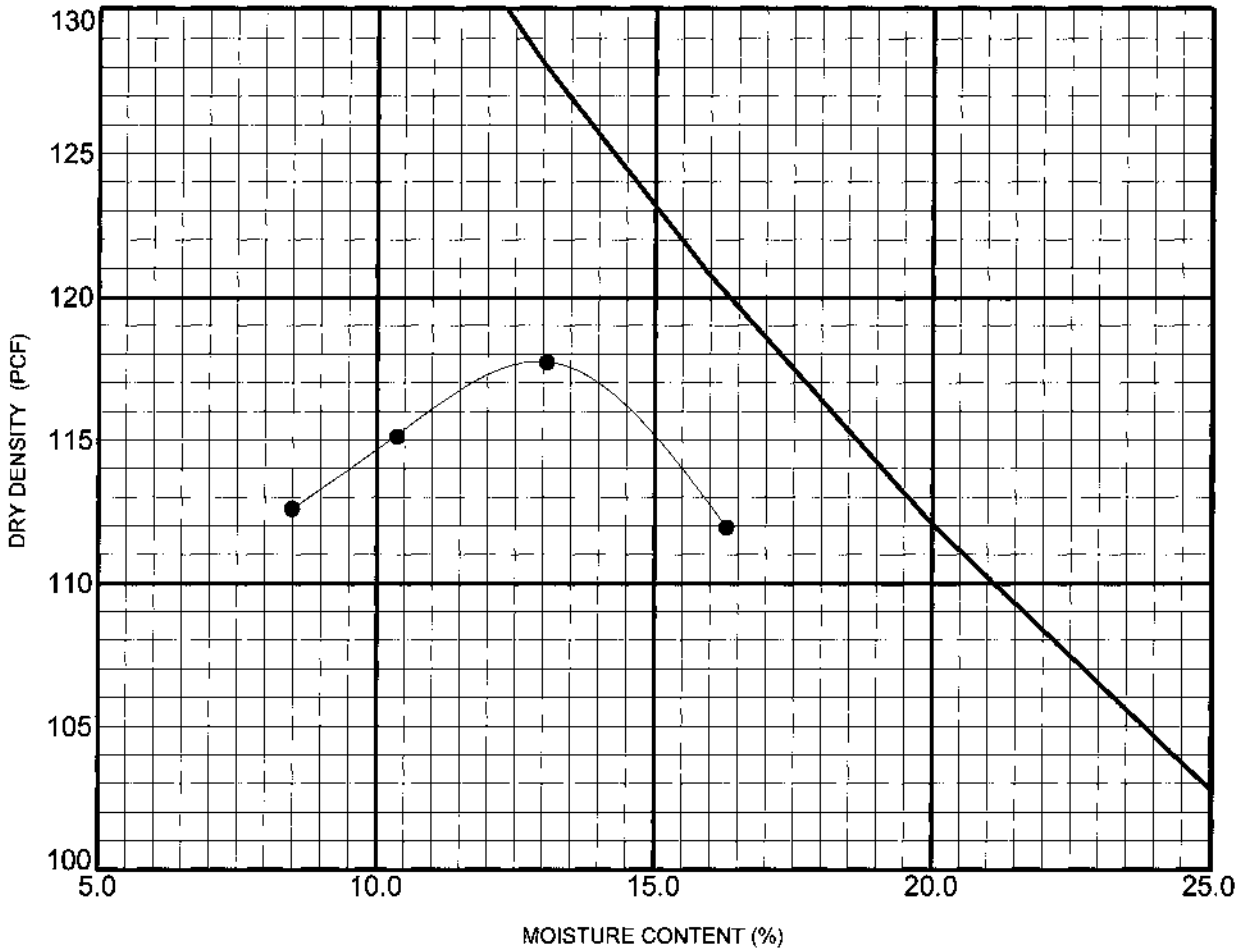
BORING NO.: TP-39 SAMPLE NO.: BS-1 SAMPLE DEPTH: 0 to 3.5 LABORATORY NO.: 373071

METHOD OF COMPACTION: D698A

LIQUID LIMIT: 27 PLASTIC LIMIT: 16 PLASTICITY INDEX: 11

CLASSIFICATION: SC ASTM SOIL DESCRIPTION: CLAYEY SAND

MAXIMUM DRY DENSITY: **117.8 PCF** OPTIMUM MOISTURE CONTENT: **12.9%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line — PROJECT NO.: 120751TF

LOCATION: Page to Cameron — DATE: 6/6/12

BORING NO.: TP-40 SAMPLE NO.: BS-1 SAMPLE DEPTH: 0 to 5 LABORATORY NO.: 373072

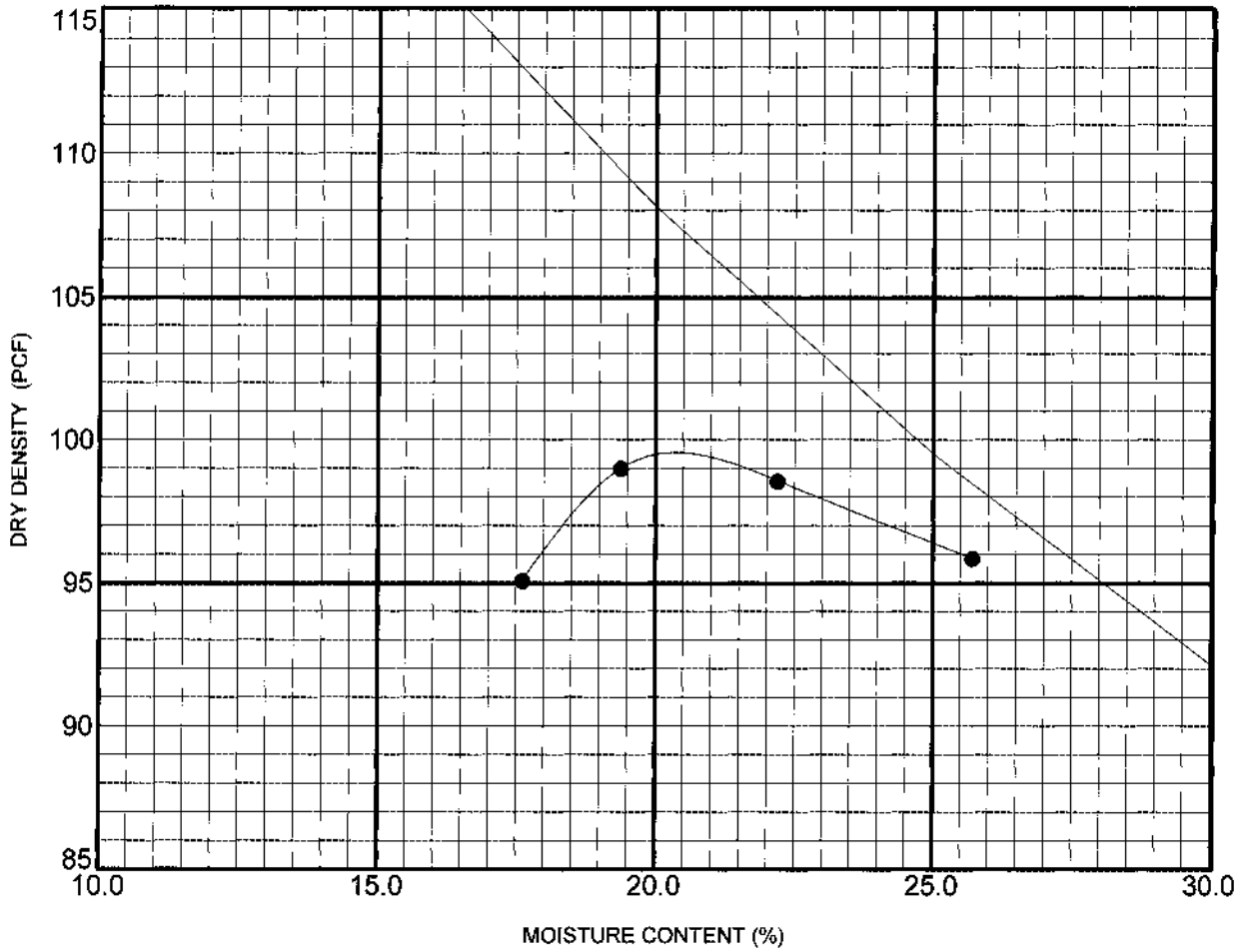
METHOD OF COMPACTION: D698A

LIQUID LIMIT: 59 PLASTIC LIMIT: 19 PLASTICITY INDEX: 40

CLASSIFICATION: CH ASTM SOIL DESCRIPTION: FAT CLAY with SAND

MAXIMUM DRY DENSITY: 99.5 PCF

OPTIMUM MOISTURE CONTENT: 20.4%



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line — PROJECT NO.: 120751TF

LOCATION: Page to Cameron — DATE: 6/6/12

BORING NO.: TP-41 SAMPLE NO.: BS-1 SAMPLE DEPTH: 3 to 8 LABORATORY NO.: 373073

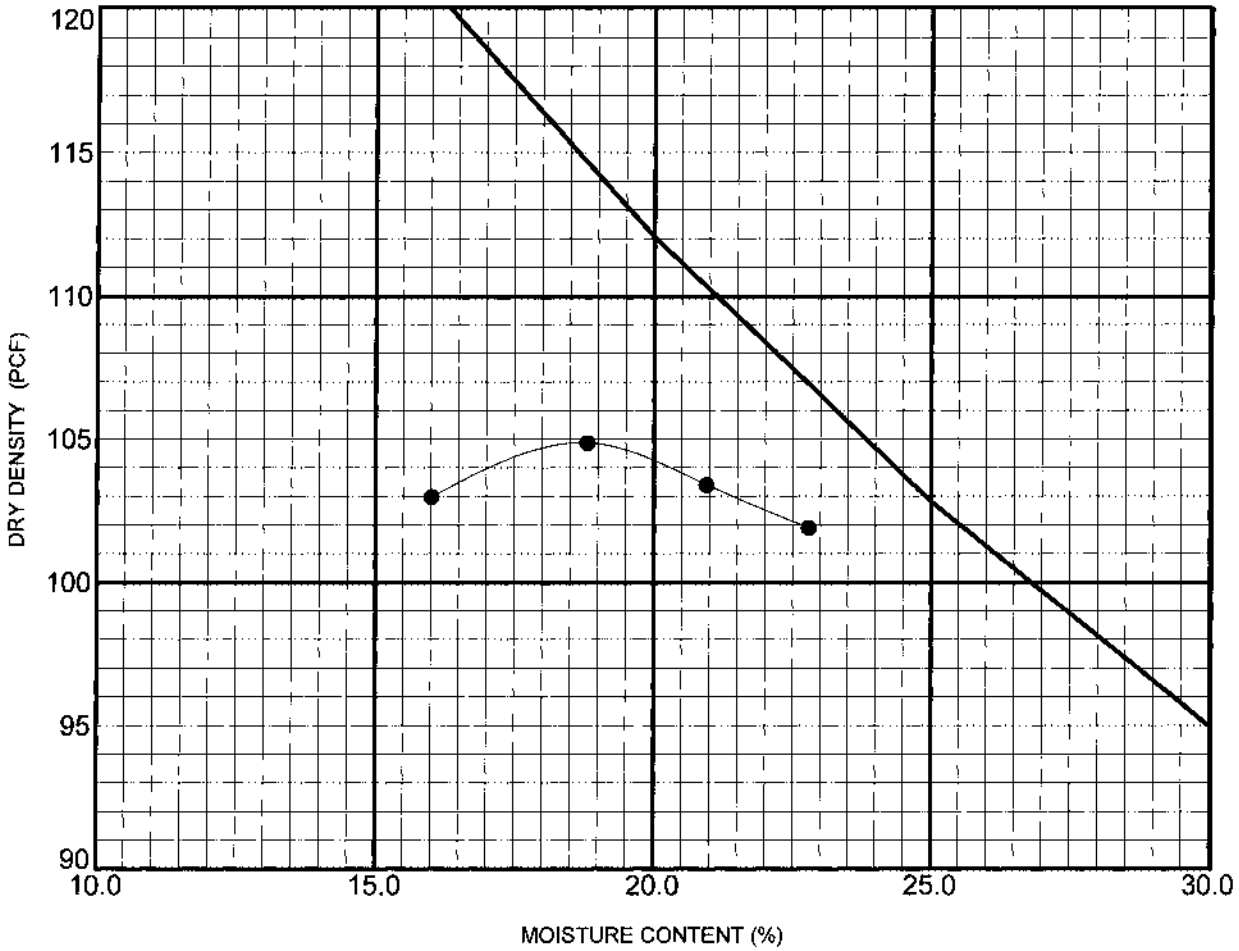
METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT PLASTIC LIMIT: NT PLASTICITY INDEX: NT

CLASSIFICATION: CH ASTM SOIL DESCRIPTION: CLAYSTONE (FAT CLAY)

MAXIMUM DRY DENSITY: 104.9 PCF

OPTIMUM MOISTURE CONTENT: 18.7%



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line — PROJECT NO.: 120751TF

LOCATION: Page to Cameron — DATE: 6/6/12

BORING NO.: TP-42 SAMPLE NO.: BS-1 SAMPLE DEPTH: 7 to 14.5 LABORATORY NO.: 373074

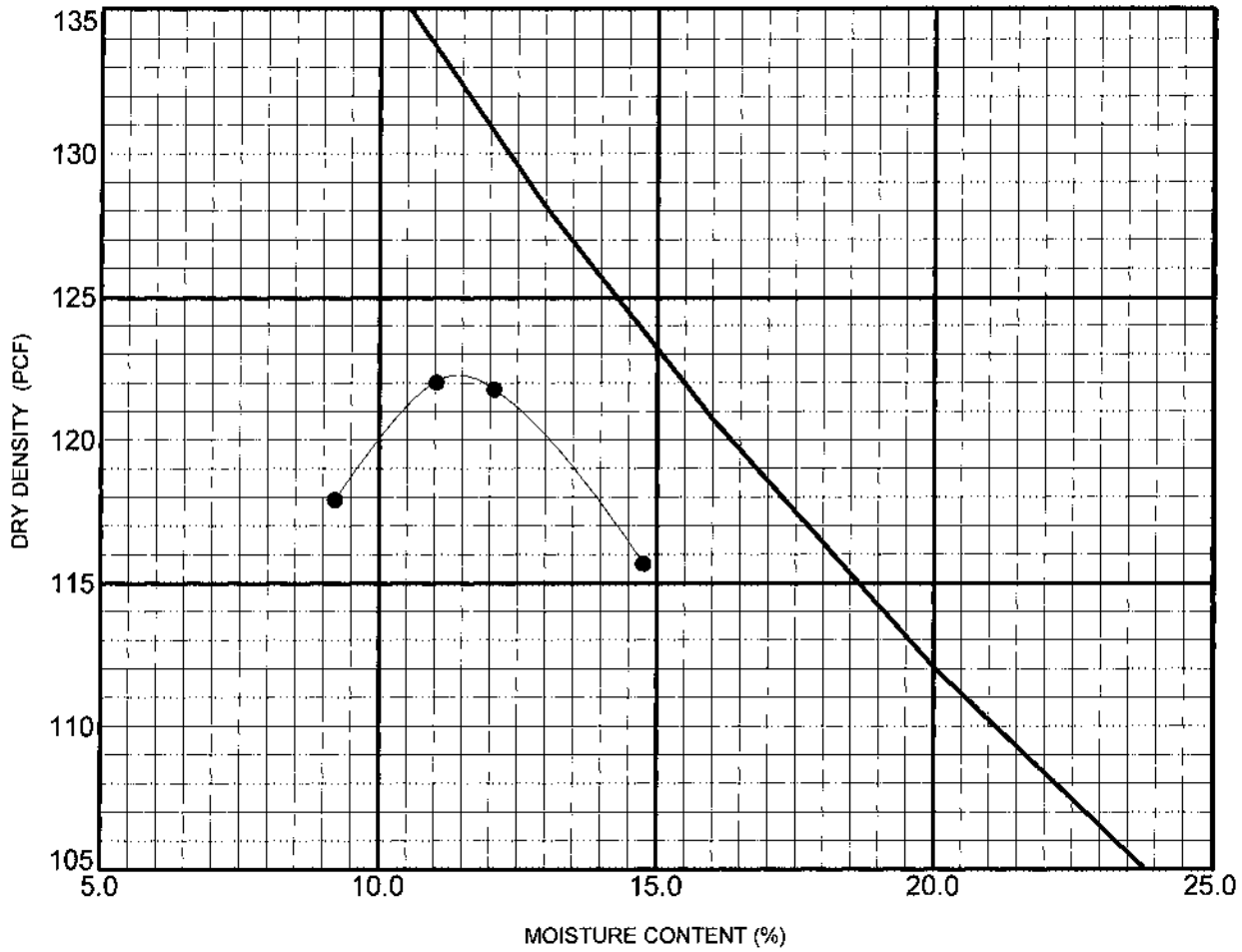
METHOD OF COMPACTION: D698A

LIQUID LIMIT: 28 PLASTIC LIMIT: 18 PLASTICITY INDEX: 10

CLASSIFICATION: SC ASTM SOIL DESCRIPTION: CLAYEY SAND

MAXIMUM DRY DENSITY: 122.2 PCF

OPTIMUM MOISTURE CONTENT: 11.4%



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line — PROJECT NO.: 120751TF

LOCATION: Page to Cameron — DATE: 6/6/12

BORING NO.: TP-43 SAMPLE NO.: BS-1 SAMPLE DEPTH: 0 to 6 LABORATORY NO.: 373075

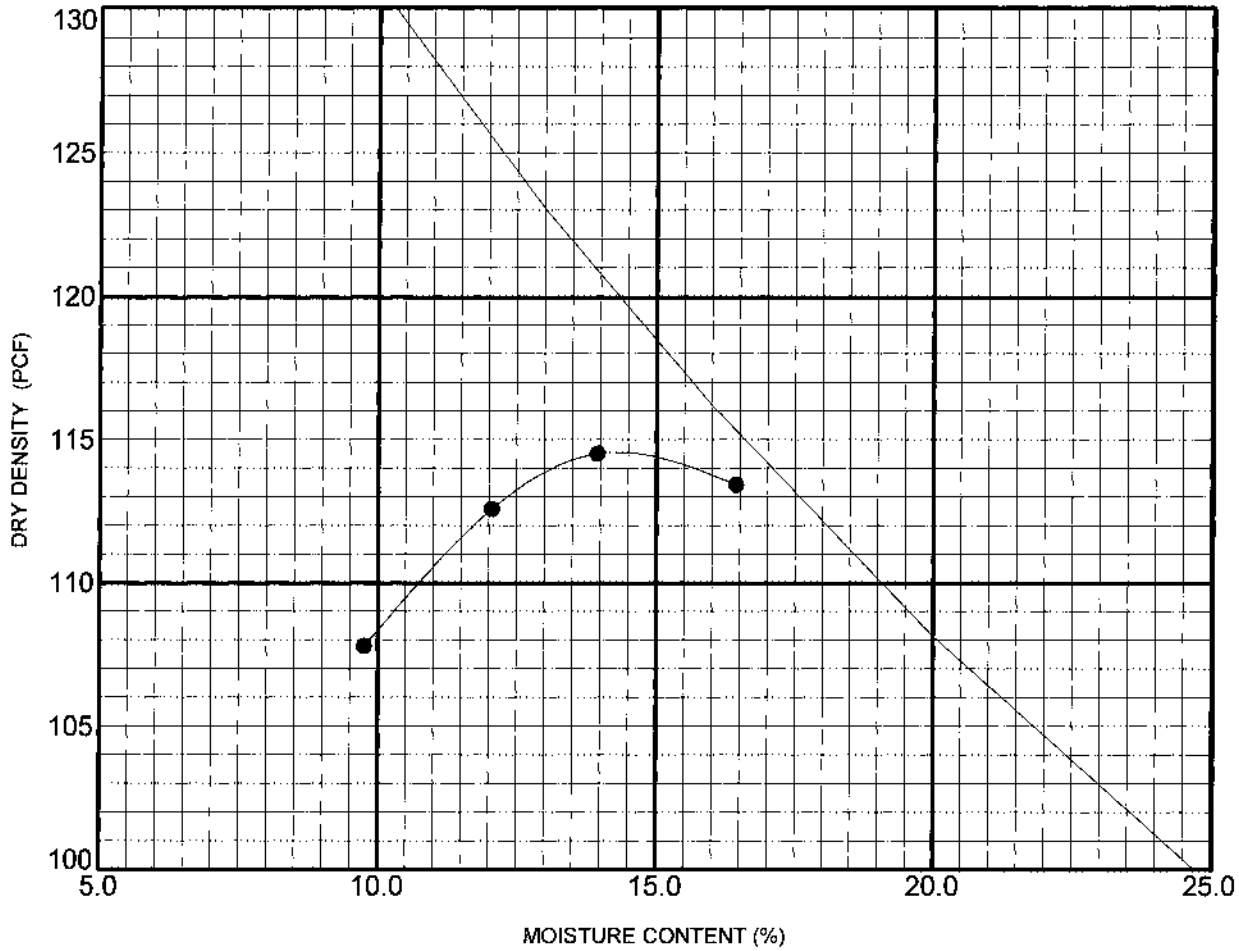
METHOD OF COMPACTION: D698A

LIQUID LIMIT: 25 PLASTIC LIMIT: 18 PLASTICITY INDEX: 8

CLASSIFICATION: SC-SM ASTM SOIL DESCRIPTION: SILTY, CLAYEY SAND

MAXIMUM DRY DENSITY: 114.5 PCF

OPTIMUM MOISTURE CONTENT: 14.3%



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line PROJECT NO.: 120751TF

LOCATION: Page to Cameron DATE: 6/5/12

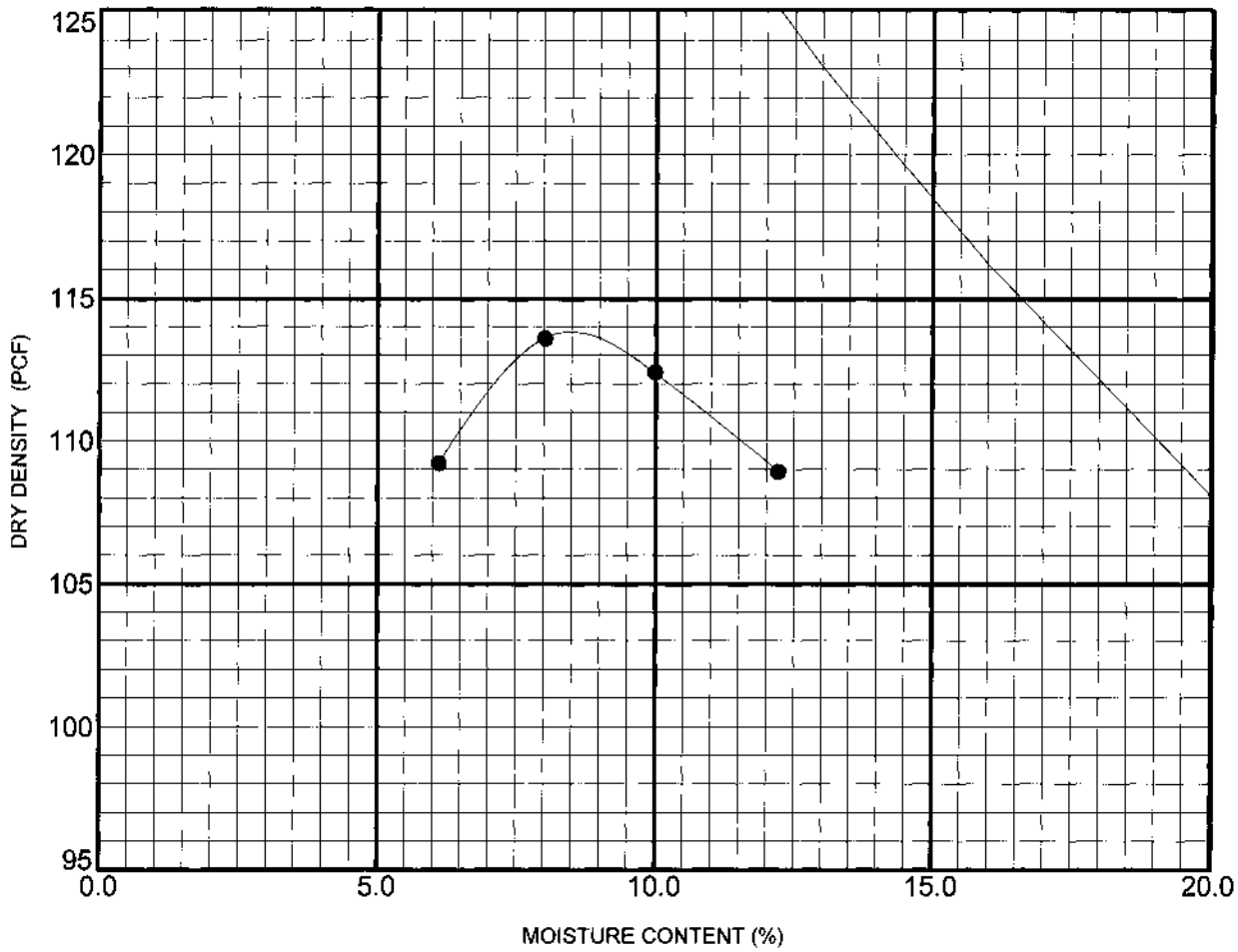
BORING NO.: TP-44 SAMPLE NO.: BS-1 SAMPLE DEPTH: 0.8 to 8.5 LABORATORY NO.: 372912

METHOD OF COMPACTION: D698A

LIQUID LIMIT: 24 PLASTIC LIMIT: 19 PLASTICITY INDEX: 5

CLASSIFICATION: SC-SM ASTM SOIL DESCRIPTION: SILTY, CLAYEY SAND

MAXIMUM DRY DENSITY: 113.9 PCF OPTIMUM MOISTURE CONTENT: 9.5%



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/9/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line — PROJECT NO.: 120751TF

LOCATION: Page to Cameron — DATE: 6/5/12

BORING NO.: TP-45 SAMPLE NO.: BS-1 SAMPLE DEPTH: 0 to 14 LABORATORY NO.: 372908

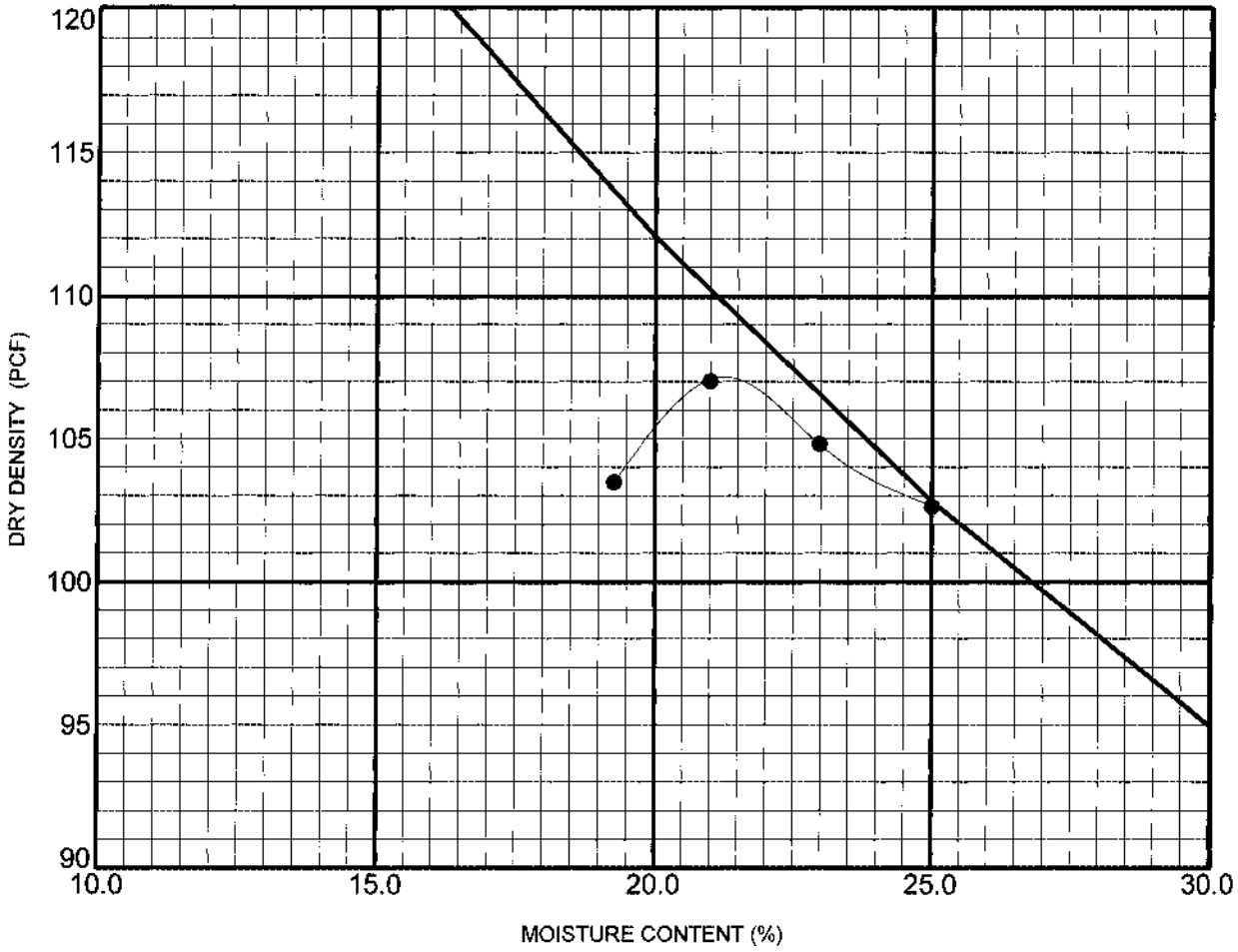
METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT PLASTIC LIMIT: NT PLASTICITY INDEX: NT

CLASSIFICATION: CL ASTM SOIL DESCRIPTION: CLAYSTONE (LEAN CLAY with SAND)

MAXIMUM DRY DENSITY: 107.1 PCF

OPTIMUM MOISTURE CONTENT: 21.2%



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/11/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line — PROJECT NO.: 120751TF

LOCATION: Page to Cameron — DATE: 6/5/12

BORING NO.: TP-46 SAMPLE NO.: BS-1 SAMPLE DEPTH: 0 to 8 — LABORATORY NO.: 372907

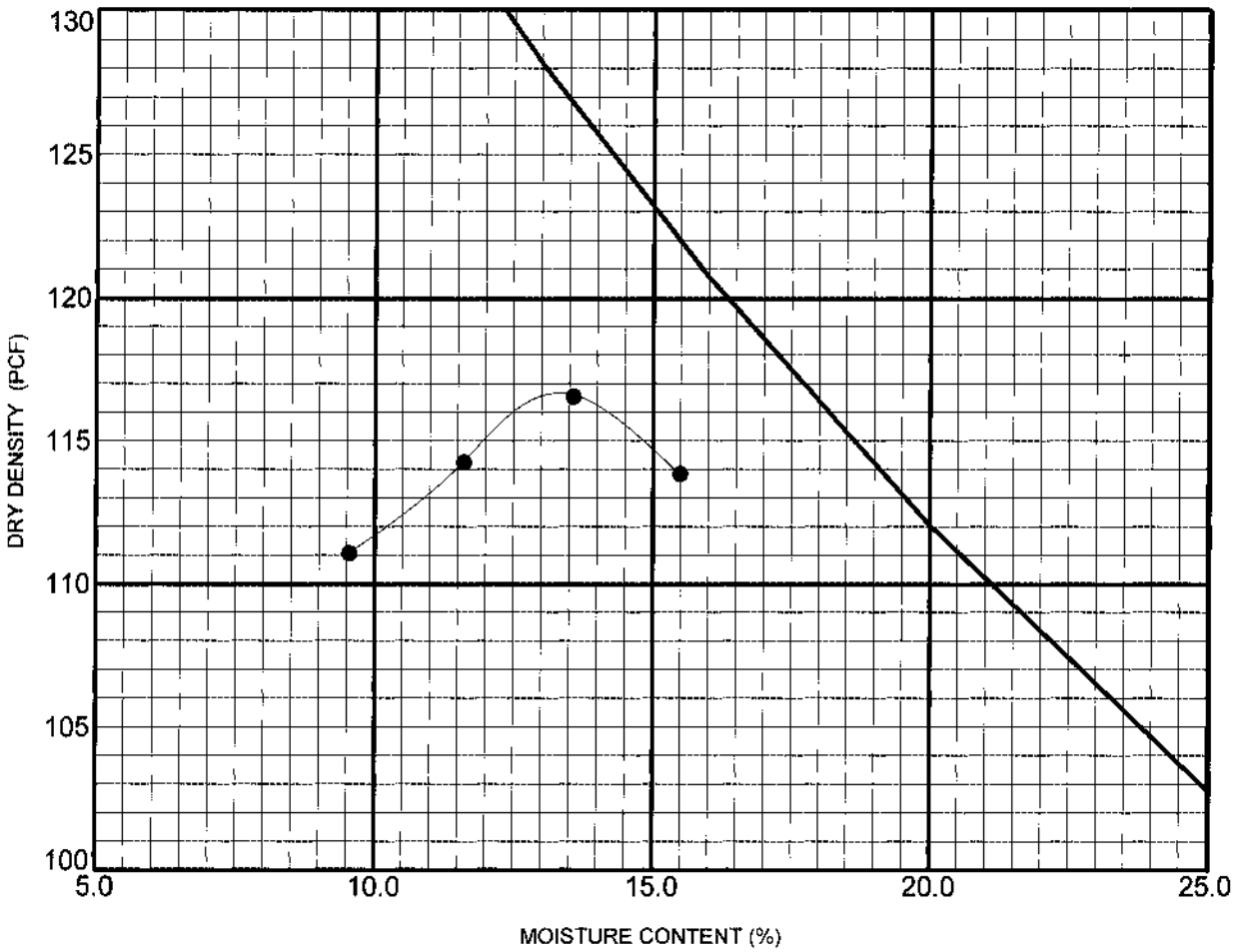
METHOD OF COMPACTION: D698A

LIQUID LIMIT: 41 PLASTIC LIMIT: 26 PLASTICITY INDEX: 15

CLASSIFICATION: ML ASTM SOIL DESCRIPTION: CLAYSTONE (SANDY SILT with GRAVEL)

MAXIMUM DRY DENSITY: **116.7 PCF**

OPTIMUM MOISTURE CONTENT: **13.4%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line — PROJECT NO.: 120751TF

LOCATION: Page to Cameron — DATE: 6/5/12

BORING NO.: TP-47 SAMPLE NO.: BS-1 SAMPLE DEPTH: 0 to 8 — LABORATORY NO.: 372906

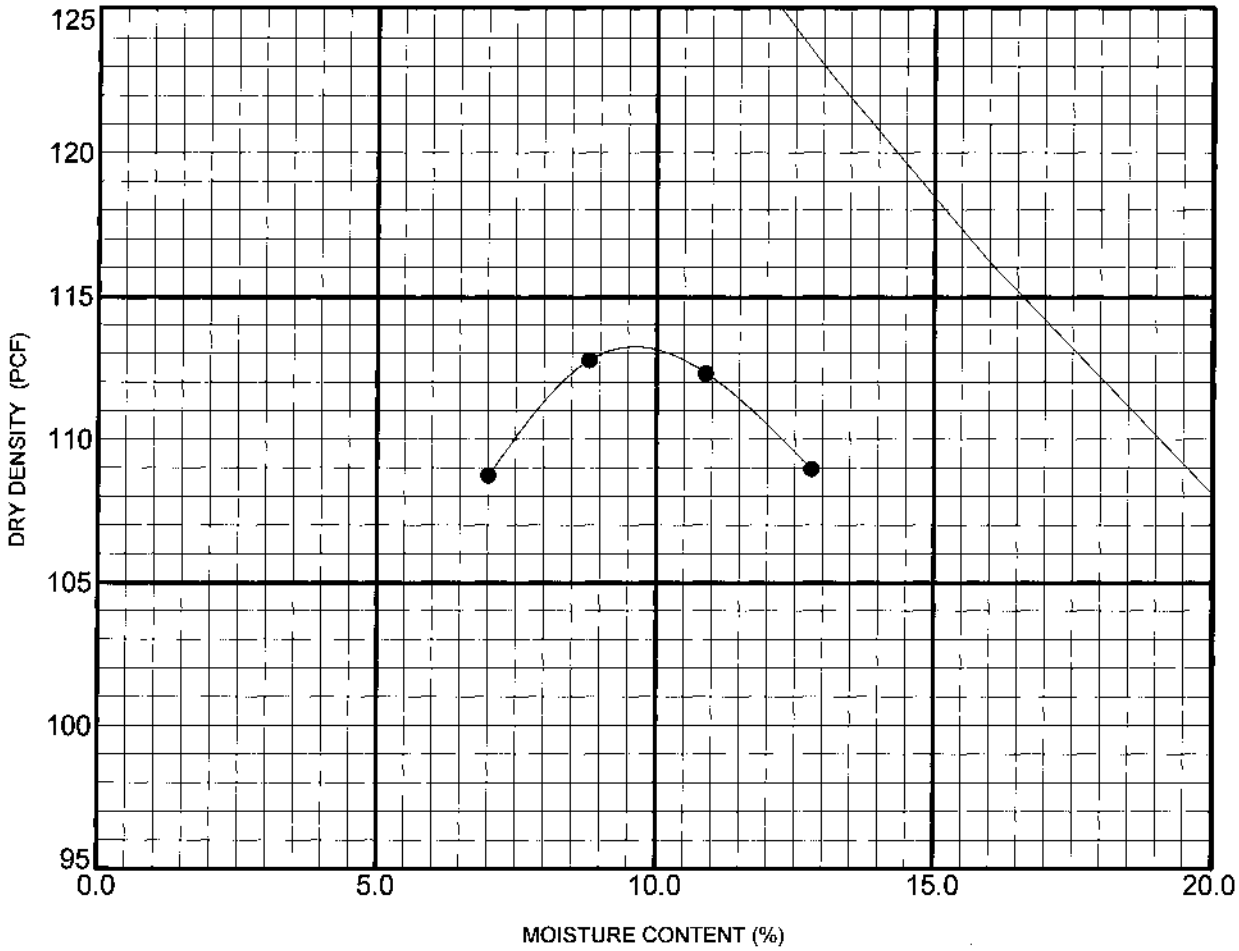
METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT PLASTIC LIMIT: NT PLASTICITY INDEX: NT

CLASSIFICATION: SC-SM ASTM SOIL DESCRIPTION: SILTY, CLAYEY SAND

MAXIMUM DRY DENSITY: 113.2 PCF

OPTIMUM MOISTURE CONTENT: 9.6%



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line PROJECT NO.: 120751TF

LOCATION: Page to Cameron DATE: 6/5/12

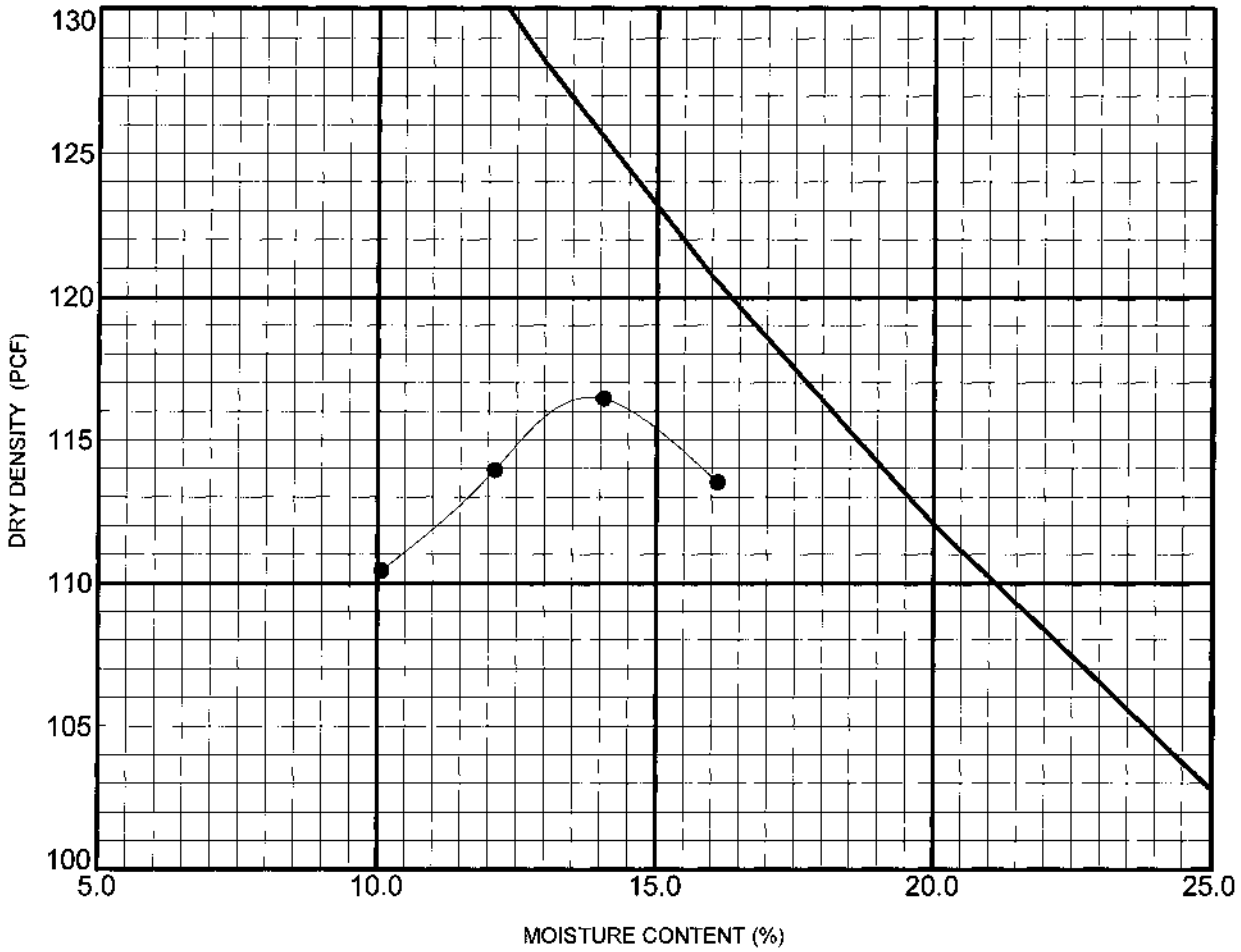
BORING NO.: TP-48 SAMPLE NO.: BS-1 SAMPLE DEPTH: 1.8 to 7.5 LABORATORY NO.: 372905

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT PLASTIC LIMIT: NT PLASTICITY INDEX: NT

CLASSIFICATION: CL ASTM SOIL DESCRIPTION: CLAYSTONE (SANDY LEAN CLAY)

MAXIMUM DRY DENSITY: 116.5 PCF OPTIMUM MOISTURE CONTENT: 13.8%



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line — PROJECT NO.: 120751TF

LOCATION: Page to Cameron — DATE: 6/18/12

BORING NO.: TP-49 SAMPLE NO.: 373697 SAMPLE DEPTH: 0 to 3.2 — LABORATORY NO.: 373697

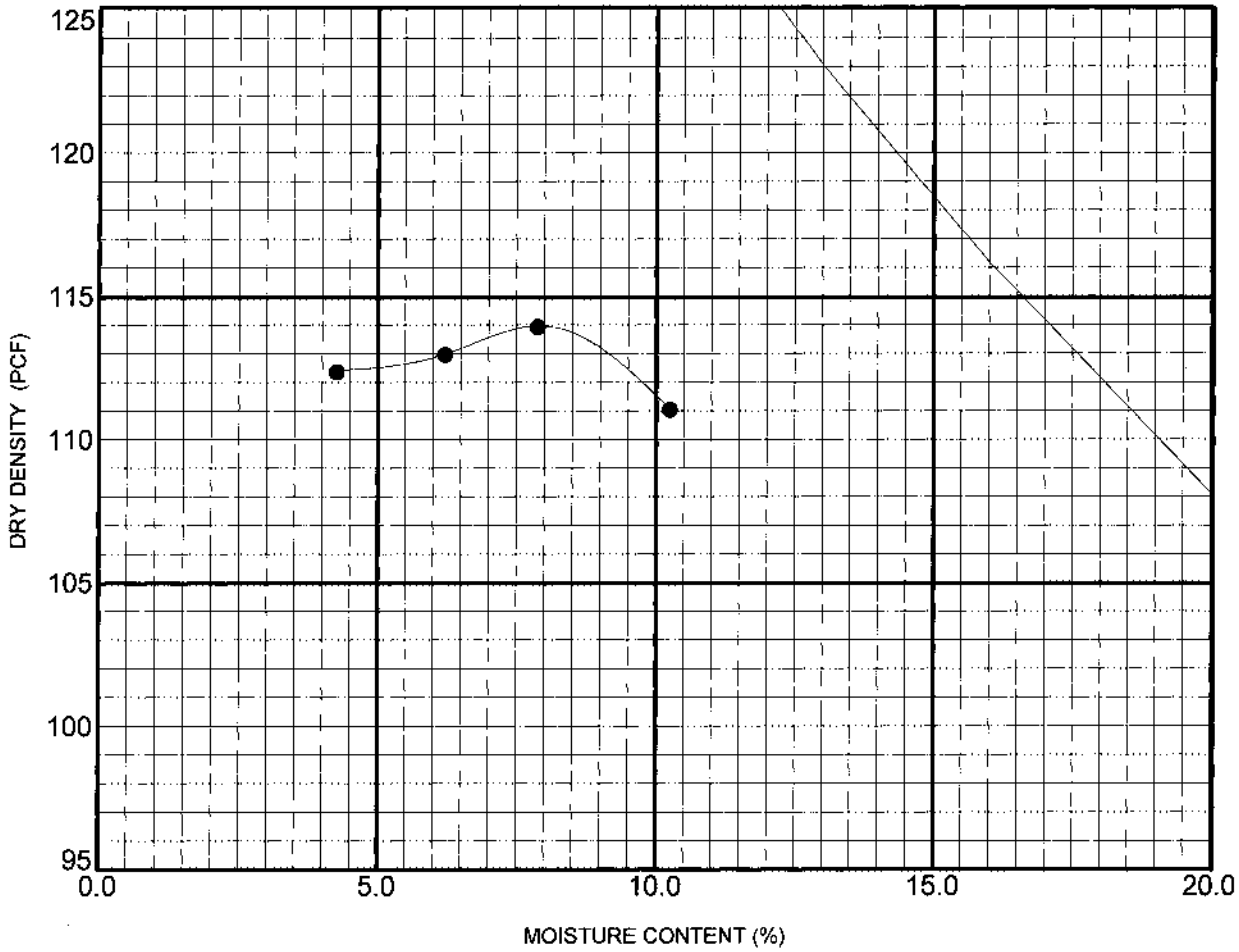
METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT PLASTIC LIMIT: NT PLASTICITY INDEX: NT

CLASSIFICATION: SP-SM-SC ASTM SOIL DESCRIPTION: POORLY GRADED SAND with SILT and CLAY

MAXIMUM DRY DENSITY: 113.9 PCF

OPTIMUM MOISTURE CONTENT: 7.9%



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line — PROJECT NO.: 120751TF

LOCATION: Page to Cameron — DATE: 6/18/12

BORING NO.: TP-50 SAMPLE NO.: BS-1 SAMPLE DEPTH: 0 to 5 — LABORATORY NO.: 373698

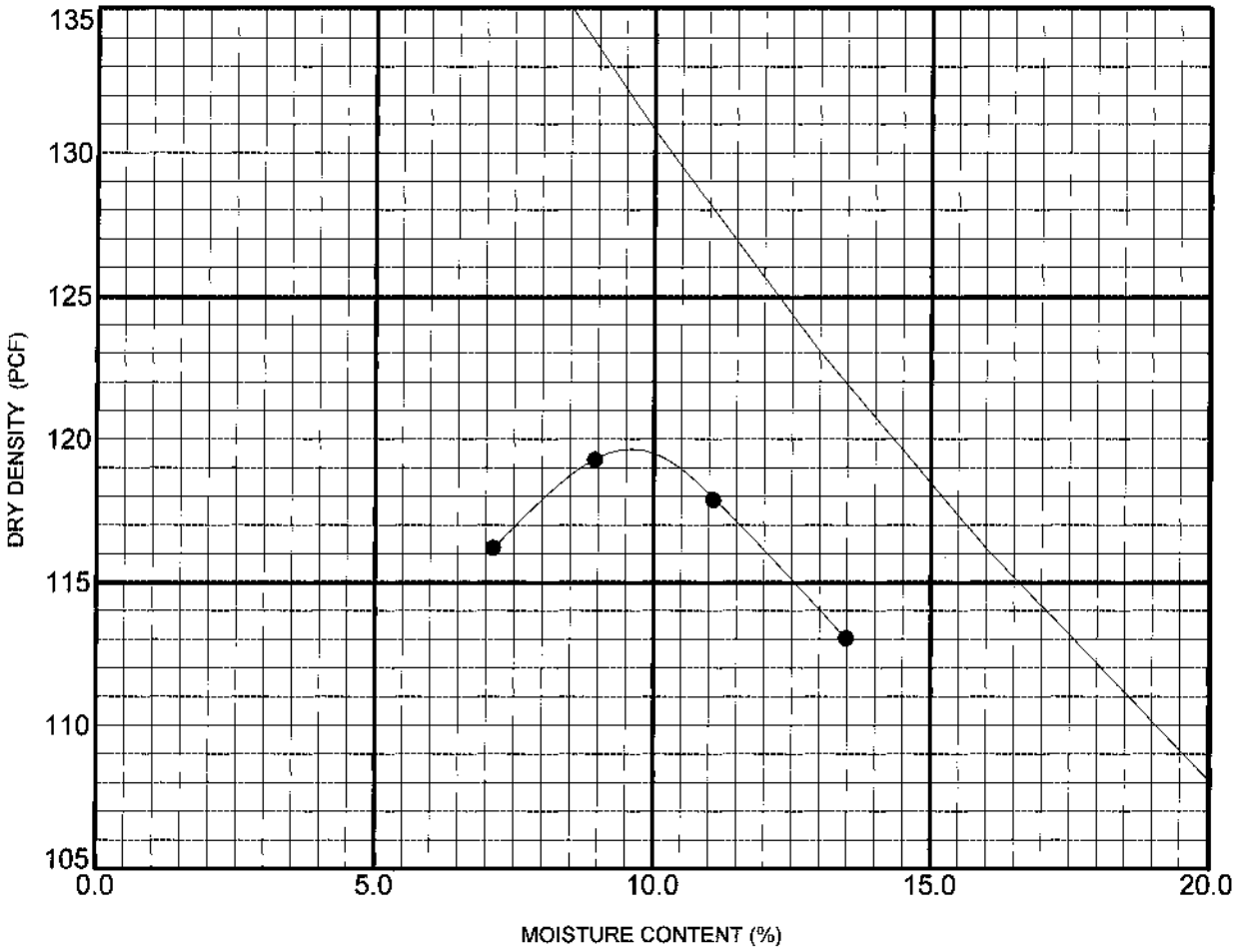
METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT PLASTIC LIMIT: NT PLASTICITY INDEX: NT

CLASSIFICATION: SC-SM ASTM SOIL DESCRIPTION: SILTY, CLAYEY SAND

MAXIMUM DRY DENSITY: 119.6 PCF

OPTIMUM MOISTURE CONTENT: 9.6%



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line — PROJECT NO.: 120751TF

LOCATION: Page to Cameron — DATE: 6/18/12

BORING NO.: TP-51 SAMPLE NO.: BS-1 SAMPLE DEPTH: 4.5 to 6.5 LABORATORY NO.: 373703

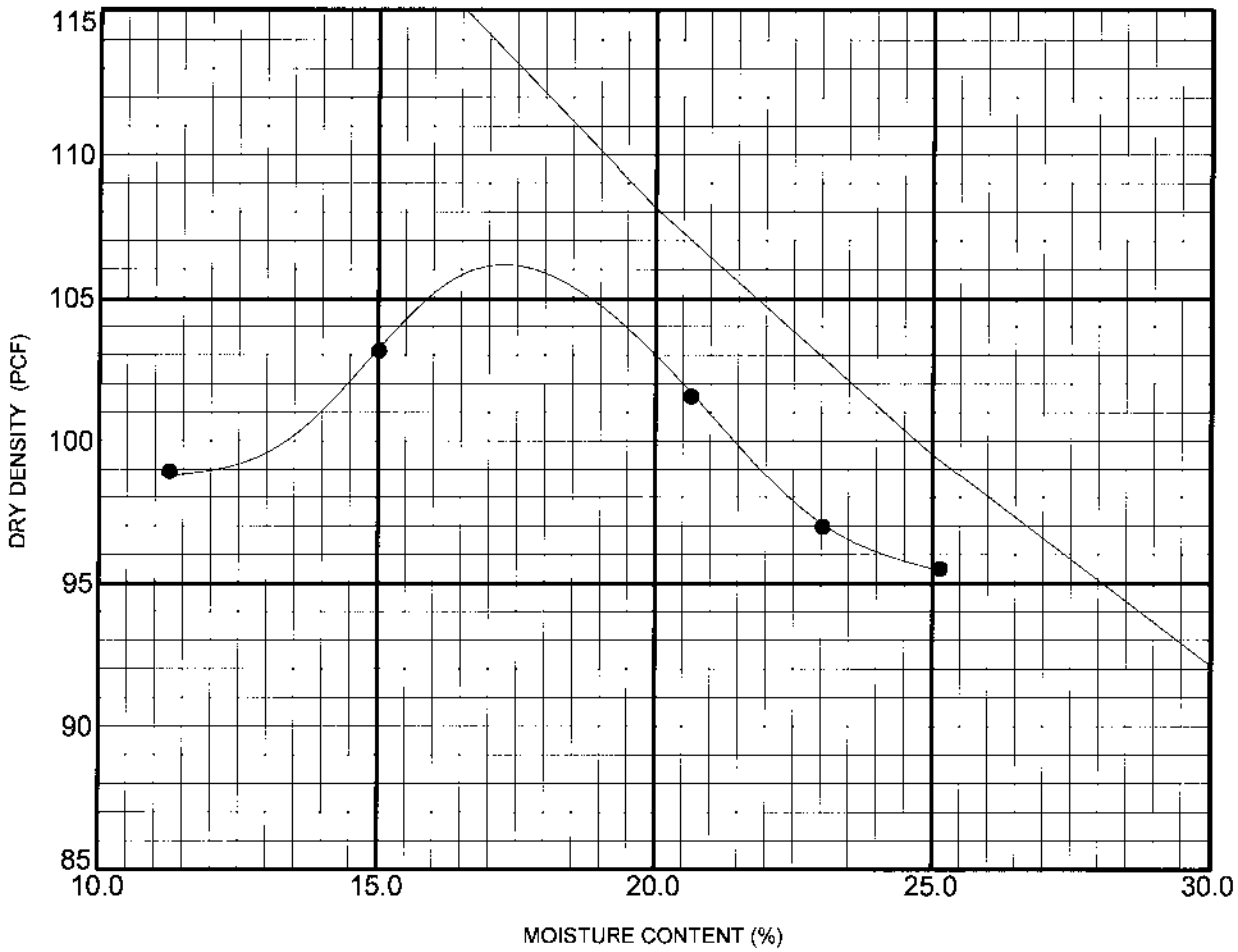
METHOD OF COMPACTION: D698A

LIQUID LIMIT: 33 PLASTIC LIMIT: 15 PLASTICITY INDEX: 18

CLASSIFICATION: CL ASTM SOIL DESCRIPTION: SANDY LEAN CLAY

MAXIMUM DRY DENSITY: 106.1 PCF

OPTIMUM MOISTURE CONTENT: 17.3%



SPEEDIE AND ASSOCIATES

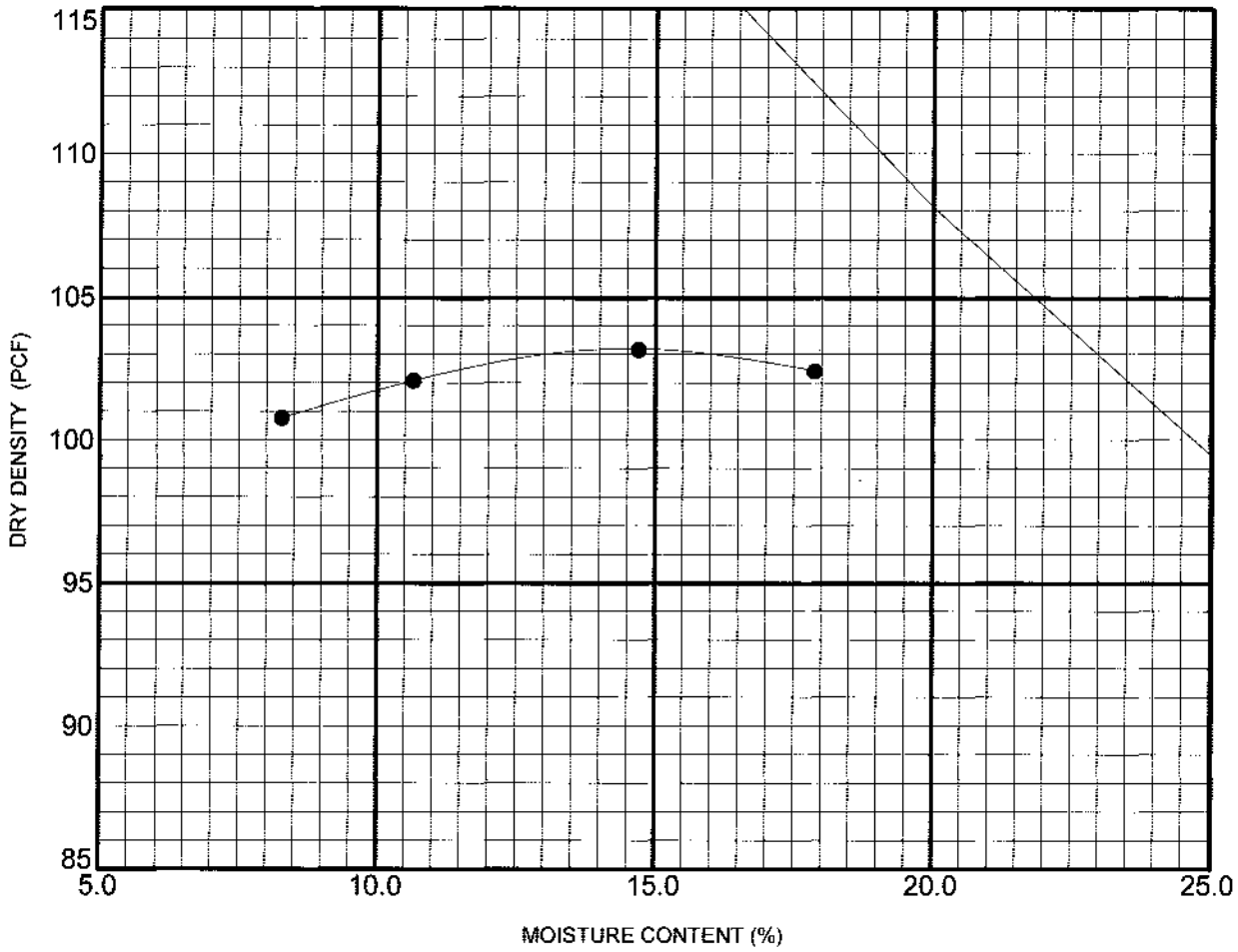
GEOTECH PROCTOR 120751TF.GPJ 7/11/12

MOISTURE-DENSITY RELATIONS

PROJECT:	Cameron Water Line		**PROJECT NO.: 120751TF**
LOCATION:	Page to Cameron		**DATE: 6/18/12**
BORING NO.: TP-52	**SAMPLE NO.: BS-1**	**SAMPLE DEPTH: 2 to 8**	**LABORATORY NO.: 373699**
METHOD OF COMPACTION:	**D698A**		
LIQUID LIMIT:	**NT**	**PLASTIC LIMIT: NT**	**PLASTICITY INDEX: NT**
CLASSIFICATION:	**SP**	**ASTM SOIL DESCRIPTION:**	**POORLY GRADED SAND**

MAXIMUM DRY DENSITY: **103.2 PCF**

OPTIMUM MOISTURE CONTENT: **14.4%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line — PROJECT NO.: 120751TF

LOCATION: Page to Cameron — DATE: 6/18/12

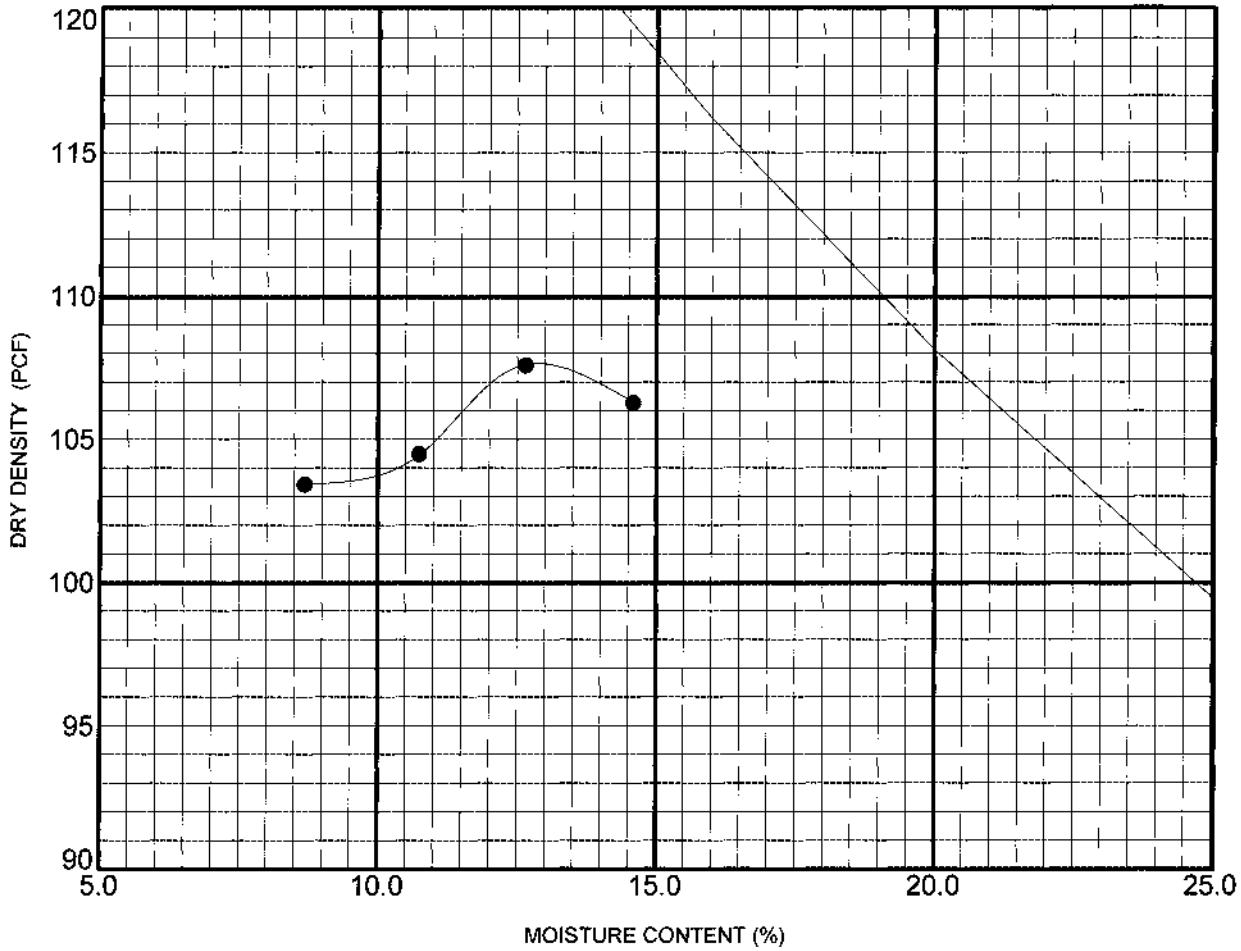
BORING NO.: TP-55 SAMPLE NO.: BS-1 SAMPLE DEPTH: 5 to 14.5 LABORATORY NO.: 373701

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT PLASTIC LIMIT: NT PLASTICITY INDEX: NT

CLASSIFICATION: SP ASTM SOIL DESCRIPTION: POORLY GRADED SAND

MAXIMUM DRY DENSITY: **107.7 PCF** OPTIMUM MOISTURE CONTENT: **12.8%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line PROJECT NO.: 120751TF

LOCATION: Page to Cameron DATE: 6/18/12

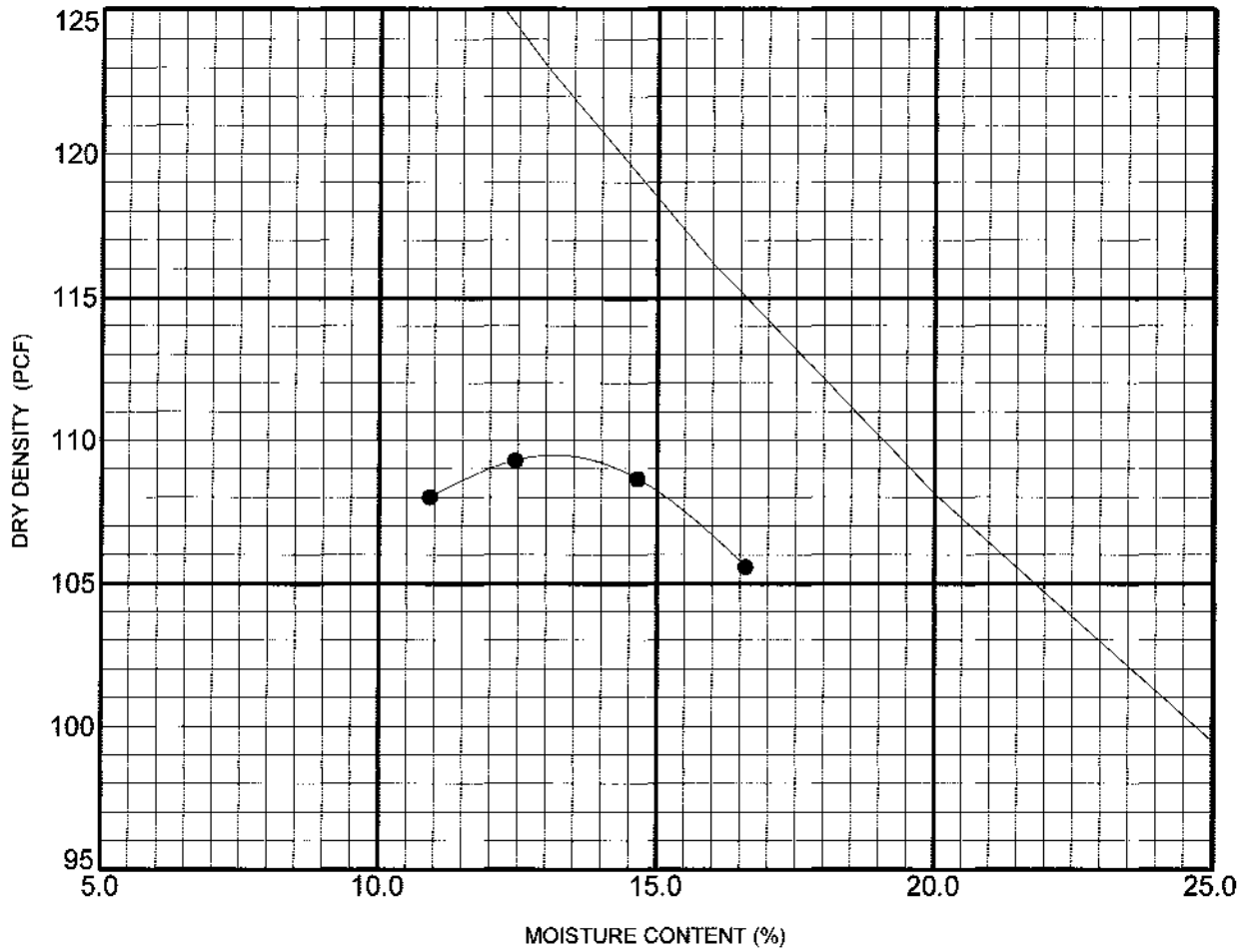
BORING NO.: TP-56 SAMPLE NO.: BS-1 SAMPLE DEPTH: 2 to 15 LABORATORY NO.: 347087

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT PLASTIC LIMIT: NT PLASTICITY INDEX: NT

CLASSIFICATION: SP-SM-SC ASTM SOIL DESCRIPTION: POORLY GRADED SAND with SILT and CLAY

MAXIMUM DRY DENSITY: 109.5 PCF OPTIMUM MOISTURE CONTENT: 13.2%



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line — PROJECT NO.: 120751TF

LOCATION: Page to Cameron — DATE: 6/19/12

BORING NO.: TP-57 SAMPLE NO.: BS-1 SAMPLE DEPTH: 0 to 10 LABORATORY NO.: 373696

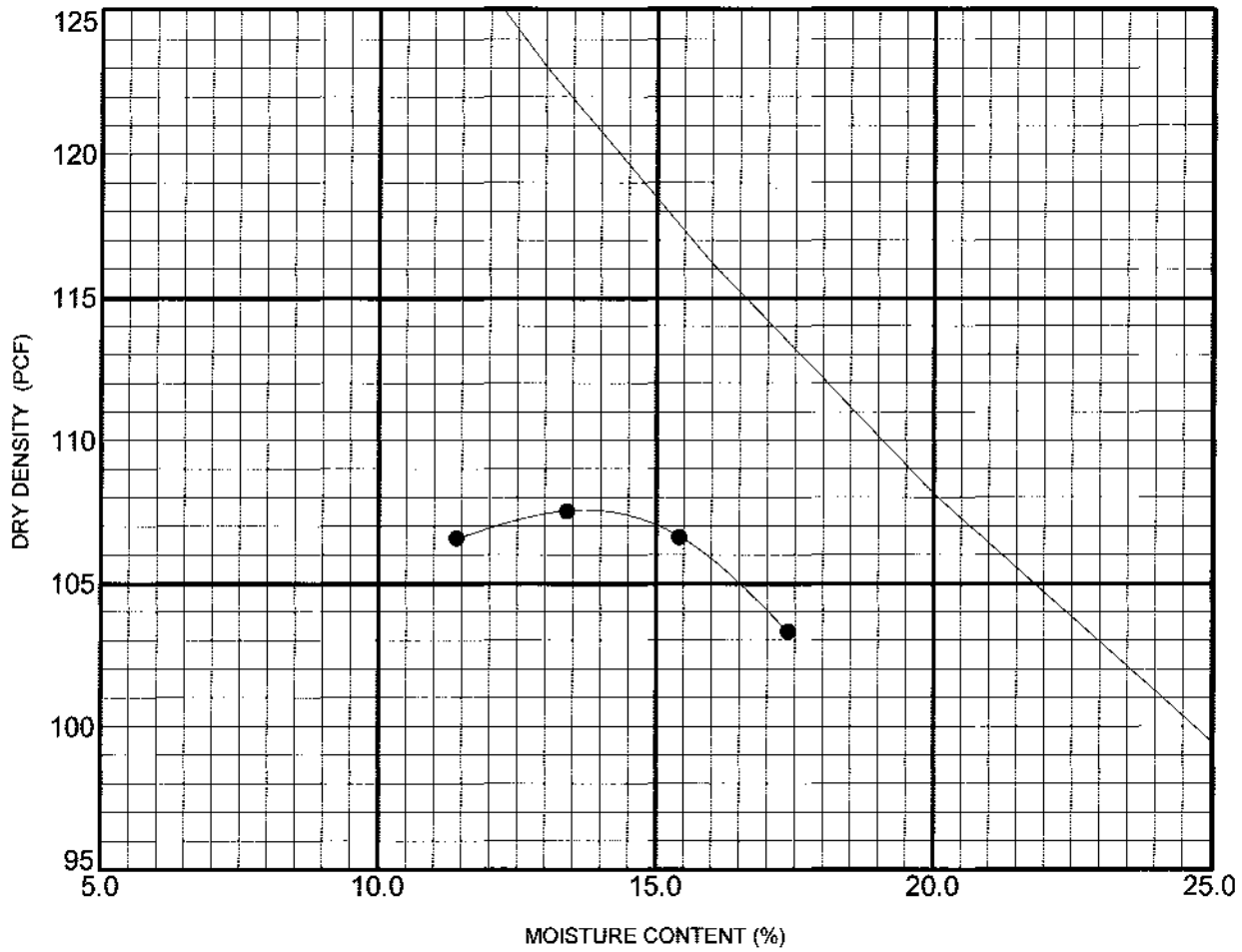
METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT PLASTIC LIMIT: NT PLASTICITY INDEX: NT

CLASSIFICATION: SP-SM-SC ASTM SOIL DESCRIPTION: POORLY GRADED SAND with SILT and CLAY

MAXIMUM DRY DENSITY: **107.5** PCF

OPTIMUM MOISTURE CONTENT: **13.7%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line — PROJECT NO.: 120751TF

LOCATION: Page to Cameron — DATE: 6/19/12

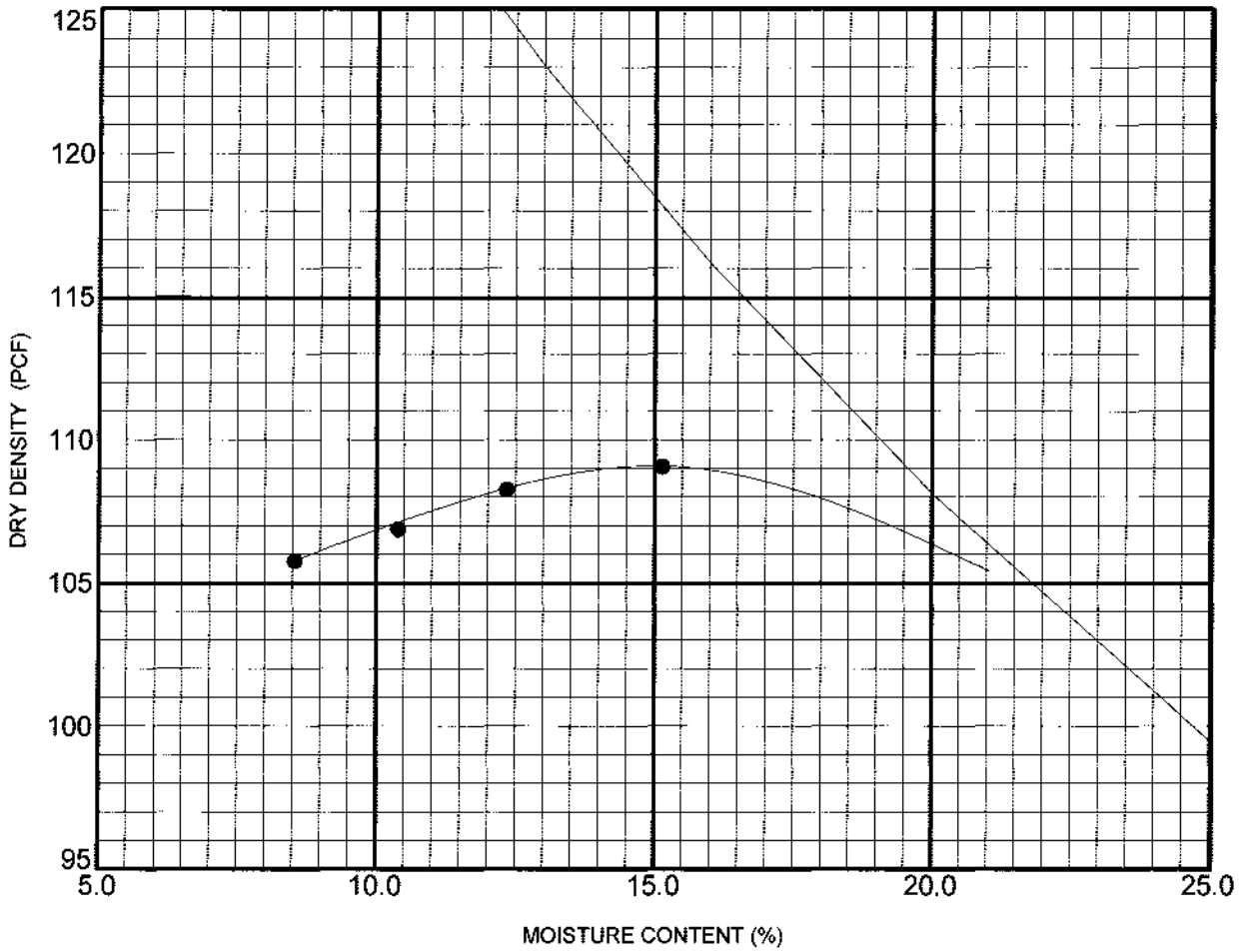
BORING NO.: TP-58 SAMPLE NO.: BS-1 SAMPLE DEPTH: 0 to 13 LABORATORY NO.: 373695

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT PLASTIC LIMIT: NT PLASTICITY INDEX: NT

CLASSIFICATION: SP ASTM SOIL DESCRIPTION: POORLY GRADED SAND

MAXIMUM DRY DENSITY: **109.1 PCF** OPTIMUM MOISTURE CONTENT: **15.1%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line PROJECT NO.: 120751TF

LOCATION: Page to Cameron DATE: 6/19/12

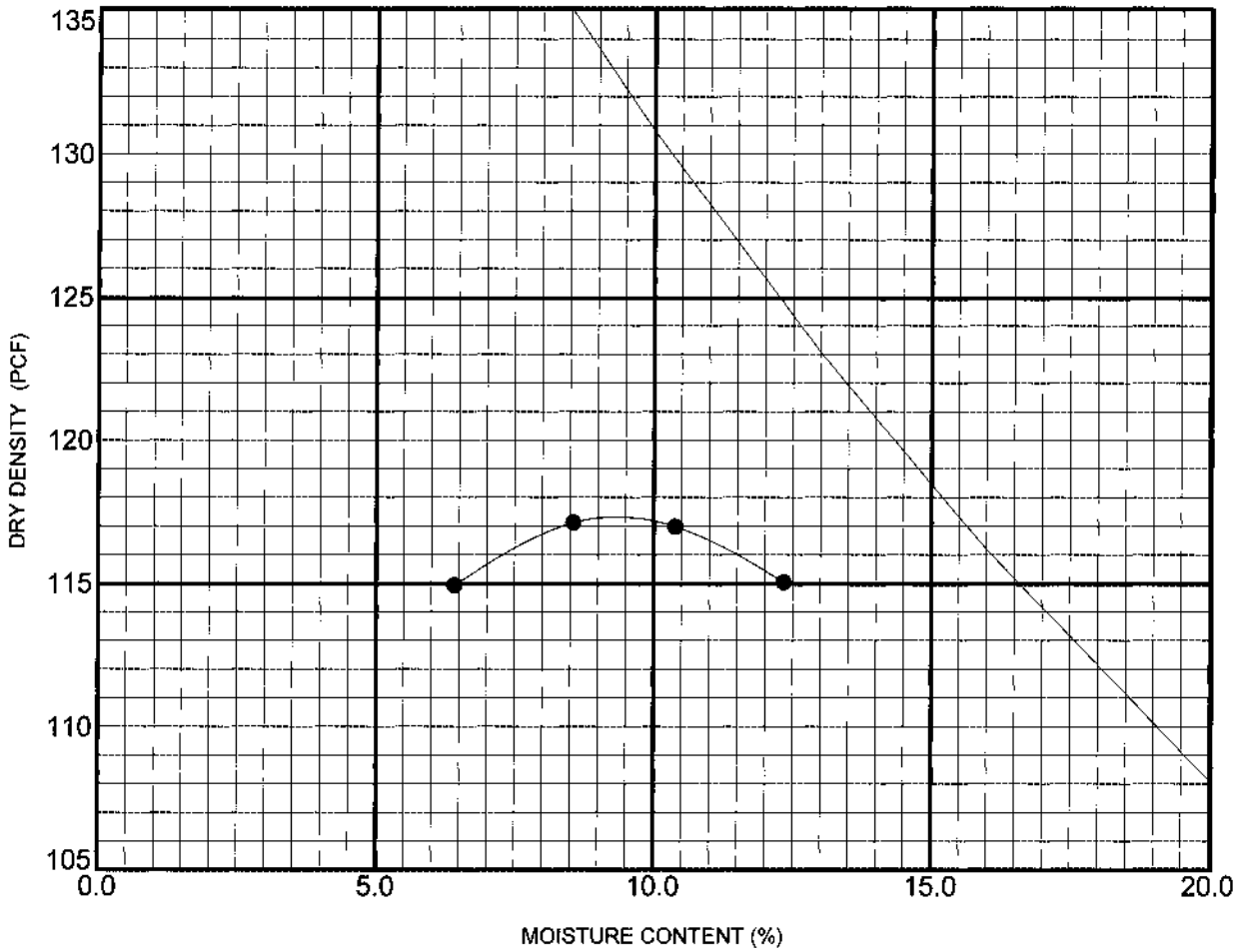
BORING NO.: TP-59 SAMPLE NO.: BS-1 SAMPLE DEPTH: 0 to 5.5 LABORATORY NO.: 373694

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT PLASTIC LIMIT: NT PLASTICITY INDEX: NT

CLASSIFICATION: SC-SM ASTM SOIL DESCRIPTION: SILTY, CLAYEY SAND

MAXIMUM DRY DENSITY: 117.3 PCF OPTIMUM MOISTURE CONTENT: 9.3%



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line — PROJECT NO.: 120751TF

LOCATION: Page to Cameron — DATE: 6/19/12

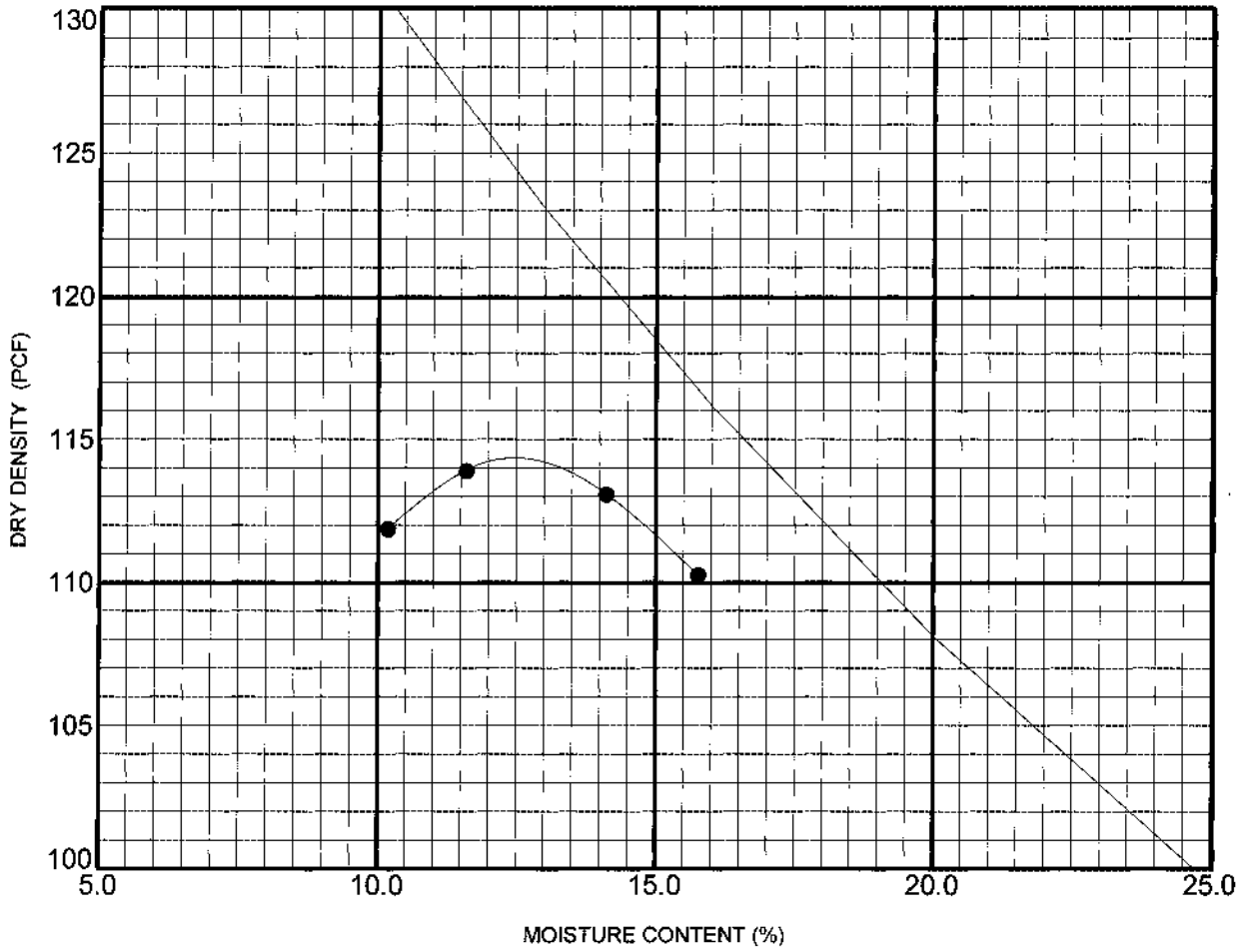
BORING NO.: TP-60 SAMPLE NO.: BS-1 SAMPLE DEPTH: 0 to 6.5 LABORATORY NO.: 373693

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT PLASTIC LIMIT: NT PLASTICITY INDEX: NT

CLASSIFICATION: SP ASTM SOIL DESCRIPTION: POORLY GRADED SAND

MAXIMUM DRY DENSITY: 114.3 PCF OPTIMUM MOISTURE CONTENT: 12.4%



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line — PROJECT NO.: 120751TF

LOCATION: Page to Cameron — DATE: 6/19/12

BORING NO.: TP-61 SAMPLE NO.: BS-1 SAMPLE DEPTH: 0 to 3.5 LABORATORY NO.: 373692

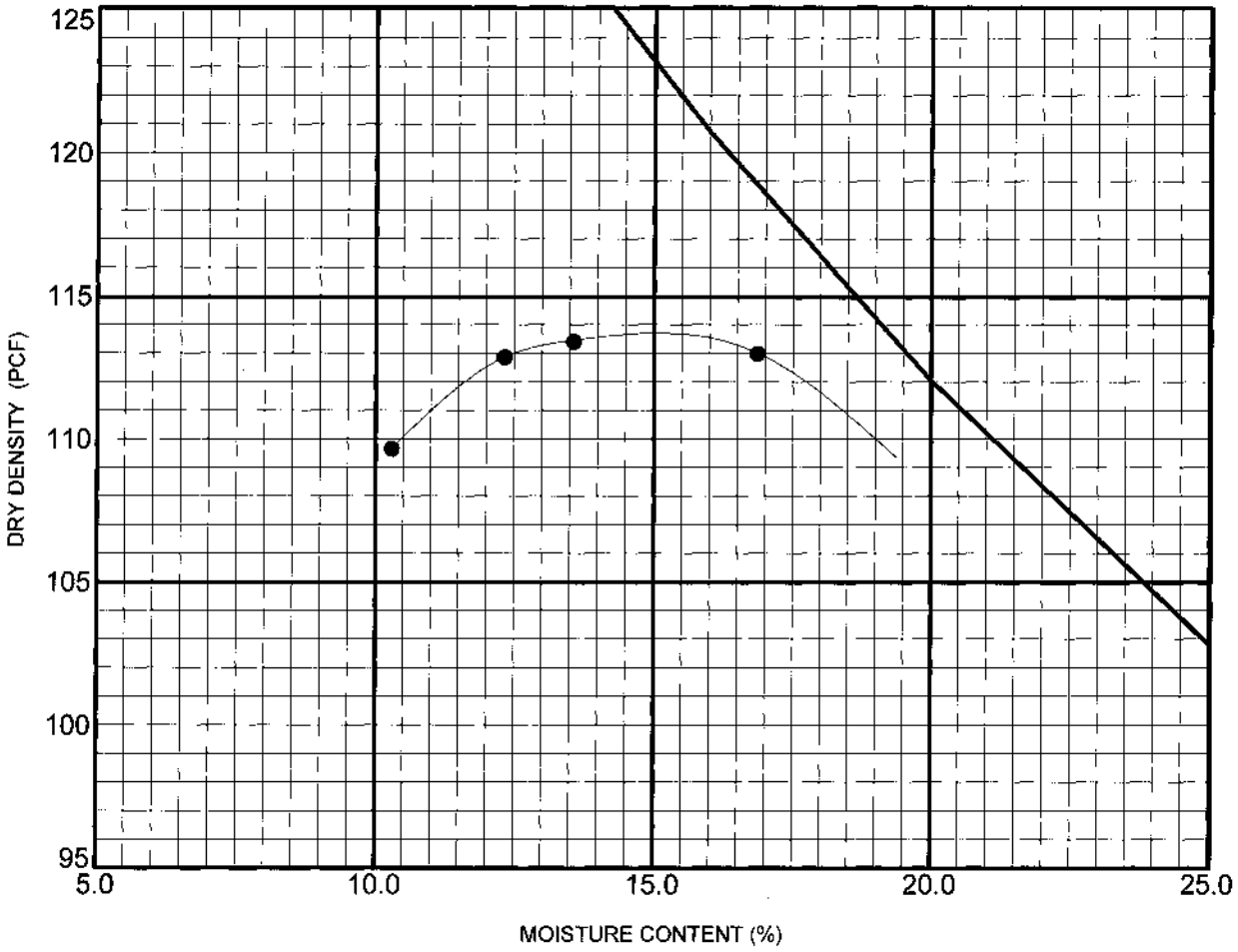
METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT PLASTIC LIMIT: NT PLASTICITY INDEX: NT

CLASSIFICATION: SP-SM-SC ASTM SOIL DESCRIPTION: POORLY GRADED SAND with SILT and CLAY

MAXIMUM DRY DENSITY: 113.8 PCF

OPTIMUM MOISTURE CONTENT: 15.1%



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line — PROJECT NO.: 120751TF

LOCATION: Page to Cameron — DATE: 6/19/12

BORING NO.: TP-62 SAMPLE NO.: BS-1 SAMPLE DEPTH: 0 to 5.5 LABORATORY NO.: 373691

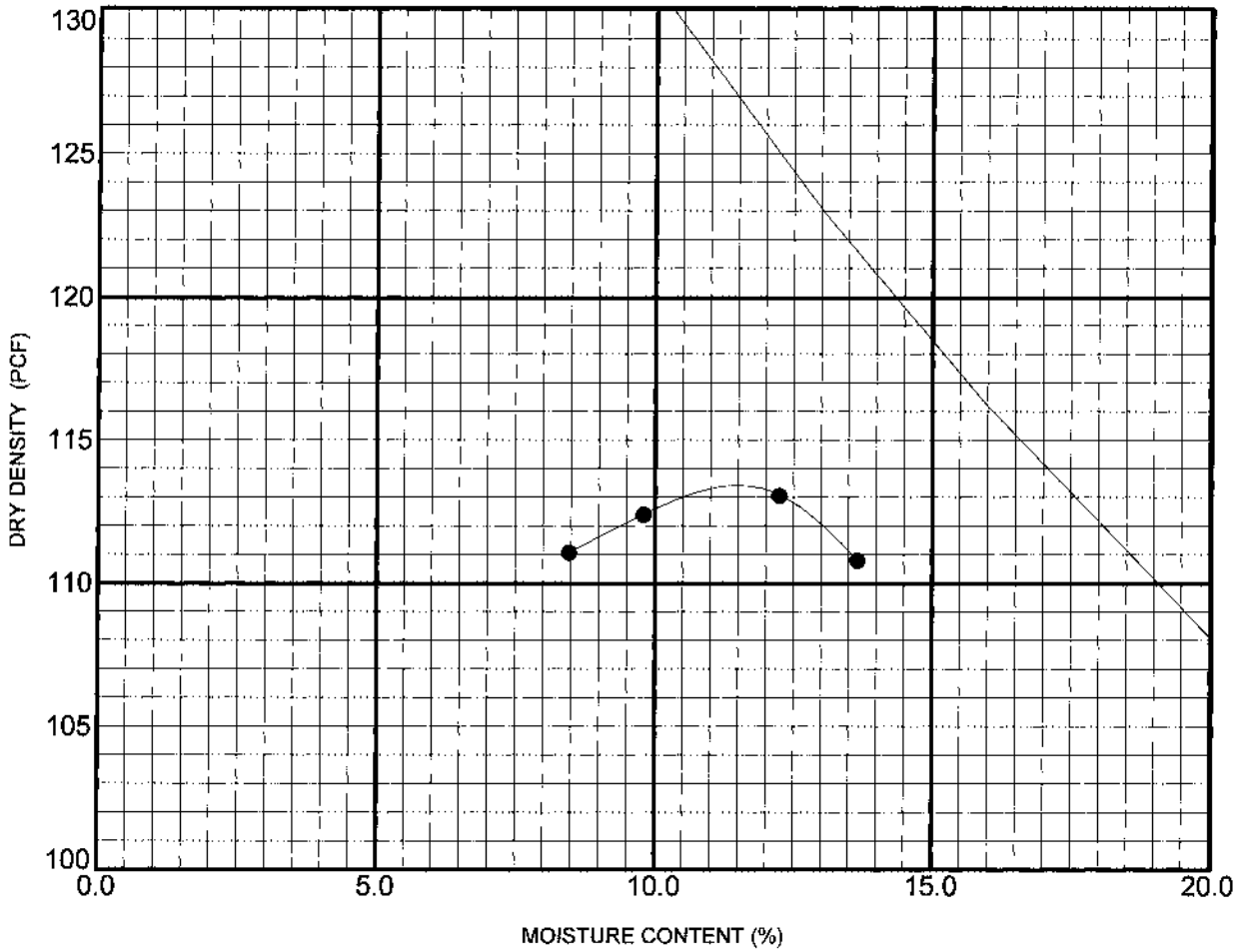
METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT PLASTIC LIMIT: NT PLASTICITY INDEX: NT

CLASSIFICATION: SP-SM-SC ASTM SOIL DESCRIPTION: POORLY GRADED SAND with SILT and CLAY

MAXIMUM DRY DENSITY: 113.4 PCF

OPTIMUM MOISTURE CONTENT: 11.5%



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line **PROJECT NO.:** 120751TF

LOCATION: Page to Cameron **DATE:** 6/19/12

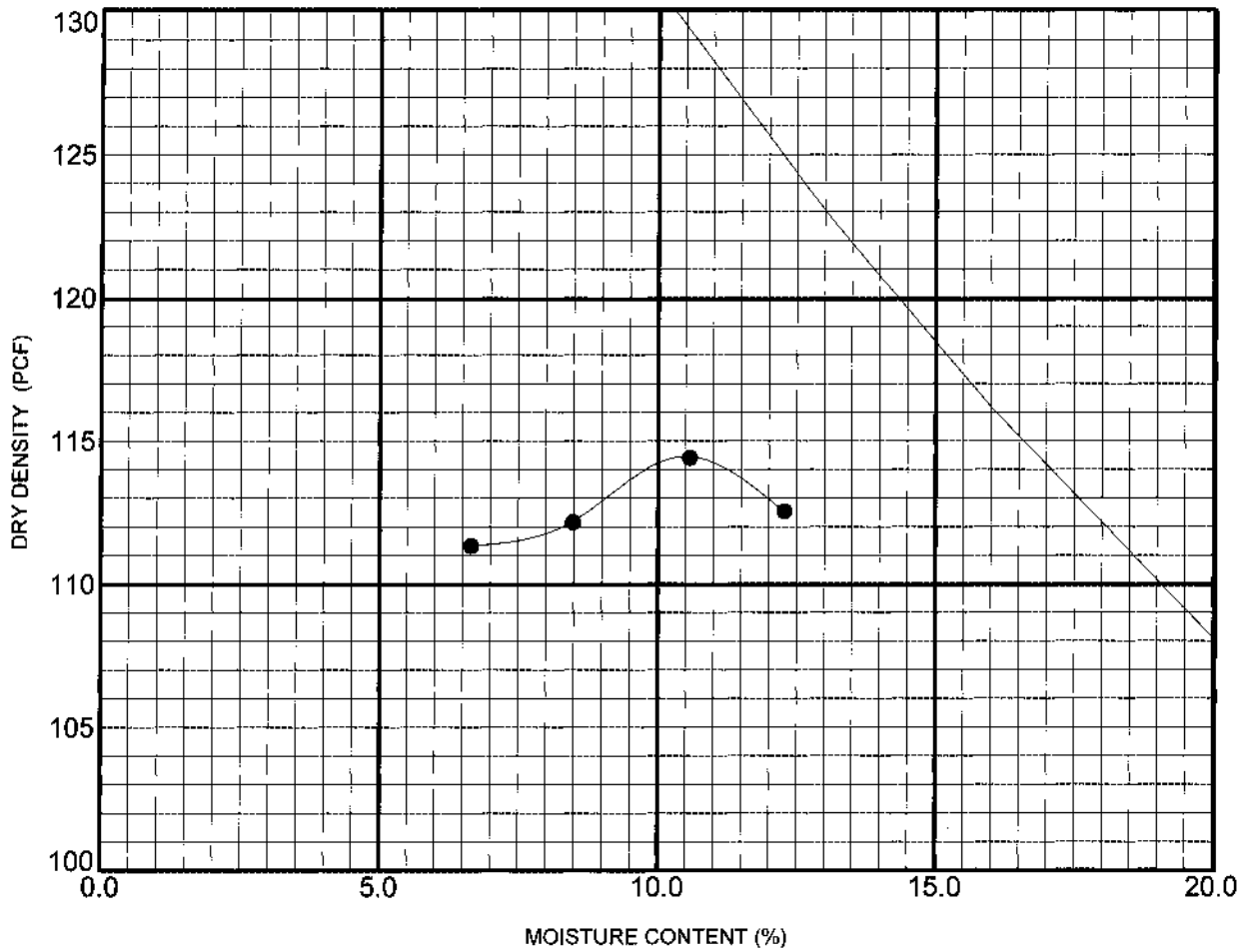
BORING NO.: TP-63 **SAMPLE NO.:** BS-1 **SAMPLE DEPTH:** 0 to 5 **LABORATORY NO.:** 373690

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT **PLASTIC LIMIT:** NT **PLASTICITY INDEX:** NT

CLASSIFICATION: SP-SM-SC **ASTM SOIL DESCRIPTION:** POORLY GRADED SAND with SILT and CLAY

MAXIMUM DRY DENSITY: **114.4 PCF** OPTIMUM MOISTURE CONTENT: **10.6%**



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line — PROJECT NO.: 120751TF

LOCATION: Page to Cameron — DATE: 6/18/12

BORING NO.: TP-67 SAMPLE NO.: BS-1 SAMPLE DEPTH: 0 to 7 — LABORATORY NO.: 373702

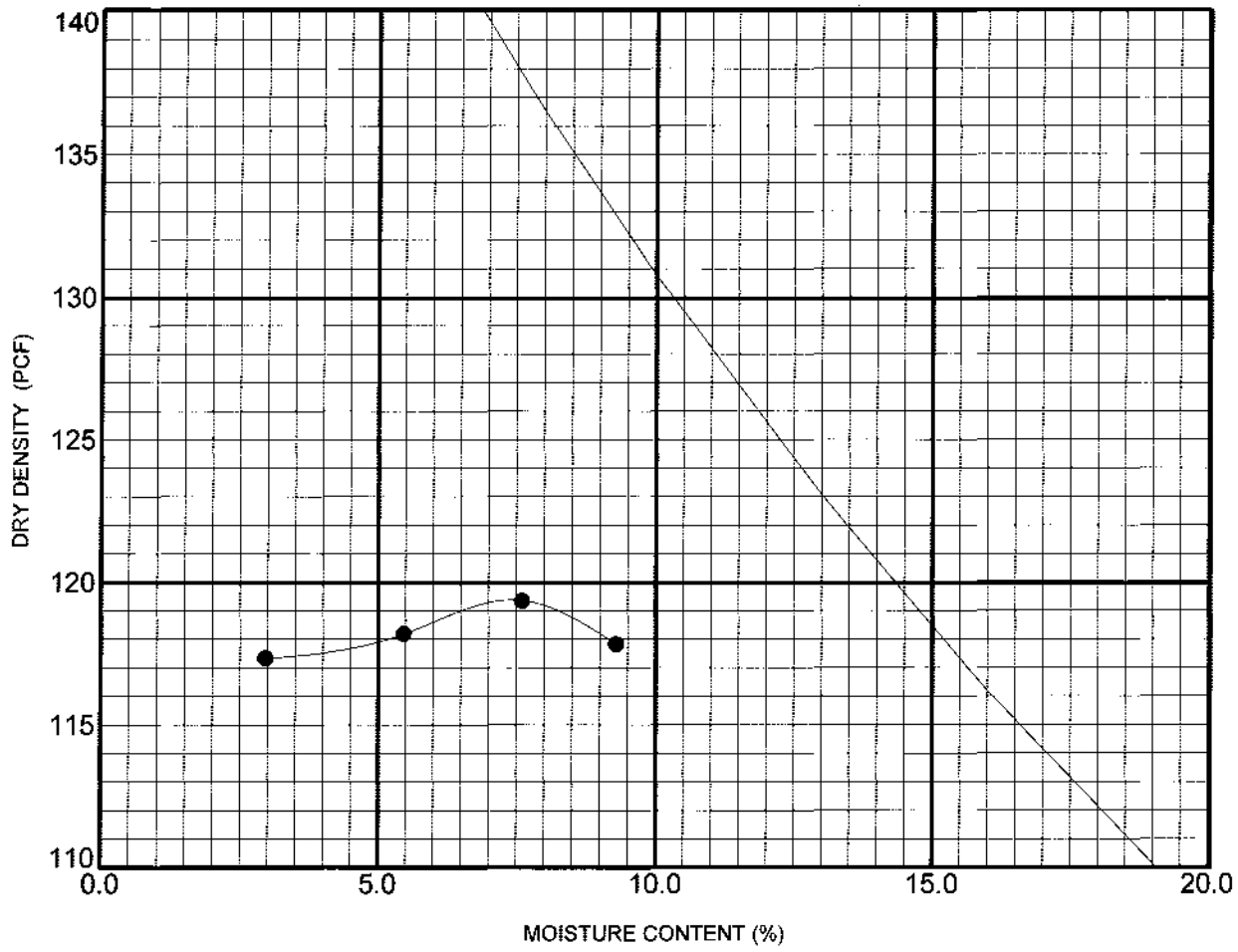
METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT PLASTIC LIMIT: NT PLASTICITY INDEX: NT

CLASSIFICATION: SP-SM-SC ASTM SOIL DESCRIPTION: POORLY GRADED SAND with SILT and CLAY

MAXIMUM DRY DENSITY: 119.4 PCF

OPTIMUM MOISTURE CONTENT: 7.4%



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/11/12

MOISTURE-DENSITY RELATIONS

PROJECT: Cameron Water Line PROJECT NO.: 120751TF

LOCATION: Page to Cameron DATE: 6/18/12

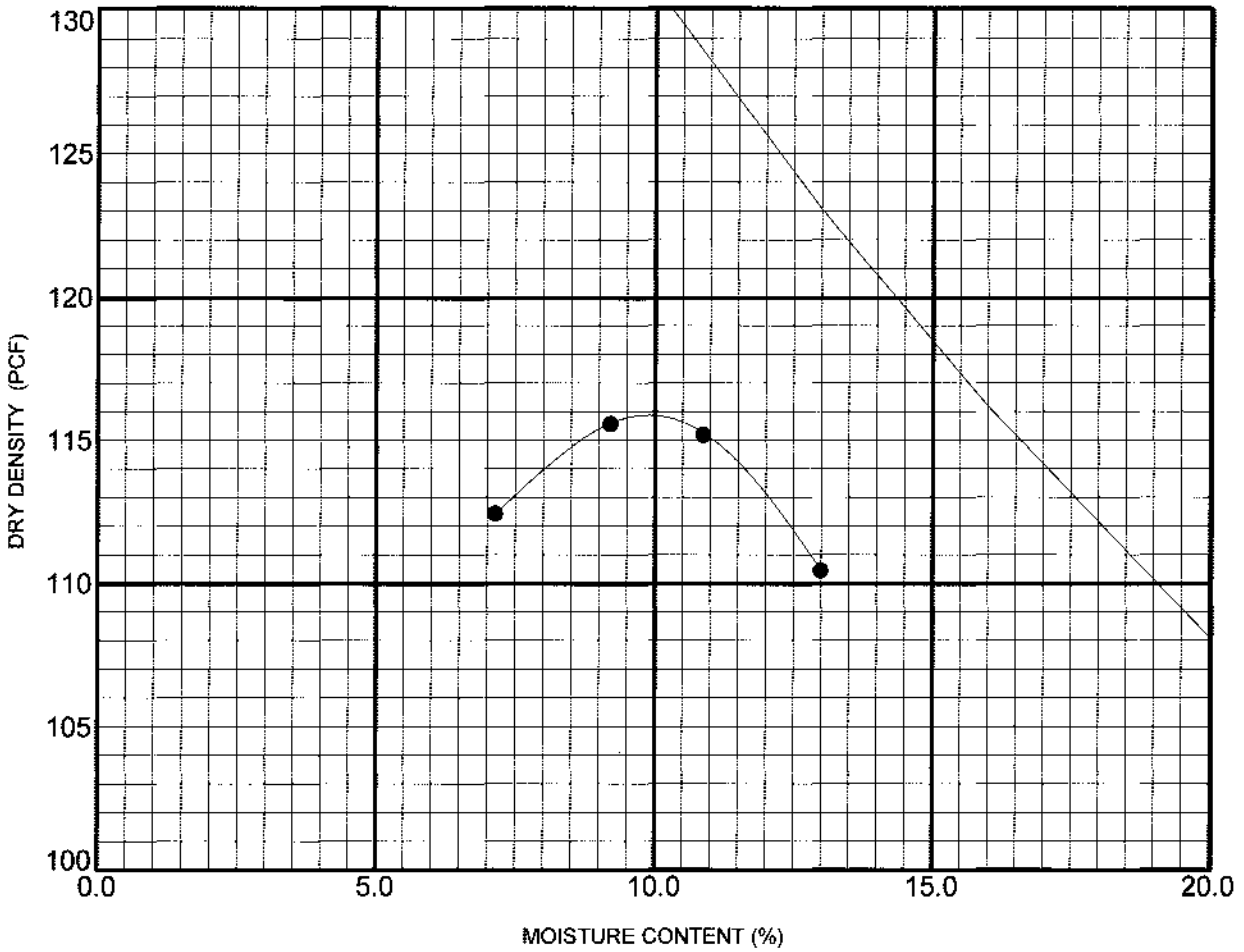
BORING NO.: TP-68 SAMPLE NO.: BS-1 SAMPLE DEPTH: 0 to 3.3 LABORATORY NO.: 373700

METHOD OF COMPACTION: D698A

LIQUID LIMIT: NT PLASTIC LIMIT: NT PLASTICITY INDEX: NT

CLASSIFICATION: SP-SM-SC ASTM SOIL DESCRIPTION: POORLY GRADED SAND with SILT and CLAY

MAXIMUM DRY DENSITY: 115.9 PCF OPTIMUM MOISTURE CONTENT: 9.8%



SPEEDIE AND ASSOCIATES

GEOTECH PROCTOR 120751TF.GPJ 7/10/12

TABULATION OF TEST DATA

SOIL BORING or TEST PIT NUMBER	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE INTERVAL (ft)	NATURAL WATER CONTENT (Percent of Dry Weight)	IN-PLACE DRY DENSITY (Pounds Per Cubic Foot)	PARTICLE SIZE DISTRIBUTION (Percent Finer)					ATTERBERG LIMITS			pH	RESISTIVITY (Ohm-Centimeters)	UNIFIED SOIL CLASSIFICATION	SPECIMEN DESCRIPTION
						#200 SIEVE	#40 SIEVE	#10 SIEVE	#4 SIEVE	3" SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX				
TP-01	BS-1	BULK	0.0 - 8.0	2.3	NT	15	84	95	97	100	NT	NT	NT	8.82	6217.6	SM	SILTY, CLAYEY SAND
TP-02	BS-1	BULK	0.0 - 12.0	4.0	NT	37	73	81	84	100	NP	NP	NP	8.48	473.3	SM	SILTY SAND with GRAVEL
TP-03	BS-1	BULK	4.0 - 13.0	1.6	NT	8	48	66	73	100	NT	NT	NT	9	3712	SP-SM-SC	POORLY GRADED SAND with SILT, CLAY, and GRAVEL
TP-04	BS-1	BULK	4.0 - 13.0	2.6	NT	15	33	42	53	100	22	18	4	8.1	482.6	GC-GM	SILTY, CLAYEY GRAVEL with SAND
TP-05	BS-1	BULK	2.0 - 12.0	2.0	NT	72	99	100	100	100	28	15	13	8.45	1020.8	CL	LEAN CLAY with SAND
TP-06	BS-1	BULK	4.0 - 10.4	1.3	NT	15	68	80	87	100	NT	NT	NT	8.88	2784	SC-SM	SILTY, CLAYEY SAND
TP-07	BS-1	BULK	0.0 - 14.0	3.0	NT	42	70	86	91	100	20	15	5	8.68	1020.8	SC-SM	SILTY, CLAYEY SAND
TP-08	BS-1	BULK	2.0 - 7.0	3.9	NT	42	57	66	75	100	26	15	11	8.7	1856	SC	CLAYEY SAND with GRAVEL
TP-09	BS-1	BULK	6.0 - 10.0	3.9	NT	21	36	57	71	100	21	15	6	8.22	658.9	SC-SM	SILTY, CLAYEY SAND with GRAVEL
TP-10	BS-1	BULK	0.0 - 9.0	2.6	NT	30	47	59	67	100	21	16	5	8.48	2041.6	SC-SM	SILTY, CLAYEY SAND with GRAVEL
TP-11	BS-1	BULK	0.0 - 6.0	3.2	NT	38	63	71	77	100	22	14	8	7.26	853.8	SC	CLAYEY SAND with GRAVEL
TP-12	BS-1	BULK	3.8 - 11.5	4.8	NT	30	58	82	91	100	22	14	8	7.66	1856	SC	CLAYEY SAND

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SOIL BORING or TEST PIT NUMBER	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE INTERVAL (ft)	NATURAL WATER CONTENT (Percent of Dry Weight)	IN-PLACE DRY DENSITY (Pounds Per Cubic Foot)	PARTICLE SIZE DISTRIBUTION (Percent Finer)					ATTERBERG LIMITS			pH	RESISTIVITY (Ohm-Centimeters)	UNIFIED SOIL CLASSIFICATION	SPECIMEN DESCRIPTION
						#200 SIEVE	#40 SIEVE	#10 SIEVE	#4 SIEVE	3" SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX				
TP-13	BS-1	BULK	0.0 - 4.5	4.9	NT	39	70	95	98	100	21	14	7	8.5	1948.8	SC-SM	SILTY, CLAYEY SAND
TP-14	BS-1	BULK	0.0 - 10.0	1.9	NT	15	68	85	91	100	NT	NT	NT	8.32	1948.8	SC-SM	SILTY, CLAYEY SAND
TP-15	BS-1	BULK	0.0 - 5.5	3.4	NT	23	52	77	85	100	20	15	5	8.8	2041.6	SC-SM	SILTY, CLAYEY SAND
TP-16	BS-1	BULK	0.0 - 3.5	5.4	NT	51	72	81	87	100	NT	NT	NT	8.48	2227.2	CL	CLAYSTONE (SANDY LEAN CLAY)
TP-18	BS-1	BULK	2.5 - 9.0	16.0	NT	94	98	100	100	100	NT	NT	NT	7.25	751.7	CL	CLAYSTONE (LEAN CLAY)
TP-19	BS-1	BULK	0.0 - 8.0	6.0	NT	19	41	64	74	100	22	13	9	8.54	928	SC	CLAYEY SAND with GRAVEL
TP-20	BS-1	BULK	0.0 - 8.5	3.8	NT	28	61	86	94	100	23	18	5	8.41	1856	SC-SM	SILTY, CLAYEY SAND
TP-21	BS-1	BULK	3.0 - 5.0	2.0	NT	5	17	45	62	100	NT	NT	NT	9.7	3526.4	SW-SM-SC	WELL-GRADED SAND with SILT, CLAY, and GRAVEL
TP-21	BS-2	BULK	8.0 - 15.0	13.6	NT	68	97	100	100	100	42	24	18	8.83	2876.8	CL	CLAYSTONE (SANDY LEAN CLAY)
TP-22	BS-1	BULK	6.0 - 14.0	12.2	NT	12	25	43	57	100	NT	NT	NT	10.16	779.5	SW-SM-SC	WELL-GRADED SAND with SILT, CLAY, and GRAVEL
TP-23	BS-1	BULK	0.0 - 6.0	2.6	NT	31	89	98	99	100	NP	NP	NP	9.29	2227.2	SM	SILTY SAND
TP-23	BS-2	BULK	6.0 - 8.0	9.0	NT	18	45	75	85	100	22	13	9	9.83	1948.8	SC	CLAYEY SAND with GRAVEL
TP-24	BS-1	BULK	5.0 - 15.0	2.4	NT	7	27	49	58	100	NT	NT	NT	9.11	1577.6	SP-SM-SC	POORLY GRADED SAND with SILT, CLAY, and GRAVEL

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						#200 SIEVE	#40 SIEVE	#10 SIEVE	#4 SIEVE	3" SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX				
TP-25	BS-1	BULK	8.0 - 12.0	2.8	NT	12	66	85	89	100	NT	NT	NT	7.31	4640	SC-SM	SILTY, CLAYEY SAND
TP-26	BS-1	BULK	3.5 - 10.5	8.9	NT	12	57	97	98	100	NT	NT	NT	8.8	1577.6	SC-SM	SILTY, CLAYEY SAND
TP-27	BS-1	BULK	0.0 - 5.0	11.5	NT	10	54	83	92	100	NT	NT	NT	9.7	2041.6	SP-SM-SC	POORLY GRADED SAND with SILT and CLAY
TP-28	BS-1	BULK	0.0 - 14.0	5.5	NT	15	42	66	75	100	NT	NT	NT	8.71	510.4	SC-SM	SILTY, CLAYEY SAND with GRAVEL
TP-29	BS-1	BULK	0.5 - 10.0	8.9	NT	73	90	94	95	100	38	18	20	8.85	2969.6	CL	CLAYSTONE (LEAN CLAY with SAND)
TP-30	BS-1	BULK	2.0 - 14.0	24.2	NT	78	92	99	100	100	22	14	8	7.84	408.3	CL	LEAN CLAY with SAND
TP-31	BS-1	BULK	0.0 - 3.0	4.5	NT	29	73	95	97	100	35	19	16	8.9	371.2	SC	CLAYEY SAND
TP-32	BS-1	BULK	0.0 - 14.0	3.2	NT	13	33	70	81	100	NT	NT	NT	8.91	1670.4	SC-SM	SILTY, CLAYEY SAND with GRAVEL
TP-33	BS-1	BULK	0.0 - 2.0	2.8	NT	23	58	87	93	100	24	19	5	8.91	1020.8	SC-SM	SILTY, CLAYEY SAND
TP-34	BS-1	BULK	1.5 - 13.0	11.9	NT	76	92	98	99	100	42	23	19	7.4	436.2	CL	CLAYSTONE (LEAN CLAY with SAND)
TP-35	BS-1	BULK	0.0 - 4.5	4.3	NT	35	64	84	92	100	28	11	17	8.86	779.5	SC	CLAYEY SAND
TP-36	BS-1	BULK	7.0 - 13.5	6.1	NT	28	64	86	93	100	33	14	19	8.48	742.4	SC	CLAYEY SAND
TP-37	BS-1	BULK	1.0 - 4.5	3.6	NT	23	75	94	98	100	33	25	8	8	742.4	SM	SILTY SAND
TP-38	BS-1	BULK	1.0 - 4.0	8.2	NT	28	85	99	99	100	NP	NP	NP	7.73	1484.8	SM	SILTY SAND
TP-39	BS-1	BULK	0.0 - 3.5	4.3	NT	25	65	88	94	100	27	16	11	7.89	194.9	SC	CLAYEY SAND

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						#200 SIEVE	#40 SIEVE	#10 SIEVE	#4 SIEVE	3" SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX				
TP-40	BS-1	BULK	0.0 - 5.0	18.6	NT	74	89	97	98	100	59	19	40	8.85	436.2	CH	FAT CLAY with SAND
TP-41	BS-1	BULK	3.0 - 8.0	14.7	NT	91	98	100	100	100	NT	NT	NT	7.09	751.7	CH	CLAYSTONE (FAT CLAY)
TP-42	BS-1	BULK	7.0 - 14.5	5.9	NT	47	87	93	96	100	28	18	10	9.11	1392	SC	CLAYEY SAND
TP-43	BS-1	BULK	0.0 - 6.0	5.0	NT	42	92	98	99	100	25	18	7	8.95	566.1	SC-SM	SILTY, CLAYEY SAND
TP-44	BS-1	BULK	0.8 - 8.5	7.2	NT	42	89	98	99	100	24	19	5	9.44	742.4	SC-SM	SILTY, CLAYEY SAND
TP-45	BS-1	BULK	0.0 - 14.0	12.2	NT	72	96	100	100	100	NT	NT	NT	8.22	306.2	CL	CLAYSTONE (LEAN CLAY with SAND)
TP-46	BS-1	BULK	0.0 - 8.0	7.9	NT	54	74	78	82	100	41	26	15	8.35	807.4	ML	CLAYSTONE (SANDY SILT with GRAVEL)
TP-47	BS-1	BULK	0.0 - 8.0	2.4	NT	15	70	90	94	100	NT	NT	NT	9.42	733.1	SC-SM	SILTY, CLAYEY SAND
TP-48	BS-1	BULK	1.8 - 7.5	10.0	NT	51	88	96	97	100	NT	NT	NT	8.15	1020.8	CL	CLAYSTONE (SANDY LEAN CLAY)
TP-49	373697	BULK	0.0 - 3.2	1.1	NT	9	97	100	100	100	NT	NT	NT	8.9	6124.8	SP-SM-SC	POORLY GRADED SAND with SILT and CLAY
TP-50	BS-1	BULK	0.0 - 5.0	1.4	NT	13	94	100	100	100	NT	NT	NT	8.34	8816	SC-SM	SILTY, CLAYEY SAND
TP-51	BS-1	BULK	4.5 - 6.5	13.5	NT	61	97	100	100	100	33	15	18	8.84	816.6	CL	SANDY LEAN CLAY
TP-52	BS-1	BULK	2.0 - 8.0	0.6	NT	4	97	99	100	100	NT	NT	NT	8.82	9187.2	SP	POORLY GRADED SAND
TP-55	BS-1	BULK	5.0 - 14.5	1.1	NT	3	90	94	96	100	NT	NT	NT	9.09	2876.8	SP	POORLY GRADED SAND
TP-56	BS-1	BULK	2.0 - 15.0	1.1	NT	7	92	100	100	100	NT	NT	NT	8.39	2320	SP-SM-	POORLY GRADED SAND with

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SOIL BORING or TEST PIT NUMBER	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE INTERVAL (ft)	NATURAL WATER CONTENT (Percent of Dry Weight)	IN-PLACE DRY DENSITY (Pounds Per Cubic Foot)	PARTICLE SIZE DISTRIBUTION (Percent Finer)					ATTERBERG LIMITS			pH	RESISTIVITY (Ohm-Centimeters)	UNIFIED SOIL CLASSIFICATION	SPECIMEN DESCRIPTION
						#200 SIEVE	#40 SIEVE	#10 SIEVE	#4 SIEVE	3" SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX				
																SC	SILT and CLAY
TP-57	BS-1	BULK	0.0 - 10.0	1.4	NT	6	92	100	100	100	NT	NT	NT	8.84	13920	SP-SM-SC	POORLY GRADED SAND with SILT and CLAY
TP-58	BS-1	BULK	0.0 - 13.0	0.5	NT	4	89	100	100	100	NT	NT	NT	9.2	16704	SP	POORLY GRADED SAND
TP-59	BS-1	BULK	0.0 - 5.5	0.7	NT	12	79	100	100	100	NT	NT	NT	8	12992	SC-SM	SILTY, CLAYEY SAND
TP-60	BS-1	BULK	0.0 - 6.5	0.4	NT	4	86	100	100	100	NT	NT	NT	9.13	16704	SP	POORLY GRADED SAND
TP-61	BS-1	BULK	0.0 - 3.5	0.6	NT	7	53	98	98	100	NT	NT	NT	8.92	13920	SP-SM-SC	POORLY GRADED SAND with SILT and CLAY
TP-62	BS-1	BULK	0.0 - 5.5	0.4	NT	6	81	100	100	100	NT	NT	NT	7.88	12992	SP-SM-SC	POORLY GRADED SAND with SILT and CLAY
TP-63	BS-1	BULK	0.0 - 5.0	0.8	NT	7	86	99	100	100	NT	NT	NT	8.57	8908.8	SP-SM-SC	POORLY GRADED SAND with SILT and CLAY
TP-67	BS-1	BULK	0.0 - 7.0	0.5	NT	6	79	100	100	100	NT	NT	NT	8	9094.4	SP-SM-SC	POORLY GRADED SAND with SILT and CLAY
TP-68	BS-1	BULK	0.0 - 3.3	1.2	NT	9	91	99	100	100	NT	NT	NT	8.64	7424	SP-SM-SC	POORLY GRADED SAND with SILT and CLAY

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TABULATION OF LABORATORY TEST DATA

TEST PIT NUMBER	SAMPLE INTERVAL (ft)	NATURAL WATER CONTENT (Percent of Dry Weight)	PARTICLE SIZE DISTRIBUTION (Percent Finer)					ATTERBERG LIMITS			UNIFIED SOIL CLASSIFICATION SYMBOL	UNIFIED SOIL CLASSIFICATION	pH	RESISTIVITY (Ohm-Centimeters)	SULFATES (SO_4) (ppm)	SULFIDE (ppm)	CHLORIDE (CL) (ppm)	FIELD DENSITY (sand cone method)		EXPANSION INDEX (measured) (EIM)		% FINES	% SAND	% GRAVEL	DEPTH TO ROCK	REFUSAL DEPTH	REASON FOR TERMINATION	Material
			#200 SIEVE	#40 SIEVE	#10 SIEVE	#4 SIEVE	3 INCH SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX								DEPTH (ft)	lb/ft3	DEPTH (ft)								
TP-01	0.0 - 8.0	2.3	15	84	95	97	100	NT	NT	NT	SM	SILTY SAND *	8.82	6,218	14	2	17	NT	NT	NT	NT	15	82	3	NE	12.0	Reach	Qal
TP-02	0.0 - 12.0	4.0	37	73	81	84	100	NP	NP	NP	(SM)g	SILTY SAND with GRAVEL	8.48	473	1,400	< 1	120	3.5	98.4	NT	NT	37	47	16	NE	13.0	Reach	Qal
TP-03	4.0 - 13.0	1.6	8	48	66	73	100	NT	NT	NT	(SP-SM)g	POORLY GRADED SAND with SILT and GRAVEL	9.00	3,712	25	< 1	62	NT	NT	NT	NT	8	65	27	NE	13.0	Reach	Qal
TP-04	4.0 - 13.0	2.6	15	33	42	53	100	22	18	4	(GC-GM)s	SILTY CLAYEY GRAVEL with SAND	8.10	483	530	< 1	170	3.8	91.4	NT	NT	15	38	47	NE	13.0	Reach	Qal
TP-05	2.0 - 12.0	2.0	72	99	100	100	100	28	15	13	(CL)s	LEAN CLAY with SAND	8.45	1,021	30	< 1	92	NT	NT	NT	NT	72	28	0	NE	12.0	Reach	Qal
TP-06	4.0 - 10.4	1.3	15	68	80	87	100	NT	NT	NT	SM	SILTY SAND	8.88	2,784	34	3	24	NT	NT	NT	NT	15	72	13	10.0	13.5	Reach	Ls
TP-07	0.0 - 14.0	3.0	42	70	86	91	100	20	15	5	SC-SM	SILTY, CLAYEY SAND	8.68	1,021	160	2	100	3.5	104.0	NT	NT	42	49	9	NE	14.0	Reach	Qal
TP-08	2.0 - 6.0	3.9	42	57	66	75	100	26	15	11	(SC)g	CLAYEY SAND with GRAVEL	8.70	1,856	110	6	55	NT	NT	NT	NT	42	33	25	6.0	7.5	Refusal	Clst
TP-09	6.0 - 10.0	3.9	21	36	57	71	100	21	15	6	(SC-SM)g	SILTY, CLAYEY SAND with GRAVEL	8.22	659	1,500	< 1	160	NT	NT	NT	NT	21	50	29	10.0	12.0	Refusal	Ss
TP-10	0.0 - 9.0	2.6	30	47	59	67	100	21	16	5	(SC-SM)g	SILTY, CLAYEY SAND with GRAVEL	8.48	2,042	400	< 1	140	NT	NT	NT	NT	30	37	33	9.4	13.0	Reach	Clst
TP-11	0.0 - 6.0	3.2	38	63	71	77	100	22	14	8	(SC)g	CLAYEY SAND with GRAVEL	7.26	854	1,700	< 1	72	4.2	97.6	NT	NT	38	39	23	7.5	11.5	Refusal	Ss
TP-12	3.8 - 11.5	4.8	30	58	82	91	100	22	14	8	SC	CLAYEY SAND	7.66	1,856	51	< 1	57	NT	NT	NT	NT	30	61	9	NE	11.5	Reach	Qal
TP-13	0.0 - 4.5	4.9	39	70	95	98	100	21	14	7	SC-SM	SILTY, CLAYEY SAND	8.50	1,949	22	2	60	NT	NT	NT	NT	39	59	2	4.0	11.0	Refusal	Clst
TP-14	0.0 - 10.0	1.9	15	68	85	91	100	NT	NT	NT	SM	SILTY SAND	8.32	1,949	18	2	24	NT	NT	NT	NT	15	76	9	10.0	11.0	Refusal	Ss
TP-15	0.9 - 5.5	3.4	23	52	77	85	100	20	15	5	SC-SM	SILTY, CLAYEY SAND	8.80	2,042	30	< 1	23	NT	NT	NT	NT	23	62	15	5.5	7.0	Refusal	Ss
TP-16	0.0 - 3.5	5.4	51	72	81	87	100	NT	NT	NT	s(CL)	SANDY LEAN CLAY)	8.48	2,227	11	4	22	NT	NT	NT	NT	51	36	13	3.5	6.0	Refusal	Ss
TP-18	2.5 - 9.0	16.0	94	98	100	100	100	NT	NT	NT	CL	CLAYSTONE - (LEAN CLAY)	7.25	752	73	3	74	NT	NT	2.5-9.0	49	94	6	0	2.5	9.5	Refusal	Clst
TP-19	0.0 - 8.0	6.0	19	41	64	74	100	22	13	9	(SC)g	CLAYEY SAND with GRAVEL	8.54	928	210	2	420	NT	NT	NT	NT	19	55	26	10.0	14.0	Reach	Clst
TP-20	0.0 - 8.5	3.8	28	61	86	94	100	23	18	5	SC-SM	SILTY, CLAYEY SAND	8.41	1,856	29	< 1	66	5.0	106.2	NT	NT	28	66	6	9.5	12.0	Reach	Clst
TP-21	3.0 - 5.0	2.0	5	17	45	62	100	NT	NT	NT	(SW-SC)g	WELL-GRADED SAND with CLAY and GRAVEL *	9.70	3,526	96	3	67	3.0	127.2	NT	NT	5	57	38				
TP-21	8.5 - 14.0	13.6	68	97	100	100	100	42	24	18	s(CL)	CLAYSTONE - (SANDY LEAN CLAY)	8.83	2,877	14	< 1	46	NT	NT	NT	NT	68	32	0	8.5	14.0	Reach	Clst
TP-22	7.0 - 14.0	12.2	12	25	43	57	100	NT	NT	NT	(SW-SC)g	WELL-GRADED SAND with CLAY and GRAVEL *	10.16	780	NT	NT	NT	4.0	120.9	NT	NT	12	45	43	NE	14.0	Reach	Qal
TP-23	0.0 - 4.0	2.6	31	89	98	99	100	NP	NP	NP	SM	SILTY SAND	9.29	2,227	22	2	26	4.0	100.1	NT	NT	31	68	1				
TP-23	6.0 - 8.0	9.0	18	45	75	85	100	22	13	9	(SC)g	CLAYEY SAND with GRAVEL	9.83	1,949	12	3	17	NT	NT	NT	NT	18	67	15	NE	14.0	Reach	Qal
TP-24	4.0-10.0	2.4	7	27	49	58	100	NT	NT	NT	(SP-SM)g	POORLY GRADED SAND with SILT and GRAVEL	9.11	1,578	80	2	34	3.5	123.7	NT	NT	7	51	42	NE	15.0	Reach	Qal
TP-25	8.0 - 12.0	2.8	12	66	85	89	100	NT	NT	NT	SC-SM	SILTY, CLAYEY SAND	7.31	4,640	7	< 1	17	NT	NT	NT	NT	12	77	11	NE	12.0	Reach	Qal
TP-26	3.5 - 10.5	8.9	12	57	97	98	100	NT	NT	NT	SC-SM	SILTY, CLAYEY SAND	8.80	1,578	7	5	22	NT	NT	NT	NT	12	86	2	3.5	10.5	Refusal	Ss
TP-27	0.0 - 5.0	11.5	10	54	83	92	100	NT	NT	NT	SP-SM	POORLY GRADED SAND with SILT *	9.70	2,042	33	< 1	33	NT	NT	NT	NT	10	82	8	NE	6.0	Water	Qal
TP-28	0.0 - 14.0	5.5	15	42	66	75	100	NT	NT	NT	(SM)g	SILTY SAND with GRAVEL *	8.71	510	28	2	28	NT	NT	NT	NT	15	60	25	NE	13.5	Reach	Qal
TP-29	0.5 - 10.0	8.9	73	90	94	95	100	38	18	20	(CL)s	CLAYSTONE - (LEAN CLAY with SAND)	8.85	2,970	210	< 1	2,400	3.0	115.5	NT	NT	73	22	5	0.5	10.0	Refusal	Clst
TP-30	2.3 - 14.0	24.2	78	92	99	100	100	22	14	8	(CL)s	LEAN CLAY with SAND	7.84	408	86	< 1	180	NT	NT	2.3-14.0	129	78	22	0	2.3	14.0	Reach	Clst
TP-31	1.8 - 3.0	4.5	29	73	95	97	100	35	19	16	SC	CLAYEY SAND	8.90	371	1,800	4	268	4.0	116.8	NT	NT	29	68	3	1.0	5.0	Refusal	Ss
TP-32	0.0 - 13.5	3.2	13	33	70	81	100	NT	NT	NT	(SM)g	SILTY SAND with GRAVEL *	8.91	1,670	NT	NT	NT	NT	NT	NT	NT	13	68	19	NE	14.0	Reach	Qal
TP-33	0.0 - 3.0	2.8	23	58	87	93	100	24	19	5	SC-SM	SILTY, CLAYEY SAND	8.91	1,021	180	6	49	NT	NT	NT	NT	23	70	7	3.0	5.5	Refusal	Ss
TP-34	1.5 - 13.0	11.9	76	92	98	99	100	42	23	19	(CL)s	CLAYSTONE - (LEAN CLAY with SAND)	7.40	436	3,500	< 1	53	NT	NT	NT	NT	76	23	1	1.5	13.0	Reach	Clst
TP-35	0.0 - 4.5	4.3	35	64	84	92	100	28	11	17	SC	CLAYEY SAND	8.86	780	450	6	17	4.5	113.1	NT	NT	35	57	8	6.0	9.5	Refusal	Clst

TABULATION OF LABORATORY TEST DATA

TEST PIT NUMBER	SAMPLE INTERVAL (ft)	NATURAL WATER CONTENT (Percent of Dry Weight)	PARTICLE SIZE DISTRIBUTION (Percent Finer)					ATTERBERG LIMITS			UNIFIED SOIL CLASSIFICATION SYMBOL	UNIFIED SOIL CLASSIFICATION	pH	RESISTIVITY (Ohm-Centimeters)	SULFATES (SO_4) (ppm)	SULFIDE (ppm)	CHLORIDE (CL) (ppm)	FIELD DENSITY (sand cone method)		EXPANSION INDEX (measured) (EIM)		% FINES	% SAND	% GRAVEL	DEPTH TO ROCK	REFUSAL DEPTH	REASON FOR TERMINATION	Material
			#200 SIEVE	#40 SIEVE	#10 SIEVE	#4 SIEVE	3 INCH SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX								DEPTH (ft)	lb/ft3	DEPTH (ft)								
TP-36	7.0 - 13.5	6.1	28	64	86	93	100	33	14	19	SC	CLAYEY SAND	8.48	742	2,100	< 1	37	NT	NT	NT	NT	28	65	7	NE	13.5	Reach	Qal
TP-37	1.0 - 4.5	3.6	23	75	94	98	100	33	25	8	SM	SILTY SAND	8.00	742	1,300	< 1	28	4.5	113.2	NT	NT	23	75	2	4.5	10.5	Refusal	Ss
TP-38	1.0 - 4.0	8.2	28	85	99	99	100	NP	NP	NP	SM	SILTY SAND	7.73	1,485	2,100	2	240	NT	NT	NT	NT	28	71	1	1.0	4.0	Refusal	Ss
TP-39	0.0 - 3.5	4.3	25	65	88	94	100	27	16	11	SC	CLAYEY SAND	7.89	195	450	< 1	260	NT	NT	NT	NT	25	69	6	3.5	7.5	Refusal	Ss
TP-40	0.0 - 5.0	18.6	74	89	97	98	100	59	19	40	(CH)s	FAT CLAY with SAND	8.85	436	3,800	< 1	2,300	4.0	72.9	0.0-5.0	137	74	24	2	5.5	13.0	Refusal	Clst
TP-41	3.0 - 8.0	14.7	91	98	100	100	100	NT	NT	NT	CH	CLAYSTONE - (FAT CLAY)	7.09	752	3,900	< 1	720	NT	NT	3.0-8.0	117	91	9	0	8.0	12.0	Refusal	Clst
TP-42	7.0 - 14.5	5.9	47	87	93	96	100	28	18	10	SC	CLAYEY SAND	9.11	1,392	36	9	38	5.0	93.5	NT	NT	47	49	4	NE	14.5	Reach	Qal
TP-43	0.0 - 6.0	5.0	42	92	98	99	100	25	18	7	SC-SM	SILTY, CLAYEY SAND	8.95	566	97	2	200	NT	NT	NT	NT	42	57	1	6.0	13.0	Refusal	Clst
TP-44	0.8 - 8.5	7.2	42	89	98	99	100	24	19	5	SC-SM	CLAYSTONE - (SILTY, CLAYEY SAND)	9.44	742	110	2	700	NT	NT	NT	NT	42	57	1	0.8	8.5	Refusal	Clst
TP-45	4.5 - 13.4	12.2	72	96	100	100	100	NT	NT	NT	(CL)s	CLAYSTONE - (LEAN CLAY with SAND)	8.22	306	75	3	450	NT	NT	NT	NT	72	28	0	1.0	13.4	Reach	Clst
TP-46	0.0 - 8.0	7.9	54	74	78	82	100	41	26	15	s(ML)g	CLAYSTONE - (SANDY SILT with GRAVEL)	8.35	807	1,500	< 1	620	NT	NT	0.0-8.0	40	54	28	18	0.0	8.0	Refusal	Clst
TP-47	0.0 - 8.0	2.4	15	70	90	94	100	NT	NT	NT	SM	SILTY SAND *	9.42	733	300	< 1	83	NT	NT	NT	NT	15	79	6	8.0	13.5	Reach	Clst
TP-48	1.8 - 7.5	10.0	51	88	96	97	100	NT	NT	NT	s(CL)	CLAYSTONE - (SANDY LEAN CLAY)	8.15	1,021	2,100	< 1	390	NT	NT	1.8-7.5	20	51	46	3	1.8	7.5	Refusal	Clst
TP-49	0.0 - 3.2	1.1	9	97	100	100	100	NT	NT	NT	SP-SM	POORLY GRADED SAND with SILT *	8.90	6,125	3	< 1	7	NT	NT	NT	NT	9	91	0	3.2	7.0	Refusal	Ss
TP-50	0.0 - 5.0	1.4	13	94	100	100	100	NT	NT	NT	SM	SILTY SAND *	8.34	8,816	2	< 1	7	NT	NT	NT	NT	13	87	0	5.0	5.0	Refusal	Ss
TP-51	4.5 - 6.5	13.5	61	97	100	100	100	33	15	18	s(CL)	SANDY LEAN CLAY	8.84	817	100	< 1	143	NT	NT	NT	NT	61	39	0	10.4	13.0	Refusal	Ss
TP-52	2.0 - 8.0	0.6	4	97	99	100	100	NT	NT	NT	SP	POORLY GRADED SAND	8.82	9,187	6	< 1	8	NT	NT	NT	NT	4	96	0	3.8	7.0	Refusal	Ss
TP-53	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NOT TESTED	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	3.5	8.0	Refusal	Ss
TP-54	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NOT TESTED	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	2.4	6.5	Refusal	Ss
TP-55	5.0 - 14.5	1.1	3	90	94	96	100	NT	NT	NT	SP	POORLY GRADED SAND	9.09	2,877	23	< 1	36	NT	NT	NT	NT	3	93	4	NE	14.5	Reach	Qe
TP-56	2.7 - 15.0	1.1	7	92	100	100	100	NT	NT	NT	SP-SM	POORLY GRADED SAND with SILT *	8.39	2,320	38	< 1	55	NT	NT	NT	NT	7	93	0	NE	15.0	Reach	Qe
TP-57	0.0 - 10.0	1.4	6	92	100	100	100	NT	NT	NT	SP-SM	POORLY GRADED SAND with SILT *	8.84	13,920	1	< 1	7	NT	NT	NT	NT	6	94	0	10.0	10.0	Refusal	Ss
TP-58	0.0 - 13.0	0.5	4	89	100	100	100	NT	NT	NT	SP	POORLY GRADED SAND	9.20	16,704	4	< 1	11	4.5	101.6	NT	NT	4	96	0	NE	13.0	Reach	Qe
TP-59	0.0 - 5.5	0.7	12	79	100	100	100	NT	NT	NT	SM	SILTY SAND *	8.00	12,992	1	< 1	7	NT	NT	NT	NT	12	88	0	5.5	5.5	Refusal	Ss
TP-60	0.0 - 6.5	0.4	4	86	100	100	100	NT	NT	NT	SP	POORLY GRADED SAND	9.13	16,704	3	< 1	7	NT	NT	NT	NT	4	96	0	6.5	6.5	Refusal	Ss
TP-61	0.0 - 3.5	0.6	7	53	98	98	100	NT	NT	NT	SP-SM	POORLY GRADED SAND with SILT *	8.92	13,920	3	< 1	7	NT	NT	NT	NT	7	91	2	3.5	7.0	Refusal	Ss
TP-62	0.0 - 5.5	0.4	6	81	100	100	100	NT	NT	NT	SP-SM	POORLY GRADED SAND with SILT *	7.88	12,992	1	2	14	5.5	112.0	NT	NT	6	94	0	5.5	6.5	Refusal	Ss
TP-63	0.0 - 5.0	0.8	7	86	99	100	100	NT	NT	NT	SP-SM	POORLY GRADED SAND with SILT *	8.57	8,909	5	2	14	4.5	104.3	NT	NT	7	93	0	5.0	10.0	Refusal	Ss
TP-67	0.0 - 7.0	0.5	6	79	100	100	100	NT	NT	NT	SP-SM	POORLY GRADED SAND with SILT *	8.00	9,094	4	< 1	8	NT	NT	NT	NT	6	94	0	7.0	9.0	Refusal	Ss
TP-68	0.0 - 3.3	1.2	9	91	99	100	100	NT	NT	NT	SP-SM	POORLY GRADED SAND with SILT *	8.64	7,424	1	< 1	7	NT	NT	NT	NT	9	91	0	3.3	5.5	Refusal	Ss

*Descriptor based on plasticity of field specimen.

NT = Not Tested

NP = Nonplastic

NE = Not Encountered

Summary of Test Pits

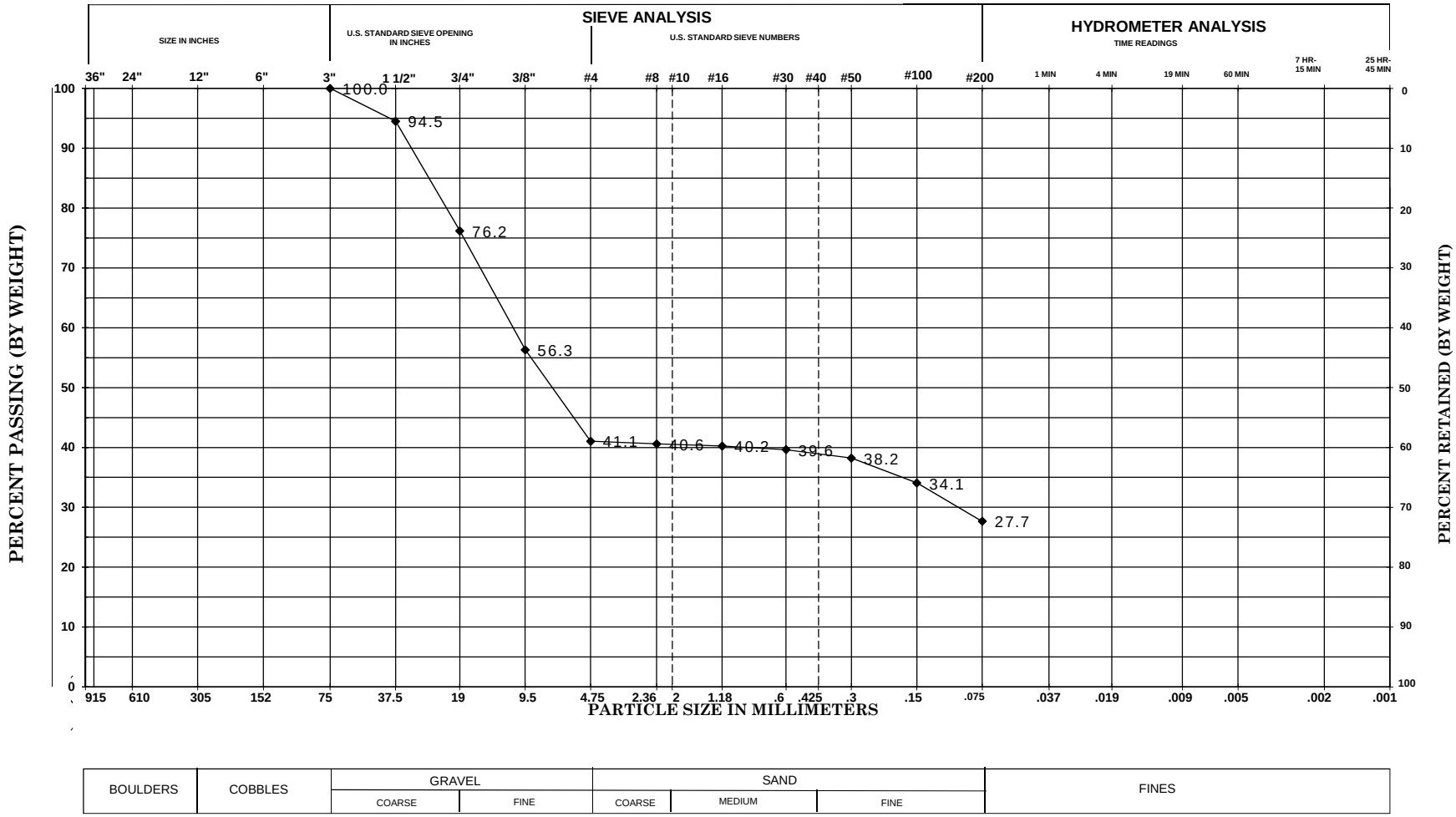
NCAWSFS - Tuba City

May, 2013

Date Sampled	Location	Depth	Unified Soil Classification		% Gravel	% Sand	% Fines	Max. Size	C_U	C_C	Moisture Content	In-place Dry Density (lbm/ft³)	Lab. Max Dry Density (lbm/ft³)	Optimum Moisture Content %	Liquid Limit	Plasticity Index
05/07/13	TP-69	0'-4.5'	GP	Poorly Graded Gravel	59	13	28	5"	-	-	-	-	-	-	-	-
05/07/13	TP-69	clay stone	CL	Lean Clay with Sand	0	31	69	No.4	-	-	-	-	-	-	31.0	14.4
05/07/13	TP-70	10'-12'	SP-SM	Poorly Graded Sand with Silt	0	91	9	No.8	2.3	0.8	1.2	-	102.1	15.3	-	NP
05/07/13	TP-71	0'-9'	SM	Silty Sand	9	69	22	1.5"	23.8	5.5	1.9	108.7	121.4	10.8	-	NP
05/07/13	TP-72		SM	Silty Sand	0	87	13	No.4	4.0	1.2	1.3	102.6	106.1	13.5	-	NP
05/07/13	TP-75	0'-4.8'	SM	Silty Sand	0	68	32	No.4	-	-	2.7	-	-	-	-	NP
05/07/13	TP-76	0'-6'	SM	Silty Sand	0	69	31	No.8	6.5	2.3	3.1	-	114.1	11.0	-	NP
05/08/13	TP-77	0'-5.5'	SM	Silty Sand	0	85	15	No.8	4.2	1.2	2.2	-	118.5	11.3	20.6	2.3
05/08/13	TP-78	0'-6'	SM	Silty Sand	0	69	31	No.4	-	-	4.1	-	122.2	10.0	18.4	2.4
05/08/13	TP-79	5'	SM	Silty Sand	0	88	12	No.4	2.9	1.2	1.5	107.8	107.2	13.9	-	NP
05/08/13	TP-80	0'-6'	SM	Silty Sand	0	78	22	No.8	3.1	1.5	1.9	108.7	106.6	13.2	-	NP
05/08/13	TP-81	0'-6'	SP-SM	Poorly Graded Sand with Silt	0	95	5	No.16	2.5	1.3	1.0	99.4	105.4	14.9	-	NP

NCAWSFS Tuba City TP - 69 Soil As Excavated 0' to 4.5' 05/07/13

GRAIN SIZE DISTRIBUTION



Unified Soil Classification: **GP Poorly Graded Gravel**

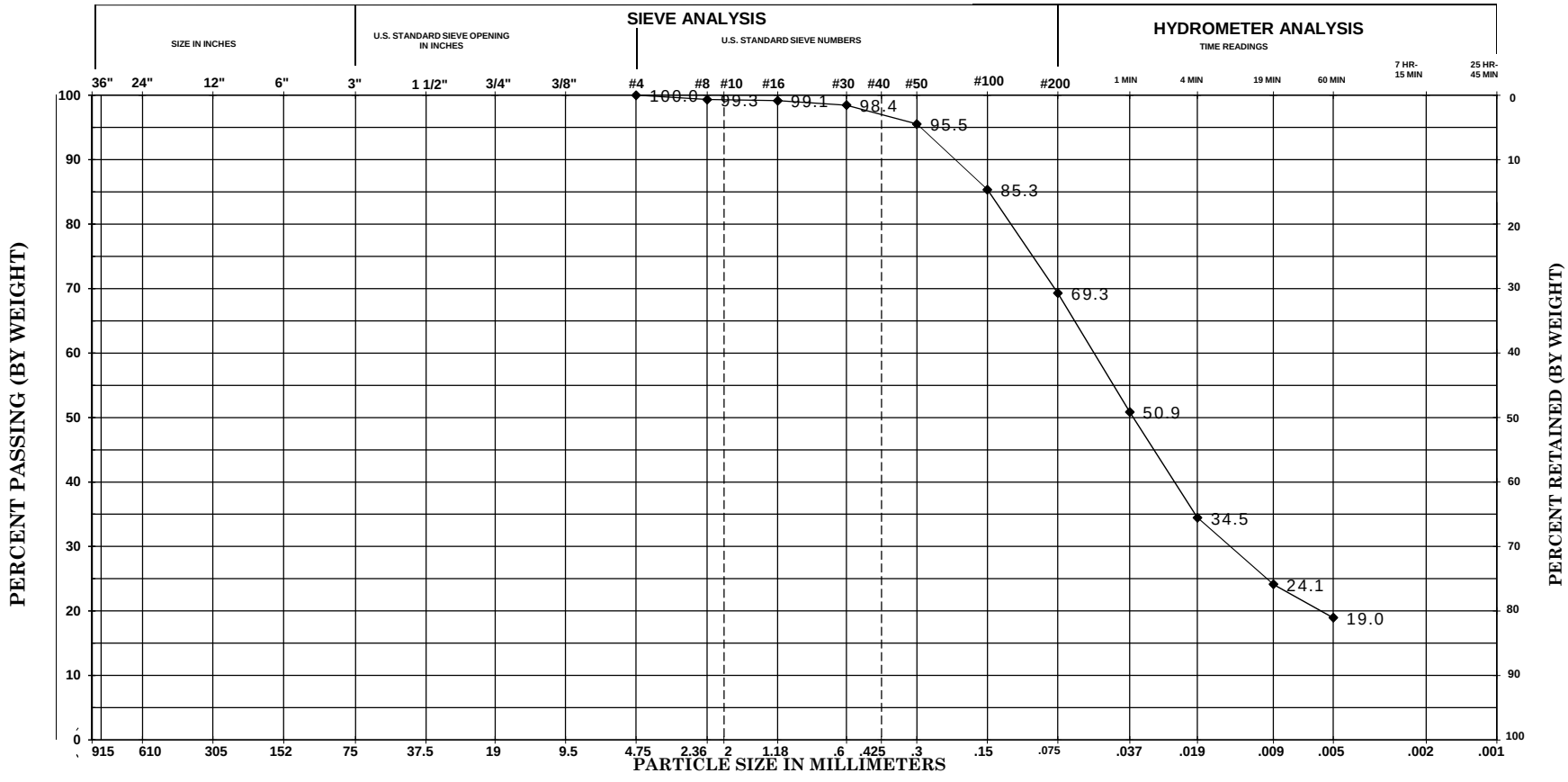
Sample Collected by: J. Fitzsimmons

58.9 % Gravel	Maximum Size: 5"	In-place Dry Density:	lbm/ft³	D_{50}:	7.131 mm 0.281 in
13.4 % Sand	Moisture Content:	Lab. Max Dry Density:	lbm/ft³	C_U:	
27.7 % Fines	Liquid Limit:	Optimum Moisture:	%	C_C:	
4.8 % Oversize	Plasticity Index:				

Note: The coarse material in this sample readily broke down on exposure to water. Resulting in a material that would be classified as CL Lean Clay.

NCAWSFS Tuba City TP - 69 Clay Stone After Water Exposure 0' to 4.5' 05/07/13

GRAIN SIZE DISTRIBUTION



Unified Soil Classification: **CL Lean Clay with Sand**

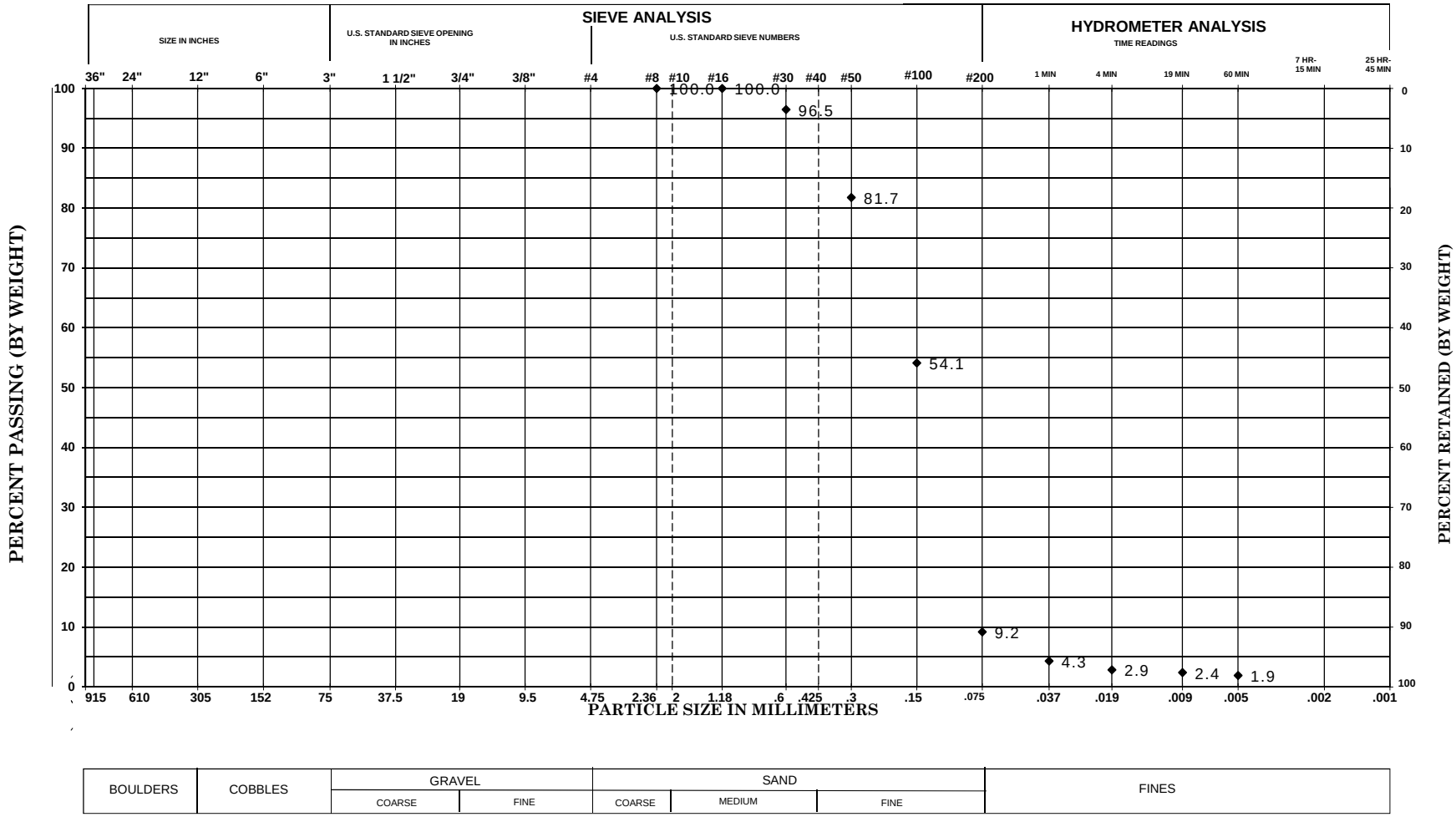
Sample Collected by: J. Fitzsimmons

0.0 % Gravel	Maximum Size: No. 4	In-place Dry Density:	-	lbm/ft³	D_{50}:	0.036 mm	0.001 in
30.7 % Sand	Moisture Content:	Lab. Max Dry Density:	-	lbm/ft³	C_U:		
69.3 % Fines	Liquid Limit: 31.0	Optimum Moisture:	-	%	C_C:		
% Oversize	Plasticity Index: 14.4						

Note: Sample of Clay Stone subjected to standard Hydrometer Analysis
Earth Maual USBR 5330, ASTM D-422

NCAWSFS Tuba City **TP - 70** **10' to 12'** **05/07/13**

GRAIN SIZE DISTRIBUTION



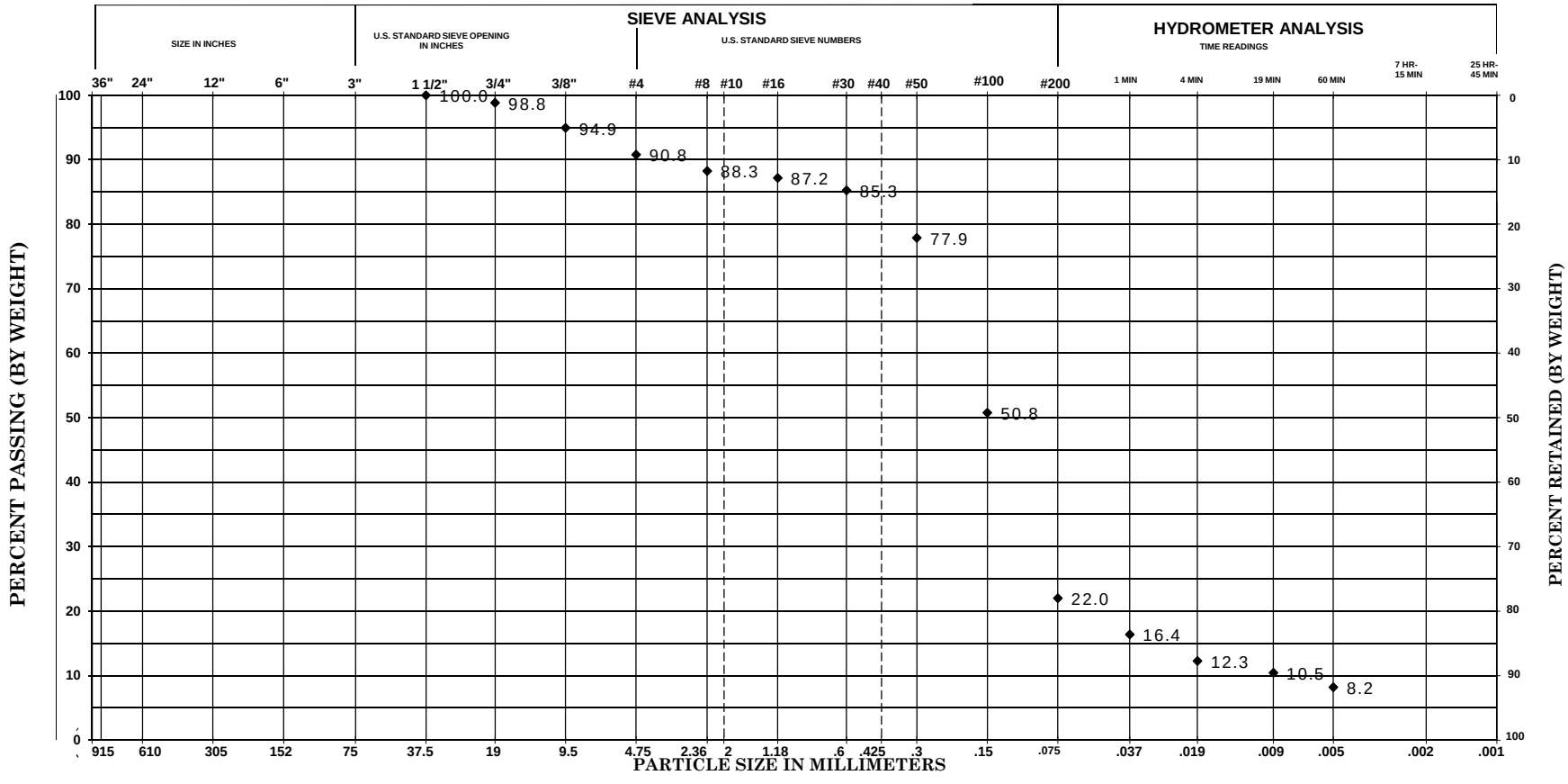
Unified Soil Classification: **SP-SM Poorly Graded Sand with Silt**

Sample Collected by: M. Miller

0.0 % Gravel	Maximum Size: No. 8	In-place Dry Density:	-	lbm/ft³	D_{50}:	0.141 mm	0.006 in
90.8 % Sand	Moisture Content: 1.2 %	Lab. Max Dry Density:	102.1	lbm/ft³	C_U:	2.3	
9.2 % Fines	Liquid Limit:	Optimum Moisture:	15.3	%	C_C:	0.8	
% Oversize	Plasticity Index: Nonplastic						

NCAWSFS Tuba City **TP - 71** **0' to 9'** **05/07/13**

GRAIN SIZE DISTRIBUTION



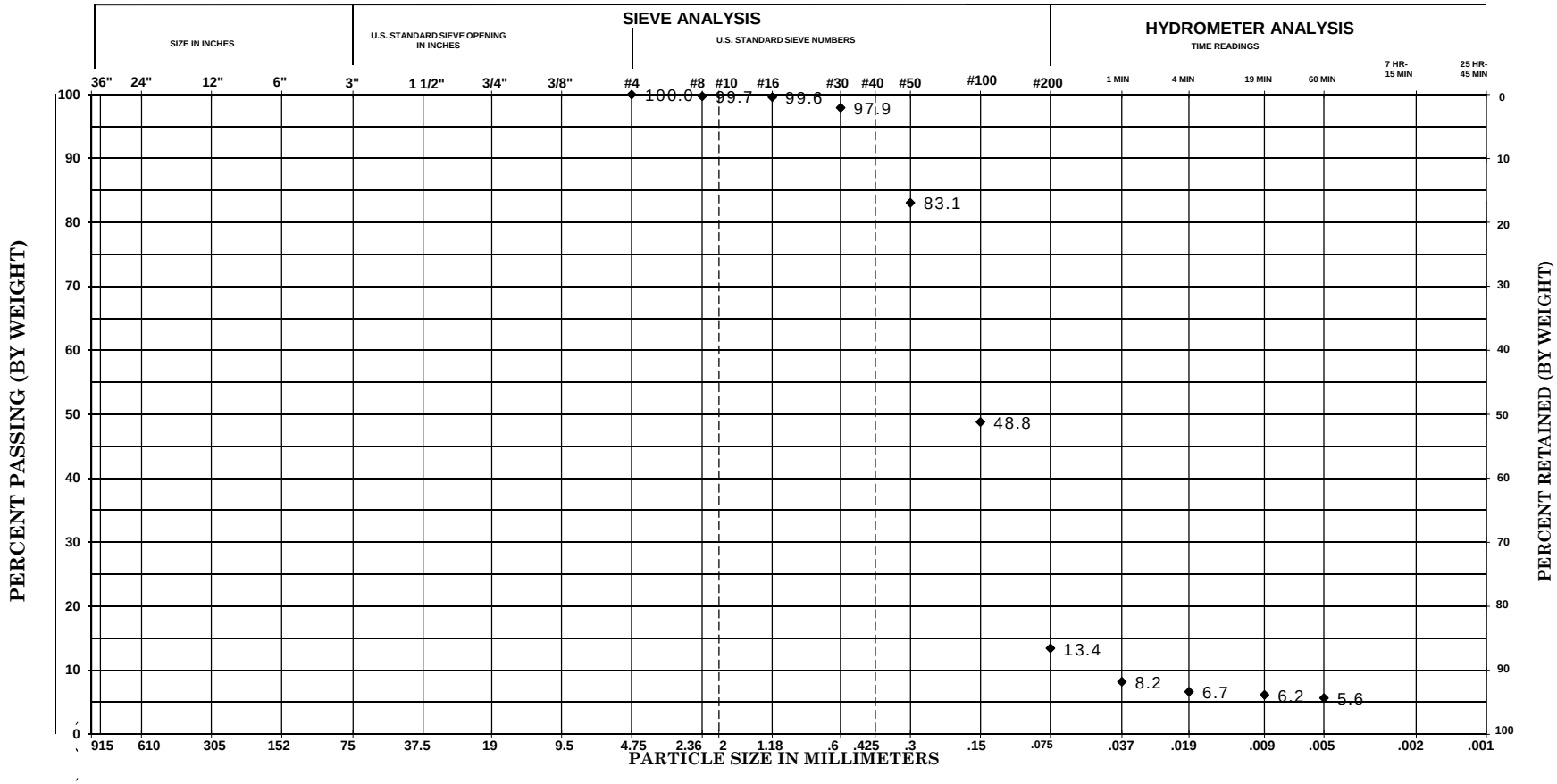
Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J. Fitzsimmons

9.2 % Gravel	Maximum Size: 1 1/2"	In-place Dry Density:	108.7	lbm/ft³	D_{50}:	0.147 mm	0.006 in
68.8 % Sand	Moisture Content: 1.9 %	Lab. Max Dry Density:	121.4	lbm/ft³	C_U:	23.8	
22.0 % Fines	Liquid Limit:	Optimum Moisture:	10.8	%	C_C:	5.5	
% Oversize	Plasticity Index: Nonplastic						

NCAWSFS Tuba City **TP - 72** **05/07/13**

GRAIN SIZE DISTRIBUTION



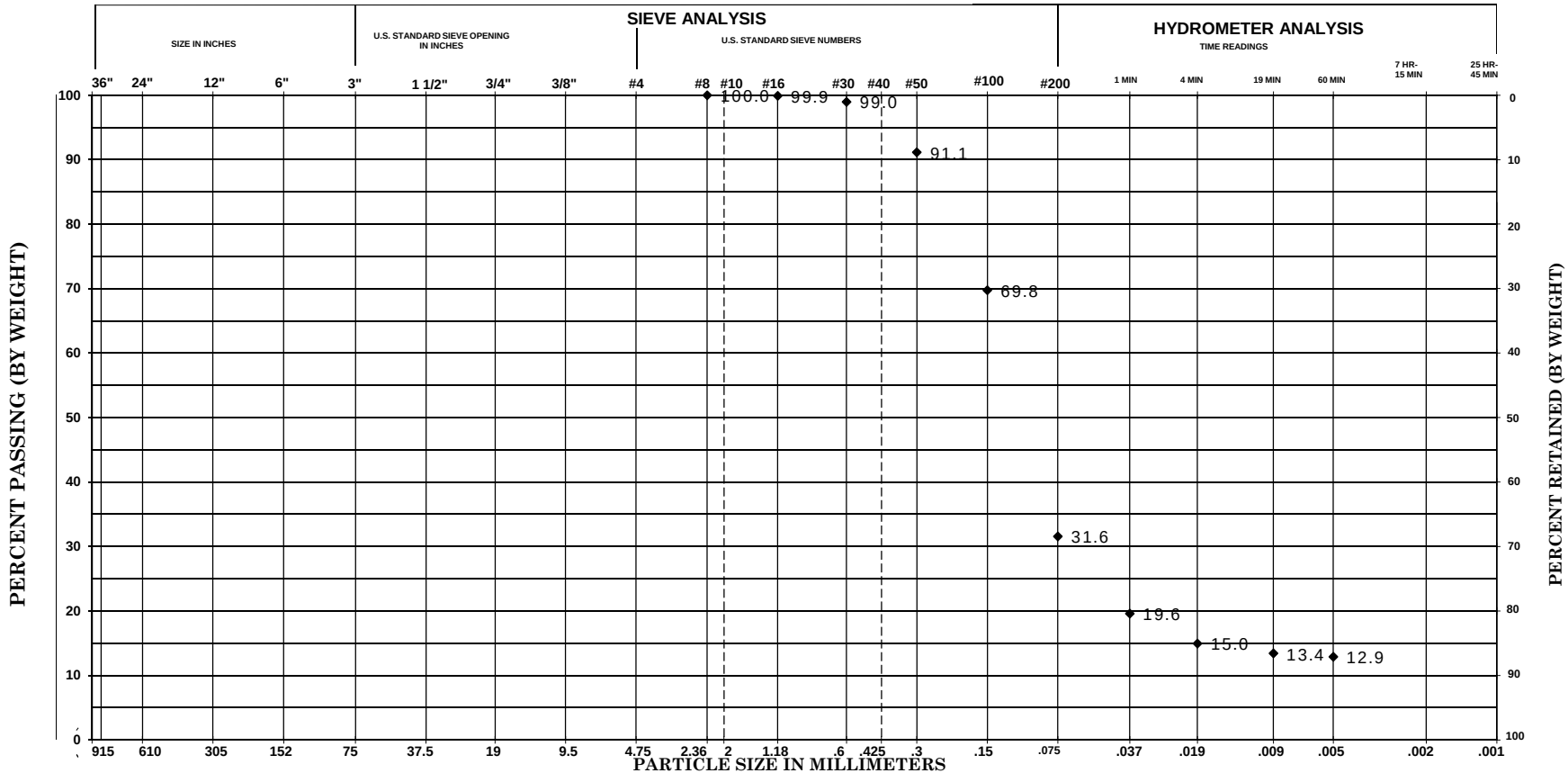
Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J. Fitzsimmons

0.0 % Gravel	Maximum Size: No. 4	In-place Dry Density:	102.6	lbm/ft³	D_{50}:	0.154 mm	0.006 in
86.6 % Sand	Moisture Content: 1.3 %	Lab. Max Dry Density:	106.1	lbm/ft³	C_U:	4.0	
13.4 % Fines	Liquid Limit:	Optimum Moisture:	13.5	%	C_C:	1.2	
% Oversize	Plasticity Index: Nonplastic						

NCAWSFS Tuba City **TP - 75** **0' to 4.8'** **05/07/13**

GRAIN SIZE DISTRIBUTION



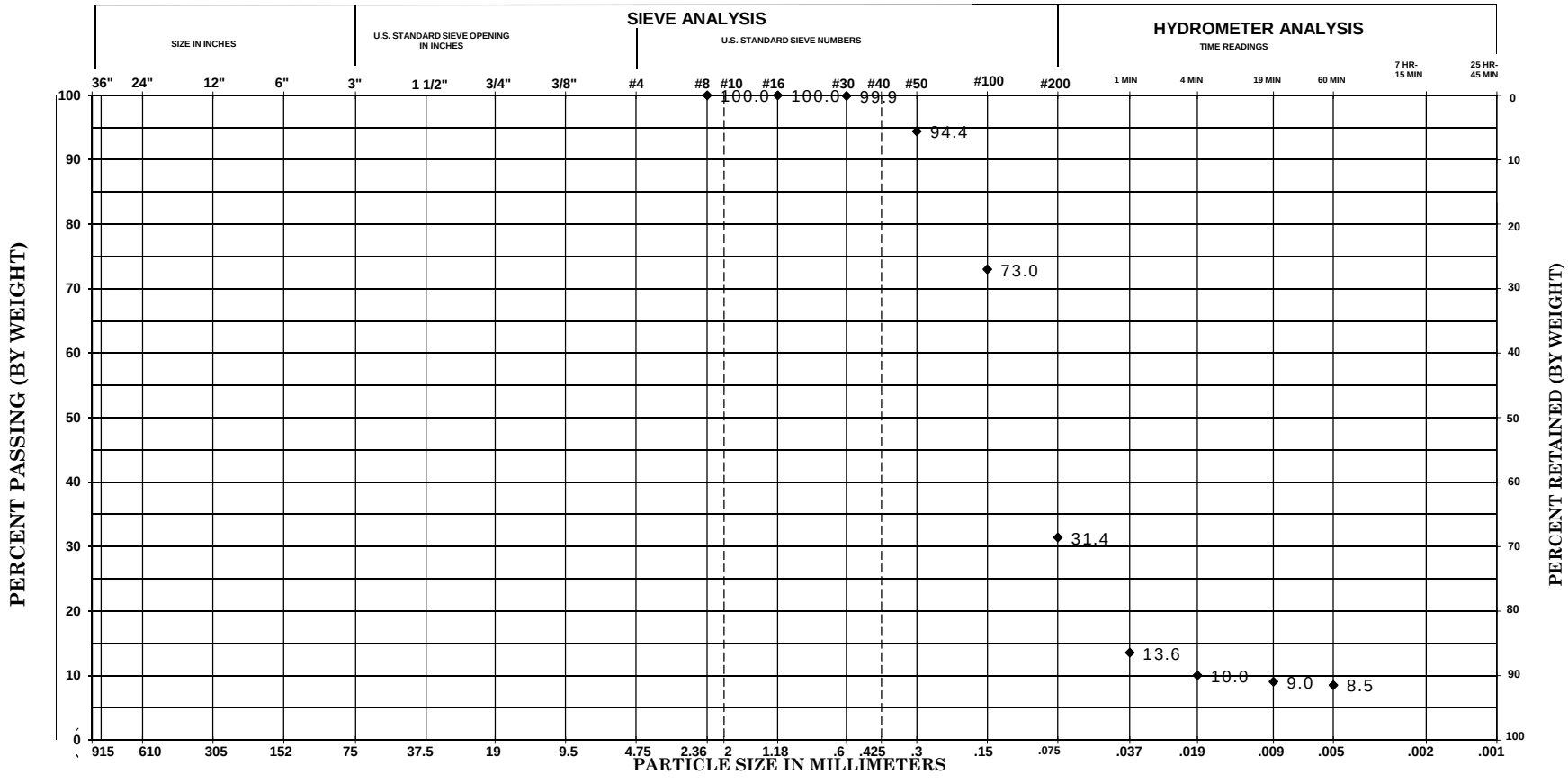
Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J. Fitzsimmons

0.0 % Gravel	Maximum Size: No. 4	In-place Dry Density:	lbm/ft³	D_{50}:	0.105 mm	0.004 in
68.4 % Sand	Moisture Content: 2.7 %	Lab. Max Dry Density:	lbm/ft³	C_U:		
31.6 % Fines	Liquid Limit:	Optimum Moisture:	%	C_C:		
% Oversize	Plasticity Index: Nonplastic					

NCAWSFS Tuba City **TP - 76** **0' to 6'** **05/07/13**

GRAIN SIZE DISTRIBUTION



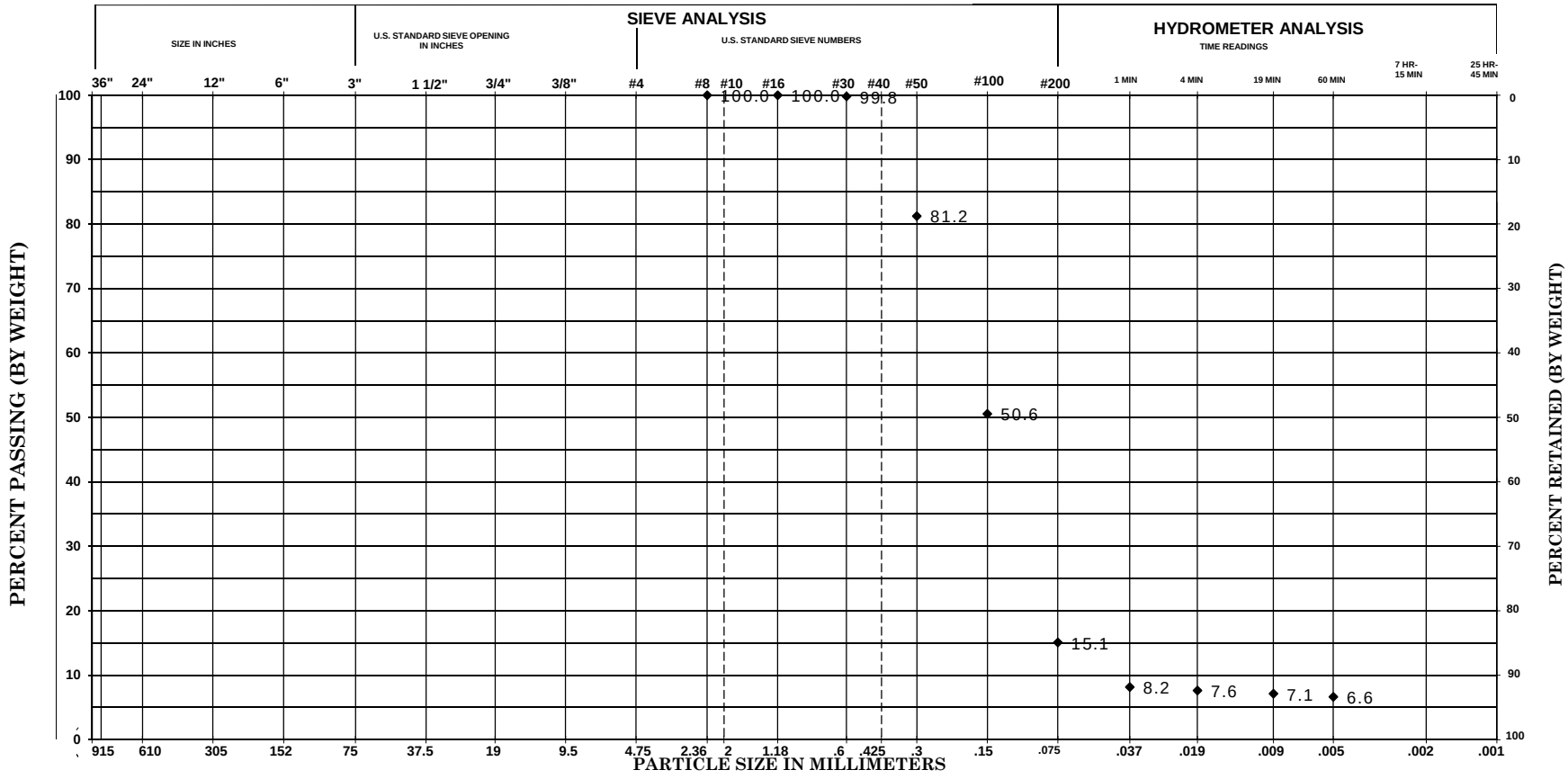
Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J. Fitzsimmons

0.0 % Gravel	Maximum Size: No. 8	In-place Dry Density:	-	lbm/ft³	D_{50}:	0.102 mm	0.004 in
68.6 % Sand	Moisture Content: 3.1 %	Lab. Max Dry Density:	114.1	lbm/ft³	C_U:	6.5	
31.4 % Fines	Liquid Limit:	Optimum Moisture:	11.0	%	C_C:	2.3	
% Oversize	Plasticity Index: Nonplastic						

NCAWSFS Tuba City **TP - 77** **0' to 5.5'** **05/08/13**

GRAIN SIZE DISTRIBUTION



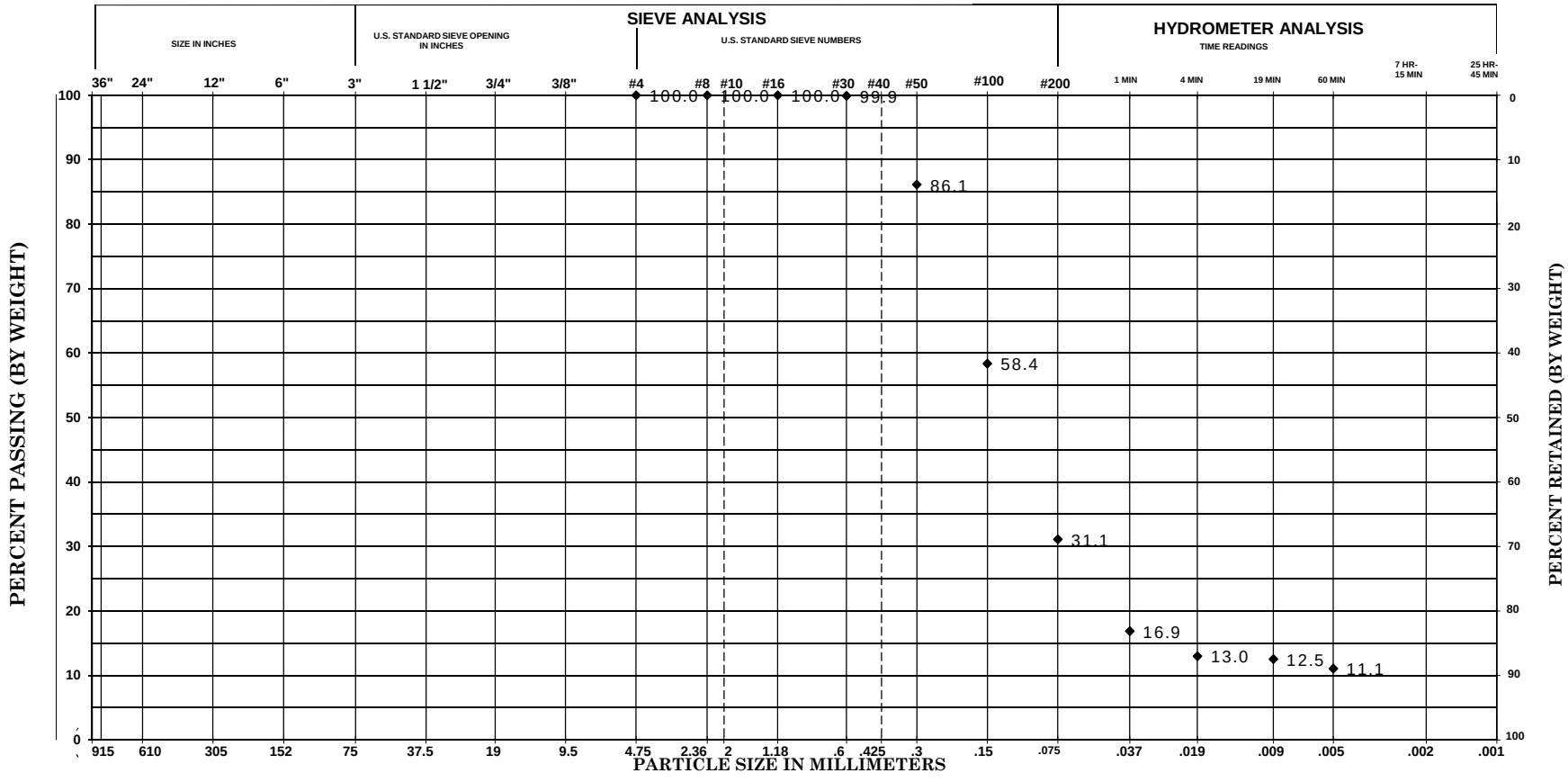
Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J. Fitzsimmons

0.0 % Gravel	Maximum Size: No. 8	In-place Dry Density:	-	lbm/ft³	D_{50}:	0.148 mm	0.006 in
84.9 % Sand	Moisture Content: 2.2 %	Lab. Max Dry Density:	118.5	lbm/ft³	C_U:	4.2	
15.1 % Fines	Liquid Limit: 20.6	Optimum Moisture:	11.3	%	C_C:	1.2	
% Oversize	Plasticity Index: 2.3						

NCAWSFS Tuba City **TP - 78** **0' to 6'** **05/08/13**

GRAIN SIZE DISTRIBUTION



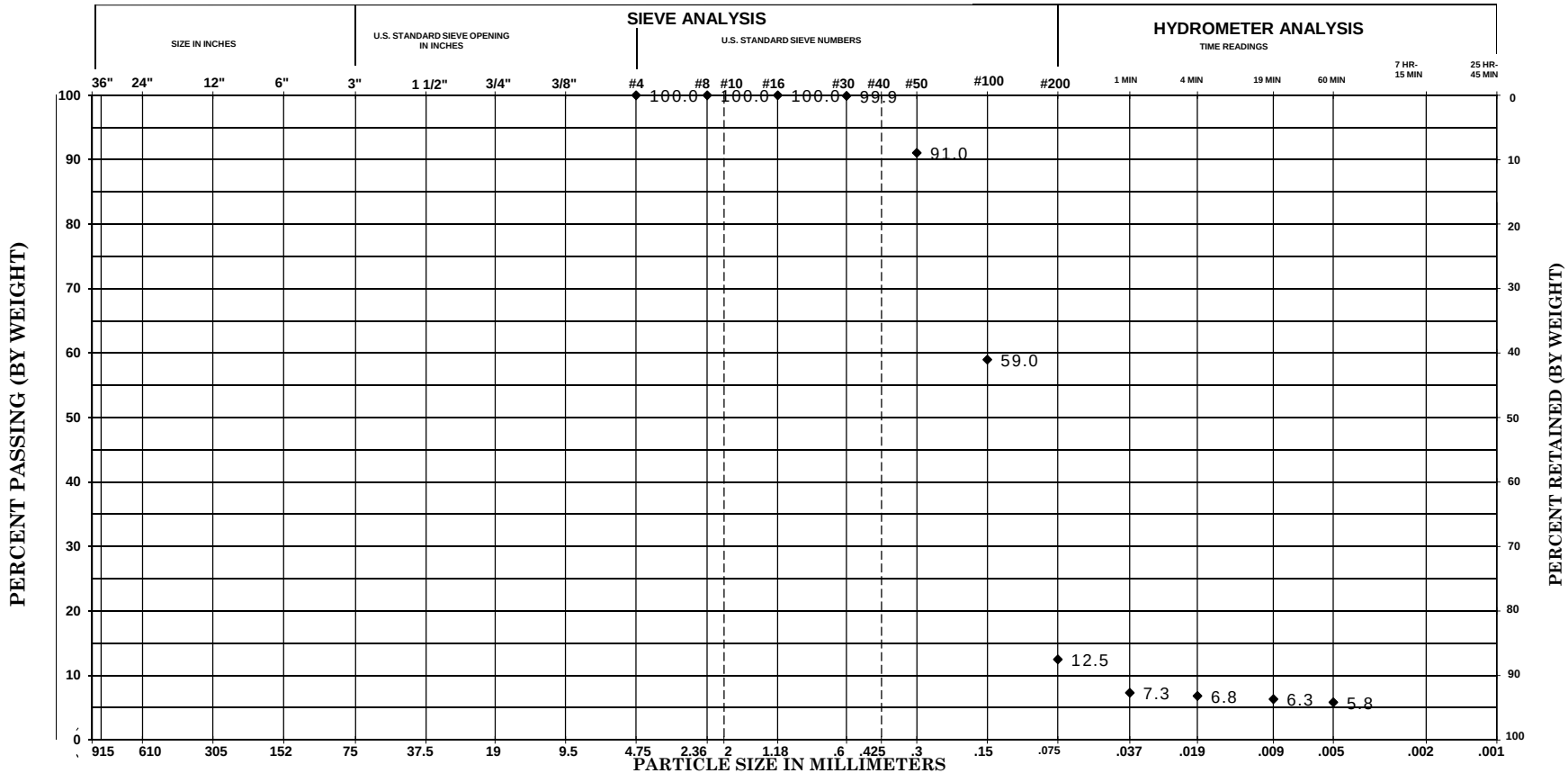
Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J. Fitzsimmons

0.0 % Gravel	Maximum Size: No. 4	In-place Dry Density:	-	lbm/ft³	D_{50}:	0.121 mm	0.005 in
68.9 % Sand	Moisture Content: 4.1 %	Lab. Max Dry Density:	122.3	lbm/ft³	C_U:		
31.1 % Fines	Liquid Limit: 18.4	Optimum Moisture:	10.0	%	C_C:		
% Oversize	Plasticity Index: 2.4						

NCAWSFS Tuba City **TP - 79** **5'** **05/08/13**

GRAIN SIZE DISTRIBUTION



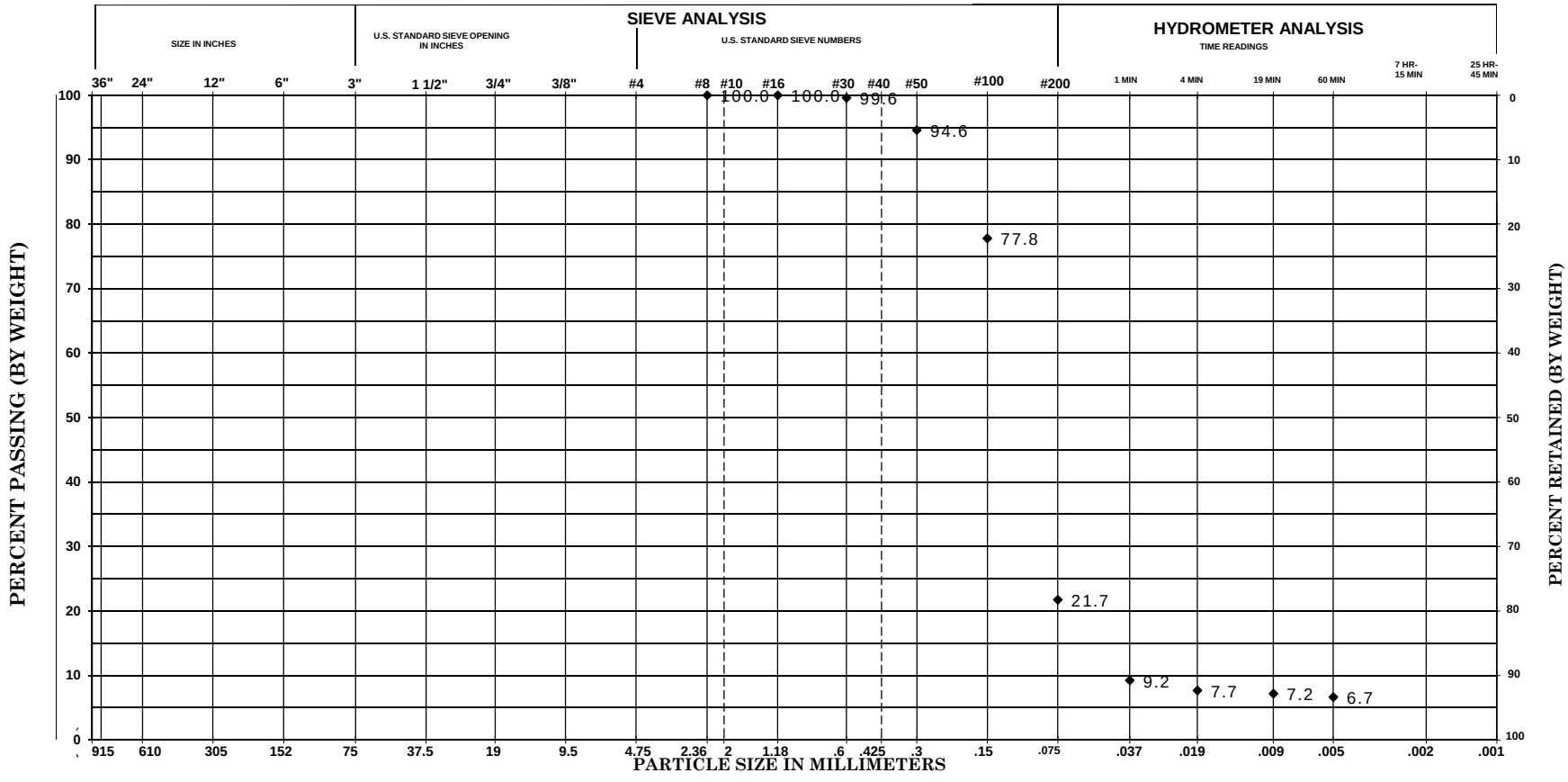
Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J. Fitzsimmons

0.0 % Gravel	Maximum Size: No. 4	In-place Dry Density:	107.8	lbm/ft³	D_{50}:	0.131 mm	0.005 in
87.5 % Sand	Moisture Content: 1.5 %	Lab. Max Dry Density:	107.2	lbm/ft³	C_U:	2.9	
12.5 % Fines	Liquid Limit:	Optimum Moisture:	13.9	%	C_C:	1.2	
% Oversize	Plasticity Index: Nonplastic						

NCAWSFS Tuba City **TP - 80** **0' to 6'** **05/08/13**

GRAIN SIZE DISTRIBUTION



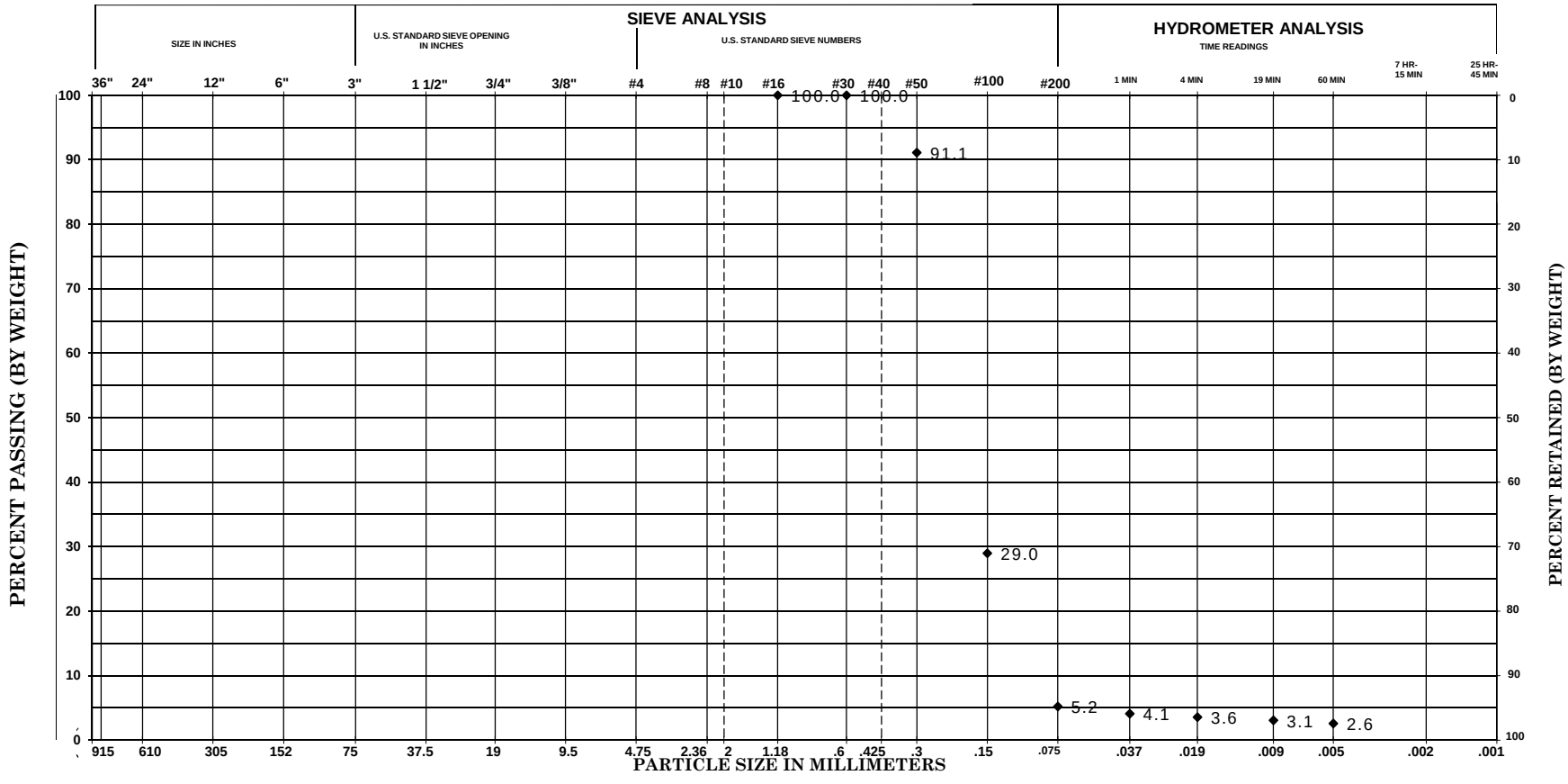
Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J. Fitzsimmons

0.0 % Gravel	Maximum Size: No. 8	In-place Dry Density:	108.7	lbm/ft³	D_{50}:	0.106 mm	0.004 in
78.3 % Sand	Moisture Content: 1.9	Lab. Max Dry Density:	106.6	lbm/ft³	C_U:	3.1	
21.7 % Fines	Liquid Limit:	Optimum Moisture:	13.2	%	C_C:	1.5	
% Oversize	Plasticity Index: Nonplastic						

NCAWSFS Tuba City **TP - 81** **0' to 6'** **05/08/13**

GRAIN SIZE DISTRIBUTION



Unified Soil Classification: **SP-SM Poorly Graded Sand with Silt**

Sample Collected by: J. Fitzsimmons

0.0 % Gravel	Maximum Size: No. 16	In-place Dry Density:	99.4	lbm/ft³	D_{50}:	0.19 mm	0.007 in
94.8 % Sand	Moisture Content: 1.0 %	Lab. Max Dry Density:	105.4	lbm/ft³	C_U:	2.5	
5.2 % Fines	Liquid Limit:	Optimum Moisture:	14.9	%	C_C:	1.3	
% Oversize	Plasticity Index: Nonplastic						

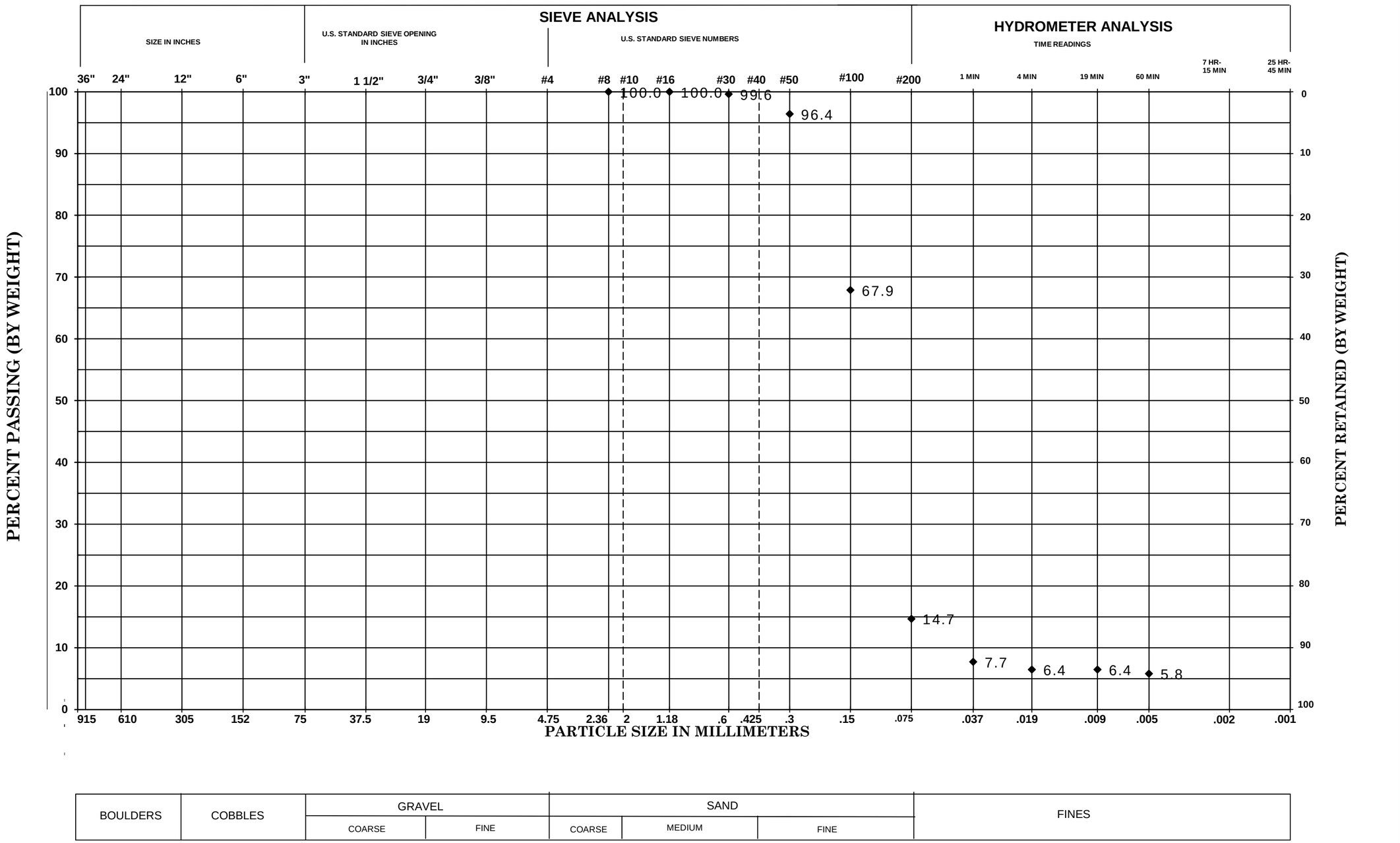
Summary of Test Pits

NCAWSFS - Test Pits (Tuba City)

April, 2016

Date Sampled	Location	Depth	Unified Soil Classification		% Gravel	% Sand	% Fines	Max. Size	C_U	C_C	Inplace Moisture Content %	In-place Dry Density (lbm/ft³)	Lab. Max Dry Density (lbm/ft³)	Optimum Moisture Content %	Liquid Limit	Plasticity Index
04/19/16	TP-201	0' to 5.5'	SM	Silty Sand	0	85	15	No. 8	2.9	1.3	1.9	98.5	109.3	13.2		NP
04/19/16	TP-202	0' to 3.5'	SP-SM	Poorly Graded Sand with Silt	Trace	94	6	1.5"	2.7	1.1	0.9	-	110.4	12.7		NP
04/19/16	TP-203	0' to 5.5'	SM	Silty Sand	Trace	79	21	1"	5.3	1.3	1.7	105.7	115.2	10.6		NP
04/19/16	TP-204	0' to 7'	SM	Silty Sand	2	81	17	1.5"	5.9	1.5	1.9	-	115.4	8.6		NP
04/19/16	TP-205	0' to 4.6'	SM	Silty Sand	0	85	15	No. 8	5.0	1.5	1.5	105.6	109.1	13.3		NP
04/19/16	TP-206	0' to 15'	SM	Silty Sand	0	78	22	No. 8	-	-	3.5	-	115.7	13.7		NP
04/19/16	TP-207	0' to 5.3'	SM	Silty Sand	0	67	33	No. 8	-	-	4.1	97.8	117.3	13.6		NP
04/19/16	TP-208	0' to 5'	SM	Silty Sand	1	78	21	1"	14.7	3.9	2.2	-	117.0	10.5		NP
04/20/16	TP-209	0' to 4.5'	SM	Silty Sand	Trace	77	23	1.5"	25.6	6.4	2.4	-	118.3	11.5		NP
04/20/16	TP-210	0' to 6'	SM	Silty Sand	0	81	19	No. 8	7.0	1.6	1.6	-	120.4	9.3		NP
04/20/16	TP-211	0' to3'	CL	Sandy Lean Clay	Trace	47	53	.75"	-	-	6.1	-	116.7	11.5	21.4	10.2
04/20/16	TP-212	0' to 2'	SM	Silty Sand	1	56	43	2"	-	-	4.2	-	119.6	12.1	19.6	3.9
04/20/16	TP-213	0' to 6'	CL	Sandy Lean Clay	0	47	53	No. 4	-	-	5.5	-	117.8	12.9	24.7	14.0

GRAIN SIZE DISTRIBUTION

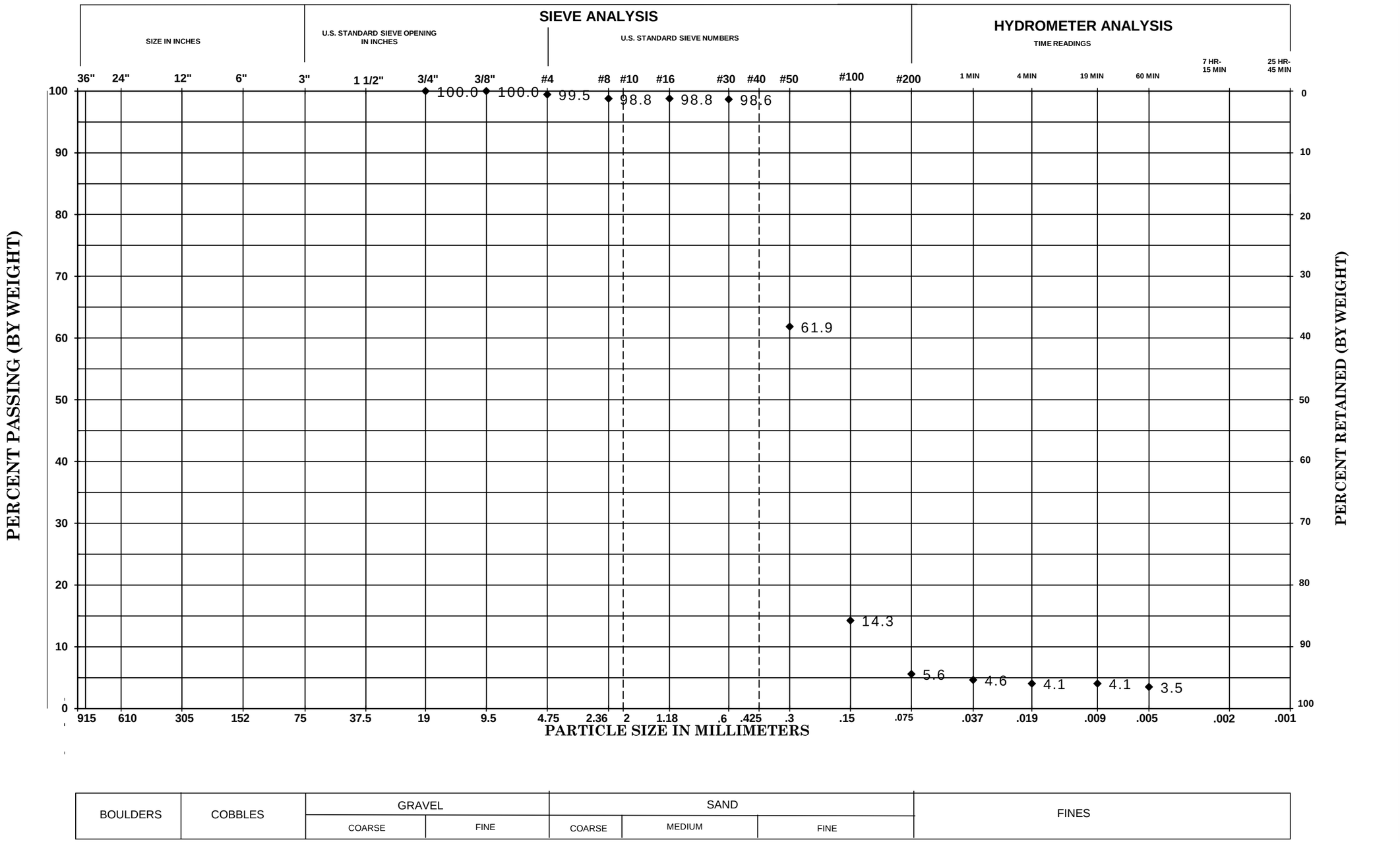


Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J.Fitzsimmons

0.0 % Gravel	Maximum Size: No. 8	Specific Gravity	D_{50}: 0.005 in
85.3 % Sand	Moisture Content: 1.9%	Plus No. 4:	C_U: 2.9
14.7 % Fines	Liquid Limit:	Minus No. 4:	C_C: 1.3
% Oversize	Plasticity Index: Nonplastic		

GRAIN SIZE DISTRIBUTION

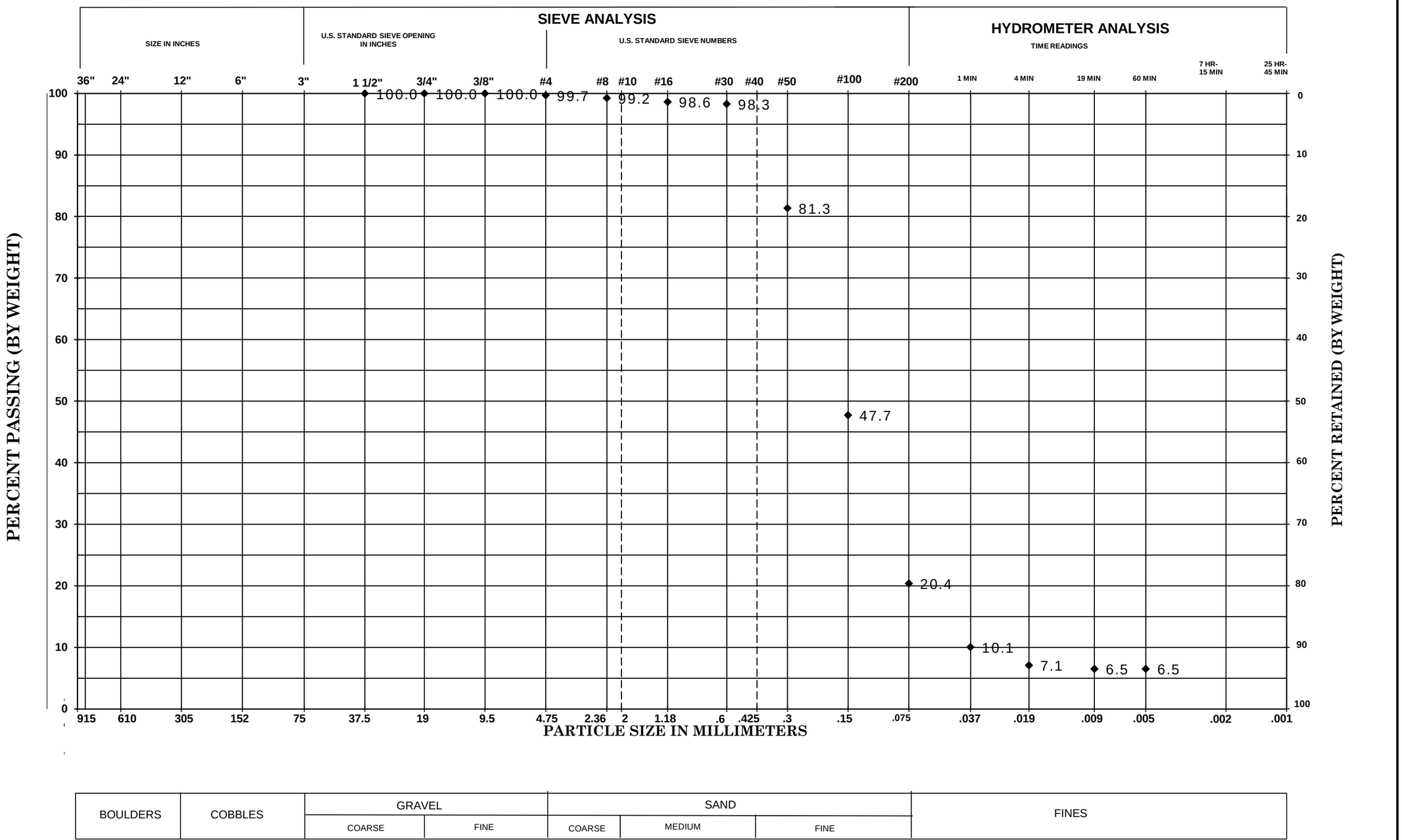


Unified Soil Classification: **SP-SM Poorly Graded Sand with Silt**

Sample Collected by: J.Fitzsimmons

0.5 % Gravel	Maximum Size: 1 1/2"	Specific Gravity	D_{50}: 0.010 in
93.9 % Sand	Moisture Content: 0.9%	Plus No. 4:	C_U: 2.7
5.6 % Fines	Liquid Limit:	Minus No. 4:	C_C: 1.1
% Oversize	Plasticity Index: Nonplastic		

GRAIN SIZE DISTRIBUTION

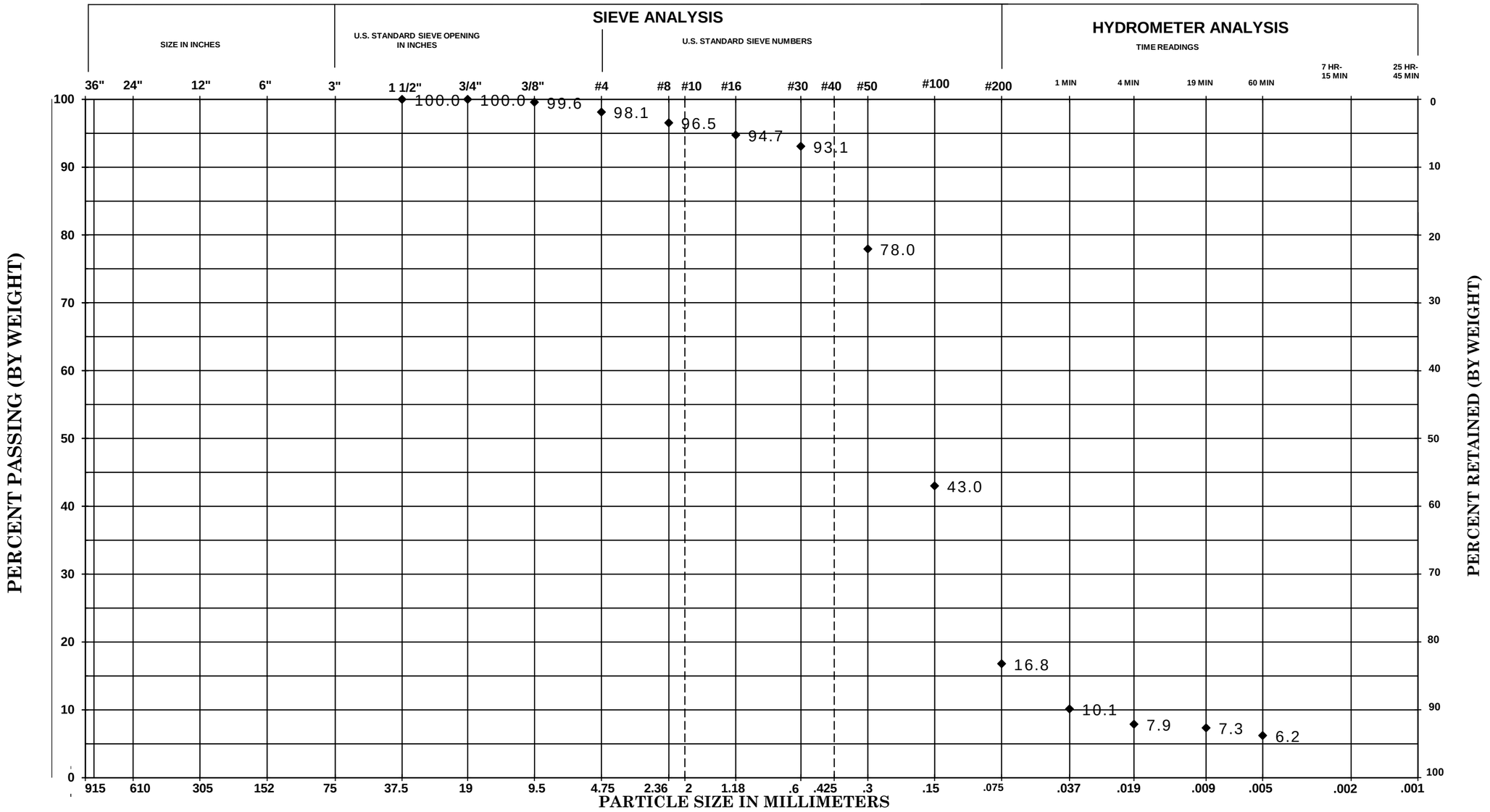


Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J.Fitzsimmons

Trace % Gravel	Maximum Size: 1"	Specific Gravity	D_{50}: 0.006 in
79.3 % Sand	Moisture Content: 1.7%	Plus No. 4:	C_U: 5.3
20.4 % Fines	Liquid Limit:	Minus No. 4:	C_C: 1.3
% Oversize	Plasticity Index: Nonplastic		

GRAIN SIZE DISTRIBUTION



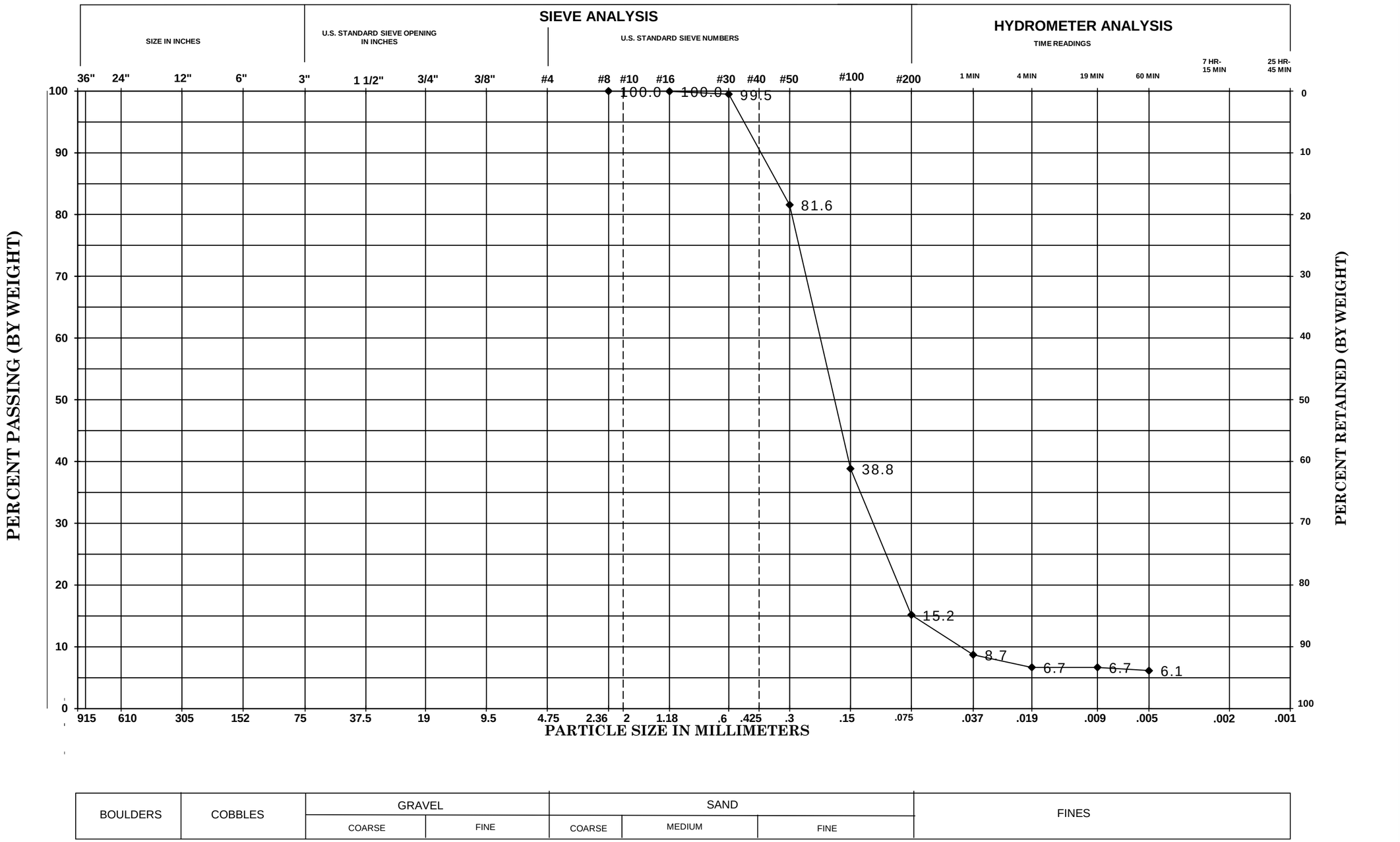
BOULDERS	COBBLES	GRAVEL		SAND			FINES
		COARSE	FINE	COARSE	MEDIUM	FINE	

Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J.Fitzsimmons

1.9 % Gravel	Maximum Size: 1 1/2"	Specific Gravity	D_{50}: 0.007 in
81.3 % Sand	Moisture Content: 1.9%	Plus No. 4:	C_U: 5.9
16.8 % Fines	Liquid Limit:	Minus No. 4:	C_C: 1.5
% Oversize	Plasticity Index: Nonplastic		

GRAIN SIZE DISTRIBUTION



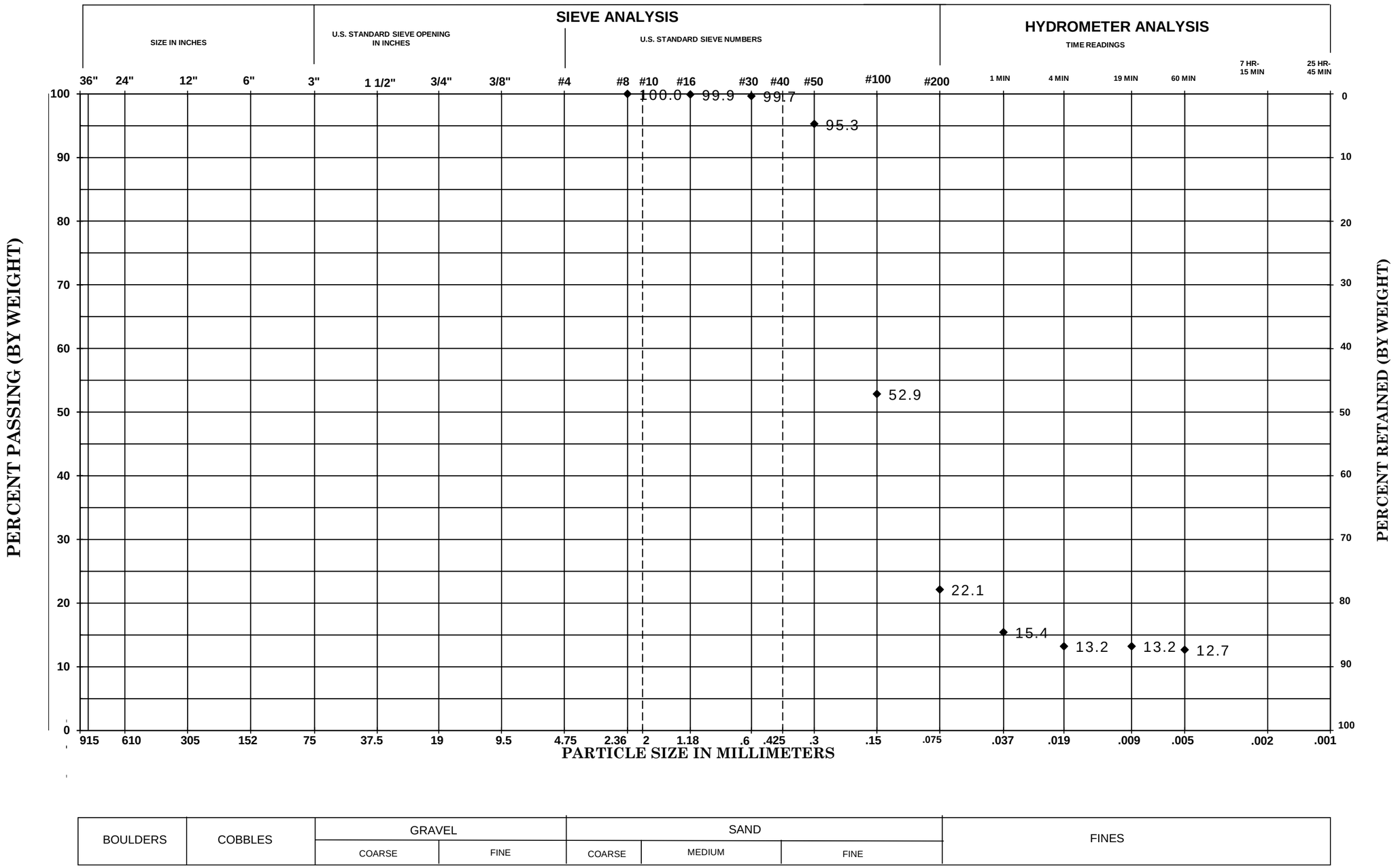
BOULDERS	COBBLES	GRAVEL		SAND			FINES
		COARSE	FINE	COARSE	MEDIUM	FINE	

Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J.Fitzsimmons

0.0 % Gravel	Maximum Size: No. 8	Specific Gravity	D_{50}: 0.007 in
84.8 % Sand	Moisture Content: 1.5%	Plus No. 4:	C_U: 5.0
15.2 % Fines	Liquid Limit:	Minus No. 4:	C_C: 1.5
% Oversize	Plasticity Index: Nonplastic		

GRAIN SIZE DISTRIBUTION



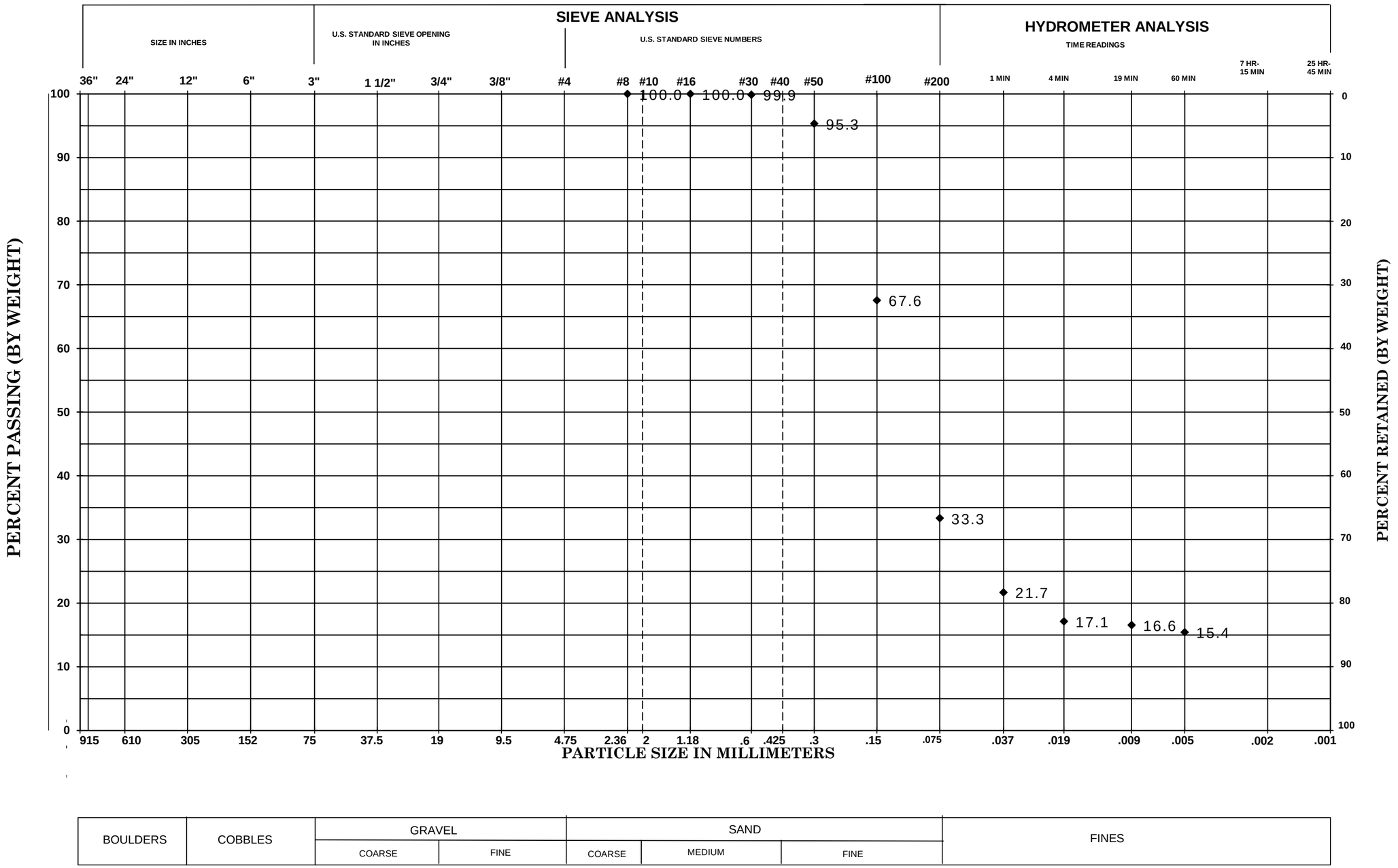
Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J.Fitzsimmons

0.0 % Gravel	Maximum Size: No. 8	Specific Gravity	D_{50}: 0.006 in
77.9 % Sand	Moisture Content: 3.5%	Plus No. 4:	C_U:
22.1 % Fines	Liquid Limit:	Minus No. 4:	C_C:
% Oversize	Plasticity Index: Nonplastic		

Note; Clayey bits in sample.

GRAIN SIZE DISTRIBUTION

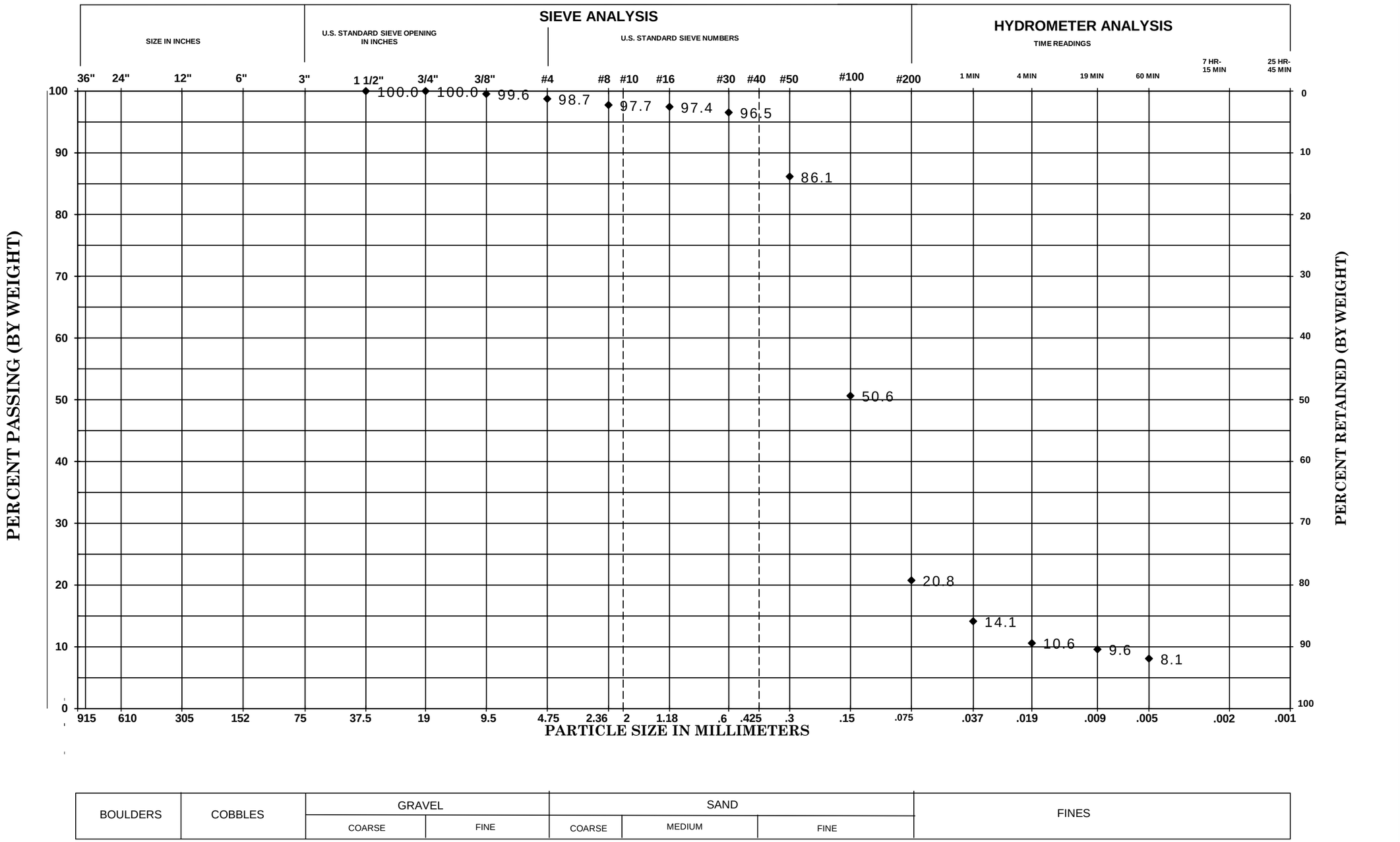


Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J.Fitzsimmons

0.0 % Gravel	Maximum Size: No. 8	Specific Gravity	D_{50}: 0.004 in
66.7 % Sand	Moisture Content: 4.1%	Plus No. 4:	C_U:
33.3 % Fines	Liquid Limit:	Minus No. 4:	C_C:
% Oversize	Plasticity Index: Nonplastic		

GRAIN SIZE DISTRIBUTION

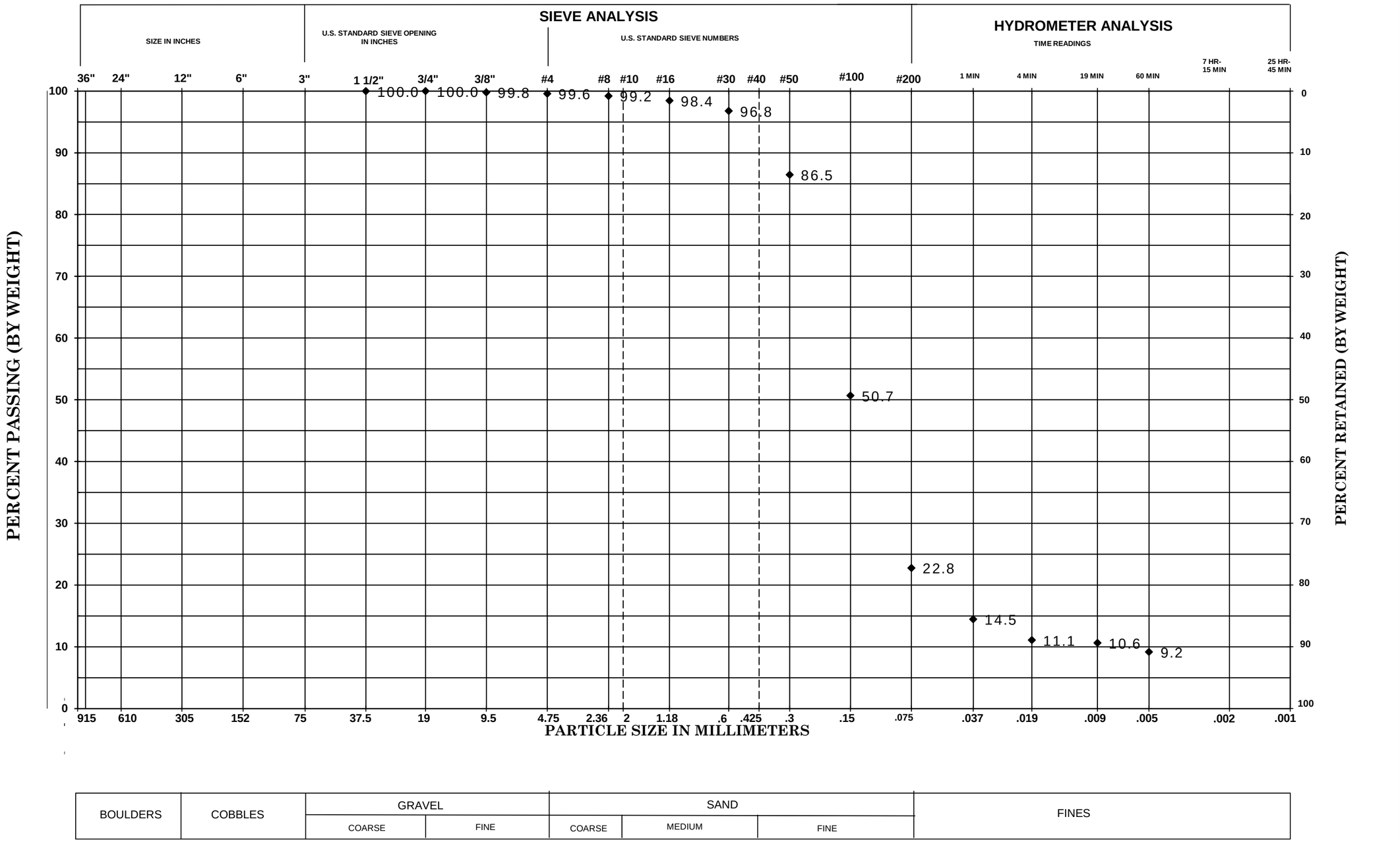


Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J.Fitzsimmons

1.3 % Gravel	Maximum Size: 1"	Specific Gravity	D_{50}: 0.006 in
78.0 % Sand	Moisture Content: 2.2%	Plus No. 4:	C_U: 14.7
20.8 % Fines	Liquid Limit:	Minus No. 4:	C_C: 3.9
% Oversize	Plasticity Index: Nonplastic		

GRAIN SIZE DISTRIBUTION

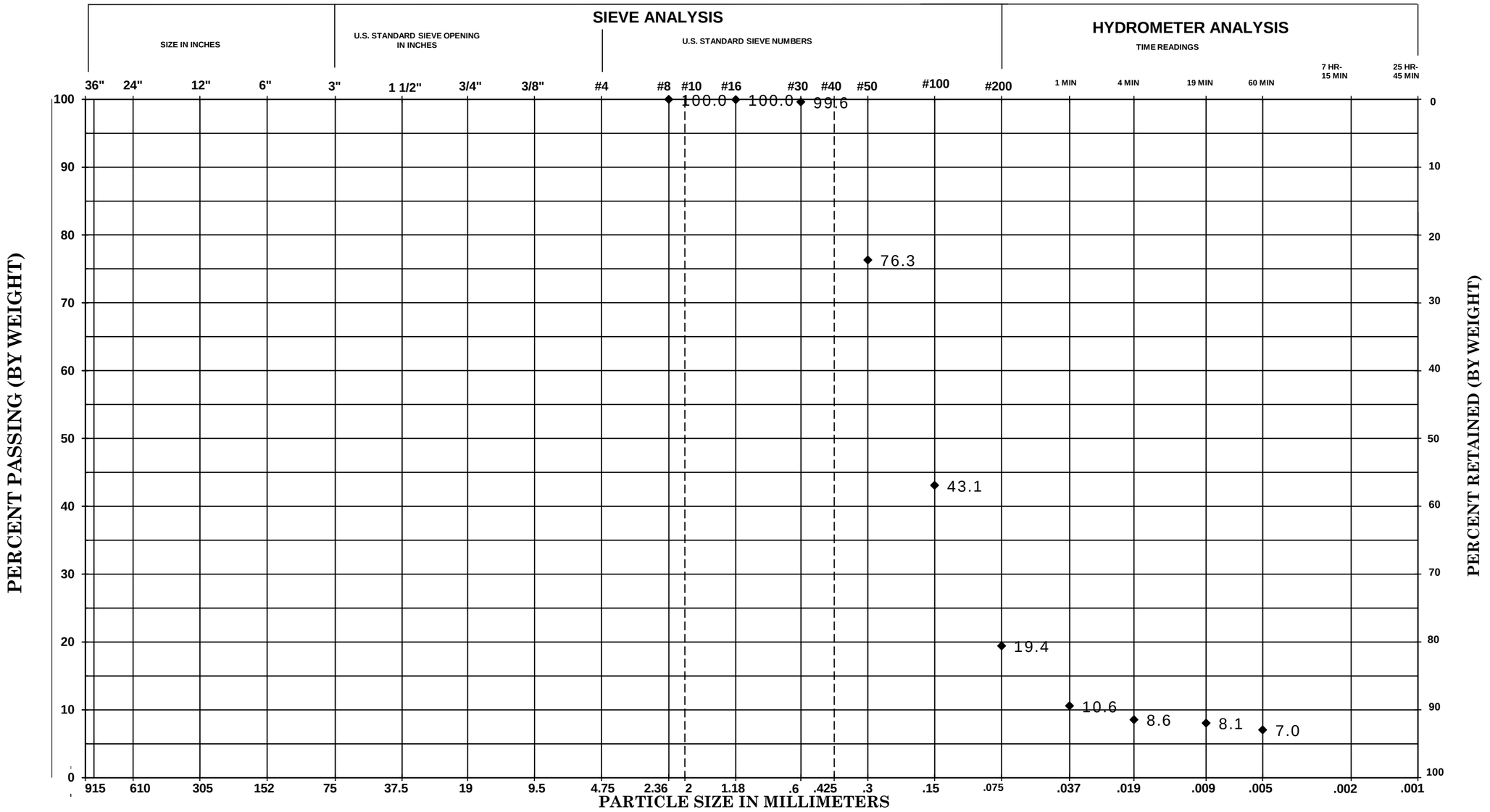


Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J.Fitzsimmons

Trace % Gravel	Maximum Size: 1 1/2"	Specific Gravity	D_{50}: 0.006 in
76.8 % Sand	Moisture Content: 2.4%	Plus No. 4:	C_U: 25.6
22.8 % Fines	Liquid Limit:	Minus No. 4:	C_C: 6.4
% Oversize	Plasticity Index: Nonplastic		

GRAIN SIZE DISTRIBUTION



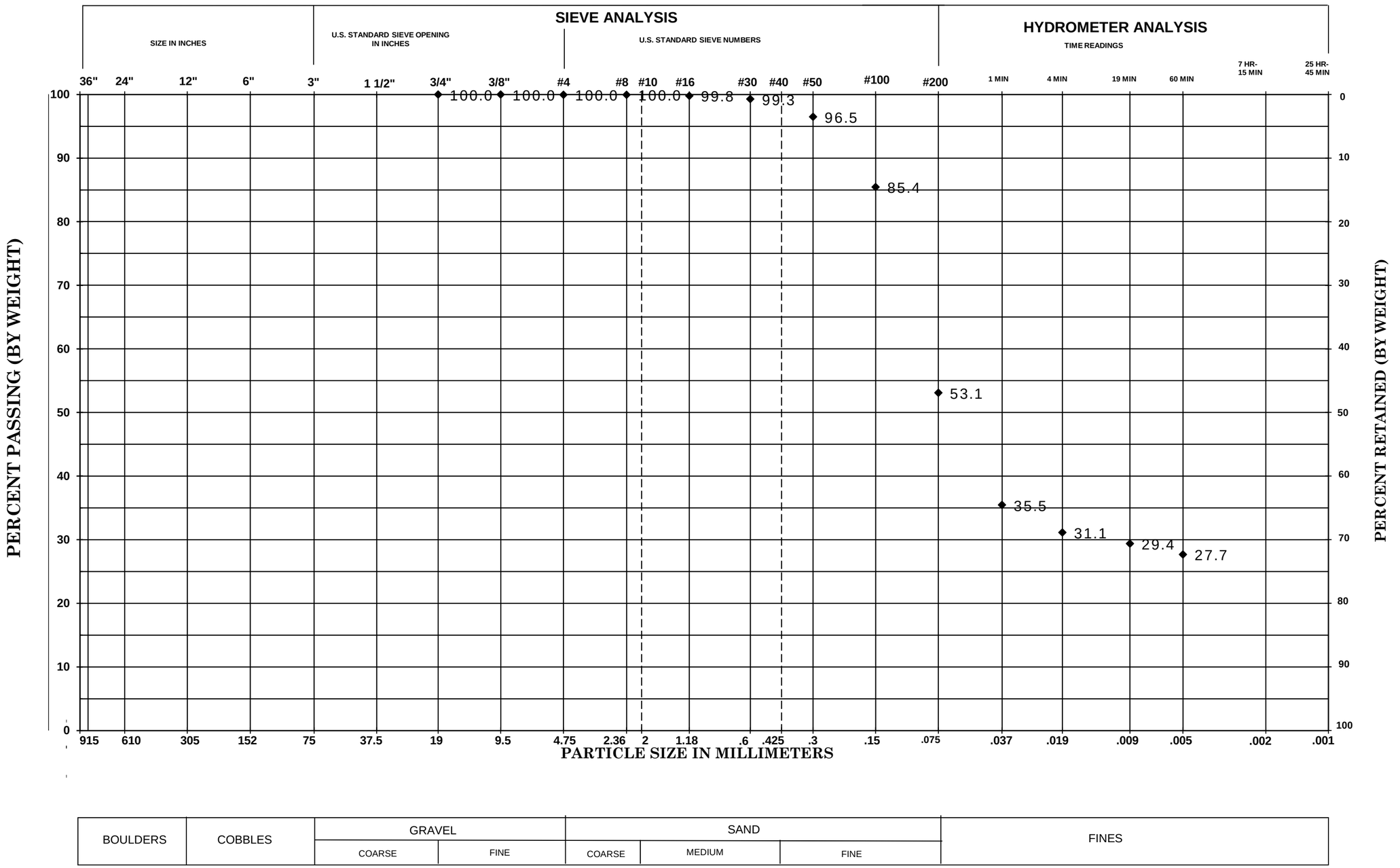
BOULDERS	COBBLES	GRAVEL		SAND			FINES
		COARSE	FINE	COARSE	MEDIUM	FINE	

Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J.Fitzsimmons

0.0 % Gravel	Maximum Size: No. 8	Specific Gravity	D_{50}: 0.007 in
80.6 % Sand	Moisture Content: 1.6%	Plus No. 4:	C_U: 7.0
19.4 % Fines	Liquid Limit:	Minus No. 4:	C_C: 1.6
% Oversize	Plasticity Index: Nonplastic		

GRAIN SIZE DISTRIBUTION

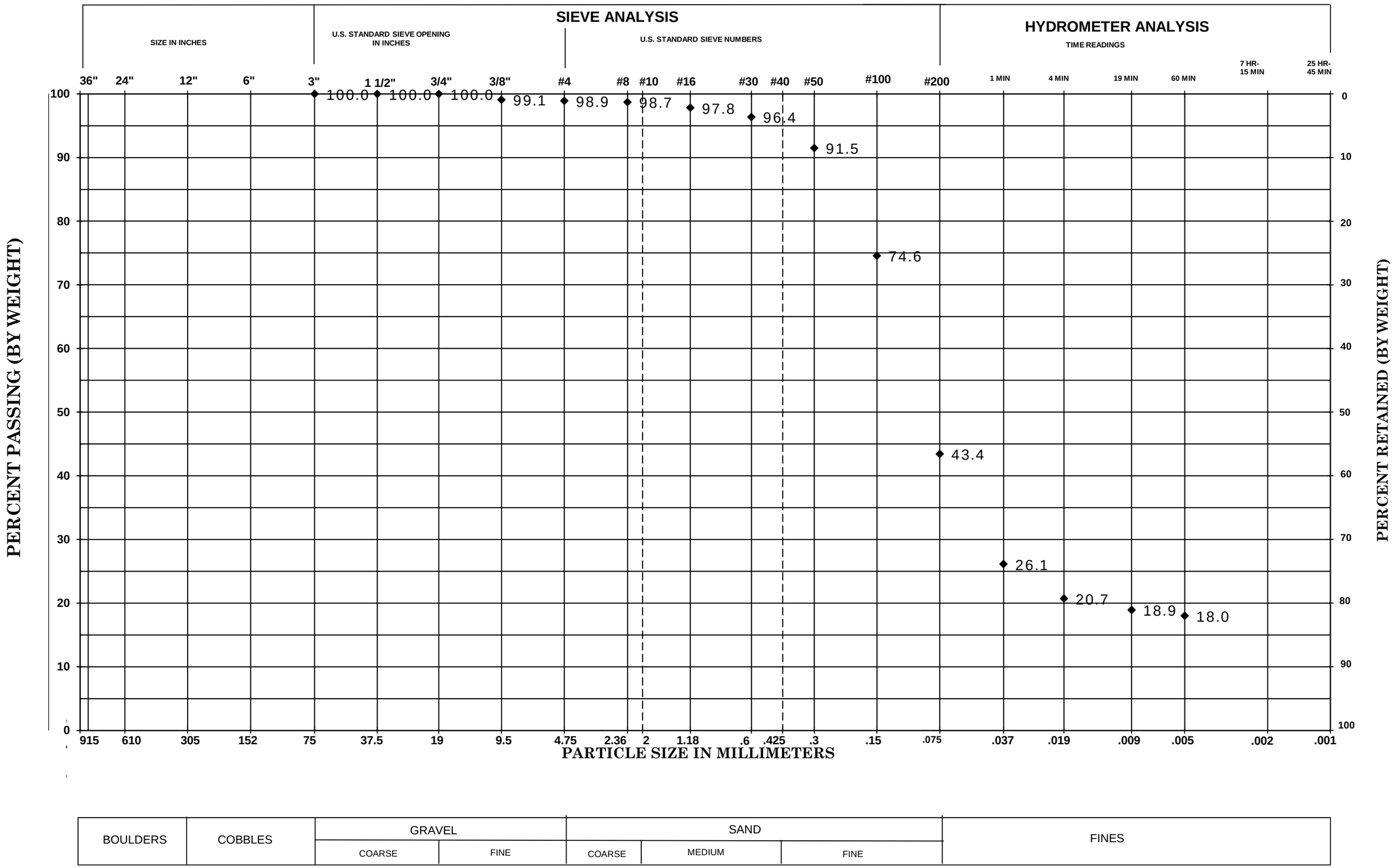


Unified Soil Classification: **CL Sandy Lean Clay**

Sample Collected by: J.Fitzsimmons

Trace % Gravel	Maximum Size: 3/4"	Specific Gravity	D_{50}: 0.003 in
46.9 % Sand	Moisture Content: 6.1%	Plus No. 4:	C_U:
53.1 % Fines	Liquid Limit: 21.4	Minus No. 4:	C_C:
% Oversize	Plasticity Index: 10.2		

GRAIN SIZE DISTRIBUTION

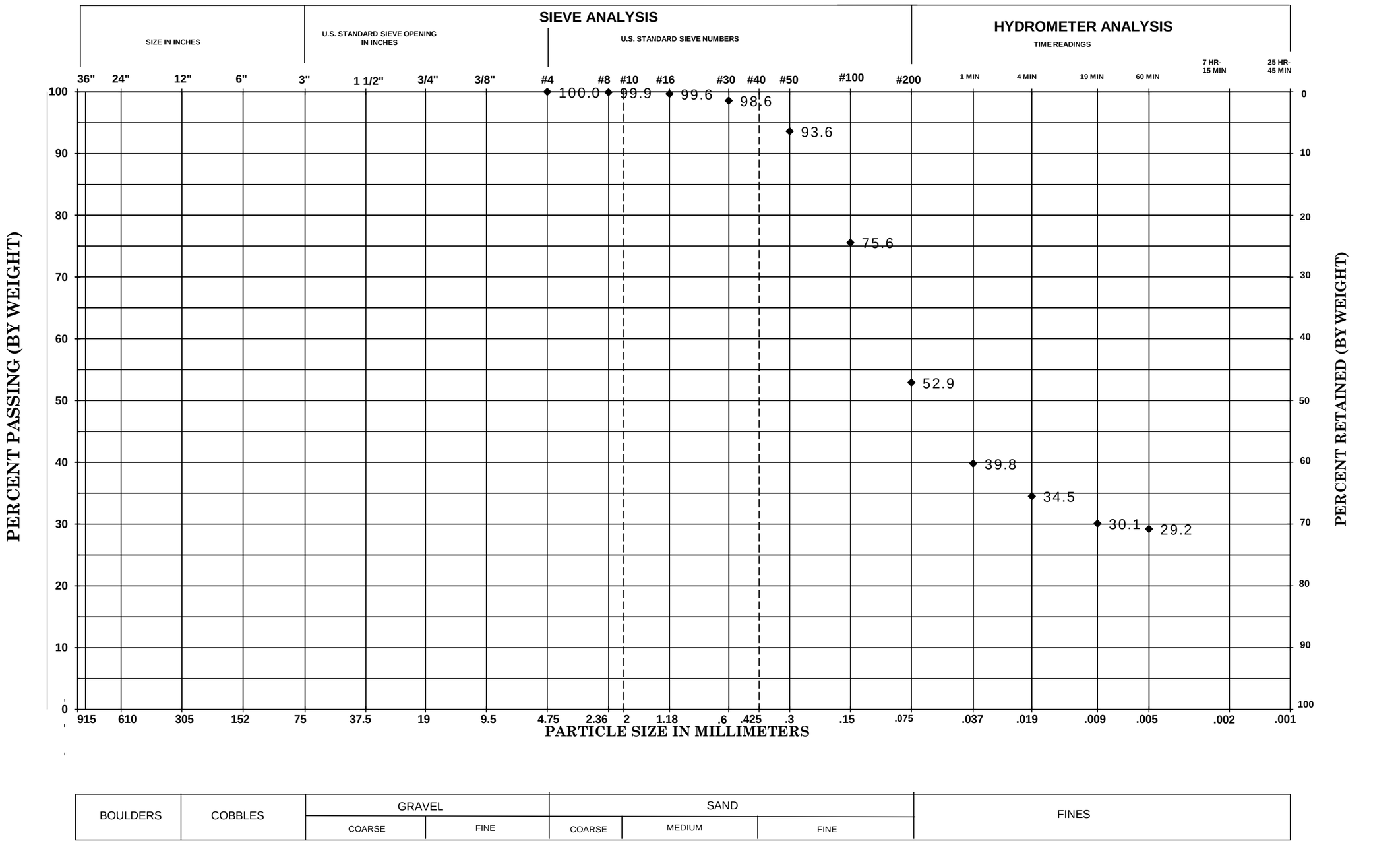


Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J.Fitzsimmons

1.1 % Gravel	Maximum Size: 2"	Specific Gravity	D_{50}: 0.003 in
55.5 % Sand	Moisture Content: 4.2%	Plus No. 4:	C_U:
43.4 % Fines	Liquid Limit: 19.6	Minus No. 4:	C_C:
% Oversize	Plasticity Index: 3.9		

GRAIN SIZE DISTRIBUTION



Unified Soil Classification: **CL Sandy Lean Clay**

Sample Collected by: J.Fitzsimmons

0.0 % Gravel	Maximum Size: No. 4	Specific Gravity	D_{50}: 0.003 in
47.1 % Sand	Moisture Content: 5.5%	Plus No. 4:	C_U:
52.9 % Fines	Liquid Limit: 24.7	Minus No. 4:	C_C:
% Oversize	Plasticity Index: 14.0		

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PHYSICAL PROPERTIES OF SOILS & AGGREGATES

Date of Report **04-27-16**
Job No. **2146JL123**

Client **BUREAU OF RECLAMATION**
6150 W THUNDERBIRD RD
GLENDALE, AZ 85306

Event / Invoice No. 1 — Lab No. **68311**
Authorized by **MIKE MILLER** — Date **04-21-16**
Sampled by **MIKE MILLER** — Date **04-19-16**
Submitted by **MIKE MILLER** — Date **04-21-16**
Source / Location Designated by **MIKE MILLER** — Date **04-19-16**

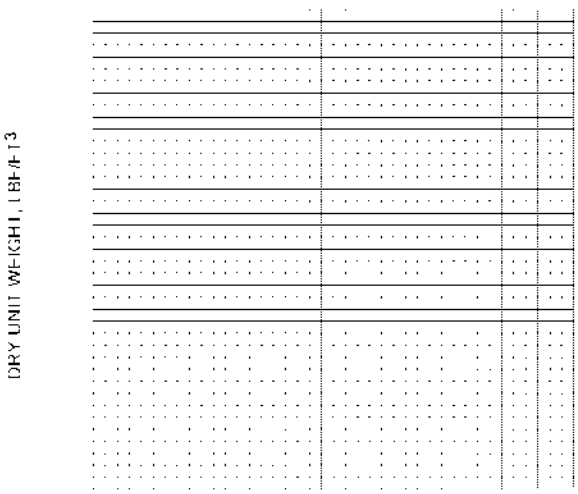
Project	**HPI SPUR**
Location	**SR 264**
Type / Use of Material	**EXISTING SOIL**
Supplier / Source	**PROJECT SITE**
Sample Source / Location	**TP-202 0-3.5'**
Special Instructions	

TEST RESULTS

SIEVE ANALYSIS :
FINER THAN NO. 200 :

SIEVE	ACCUMULATIVE % PASSING	SPECIFICATION

LABORATORY COMPACTION CHARACTERISTICS : METHOD



SAMPLE PREPARATION: ☐ WET ☐ DRY
RAMMER USED:
2 IN. CIRCULAR FACE — OTHER
MECHANICAL — MANUAL

MAXIMUM DRY UNIT WEIGHT, LBF/FT^3 →
OPTIMUM WATER CONTENT, % →

OVERSIZE AGGREGATE :
BULK SPECIFIC GRAVITY :
ABSORPTION, % :
% OVERSIZE IN LAB SAMPLE :

SPECIFIC GRAVITY IN ZERO AIR VOID CURVE :

WATER CONTENT, % DRY WEIGHT

TEST PROCEDURE	RESULT	SPECS
LIQUID & PLASTIC PROPERTIES :		
LIQUID LIMIT →		
ESTIMATED % RETAINED ON NO. 40 — PLASTIC LIMIT →		
SAMPLE AIR DRIED ☐ YES ☐ NO — PLASTICITY INDEX →		
MOISTURE CONTENT :		
PORTION TESTED — % DRY WEIGHT →		
EXPANSION / COMPRESSION PROPERTIES OF COHESIVE SOIL :		
☐ EXPANSION ☐ COMPRESSION, % →		
MAXIMUM SWELL PRESSURE, KSF →		
SURCHARGE, PSF		
INITIAL WATER CONTENT, % — DRY UNIT WEIGHT LBF/FT^3		
EXPANSION INDEX OF SOIL :		
INITIAL WATER CONTENT, % :		
INITIAL DRY UNIT WEIGHT LBF/FT^3 : — EI →		
INITIAL DEGREE OF SATURATION :		
FINAL WATER CONTENT, % :		

TEST PROCEDURE	RESULT	SPECS
RESISTANCE TO DEGRADATION OF SMALL-SIZE COARSE AGGREGATES BY ABRASION :		
GRADING — 100 REV, % LOSS →		
GRADING — 500 REV, % LOSS →		
SPECIFIC GRAVITY :		
MAX. PARTICLE SIZE, IN — SPECIFIC GRAVITY @ 20 C →		
pH DETERMINATION : AZ 237		
pH →	**8.8**	
SOLUBLE SALTS :		
PPM →		
MINIMUM RESISTIVITY : AZ 236		
OHM-CM →	**3802**	
SOIL CLASSIFICATION : — GROUP SYMBOL:		
NAME:		

Comments :

Copies to : **CLIENT**

THE SERVICES REFERRED TO HEREIN WERE PERFORMED IN ACCORDANCE WITH THE STANDARD OF CARE PRACTICED LOCALLY FOR THE REFERENCED METHOD(S) AND RELATE ONLY TO THE CONDITION(S) OR SAMPLE(S) TESTED AS STATED HEREIN. WESTERN TECHNOLOGIES INC. MAKES NO OTHER WARRANTY OR REPRESENTATION, EXPRESSED OR IMPLIED, AND HAS NOT CONFIRMED INFORMATION INCLUDING SOURCE OF MATERIALS SUBMITTED BY OTHERS.

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PHYSICAL PROPERTIES OF SOILS & AGGREGATES

Client **BUREAU OF RECLAMATION**
6150 W THUNDERBIRD RD
GLENDALE, AZ 85306

Date of Report: **04-27-16**
Job No. **2146JL123**
Event / Invoice No. 1 — Lab No. **68310**
Authorized by **MIKE MILLER** — Date **04-21-16**
Sampled by **MIKE MILLER** — Date **04-19-16**
Submitted by **MIKE MILLER** — Date **04-21-16**
Source / Location Designated by **MIKE MILLER** — Date **04-19-16**

Project	**HOPI SPUR**
Location	**SR 264**
Type / Use of Material	**EXISTING SOIL**
Supplier / Source	**PROJECT SITE**
Sample Source / Location	**TP-206 0-5'**
Special Instructions	

TEST RESULTS

SIEVE ANALYSIS :
FINER THAN NO. 200 :

SIEVE	ACCUMULATIVE % PASSING	SPECIFICATION

LABORATORY COMPACTION CHARACTERISTICS : METHOD

SAMPLE PREPARATION: WET DRY
RAMMER USED: 2 IN. CIRCULAR FACE OTHER
MECHANICAL MANUAL

MAXIMUM DRY UNIT WEIGHT, LBF/FT³ →
OPTIMUM WATER CONTENT, % →

OVERSIZE AGGREGATE :
BULK SPECIFIC GRAVITY :
ABSORPTION, % :
% OVERSIZE IN LAB SAMPLE :

SPECIFIC GRAVITY IN ZERO AIR VOID CURVE :

DRY UNIT WEIGHT, LBF/FT³

WATER CONTENT, % DRY WEIGHT

TEST PROCEDURE	RESULT	SPECS
LIQUID & PLASTIC PROPERTIES :		
LIQUID LIMIT →		
ESTIMATED % RETAINED ON NO. 40 — PLASTIC LIMIT →		
SAMPLE AIR DRIED YES NO — PLASTICITY INDEX →		
MOISTURE CONTENT :		
PORTION TESTED — % DRY WEIGHT →		
EXPANSION / COMPRESSION PROPERTIES OF COHESIVE SOIL :		
EXPANSION — COMPRESSION, % →		
MAXIMUM SWELL PRESSURE, KSF →		
SURCHARGE, PSF		
INITIAL WATER CONTENT, % — DRY UNIT WEIGHT LBF/FT³		
EXPANSION INDEX OF SOIL :		
INITIAL WATER CONTENT, %		
INITIAL DRY UNIT WEIGHT LBF/FT³ — EI →		
INITIAL DEGREE OF SATURATION		
FINAL WATER CONTENT, %		

TEST PROCEDURE	RESULT	SPECS
RESISTANCE TO DEGRADATION OF SMALL-SIZE COARSE AGGREGATES BY ABRASION :		
GRADING — 100 REV, % LOSS →		
GRADING — 500 REV, % LOSS →		
SPECIFIC GRAVITY :		
MAX. PARTICLE SIZE IN — SPECIFIC GRAVITY @ 20 C →		
pH DETERMINATION : AZ 237		
pH →	8.8	
SOLUBLE SALTS :		
PPM →		
MINIMUM RESISTIVITY : AZ 236		
OHM-CM →	2735	
SOIL CLASSIFICATION : GROUP SYMBOL:		
NAME:		

Comments :

Copies to : **CLIENT**

THE SERVICES REFERRED TO HEREIN WERE PERFORMED IN ACCORDANCE WITH THE STANDARD OF CARE PRACTICED LOCALLY FOR THE REFERENCED METHOD(S) AND RELATE ONLY TO THE CONDITIONS OR SAMPLE(S) TESTED AS STATED HEREIN. WESTERN TECHNOLOGIES INC. MAKES NO OTHER WARRANTY OR REPRESENTATION, EXPRESSED OR IMPLIED, AND HAS NOT CONFIRMED INFORMATION INCLUDING SOURCE OF MATERIALS SUBMITTED BY OTHERS.

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PHYSICAL PROPERTIES OF SOILS & AGGREGATES

Client **BUREAU OF RECLAMATION**
6150 W THUNDERBIRD RD
GLENDALE, AZ 85306

Date of Report **04-27-16**
Job No. **2146JL123**
Event / Invoice No. 1 — Lab No. **68312**
Authorized by **MIKE MILLER** — Date **04-21-16**
Sampled by **MIKE MILLER** — Date **04-20-16**
Submitted by **MIKE MILLER** — Date **04-21-16**
Source / Location Designated by **MIKE MILLER** — Date **04-20-16**

Project	**HOPI SPUR**
Location	**SR 264**
Type / Use of Material	**EXISTING SOIL**
Supplier / Source	**PROJECT SITE**
Sample Source / Location	**TP-211 0-3'**
Special Instructions	

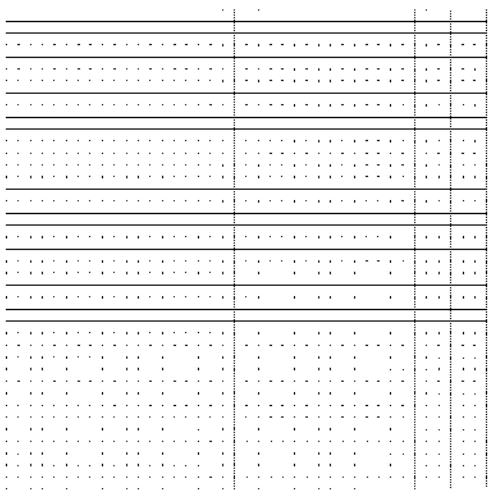
TEST RESULTS

SIEVE ANALYSIS :
FINER THAN NO. 200 :

SIEVE	ACCUMULATIVE % PASSING	SPECIFICATION

LABORATORY COMPACTION CHARACTERISTICS : METHOD

DRY UNIT WEIGHT, LBF/FT3



SAMPLE PREPARATION: ☐ WET ☐ DRY
RAMMER USED:
☐ 2 IN. CIRCULAR FACE ☐ OTHER
☐ MECHANICAL ☐ MANUAL

MAXIMUM DRY UNIT WEIGHT, LBF/FT^3 →
OPTIMUM WATER CONTENT, % →

OVERSIZE AGGREGATE :
BULK SPECIFIC GRAVITY :
ABSORPTION, % :
% OVERSIZE IN LAB SAMPLE :

SPECIFIC GRAVITY IN ZERO AIR VOID CURVE :

WATER CONTENT, % DRY WEIGHT

TEST PROCEDURE	RESULT	SPECS
LIQUID & PLASTIC PROPERTIES :		
LIQUID LIMIT →		
ESTIMATED % RETAINED ON NO. 40 — PLASTIC LIMIT →		
SAMPLE AIR DRIED ☐ YES ☐ NO — PLASTICITY INDEX →		
MOISTURE CONTENT :		
PORTION TESTED — % DRY WEIGHT →		
EXPANSION / COMPRESSION PROPERTIES OF COHESIVE SOIL :		
☐ EXPANSION ☐ COMPRESSION, % →		
MAXIMUM SWELL PRESSURE, KSF →		
SURCHARGE, PSF		
INITIAL WATER CONTENT, % — DRY UNIT WEIGHT LBF/FT^3		
EXPANSION INDEX OF SOIL :		
INITIAL WATER CONTENT, % :		
INITIAL DRY UNIT WEIGHT LBF/FT^3 : — EI →		
INITIAL DEGREE OF SATURATION :		
FINAL WATER CONTENT, % :		

TEST PROCEDURE	RESULT	SPECS
RESISTANCE TO DEGRADATION OF SMALL-SIZE COARSE AGGREGATES BY ABRASION :		
GRADING — 100 REV, % LOSS →		
GRADING — 500 REV, % LOSS →		
SPECIFIC GRAVITY :		
MAX. PARTICLE SIZE, IN — SPECIFIC GRAVITY @ 20 C →		
pH DETERMINATION : AZ 237		
pH →	**8.5**	
SOLUBLE SALTS :		
PPM →		
MINIMUM RESISTIVITY : AZ 236		
OHM-CM →	**2068**	
SOIL CLASSIFICATION : GROUP SYMBOL:		
NAME:		

Comments :

Copies to : **CLIENT**

THE SERVICES REFERRED TO HEREIN WERE PERFORMED IN ACCORDANCE WITH THE STANDARD OF CARE PRACTICED LOCALLY FOR THE REFERENCED METHOD(S) AND RELATE ONLY TO THE CONDITION(S) OR SAMPLE(S) TESTED AS STATED HEREIN. WESTERN TECHNOLOGIES INC. MAKES NO OTHER WARRANTY OR REPRESENTATION, EXPRESSED OR IMPLIED, AND HAS NOT CONFIRMED INFORMATION INCLUDING SOURCE OF MATERIALS SUBMITTED BY OTHERS.

REVIEWED BY M. WHITMAN
(SIGNED COPY ON FILE)

Summary of Test Pits

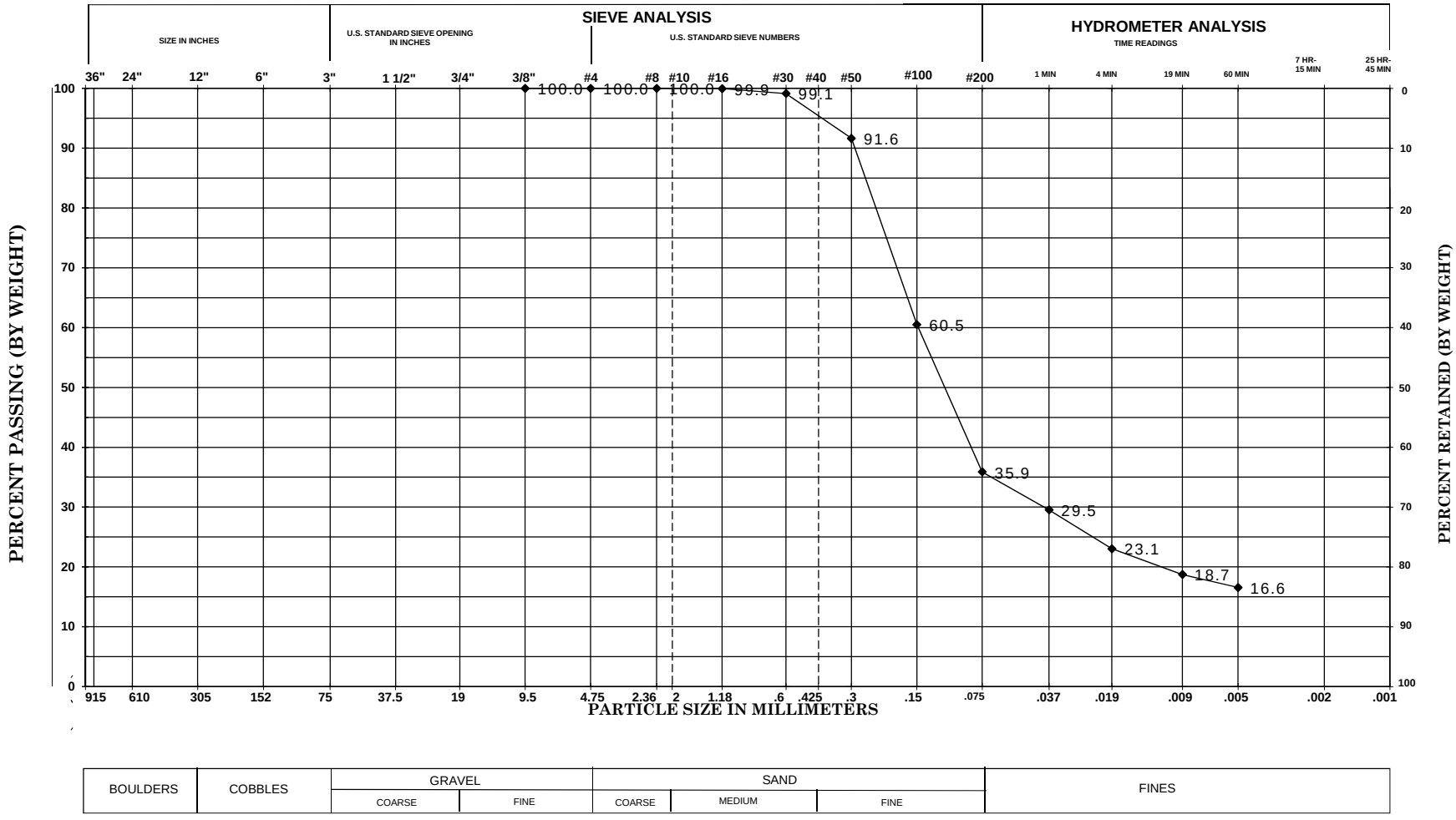
NCAWSFS - Hopi Test Pits (Tuba City)

October 2015

Date Sampled	Location	Depth	Unified Soil Classification		% Gravel	% Sand	% Fines	Max. Size	C_U	C_C	Inplace Moisture Content %	In-place Dry Density (lbm/ft³)	Lab. Max Dry Density (lbm/ft³)	Optimum Moisture Content %	Liquid Limit	Plasticity Index
10/05/15	TP-216	0' to 6'	SM	Silty Sand	Trace	64	36	1/2"	-	-	4.7	101.6	121.5	10.9		NP
10/05/15	TP-217	0' to 3'	ML	Sandy Silt	Trace	49	51	3/4"	-	-	4.7	-	121.8	11.7	21.1	2.3
10/05/15	TP-219	0' to 3'	SC	Clayey Sand	Trace	60	40	3/4"	-	-	4.3	-	122.5	11.0	20.0	8.1
10/05/15	TP-219	3'' to 6'	SM	Silty Sand	8	74	18	3/4"	55.0	11.2	-	-	-	-		NP
10/05/15	TP-220	0' to 4'	SM	Silty Sand	0	87	13	No. 8	8.2	2.7	2.4	104.1	116.9	9.8		NP
10/06/15	TP-221	4' to 7.5'	SM	Silty Sand	0	85	15	No. 4	4.9	1.4	1.8	-	117.4	12.9		NP
10/06/15	TP-222	4' to 10'	SM	Silty Sand	Trace	82	18	3/4"	-	-	2.7	-	118.0	10.4		NP
10/06/15	TP-224	0' to 4.8'	SM	Silty Sand	0	86	14	1/2"	9.7	1.7	4.3	117.6	118.4	9.4		NP
10/06/15	TP-225	0' to 8'	SM	Silty Sand	Trace	84	16	3/4"	9.1	2.6	2.2	-	117.1	10.6		NP
10/06/15	TP-229	0' to 4'	SC-SM	Silty Clayey Sand	Trace	53	47	1"	-	-	5.2	-	118.2	12.3	21.8	5.4
10/06/15	TP-230	0' to 6'	CL	Sandy Lean Clay	0	48	52	No. 4	-	-	6.6	-	119.6	12.8	24.7	13.2
10/06/15	TP-231	0' to 4.5'	SM	Silty Sand	0	55	45	No. 8	-	-	3.6	94.0	116.5	12.9		NP
10/07/15	TP-232	0' to 4.5'	SC/CL	Clayey Sand	Trace	51	49	3/4"	-	-	4.3	90.8	118.9	12.4	22.3	9.3
10/07/15	TP-233	0' to 7'	CL	Sandy Lean Clay	Trace	36	64	1/2"	-	-	5.3	-	115.1	13.8	23.6	12.1
10/07/15	TP-234	0' to 13'	CL	Lean Clay with Sand	0	24	76	No. 8	-	-	9.0	-	109.9	16.4	33.8	21.1
10/07/15	TP-235	0' to 5'	SM	Silty Sand	Trace	78	22	3/4"	30.4	7.8	2.3	100.4	121.0	12.6		NP
10/07/15	TP-236	0' to 7'	SP-SM	Poorly Graded Sand with Silt	Trace	88	12	1/2"	4.1	1.8	-	-	109.9	10.2		NP
10/07/15	TP-237	0' to 12'	SM	Silty Sand	Trace	85	15	3/4"	5.2	1.7	-	-	112.1	11.6		NP

NCAWSFS **TP-216** **0' to 6'** **10/05/15**

GRAIN SIZE DISTRIBUTION



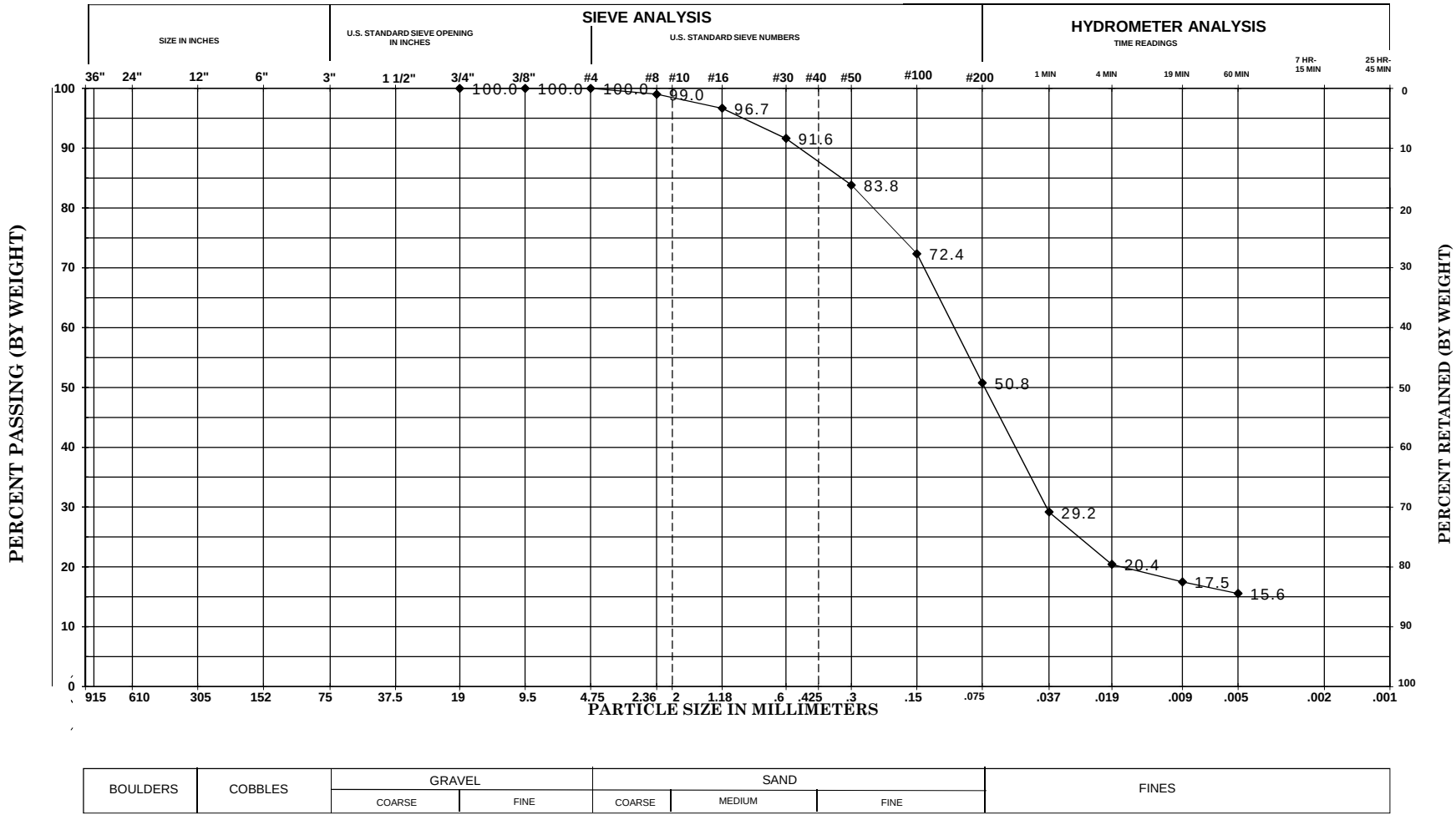
Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J.Fitzsimmons

Trace % Gravel	Maximum Size: 1/2"	Specific Gravity	D_{50}: 0.004 in
64.1 % Sand	Moisture Content: 4.7%	Plus No. 4:	C_U:
35.9 % Fines	Liquid Limit:	Minus No. 4:	C_C:
% Oversize	Plasticity Index: Nonplastic		

NCAWSFS **TP-217** **0' to 3'** **10/05/15**

GRAIN SIZE DISTRIBUTION



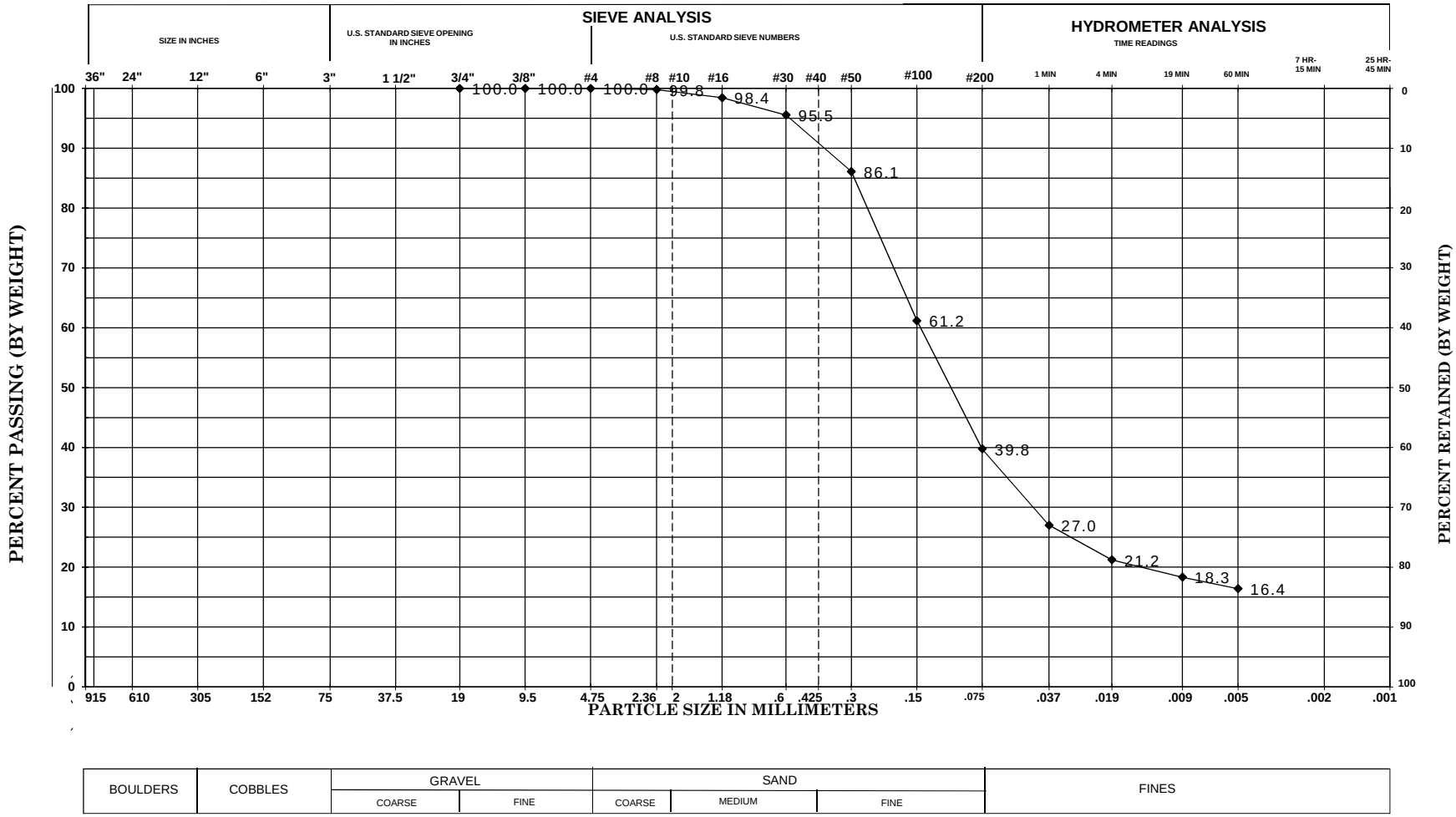
Unified Soil Classification: **ML Sandy Silt**

Sample Collected by: J.Fitzsimmons

Trace % Gravel	Maximum Size: 3/4"	Specific Gravity	D_{50}: 0.003 in
49.2 % Sand	Moisture Content: 4.7%	Plus No. 4:	C_U:
50.8 % Fines	Liquid Limit: 21.1	Minus No. 4:	C_C:
% Oversize	Plasticity Index: 2.3		

NCAWSFS **TP-219** **0' to 3'** **10/05/15**

GRAIN SIZE DISTRIBUTION



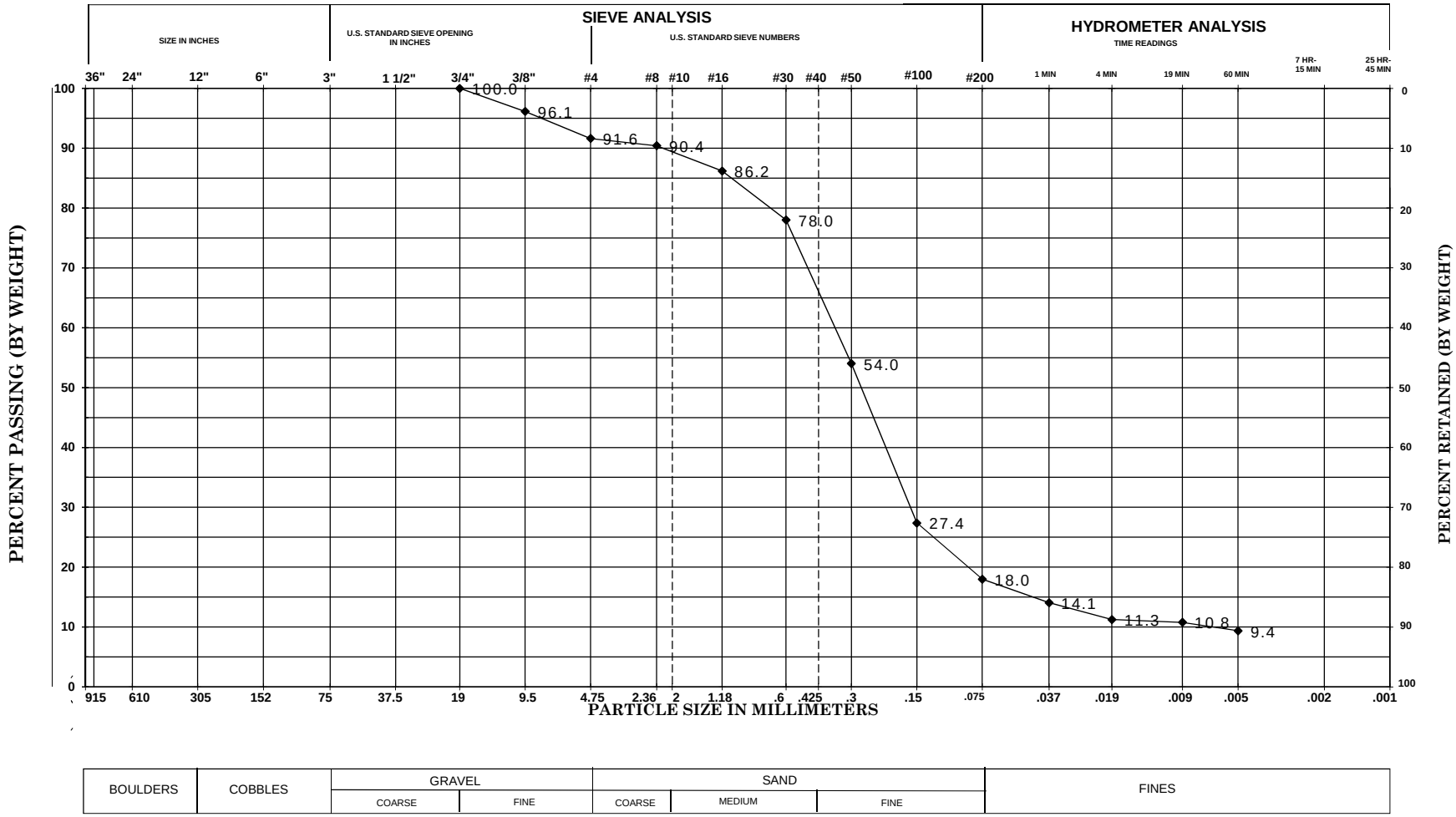
Unified Soil Classification: **SC Clayey Sand**

Sample Collected by: J.Fitzsimmons

Trace % Gravel	Maximum Size: 3/4"	Specific Gravity	D_{50}: 0.004 in
60.2 % Sand	Moisture Content: 4.3%	Plus No. 4:	C_U:
39.8 % Fines	Liquid Limit: 20.0	Minus No. 4:	C_C:
% Oversize	Plasticity Index: 8.1		

NCAWSFS	TP-219	3' to 6'	10/05/15

GRAIN SIZE DISTRIBUTION



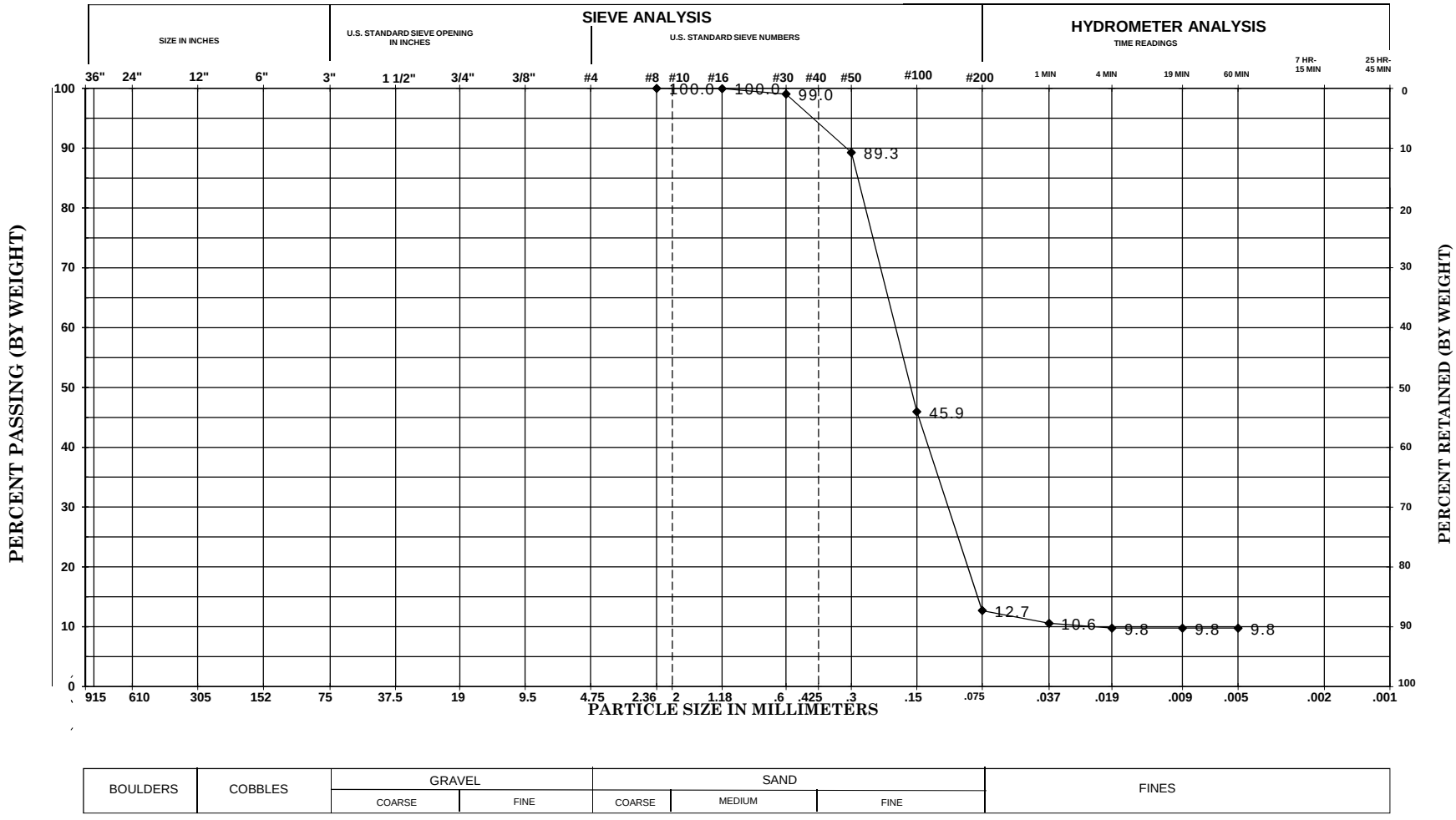
Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J.Fitzsimmons

8.4 % Gravel	Maximum Size: 3/4"	Specific Gravity	D_{50}: 0.011 in
73.6 % Sand	Moisture Content:	Plus No. 4:	C_U: 55.0
18.0 % Fines	Liquid Limit:	Minus No. 4:	C_C: 11.2
% Oversize	Plasticity Index: Nonplastic		

NCAWSFS **TP-220** **0' to 4'** **10/05/15**

GRAIN SIZE DISTRIBUTION



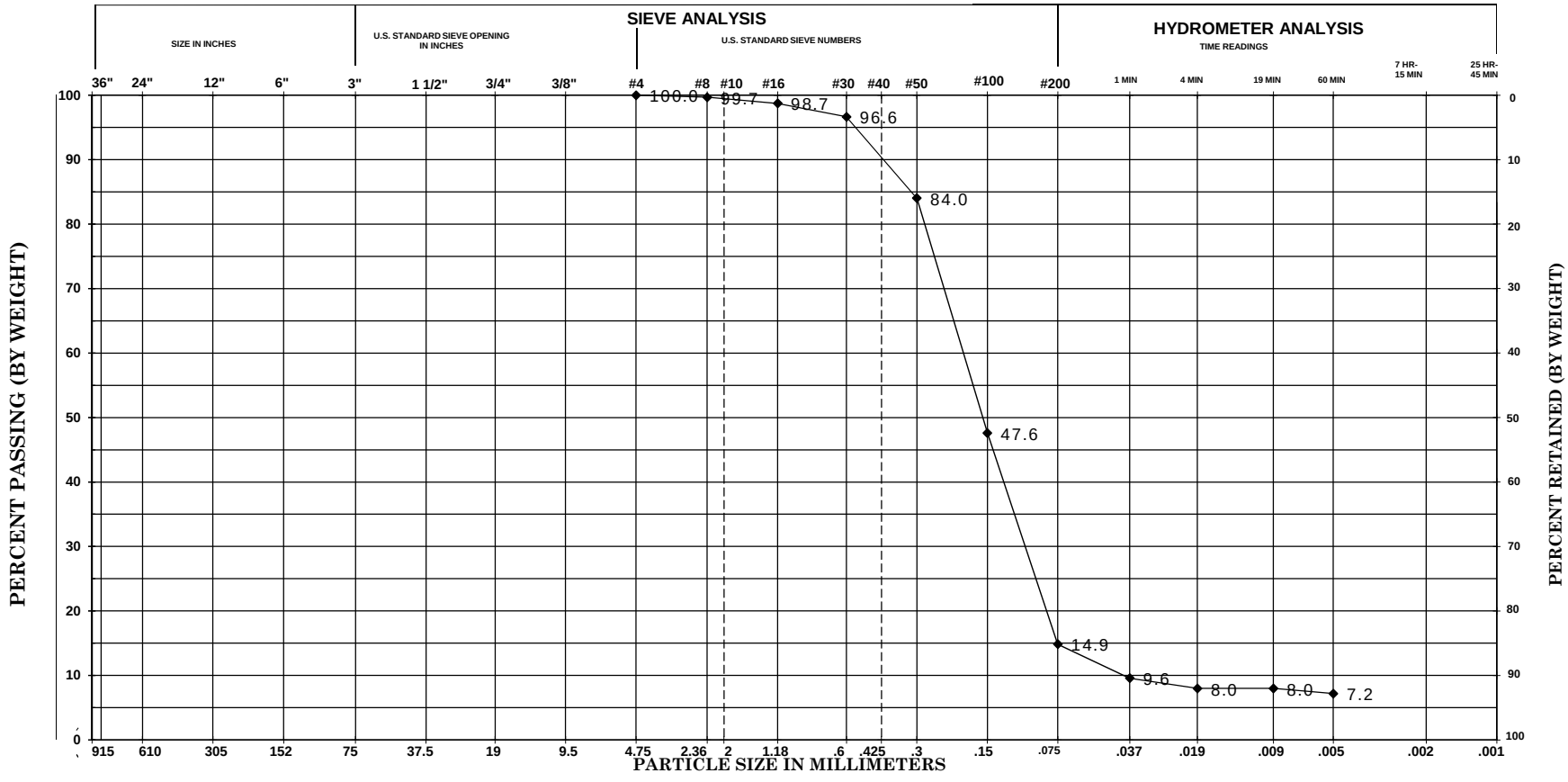
Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J.Fitzsimmons

0.0 % Gravel	Maximum Size: No. 8	Specific Gravity	D_{50}: 0.006 in
87.3 % Sand	Moisture Content: 2.4%	Plus No. 4:	C_U: 8.2
12.7 % Fines	Liquid Limit:	Minus No. 4:	C_C: 2.7
% Oversize	Plasticity Index: Nonplastic		

NCAWSFS **TP-221** **4' to 7.5'** **10/06/15**

GRAIN SIZE DISTRIBUTION



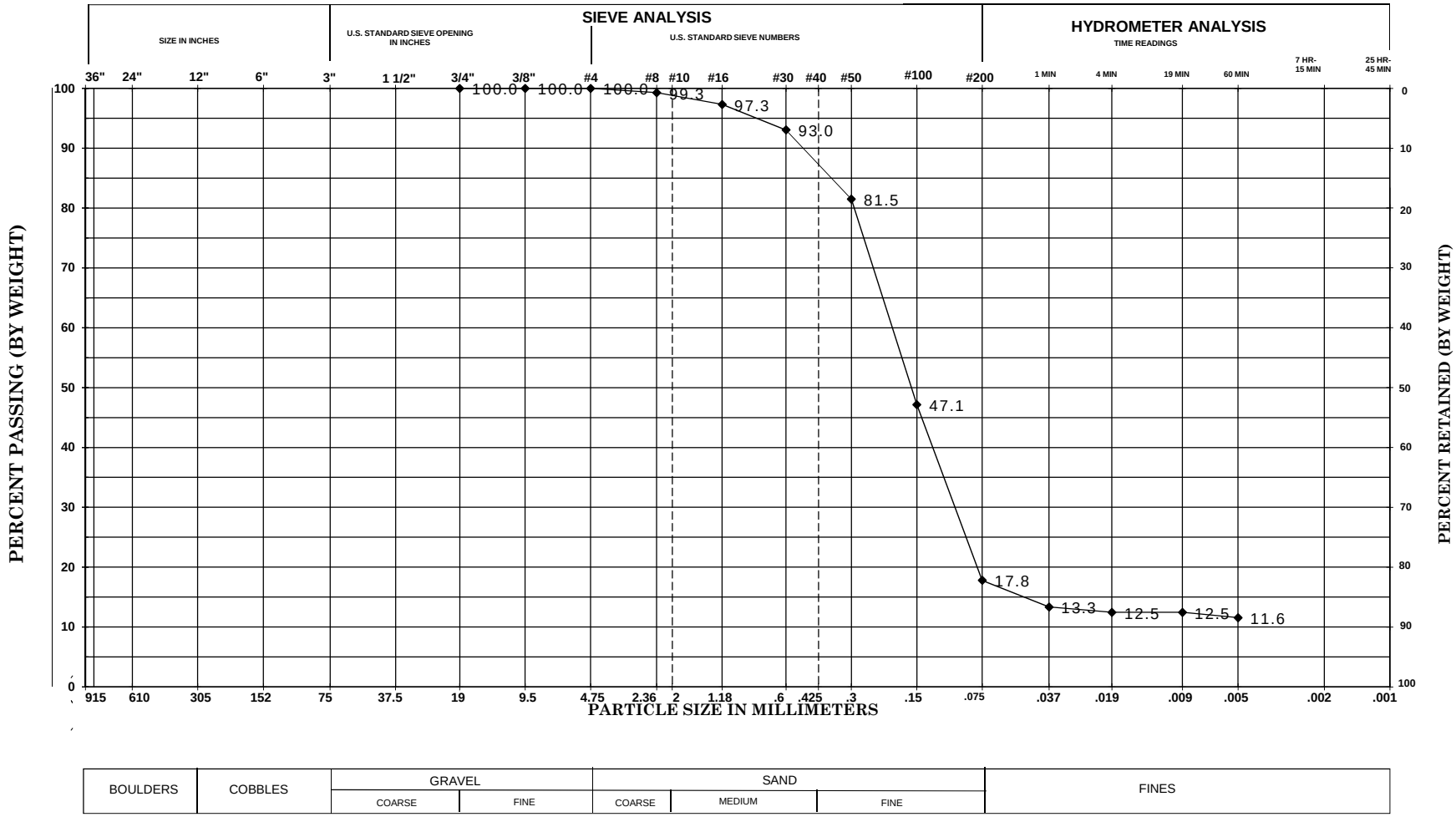
Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J.Fitzsimmons

0.0 % Gravel	Maximum Size: No. 4	Specific Gravity	D_{50}: 0.006 in
85.1 % Sand	Moisture Content: 1.8%	Plus No. 4:	C_U: 4.9
14.9 % Fines	Liquid Limit:	Minus No. 4:	C_C: 1.4
% Oversize	Plasticity Index: Nonplastic		

NCAWSFS **TP-222** **4' to 10'** **10/06/15**

GRAIN SIZE DISTRIBUTION



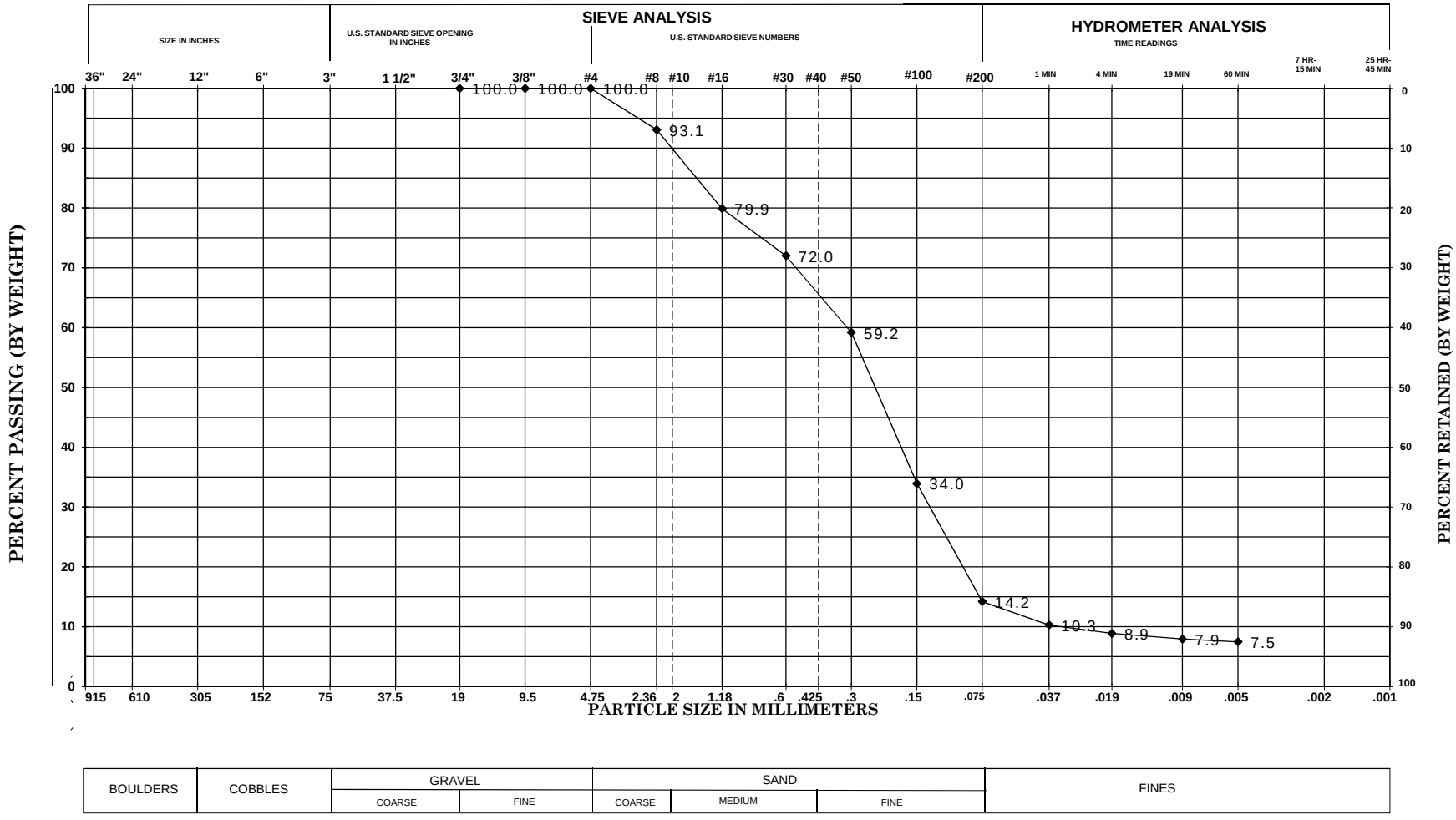
Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J.Fitzsimmons

Trace % Gravel	Maximum Size: 3/4"	Specific Gravity	D_{50}: 0.006 in
82.2 % Sand	Moisture Content: 2.7%	Plus No. 4:	C_U:
17.8 % Fines	Liquid Limit:	Minus No. 4:	C_C:
% Oversize	Plasticity Index: Nonplastic		

NCAWSFS **TP-224** **0' to 4.8'** **10/06/15**

GRAIN SIZE DISTRIBUTION



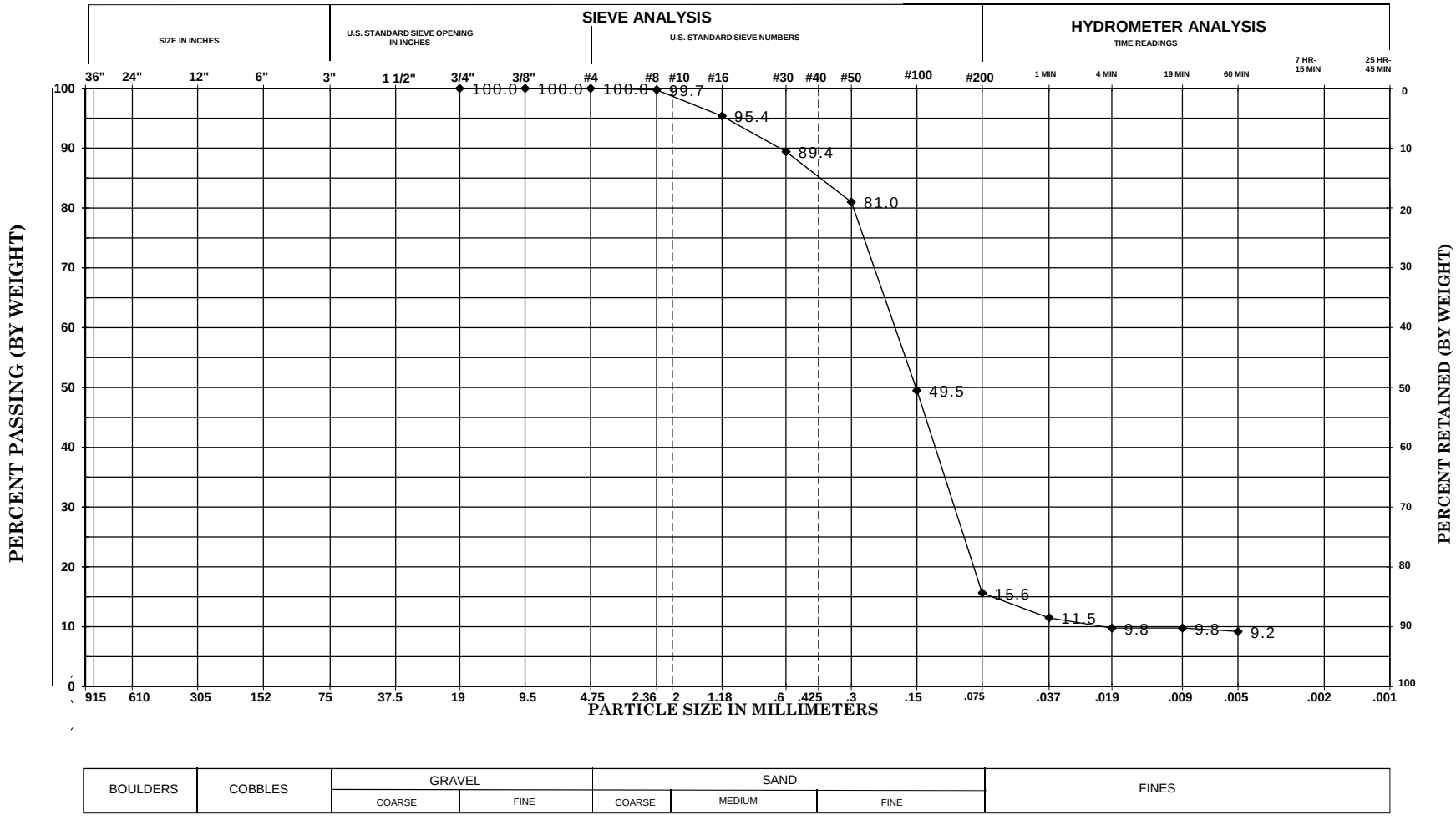
Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J.Fitzsimmons

Trace % Gravel	Maximum Size: 1/2"	Specific Gravity	D_{50}: 0.009 in
85.8 % Sand	Moisture Content: 4.3%	Plus No. 4:	C_U: 9.7
14.2 % Fines	Liquid Limit:	Minus No. 4:	C_C: 1.7
% Oversize	Plasticity Index: Nonplastic		

NCAWSFS **TP-225** **0' to 8'** **10/06/15**

GRAIN SIZE DISTRIBUTION



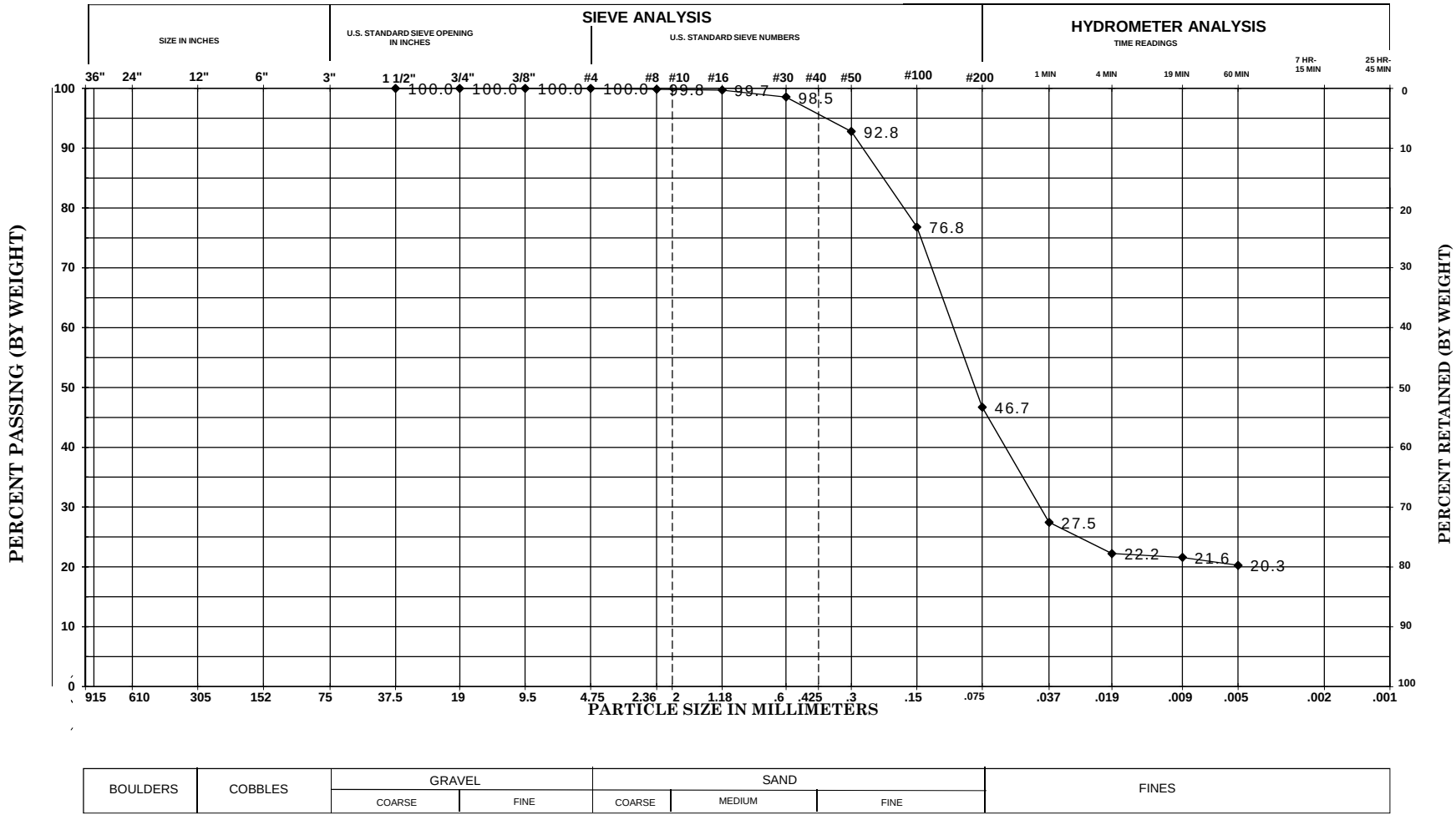
Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J.Fitzsimmons

Trace % Gravel	Maximum Size: 3/4"	Specific Gravity	D_{50}: 0.006 in
84.3 % Sand	Moisture Content: 2.2%	Plus No. 4:	C_U: 9.1
15.6 % Fines	Liquid Limit:	Minus No. 4:	C_C: 2.6
% Oversize	Plasticity Index: Nonplastic		

NCAWSFS **TP-229** **0' to 4'** **10/06/15**

GRAIN SIZE DISTRIBUTION



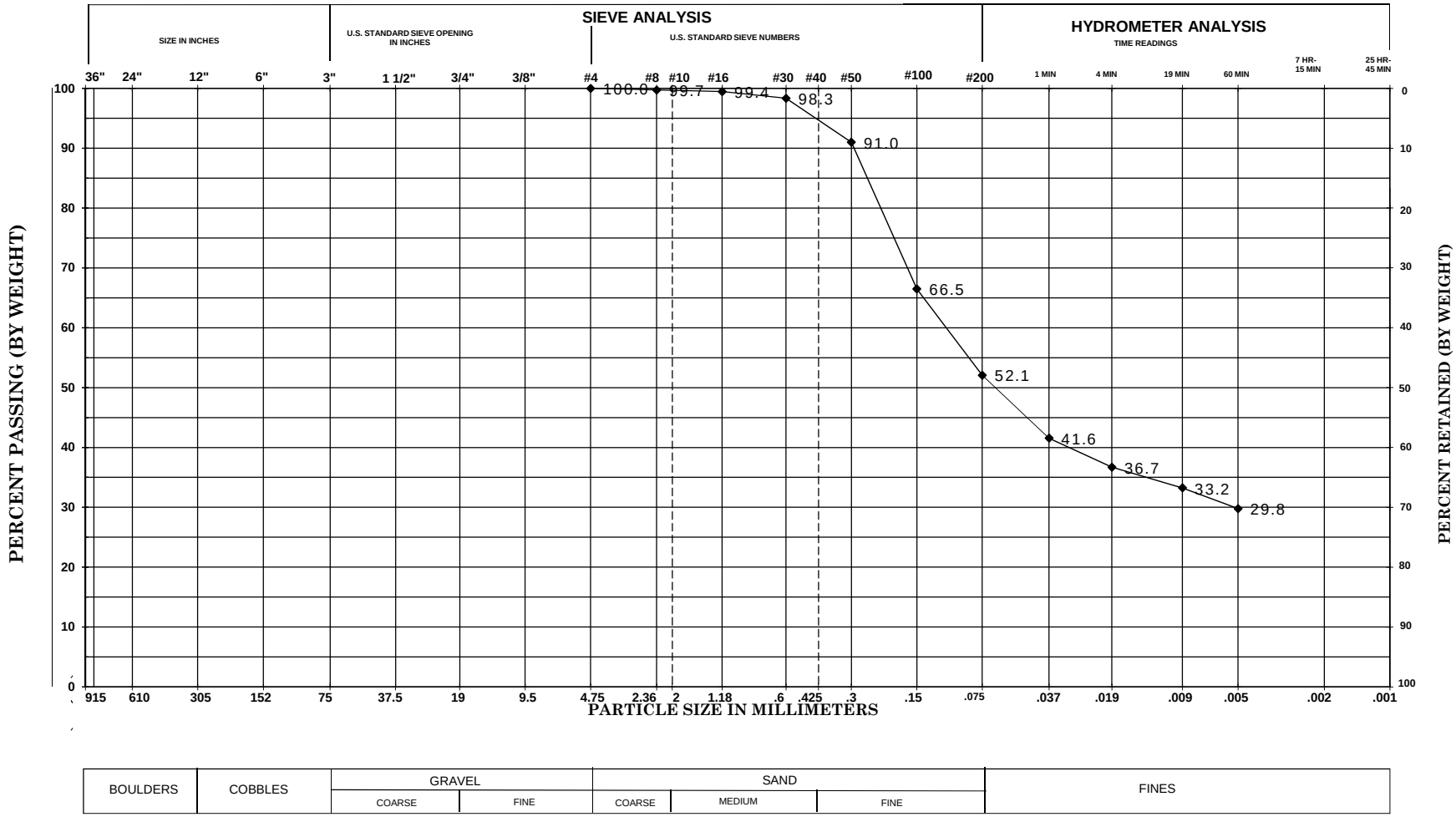
Unified Soil Classification: **SC-SM Silty Clayey Sand**

Sample Collected by: J.Fitzsimmons

Trace % Gravel	Maximum Size: 1"	Specific Gravity	D_{50}: 0.003 in
53.3 % Sand	Moisture Content: 5.2%	Plus No. 4:	C_U:
46.7 % Fines	Liquid Limit: 21.8	Minus No. 4:	C_C:
% Oversize	Plasticity Index: 5.4		

NCAWSFS **TP-230** **0' to 6'** **10/06/15**

GRAIN SIZE DISTRIBUTION



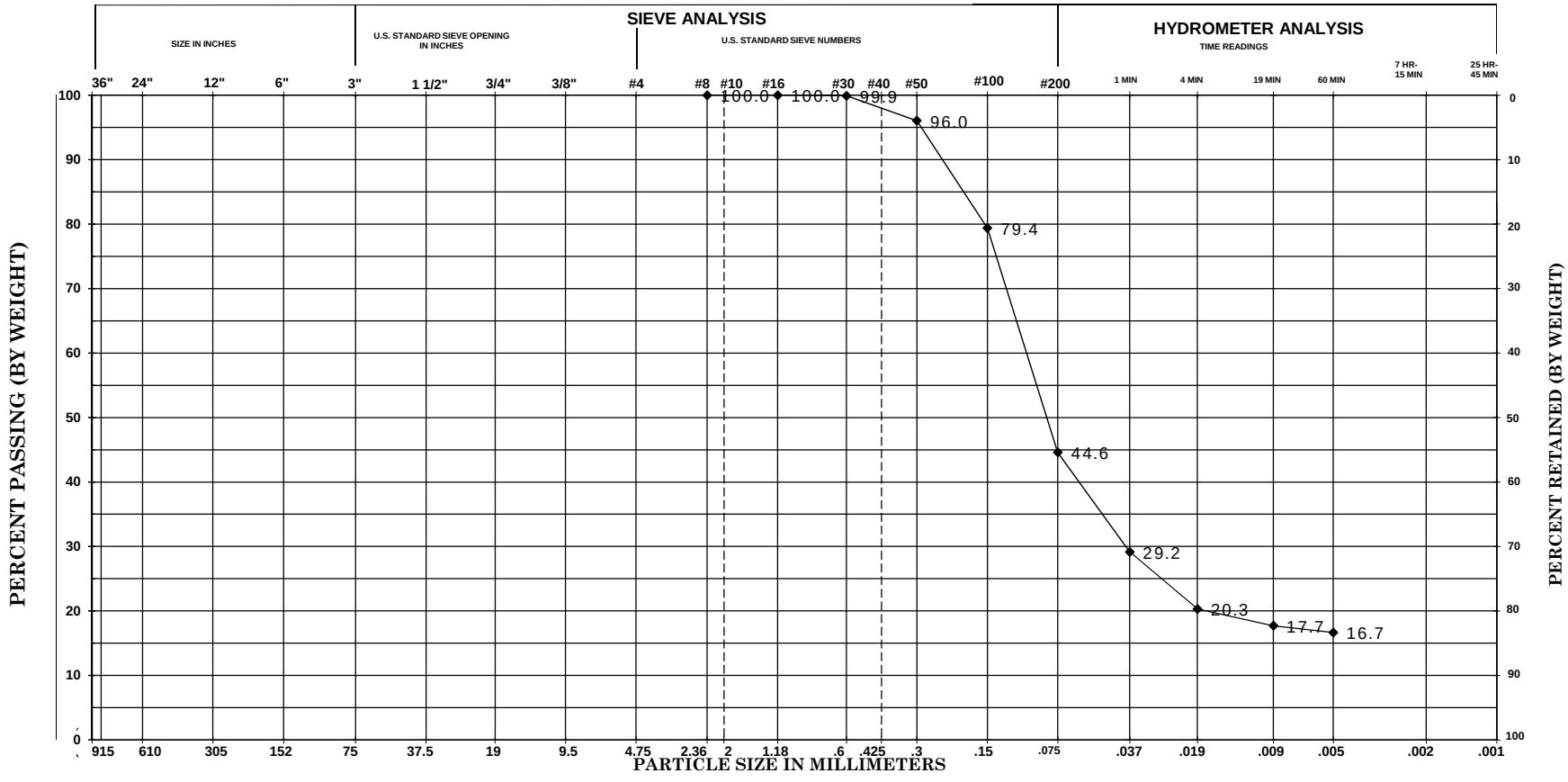
Unified Soil Classification: **CL Sandy Lean Clay**

Sample Collected by: J.Fitzsimmons

0.0 % Gravel	Maximum Size: No. 4	Specific Gravity	D_{50}:	0.003 in
47.9 % Sand	Moisture Content: 6.6%	Plus No. 4:	C_U:	
52.1 % Fines	Liquid Limit: 24.7	Minus No. 4:	C_C:	
% Oversize	Plasticity Index: 13.2			

NCAWSFS **TP-231** **0' to 4.5'** **10/06/15**

GRAIN SIZE DISTRIBUTION



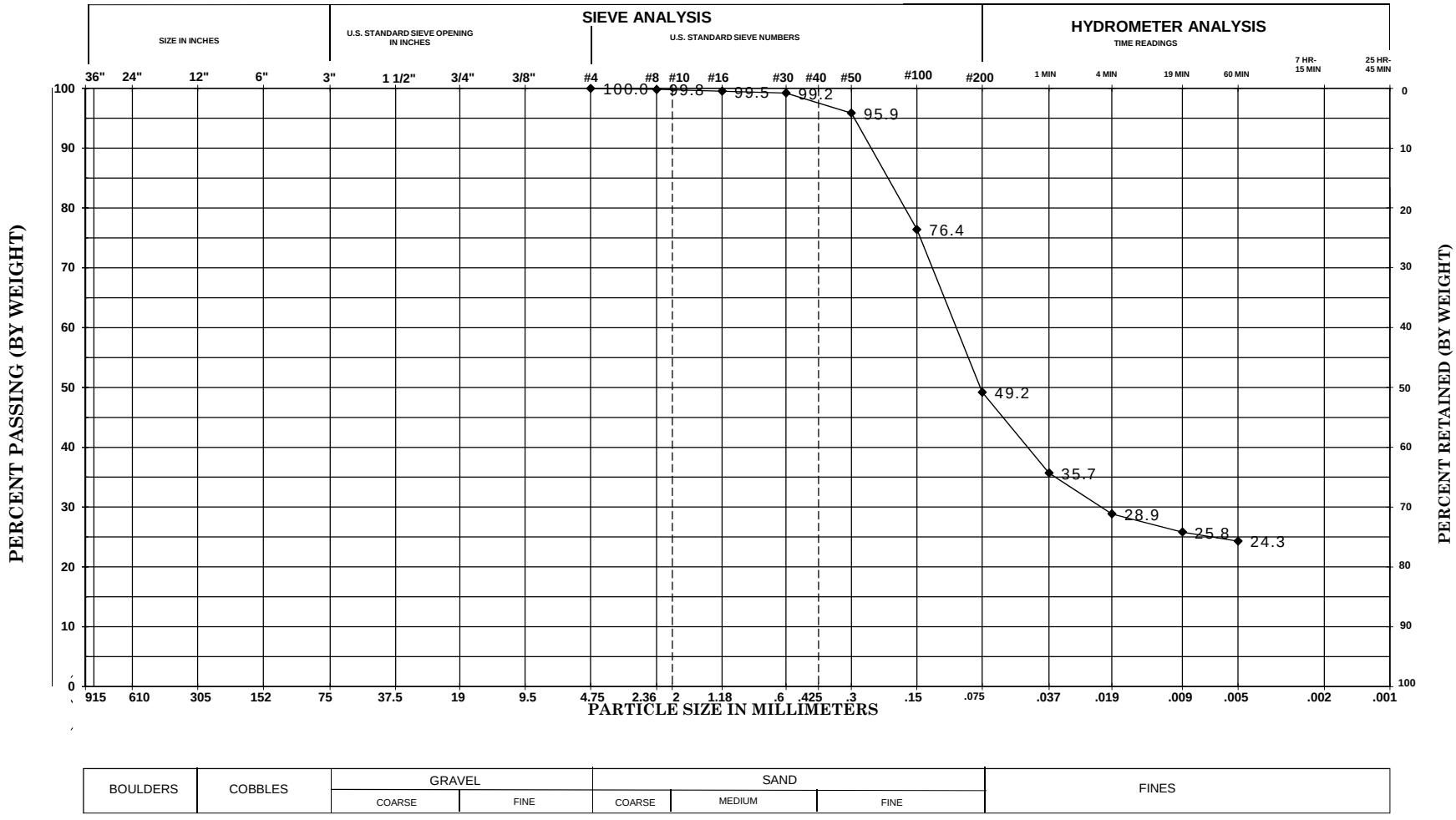
Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J.Fitzsimmons

0.0 % Gravel	Maximum Size: No. 8	Specific Gravity	D_{50}: 0.003 in
55.4 % Sand	Moisture Content: 3.6%	Plus No. 4:	C_U:
44.6 % Fines	Liquid Limit:	Minus No. 4:	C_C:
% Oversize	Plasticity Index: Nonplastic		

NCAWSFS **TP-232** **0' to 4.5'** **10/07/15**

GRAIN SIZE DISTRIBUTION



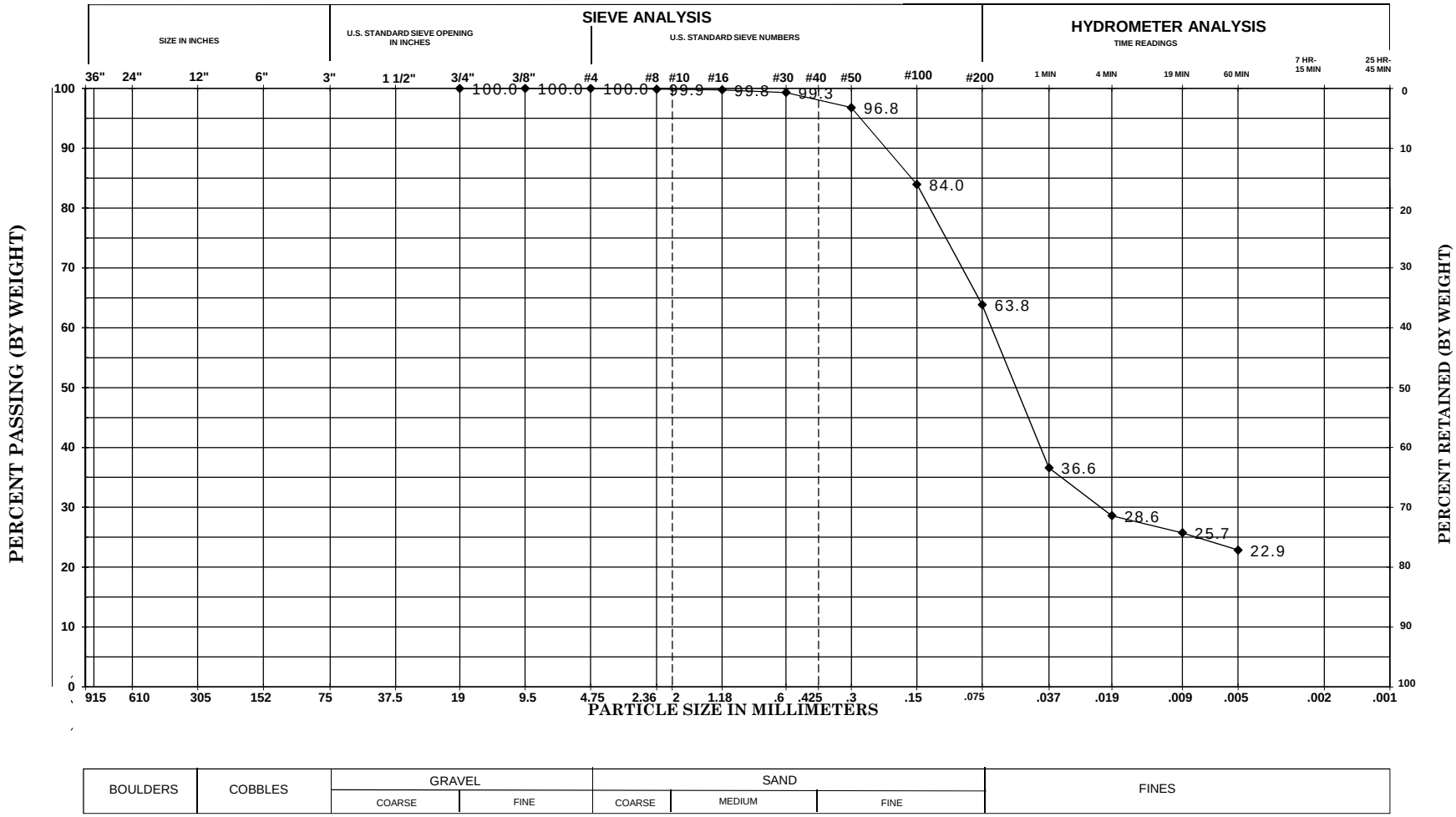
Unified Soil Classification: **SC/CL Clayey Sand**

Sample Collected by: J.Fitzsimmons

Trace % Gravel	Maximum Size: 3/4"	Specific Gravity	D_{50}:	0.003 in
50.7 % Sand	Moisture Content: 4.3%	Plus No. 4:	C_U:	
49.2 % Fines	Liquid Limit: 22.3	Minus No. 4:	C_C:	
% Oversize	Plasticity Index: 9.3			

NCAWSFS **TP-233** **0' to 7'** **10/07/15**

GRAIN SIZE DISTRIBUTION



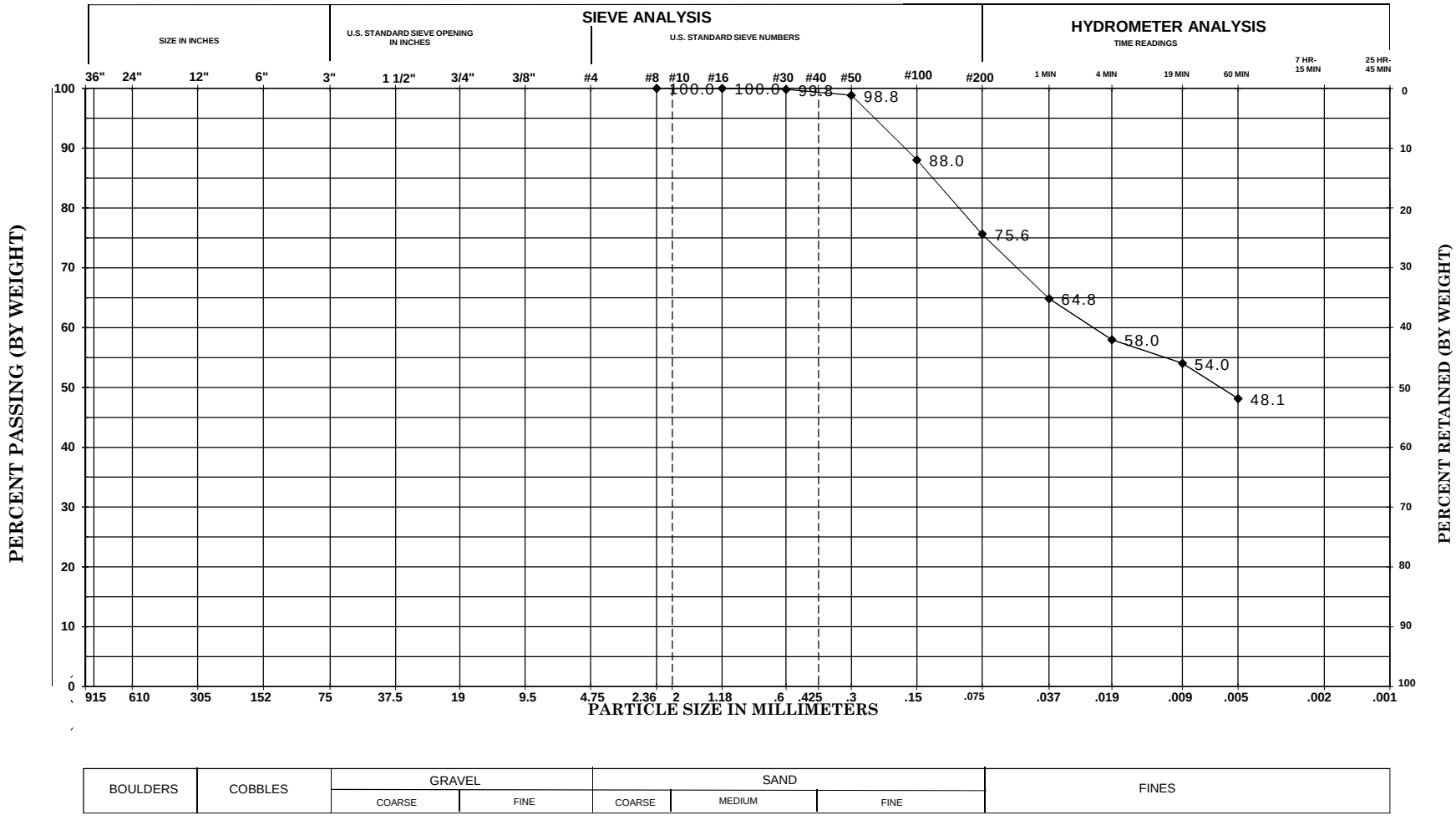
Unified Soil Classification: **CL Sandy Lean Clay**

Sample Collected by: J.Fitzsimmons

Trace % Gravel	Maximum Size: 1/2"	Specific Gravity	D_{50}:	0.002 in
36.1 % Sand	Moisture Content: 5.3%	Plus No. 4:	C_U:	
63.8 % Fines	Liquid Limit: 23.6	Minus No. 4:	C_C:	
% Oversize	Plasticity Index: 12.1			

NCAWSFS **TP-234** **0' to 13'** **10/07/15**

GRAIN SIZE DISTRIBUTION



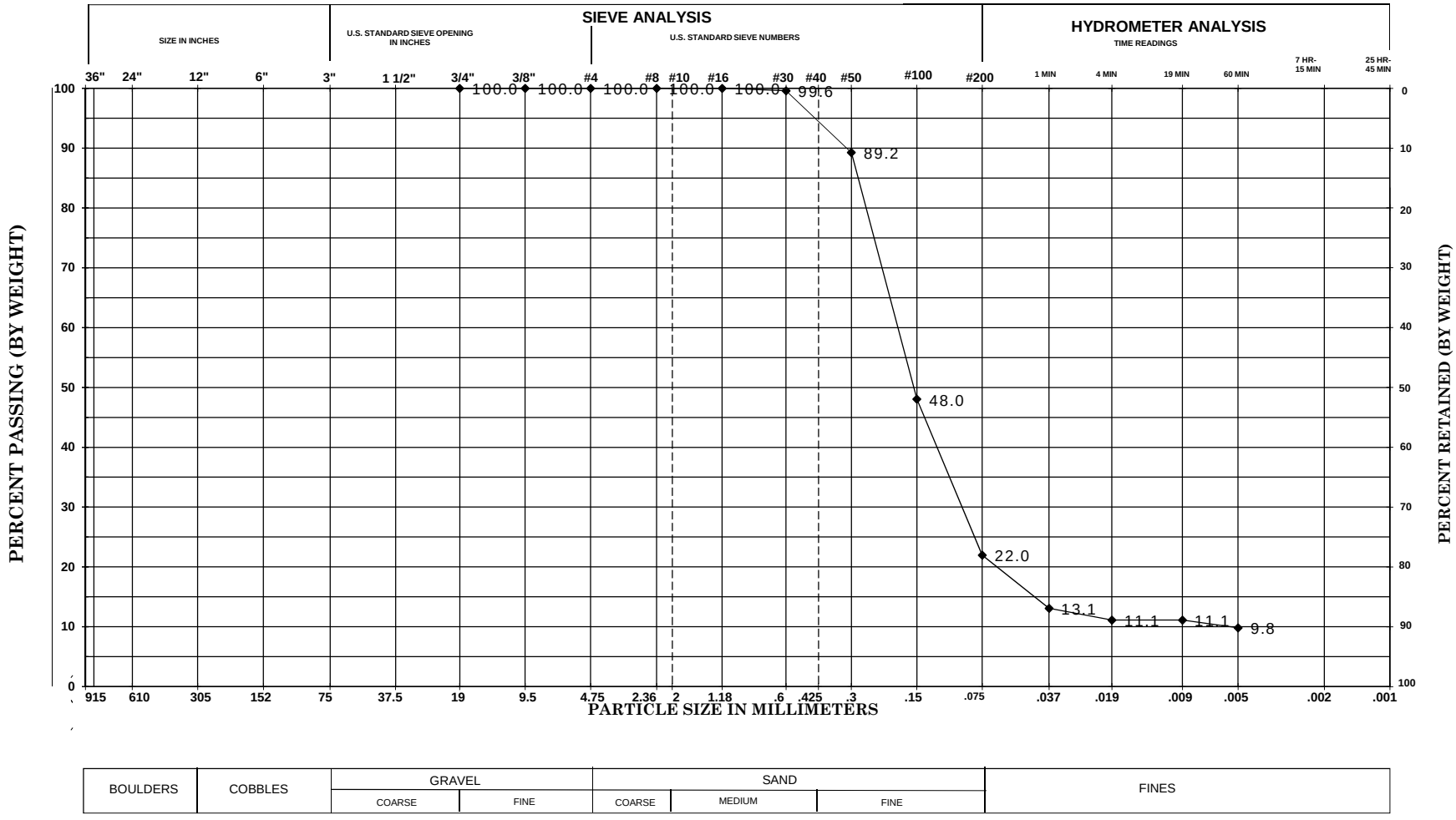
Unified Soil Classification: **CL Lean Clay with Sand**

Sample Collected by: J.Fitzsimmons

0.0 % Gravel	Maximum Size: No. 8	Specific Gravity	D_{50}:	0.000 in
24.4 % Sand	Moisture Content: 9.0%	Plus No. 4:	C_U:	
75.6 % Fines	Liquid Limit: 33.8	Minus No. 4:	C_C:	
% Oversize	Plasticity Index: 21.1			

NCAWSFS **TP-235** **0' to 5'** **10/07/15**

GRAIN SIZE DISTRIBUTION



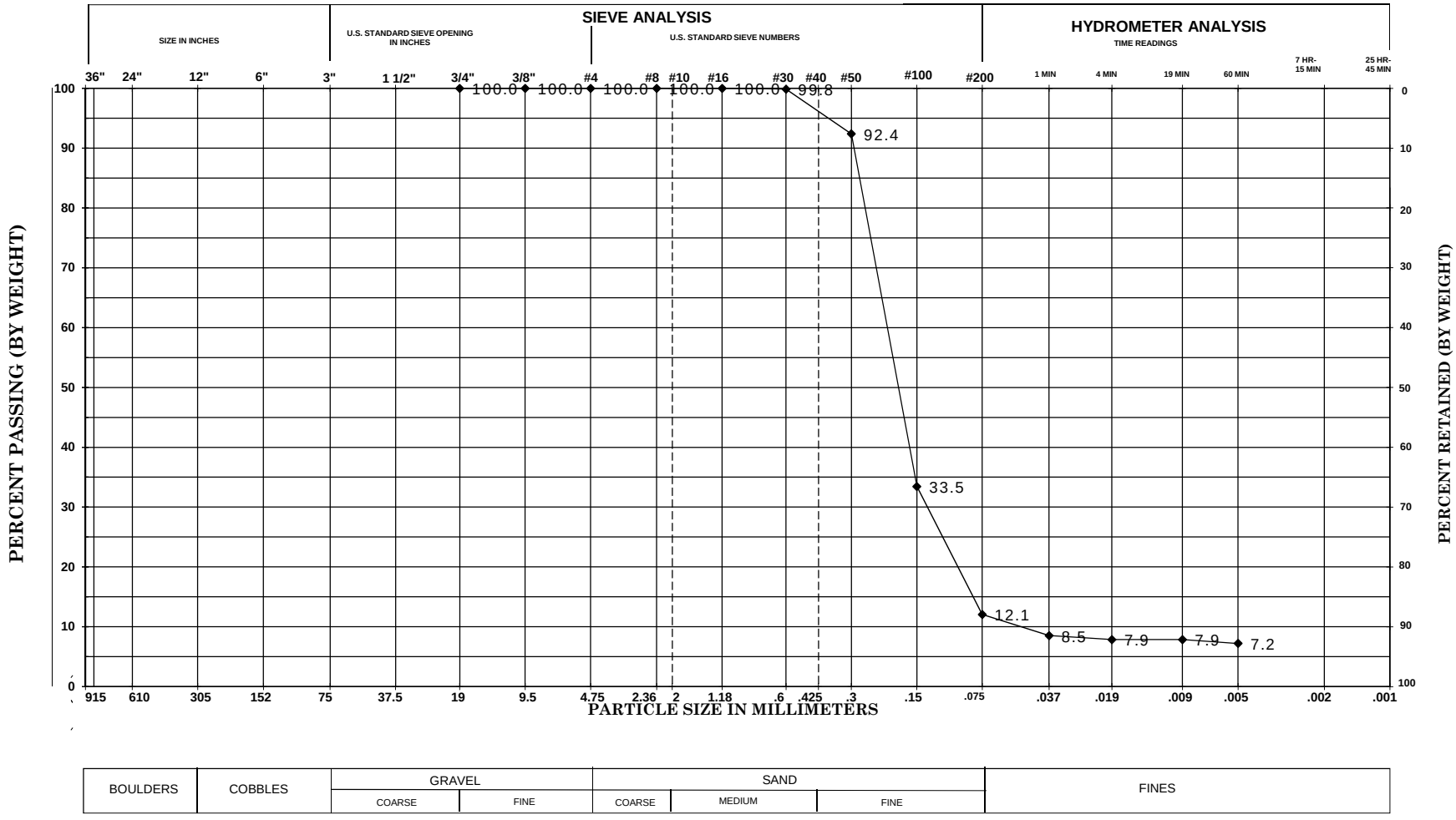
Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J.Fitzsimmons

Trace % Gravel	Maximum Size: 3/4"	Specific Gravity	D_{50}: 0.006 in
78.0 % Sand	Moisture Content: 2.3%	Plus No. 4:	C_U: 30.4
22.0 % Fines	Liquid Limit:	Minus No. 4:	C_C: 7.8
% Oversize	Plasticity Index: Nonplastic		

NCAWSFS **TP-236** **0' to 7'** **10/07/15**

GRAIN SIZE DISTRIBUTION



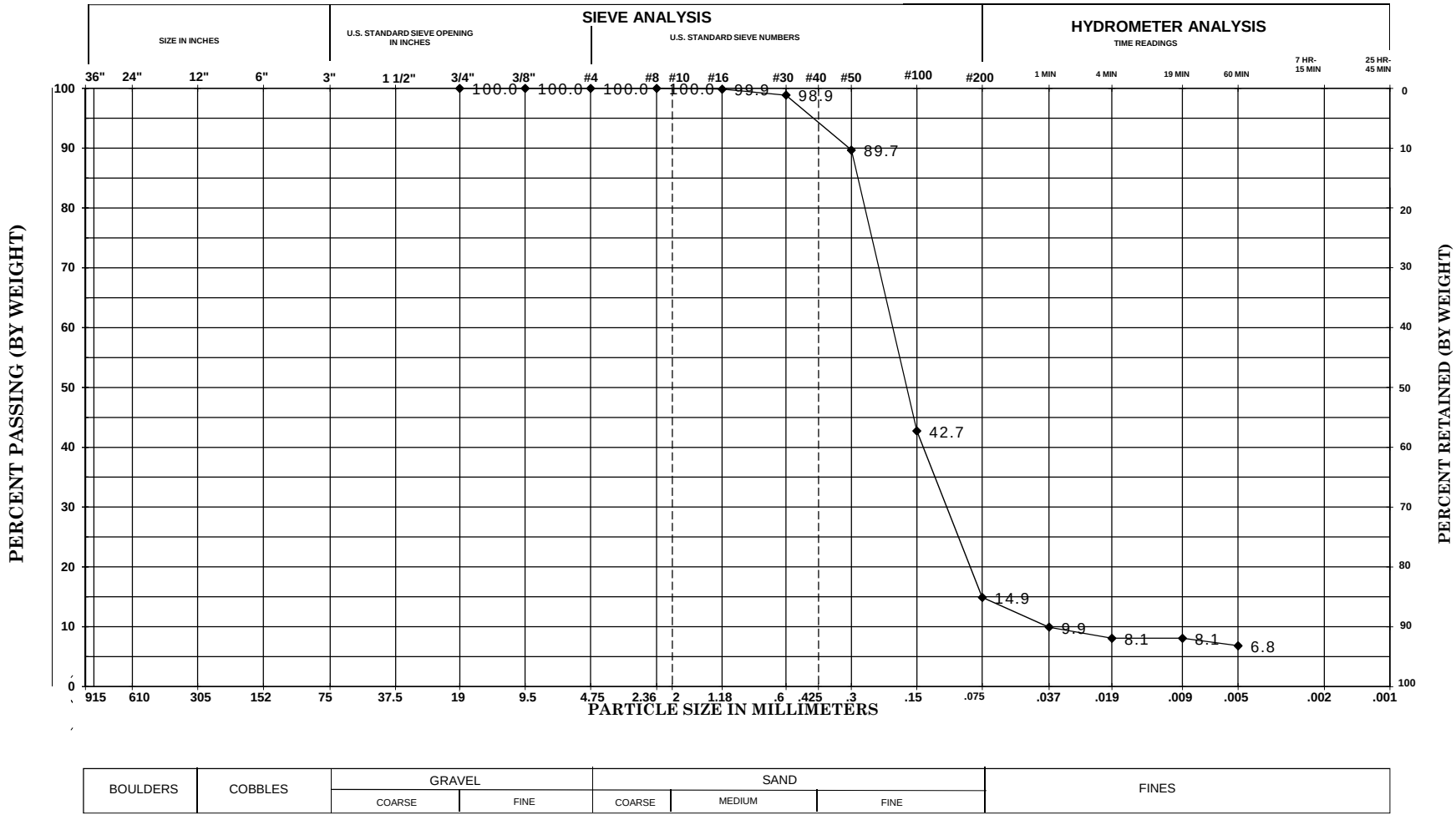
Unified Soil Classification: **SP-SM Poorly Graded Sand with Silt**

Sample Collected by: J.Fitzsimmons

Trace % Gravel	Maximum Size: 1/2"	Specific Gravity	D_{50}: 0.007 in
87.9 % Sand	Moisture Content: -	Plus No. 4:	C_U: 4.1
12.1 % Fines	Liquid Limit:	Minus No. 4:	C_C: 1.8
% Oversize	Plasticity Index: Nonplastic		

NCAWSFS **TP-237** **0' to 12'** **10/07/15**

GRAIN SIZE DISTRIBUTION



Unified Soil Classification: **SM Silty Sand**

Sample Collected by: J.Fitzsimmons

Trace % Gravel	Maximum Size: 3/4"	Specific Gravity	D_{50}: 0.007 in
85.1 % Sand	Moisture Content: -	Plus No. 4:	C_U: 5.2
14.9 % Fines	Liquid Limit:	Minus No. 4:	C_C: 1.7
% Oversize	Plasticity Index: Nonplastic		

Western Technologies Inc.
The Quality People
Since 1955

3737 East Broadway Road
Phoenix, AZ 85040
(602) 437-3737

PHYSICAL PROPERTIES OF SOILS & AGGREGATES

Client **BUREAU OF RECLAMATION**
6150 W THUNDERBIRD RD
GLENDALE, AZ 85306

Date of Report **10-22-15**
Job No. **2143JL115**
Event / Invoice No. **G115-006** Lab No. **65087**
Authorized by **MIKE MILLER** Date **10-13-15**
Sampled by **CLIENT** Date **10-13-15**
Submitted by **MIKE MILLER** Date **10-13-51**

Project **NCAWSFSORY SERVICES**
Contractor **--**
Type / Use of Material **SOIL**
Sample Source / Location **TP224**
Testing Authorized :
Special Instructions :

Location **HOPI RESERVATION**
Arch. / Engr. **--**
Supplier / Source **PROJECT SITE**
Source / Location Desig. By **CLIENT** Date **10-13-15**

TEST RESULTS

SIEVE ANALYSIS :
FINER THAN NO. 200 :

SIEVE	ACCUMULATIVE % PASSING	SPECIFICATION

LABORATORY COMPACTION CHARACTERISTICS : METHOD

DRY UNIT WEIGHT, LBF/FT^3

SAMPLE PREPARATION WET DRY
RAMMER USED:
2 IN. CIRCULAR FACE OTHER
MECHANICAL MANUAL

MAXIMUM DENSITY, LBF/FT^3 →
OPTIMUM MOISTURE CONTENT, % →

OVERSIZE AGGREGATE :
BULK SPECIFIC GRAVITY :
ABSORPTION, % :
% OVERSIZE IN LAB SAMPLE :

SPECIFIC GRAVITY IN ZERO AIR VOID CURVE :

MOISTURE, % DRY WEIGHT

TEST PROCEDURE	RESULT	SPECS
LIQUID & PLASTIC PROPERTIES :		
LIQUID LIMIT →		
ESTIMATED % RETAINED ON NO. 40 PLASTIC LIMIT →		
SAMPLE AIR DRIED YES NO PLASTICITY INDEX →		
MOISTURE CONTENT :		
PORTION TESTED % DRY WEIGHT →		
EXPANSION / COMPRESSION PROPERTIES OF COHESIVE SOIL :		
EXPANSION COMPRESSION, % →		
MAXIMUM SWELL PRESSURE, KSF →		
SURCHARGE, KSF		
INITIAL WATER CONTENT, % DRY DENSITY, PCF		

TEST PROCEDURE	RESULT	SPECS
RESISTANCE TO DEGRADATION OF SMALL-SIZE COARSE AGGREGATES BY ABRASION :		
GRADING 100 REV, % LOSS →		
GRADING 500 REV, % LOSS →		
SPECIFIC GRAVITY :		
MAX. PARTICLE SIZE, IN SPECIFIC GRAVITY @ 20 C		
pH DETERMINATION : AZ 237 →		
pH →	8.7	
SOLUBLE SALTS :		
PPM →		
MINIMUM RESISTIVITY : AZ 236		
OHM-CM →	8224	

SOIL CLASSIFICATION : GROUP SYMBOL :
NAME :

Comments :

Copies to : **CLIENT**

THE SERVICES REFERRED TO HEREIN WERE PERFORMED IN ACCORDANCE WITH THE STANDARD OF CARE PRACTICED LOCALLY FOR THE REFERENCED METHOD(S) AND RELATE ONLY TO THE CONDITIONS OBSERVED OR SAMPLE(S) TESTED AT THE TIME AND PLACE STATED HEREIN. WESTERN TECHNOLOGIES INC. MAKES NO OTHER WARRANTY OR REPRESENTATION EXPRESSED OR IMPLIED AND HAS NOT CONFIRMED INFORMATION INCLUDING SOURCE OF MATERIALS SUBMITTED BY OTHERS.

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3737 East Broadway Road
Phoenix, AZ 85040
(602) 437-3737

PHYSICAL PROPERTIES OF SOILS & AGGREGATES

Client **BUREAU OF RECLAMATION**
6150 W THUNDERBIRD RD
GLENDALE, AZ 85306

Date of Report: **10-22-15**
Job No. **2143JL115**
Event / Invoice No. **G115-006** Lab No. **65086**
Authorized by **MIKE MILLER** Date **10-13-15**
Sampled by **CLIENT** Date **10-13-15**
Submitted by **MIKE MILLER** Date **10-13-15**

Project **NCAWSFS**
Contractor **--**
Type / Use of Material **SOIL**
Sample Source / Location **TP227**
Testing Authorized :
Special Instructions :

Location **HOPI RESERVATION**
Arch. / Engr. **--**
Supplier / Source **PROJECT SITE**
Source / Location Desig. By **CLIENT** Date **10-13-15**

TEST RESULTS

SIEVE ANALYSIS :
FINER THAN NO. 200 :

SIEVE	ACCUMULATIVE % PASSING	SPECIFICATION

LABORATORY COMPACTION CHARACTERISTICS : METHOD

DRY UNIT WEIGHT, LBF/FT^3

SAMPLE PREPARATION WET DRY
RAMMER USED:
2 IN. CIRCULAR FACE OTHER
MECHANICAL MANUAL

MAXIMUM DENSITY, LBF/FT^3 →
OPTIMUM MOISTURE CONTENT, % →

OVERSIZE AGGREGATE :
BULK SPECIFIC GRAVITY :
ABSORPTION, % :
% OVERSIZE IN LAB SAMPLE :

SPECIFIC GRAVITY IN ZERO AIR VOID CURVE :

MOISTURE, % DRY WEIGHT

TEST PROCEDURE	RESULT	SPECS
LIQUID & PLASTIC PROPERTIES :		
LIQUID LIMIT →		
ESTIMATED % RETAINED ON NO. 40 PLASTIC LIMIT →		
SAMPLE AIR DRIED YES NO PLASTICITY INDEX →		
MOISTURE CONTENT :		
PORTION TESTED % DRY WEIGHT →		
EXPANSION / COMPRESSION PROPERTIES OF COHESIVE SOIL :		
EXPANSION COMPRESSION, % →		
MAXIMUM SWELL PRESSURE, KSF →		
SURCHARGE, KSF		
INITIAL WATER CONTENT, % DRY DENSITY, PCF		

TEST PROCEDURE	RESULT	SPECS
RESISTANCE TO DEGRADATION OF SMALL-SIZE COARSE AGGREGATES BY ABRASION :		
GRADING 100 REV, % LOSS →		
GRADING 500 REV, % LOSS →		
SPECIFIC GRAVITY :		
MAX. PARTICLE SIZE, IN SPECIFIC GRAVITY @ 20 C		
pH DETERMINATION : AZ 237 →		
pH →	8.0	
SOLUBLE SALTS :		
PPM →		
MINIMUM RESISTIVITY : AZ 236		
OHM-CM →	423	

SOIL CLASSIFICATION : GROUP SYMBOL :
NAME :

Comments :

Copies to : **CLIENT**

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3737 East Broadway Road
Phoenix, AZ 85040
(602) 437-3737

PHYSICAL PROPERTIES OF SOILS & AGGREGATES

Client **BUREAU OF RECLAMATION**
6150 W THUNDERBIRD RD
GLENDALE, AZ 85306

Date of Report: **10-22-15**
Job No. **2143JL115**
Event / Invoice No. **G115-006** Lab No. **65088**
Authorized by **MIKE MILLER** Date **10-13-15**
Sampled by **CLIENT** Date **10-13-15**
Submitted by **MIKE MILLER** Date **10-13-15**

Project **NCAWSFS**
Contractor **--**
Type / Use of Material **SOIL**
Sample Source / Location **TP235**
Testing Authorized :
Special Instructions :

Location **HOPI RESERVATION**
Arch. / Engr. **--**
Supplier / Source **PROJECT SITE**
Source / Location Desig. By **CLIENT** Date **10-13-15**

TEST RESULTS

SIEVE ANALYSIS :
FINER THAN NO. 200 :

SIEVE	ACCUMULATIVE % PASSING	SPECIFICATION

LABORATORY COMPACTION CHARACTERISTICS : METHOD

DRY UNIT WEIGHT, LBF/FT^3

SAMPLE PREPARATION WET DRY
RAMMER USED:
2 IN. CIRCULAR FACE OTHER
MECHANICAL MANUAL

MAXIMUM DENSITY, LBF/FT^3 →
OPTIMUM MOISTURE CONTENT, % →

OVERSIZE AGGREGATE :
BULK SPECIFIC GRAVITY :
ABSORPTION, % :
% OVERSIZE IN LAB SAMPLE :

SPECIFIC GRAVITY IN ZERO AIR VOID CURVE :

MOISTURE, % DRY WEIGHT

TEST PROCEDURE	RESULT	SPECS
LIQUID & PLASTIC PROPERTIES :		
LIQUID LIMIT →		
ESTIMATED % RETAINED ON NO. 40 PLASTIC LIMIT →		
SAMPLE AIR DRIED YES NO PLASTICITY INDEX →		
MOISTURE CONTENT :		
PORTION TESTED % DRY WEIGHT →		
EXPANSION / COMPRESSION PROPERTIES OF COHESIVE SOIL :		
EXPANSION COMPRESSION, % →		
MAXIMUM SWELL PRESSURE, KSF →		
SURCHARGE, KSF		
INITIAL WATER CONTENT, % DRY DENSITY, PCF		

TEST PROCEDURE	RESULT	SPECS
RESISTANCE TO DEGRADATION OF SMALL-SIZE COARSE AGGREGATES BY ABRASION :		
GRADING 100 REV, % LOSS →		
GRADING 500 REV, % LOSS →		
SPECIFIC GRAVITY :		
MAX. PARTICLE SIZE, IN SPECIFIC GRAVITY @ 20 C		
pH DETERMINATION : AZ 237 →		
pH →	8.5	
SOLUBLE SALTS :		
PPM →		
MINIMUM RESISTIVITY : AZ 236		
OHM-CM →	2181	

SOIL CLASSIFICATION : GROUP SYMBOL :
NAME :

Comments :

Copies to : **CLIENT**

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PAGE

LECHEE

Coppermine Rd

BITTER SPRINGS

US HWY 89

CEDAR RIDGE

The GAP

US Hwy 89

TUBA CITY

MOENKOPI

AZ 264

CAMERON

Hwy 89

GRAY MOUNTAIN

KYKOTSMOVI

AZ 264

AZ 264

KEAMS CANYON

FIGURE G-2

FIGURE G-3

FIGURE G-4

FIGURE G-5

FIGURE G-6

FIGURE G-7

FIGURE G-8

FIGURE G-9

N

NTS

RECLAMATION
Managing Water in the West

ALWAYS THINK SAFETY

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
FEDERAL DOMESTIC ASSISTANCE PROGRAM

RECLAMATION RURAL WATER SUPPLY
PROGRAM 15.548

NORTH CENTRAL ARIZONA WATER SUPPLY
FEASIBILITY STUDY

DESIGNED
DRAWN
CHECKED
TECH. APPR.
APPROVED
ADMIN. APPROVAL - TITLE

PHOENIX AREA OFFICE, ARIZONA 2016-06-24

DRAWING KEY FOR GEOLOGIC FIGURES

NORTH CENTRAL ARIZONA PIPELINE

FIGURE G-1

SHEET 1

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SCALE OF FEET
2000 0 2000 4000 6000

N

LEGEND

TP-50 ■ 0.0-5.0 SM 5.0 Ss (Jn) — *Test pit location showing depth of material encountered and classification.*

TT-15 ▬ 0.0-4.5 Ss — *Test trench (2008) location showing depth of material encountered and classification.*

EXPLANATION

- PmP-2 — *Proposed pumping plant*
- *Proposed turnout*
- Jn / Jsc — *Contact*
- 00+01 — *Proposed alignment*

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NORTH CENTRAL ARIZONA WATER SUPPLY FEASIBILITY STUDY

RECLAMATION *Managing Water in the West*

X DESIGNED
X DRAWN
X CHECKED
X TECH. APPR.
X APPROVED
PHOENIX AREA OFFICE, ARIZONA 2016-06-24

SURFACE GEOLOGY AND LOCATION OF EXPLORATION

LAKE POWELL INTAKE TO LECHEE
STA. 10+00 TO STA. 518+62.66

FIGURE G-2
SHEET 1

Le Chee Turnout
518+63
1002+00
Jsc
Matchline 1030+00
Figure G-2
1050+00
1100+00
TT-3
0.0-7.0 Ss (Jsc)
PmP-4
1150+00
Jsc
1200+00
1250+00
1300+00
1350+00
Coppermine Rd
1400+00
Matchline 1408+00

1400+00
Matchline 1408+00
PmP-5
Coppermine Rd
1450+00
Jsc
1500+00
TP-63
0.0-5.0 SP
5.0-10.0 Ss (Jsc)
1550+00
Qe
TP-62
0.0-5.5 SP
5.5-6.5 Ss (Jn)
Jn
1600+00
TP-61
0.0-3.5 (SP)cb
3.5-7.0 Ss (Jn)
Jn
1650+00
TP-60
0.0-6.5 SP
6.5 Ss (Jn)
Jn
1700+00
TT-5
0.0-8.5 Ss (Jn)
TP-59
0.0-5.5 SP
5.5 Ss (Jn)
1750+00
Jn
1800+00
Qe
Matchline 1812+16

1800+00
Qe
Matchline 1812+16
TP-58
0-13.0 SP
Jn
1850+00
Qe
1900+00
TP-57
0.0-10.0 SP
10.0 Ss (Jn)
Jn
TP-63
0-5.0 SP
5.0-10.0 Ss (Jn)
1950+00
Jn
2000+00
2050+00
Jn
2100+00
Coppermine Rd
2150+00
Coppermine Chapter Turnout
PmP-Coppermine Booster Pump
2200+00
Jn
2000 0 2000 4000 6000
SCALE OF FEET
Matchline 2237+76

Matchline 2237+76
TT-7
0.0-2.0 Ss (Jn)
2250+00
Jn
COPPERMINE RD
2300+00
TP-67
0.0-7.0 SP
7.0-9.0 Ss (Jn)
2350+00
TP-56
0.0-15.0 SP
2400+00
Qe
2450+00
TP-55
0.0-14.5 SP
2500+00
Qe
Jn
2550+00
Coppermine Rd
2600+00
TP-68
0.0-3.3 SP
3.3-5.5 Ss (Jn)
Jn
2650+00
Matchline 2653+78

2650+00
Matchline 2653+78
TP-54
0.0-2.4 SP
2.4-6.5 Ss (Jn)
Jn
2700+00
TP-53
0.0-3.0 SP
3.0-3.5 (SP)g
3.5-8.0 Ss (Jn)
2750+00
Coppermine Rd
TP-52
0.0-2.0 SP
2.0-3.8 (SP)g
3.8-7.0 Ss (Jn)
Jn
2800+00
Qe
TP-51
0.0-4.5 (SP)
4.5-6.5 CL
6.5-10.4 SP
10.4-13.0 Ss (Jn)
2850+00
Jn
2900+00
TT-10
0.0-4.0 Ss (Jn)
Jn
TP-50
0.0-5.0 SM
5.0 Ss (Jn)
2950+00
3000+00
Jn
Coppermine Rd
3050+00
TP-49
0.0-3.2 SP
3.2-7.0 Ss (Jn)
Matchline 3070+19
Figure G-4

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RECLAMATION
Managing Water in the West

EXPLANATION
Proposed pumping plant
Proposed turnout
Contact
Proposed alignment
PmP-2
Jsc
Jn
10+00

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RECLAMATION RURAL WATER SUPPLY
PROGRAM 15.548
NORTH CENTRAL ARIZONA WATER SUPPLY
FEASIBILITY STUDY

LEGEND
Test pit location showing depth of material encountered and classification.
TP-50
0.0-5.0 SM
5.0 Ss (Jn)
Test trench (2008) location showing depth of material encountered and classification.
TT-15
0.0-4.5 Ss

X DESIGNED
X DRAWN
X CHECKED
X TECH. APPR.
X APPROVED
ADMIN. APPROVAL - TITLE
PHOENIX AREA OFFICE, ARIZONA 2016-06-24

SURFACE GEOLOGY AND LOCATION OF EXPLORATION

LECHEE TO THE GAP

STA. 10+02 TO STA. 3067+00

FIGURE G-3
SHEET 1

Earthstar Geographics SIO © 2016 Microsoft Corporation

RECLAMATION
Managing Water in the West

EXPLANATION

PmP-2 Proposed pumping plant

Proposed turnout

Contact

Proposed alignment

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RECLAMATION RURAL WATER SUPPLY PROGRAM 15.548

NORTH CENTRAL ARIZONA WATER SUPPLY FEASIBILITY STUDY

LEGEND

TP-50 0.0-5.0 SM 5.0 Ss (Jn) — Test pit location showing depth of material encountered and classification.

TT-15 0.0-4.5 Ss — Test trench (2008) location showing depth of material encountered and classification.

DESIGNED	X
DRAWN	X
CHECKED	X
TECH. APPR.	X
APPROVED (OPS. MANAGER - TITLE)	X
PHOENIX AREA OFFICE, ARIZONA	2016-06-24

SURFACE GEOLOGY AND LOCATION OF EXPLORATION

THE GAP TO BITTER SPRINGS

STA. 10+00 TO STA. 1398+68.17

FIGURE G-4

SHEET 1

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SCALE OF FEET: 2000 0 2000 4000 6000

US Hwy 89A

Bitter Springs Turnout

1398+68

US Hwy 89

Bitter Springs

TP-1 0.0-8.0 (SM)b 0-12.0 (SP-SM)cb

TP-2 0.0-13.0 (SM)g

TP-3 0.0-4.0 (SP)cb 4.0-13.0 (SM)gcb

TP-4 0.0-13.0 (SP-SM)gcb

TP-5 0.0-2.0 SP 2.0-12.0 (CL)s

TT-15 0.0-4.5 Ss (Pk)

TP-6 0.0-4.0 (SP)cb 4.0-10.0 (SM)g 10.0-13.5 Ls (Pk)

TP-7 0.0-14.0 (SC)c

TP-8 0.0-6.0 (SC)c 6.0-7.5 Mdst (TRcp)

TT-14 0.0-1.0 Ss (TRcs)

TP-9 0.0-4.0 (SM)g 4.0-5.8 (GP-GM)sc 5.8-10.0 (SC)g 10.0-12.0 Ss (TRcs)

TP-10 0.0-9.4 (SM)gcb 9.4-13.0 Mdst (TRcp)

TP-11 0.0-6.0 (SC)g 6.0-7.5 (GP)s 7.5-11.5 Ss (TRcp)

TP-12 0.0-3.8 (SP)c 3.8-11.5 SC

TP-13 0.0-4.0 SC 4.0-11.0 Mdst (TRcp)

TP-14 0.0-8.0 SM 8.0-10.0 (SP)g 10.0-11.0 Ss (TRcs)

TP-15 0.0-0.9 (SP)g 0.9-5.5 SM 5.5-7.0 Ss (TRcs)

TP-16 0.0-3.5 s(CL) 3.5-6.0 Ss (TRcs)

Cedar Ridge Turnout

PmP-Cedar Ridge Booster

TP-18 0.0-2.5 (CL)s 2.5-9.5 Mdst (TRcp)

TT-12 0.0-4.0 Ss (TRcs)

PmP-Bitter Springs

TP-19 0.0-10.0 (SP-SC)gcb 10.0-14.0 Mdst (TRcp)

TP-20 0.0-8.7 (SM)c 8.7-9.5 (GP)sc 9.5-12.0 Mdst (TRcp)

TP-21 0.0-3.0 SM 3.0-8.5 (GC)sc 8.5-14.0 Mdst (TRcp)

The Gap Turnout

Matchline+ Figure G-3

TP-22 0.0-4.0 SM 4.0-7.0 (GM)sc 7.0-14.0 (SC)gcb

TP-23 0.0-4.0 SM 4.0-14.0 (GC-GM)scb

TP-24 0.0-4.0 (SC)b 4.0-10.0 (GM)s 10.0-15.0 (GM)sc

TP-25 0.0-5.0 SP 5.0-8.0 (SP)g 8.0-12.0 SP-SC

TP-26 0.0-3.5 (SP)g 3.5-10.5 Ss (TRcp)

TP-27 0.0-6.0 SM

TP-28 0.0-13.5 (SM)gcb

TP-49 0.0-3.2 SP 3.2-7.0 Ss (Jn)

Coppermine Rd

Matchline 1125+80

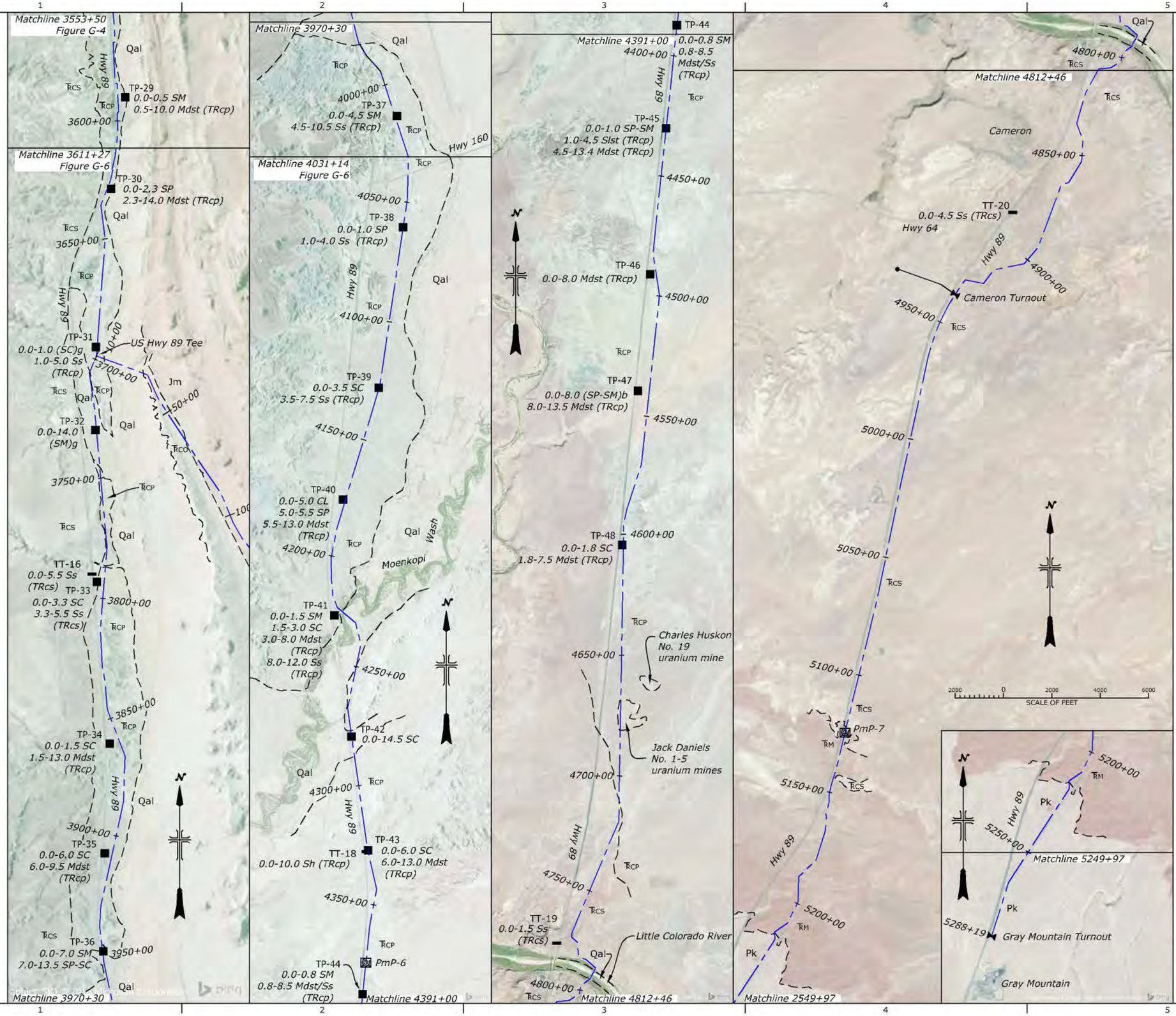
Matchline 734+52

Matchline 341+30

Matchline 3215+95

Matchline 3553+50 Figure G-5

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RECLAMATION
Managing Water in the West

EXPLANATION

Proposed pumping plant — PmP-2
Proposed turnout
Contact
Proposed alignment

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RECLAMATION RURAL WATER SUPPLY PROGRAM 15.548
NORTH CENTRAL ARIZONA WATER SUPPLY FEASIBILITY STUDY

LEGEND

TP-50 — Test pit location showing depth of material encountered and classification. 0.0-5.0 SM 5.0 Ss (Jn)

TT-15 — Test trench (2008) location showing depth of material encountered and classification. 0.0-4.5 Ss

DESIGNED	X
DRAWN	X
CHECKED	X
TECH. APPR.	X
APPROVED (OPS, ENGINEER, TITLE)	X
PHOENIX AREA OFFICE, ARIZONA	2016-06-24

SURFACE GEOLOGY AND LOCATION OF EXPLORATION

THE GAP TO GRAY MOUNTAIN

STA. 3500+00 TO STA. 5288+19.13

FIGURE G-5

SHEET 1

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Matchline 3611+27
Figure G-5

TP-30
0.0-2.3 SP
2.3-14.0 Mdst (TRcp)

TP-31
0.0-1.0 (SC)g
1.0-5.0 Ss
(TRcp)

TP-32
0.0-14.0
(SM)g

TT-16
0.0-5.5 Ss
(TRcs)

TP-33
0.0-3.3 SC
3.3-5.5 Ss
(TRcs)

TP-34
0.0-1.5 SC
1.5-13.0 Mdst
(TRcp)

TP-35
0.0-6.0 SC
6.0-9.5 Mdst
(TRcp)

TP-36
0.0-7.0 SM
7.0-13.5 SP-SC

TP-37
0.0-4.5 SM
4.5-10.5 Ss (TRcp)

Matchline 4031+14
Figure G-5

TP-69
0.0-4.5 Mdst (Jk)

TP-70
0.0-13.0 SP-SM

TP-71
0.0-9.0 SM
9.0-9.5 Mdst (Jkn)

TP-72
0.0-12.0 SM

TP-73
0.0-2.5 SP-SM
2.5-3.8 Mdst/Ss (Jkn)

PmP-Hopi 1

TP-74
0.0-0.9 SP-SM
0.9-2.4 Ss (Jkn)

TP-75
0.0-8.6 SM
8.6-8.7 Ss (Jn)

TP-76
0.0-6.0 SM
6.0-6.5 Ss (Jn)

TP-77
0.0-5.5 SM
5.5-9.0 Ss (Jn)

TP-78
0.0-6.0 SM
6.0 Ss (Jn)

TP-79
0.0-7.7 SM
7.7-11.0 Ss (Jn)

TP-80
0.0-6.0 SM
9.0 Ss (Jn)

TP-81
0.0-9.5 SP
9.5 Ss (Jn)

TT-23
0.0-0.5 Ss
(Moenave)

TT-24
0.0-4.0 Ss
(Moenave)

Tuba City Turnout

Matchline 28+00
Figure G-7

Moenave Rd
Monave Rd
Moenave
Tuba City
Hwy 89
Hwy 160
Qal
Jm
Jn
Jk
Jkn
Jsc
Qe
TRcp
TRcs
10+00
100+00
150+00
200+00
250+00
300+00
350+00
400+00
450+00
500+00
550+00
600+00
625+07.10
3650+00
3700+00
3750+00
3800+00
3850+00
3900+00
3950+00
4000+00

N

SCALE OF FEET
2000 0 2000 4000 6000

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RECLAMATION
Managing Water in the West

EXPLANATION
- PmP-2 — Proposed pumping plant
- Proposed turnout
- Contact
- Proposed alignment

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PROGRAM 15.548
NORTH CENTRAL ARIZONA WATER SUPPLY
FEASIBILITY STUDY

LEGEND
- Test pit location showing depth of material encountered and classification. — TP-50, 0.0-5.0 SM, 5.0 Ss (Jn)
- Test trench (2008) location showing depth of material encountered and classification. — TT-15, 0.0-4.5 Ss

DESIGNED	X
DRAWN	X
CHECKED	X
TECH. APPR.	X
APPROVED	X
ADMIN. APPROVAL - TITLE	
PHOENIX AREA OFFICE, ARIZONA	2016-06-24

SURFACE GEOLOGY AND LOCATION OF EXPLORATION

U.S. Hwy 89 TEE TO TUBA CITY

STA. 10+00 TO STA. 625+07.46

FIGURE G-6

SHEET 1

RECLAMATION
Managing Water in the West

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RECLAMATION RURAL WATER SUPPLY PROGRAM 15.548

NORTH CENTRAL ARIZONA WATER SUPPLY FEASIBILITY STUDY

EXPLANATION

- PmP-2 — Proposed pumping plant
- Proposed turnout
- Jsc — Contact
- Proposed alignment
- Jn
- 00+01

LEGEND

- TP-50 — Test pit location showing depth of material encountered and classification. 0.0-5.0 SM / 5.0 Ss (Jn)
- TT-15 — Test trench (2008) location showing depth of material encountered and classification. 0.0-4.5 Ss
- Contact Concealed

DESIGNED	X
DRAWN	X
CHECKED	X
TECH. APPR.	X
APPROVED	X
ADMIN. APPROVAL - TITLE	
PHOENIX AREA OFFICE, ARIZONA	2016-06-24

SURFACE GEOLOGY AND LOCATION OF EXPLORATION

TUBA CITY TO KEAMS CANYON

STA. 10+00 TO STA. 1700+00

FIGURE G-7

SHEET 1

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Matchline 470+64 — Matchline 28+00 Figure G-6 — Matchline 900+00 — Matchline 1293+44 — Matchline 1704+62

Tuba City Turnout — Tuba City — Moencopi — Moenkopi Turnout — Hwy 160 — AZ 264 — Coalmine Chapter Turnout — Coalmine Chapter

PmP-Hopi 3 — PmP-Hopi 4 — PmP-Hopi 5 — PmP-Hopi 6 — PmP-Hopi 7 — PmP-Hopi 2

TT-25 0.0-3.0 Ss (Jn)

TP-201 0.0-6.5 SM / 6.5-12.5 Ss (Jn)

TP-202 0.0-3.5 SP-SM / 3.5-7.0 SP / 7.0-9.0 Ss (Jn)

TT-26 0.0-9.0 Ss (Jn)

TP-203 0.0-13.0 SM

TP-204 0.0-7.0 SM / 7.0-9.5 SP / 9.5-11.5 Ss (Jn)

TP-205 0.0-11.0 SM / 11.0-13.0 Ss (Jn)

TP-206 0.0-15.0 SM

TP-207 0.0-14.0 SM

TP-208 0.0-5.0 SM / 5.0-6.5 SP / 6.5-7.5 Ss (Jn)

TP-209 0.0-4.5 SM / 4.5-5.0 SP / 5.0-8.0 Ss (Jn)

TP-210 0.0-6.0 SM / 6.0-9.0 Ss (Jsc)

TP-211 0.0-3.0 s(CL) / 3.0-3.5 Siltst (Kd) / 3.5-8.0 Ss (Kd)

TP-212 0.0-2.0 SM / 2.0-5.5 Ss (Kd)

TP-213 0.0-7.0 s(CL)

TP-215 0.0-2.0 SM / 2.0-5.0 s(CL) / 5.0-6.5 Cgl (Tsy) / 6.5-9.0 Ss (Tsy)

TP-216 0.0-6.0 SM / 6.0-12.0 Ss (Tsy)

TP-217 0.0-3.0 s(ML) / 3.0-12.0 Ss (Tsy)

TP-218 0.0-3.0 SM / 3.0-6.5 Sh (Km)

TP-219 0.0-3.0 SC / 3.0-6.0 SM / 6.0-11.0 Ss (Tsy)

TP-220 0.0-7.5 SM / 7.5-12.0 Sh (Km)

TP-221 0.0-7.5 SM / 7.5-10.5 Sh (Km)

TP-222 0.0-11.0 SM / 11.0-12.0 Sh (Km)

TP-224 0.0-4.8 SM / 4.8-10.0 Mdst (Kmv)

TP-225 0.0-8.0 SM / 8.0-11.0 Mdst (Kmv)

TP-226 0.0-5.5 SM / 5.5-6.0 Ss (Kmv) / 6.0-10.5 Mdst (Kmv)

TT-27 0.0-7.0 Ss (Kmv)

SCALE OF FEET: 2000 0 2000 4000 6000

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1 2 3 4 5

D C B A

Matchline 1704+62

1700+00 1750+00 1800+00 1850+00 1900+00 1950+00 2000+00 2050+00 2100+00 2150+00 2200+00 2250+00 2300+00 2350+00 2400+00 2450+00

Matchline 2467+90

2500+00 2550+00 2600+00 2650+00 2700+00 2750+00 2800+00 2850+00 2900+00 2950+00 3000+00 3050+00 3100+00 3150+00

Matchline 3155+53

Km Kmv Kd Qe Qal Jn Jsc

AZ 264

Howell Mesa Turnout

Dinnebito Wash

Harvest Rd

Hotevilla

Hotevilla Turnout

Oraibi Turnout

Oraibi Wash

Kykotsmovi Turnout

Kykotsmovi

Old Oraibi

Shungopavi Turnout

Mishongnovi Rd

PmP-Hopi 8

PmP-Hopi 9

PmP-Shungopavi

PmP-Orabi

PmP-Hotevilla

TP-227
0.0-6.0 SM
6.0-12.0 Sh (Km)

TP-228
0.0-6.0 SM
6.0-9.0 Ss (Kd)

TP-229
0.0-4.0 SC-SM
4.0-11.5 Sh (Kd)

TP-230
0.0-11.0 s(CL)

TP-231
0.0-12.0 SM

TP-232
0.0-13.0 SC/CL

TP-233
0.0-11.0 s(CL)

TP-234
0.0-13.0 (CL)s

TP-235
0.0-15.0 SM

TP-236
0.0-8.0 SP-SM
8.0-13.5 Ss (Km)

TP-237
0.0-12.0 SM

2000 0 2000 4000 6000
SCALE OF FEET

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EXPLANATION

PmP-2 Proposed pumping plant

Proposed turnout

Contact

Proposed alignment

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LEGEND

TP-50 ■ Test pit location showing depth of material encountered and classification.
0.0-5.0 SM
5.0 Ss (Jn)

TT-15 ■ Test trench (2008) location showing depth of material encountered and classification.
0.0-4.5 Ss

DESIGNED X
DRAWN X
CHECKED X
TECH. APPR. X
APPROVED X
NAME (SIGNATURE) TITLE

PHOENIX AREA OFFICE, ARIZONA 2016-06-24

SURFACE GEOLOGY AND LOCATION OF EXPLORATION

TUBA CITY TO KEAMS CANYON

STA. 1700+00 TO STA. 3150+00

FIGURE G-8

SHEET 1

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JULY 14, 2016 14:14
PLOTTED BY
EBROWN

CAD SYSTEM
AutoCAD Rel. 20.0s
CAD FILENAME
MAPPING IMAGES.DWG

CAD SYSTEM
AutoCAD Rel. 20.0s
CAD FILENAME
MAPPING IMAGES.DWG

DATE AND TIME PLOTTED
JULY 14, 2016 16:12
PLOTTED BY
EBIGPAYTE



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LEGEND

TP-50
0.0-5.0 SM
5.0 Ss (Jn)
Test pit location showing depth of material encountered and classification.

TT-15
0.0-4.5 Ss
Test trench (2008) location showing depth of material encountered and classification.

EXPLANATION

PmP-2 — **Proposed pumping plant**

Proposed turnout

Jn / Jsc — **Contact**

10+00 — **Proposed alignment**

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SURFACE GEOLOGY AND LOCATION OF EXPLORATION

TUBA CITY TO KEAMS CANYON
STA. 3150+00 TO STA. 4426+96.70

FIGURE G-9
SHEET 1

DISCONTINUITY TERMINOLOGY

DISCONTINUITY – A collective term used for all structural breaks in geologic materials which usually are unhealed and have zero or low tensile strength. Discontinuities also may be healed and exhibit high tensile strength. Discontinuities comprise fractures (including joints), planes of weakness, shears/faults, and shear/fault zones. Contacts between various units also may be considered discontinuities.

FRACTURE – A term used to describe any natural break in geologic material excluding shears and shear zones. Additional fracture terminology is provided below.

SHEAR – A structural break where differential movement has taken place along a surface or zone of failure by shear; characterized by striations, slickensides, gouge, breccia, mylonite, or any combination of these. Often direction, amount of displacement, and continuity may not be known because of limited exposures or observations.

FAULT – A shear with significant continuity which can be correlated between observations; occurs over a significant portion of a given site, foundation area, or region; or is a segment of a fault or fault zone defined in the literature. The designation of a shear as a fault or fault zone is a site-specific determination.

SHEAR/FAULT ZONE – A shear that is expressed in relative terms of width. The zone may consist of gouge, breccia, or many related faults or shears together with fractured and crushed rock between the shears and faults, or any combination of these. In the literature many fault zones simply are referred to as faults.

SHEAR/FAULT DISTURBED ZONE – An associated zone of fractures and/or folds adjacent to a shear or shear zone where the country rock has been subjected to only minor cataclastic action and may be mineralized. If adjacent to a fault or fault zone, the term is fault-disturbed zone. Occurrence, orientation, and areal extent of these phenomena depend upon depth of burial (pressure and temperature) during shearing, brittleness of materials, and the stress envelope.

FRACTURE TERMINOLOGY

EXAMPLES SHOWN FOR CORE, BUT APPLICABLE TO ANY OBSERVATION



JOINT (JT) – A relatively planar fracture along which there has been little or no shearing displacement.



FOLIATION JOINT (FJ) OR BEDDING JOINT (BJ) – a relatively planar fracture which is parallel to foliation or bedding along which there has been little or no shearing displacement.



BEDDING PLANE SEPARATION – A separation along bedding after extraction or exposure due to stress relief or slaking.

INCIPIENT JOINT (IJ) OR INCIPIENT FRACTURE (IF) – A joint or fracture which does not continue through the specimen or at least not seen with the naked eye. However, when the specimen is wetted, and then allowed to dry, the joint or fracture trace is evident. When core is broken, it breaks along an existing plane.



RANDOM FRACTURE (RF) – A natural break (fracture) with a generally rough, very irregular, nonplanar surface which does not belong to a joint set.

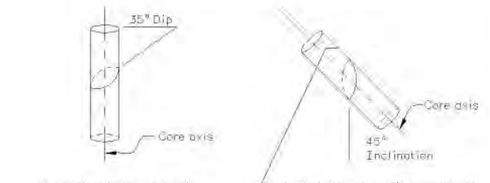


MECHANICAL BREAK (MB) – A break due to drilling, blasting, or handling. Mechanical breaks parallel to bedding or foliation are called Bedding Breaks (BB) or Foliation Breaks (FB), respectively. Recognizing mechanical breaks may be difficult. The absence of oxidation, staining, or mineral fillings, and often a hackly or irregular surface are clues for recognition.



FRACTURE ZONE (FZ) – Numerous, very closely spaced intersecting fractures. Often fragmented core cannot be fitted together.

METHOD OF MEASURING DIP OF PLANAR DISCONTINUITIES, FOLIATION, AND BEDDING IN CORE

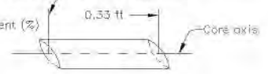


1. Vertical hole – true dip is measured and reported.
2. Angle hole – true dip usually not known; angle is measured from core axis and is called inclination.

ROCK QUALITY DESIGNATION (RQD)

$$RQD = \frac{\text{Sum of length of solid core pieces} > 0.33 \text{ ft [4 in] (100 mm) long}}{\text{Length of the run in feet (mm)}} \times 100$$

Expressed as percent (%)



FRACTURE FREQUENCY

FRACTURE FREQUENCY – The number of natural fractures occurring within a base length or core run. The number of fractures is divided by the length and is reported as fractures per foot or fractures per meter. Expressed as 3/m or 6/ft.

FRACTURE DENSITY

FRACTURE DENSITY – Based on the spacing of all natural fractures in an exposure or core recovery lengths in boreholes; excludes mechanical breaks, shears, and shear zones; however, shear-disturbed zones (fracturing outside the shear) are included. Descriptors for fracture density apply to all rock exposures such as tunnel walls, dozer trenches, outcrops, or foundation cut slopes and inverts, as well as boreholes. Descriptive criteria presented below are based on borehole cores where lengths are measured along the core axis; for other exposures the criteria is distance measured between fractures (size of blocks).

UNFRACTURED (FD0): No fractures.

VERY SLIGHTLY FRACTURED (FD1): Core recovered mostly in lengths greater than 3 feet (1 m).

SLIGHTLY TO VERY SLIGHTLY FRACTURED (FD2) *

SLIGHTLY FRACTURED (FD3): Core recovered mostly in lengths from 1 to 3 feet (300 to 1000 mm) with few scattered lengths less than 1 foot (300 mm) or greater than 3 feet (1000 mm).

MODERATELY TO SLIGHTLY FRACTURED (FD4) *

MODERATELY FRACTURED (FD5): Core recovered mostly in 0.3- to 1.0-foot (100- to 300-mm) lengths with most lengths about 0.6 foot (200 mm).

INTENSELY TO MODERATELY FRACTURED (FD6) *

INTENSELY FRACTURED (FD7): Lengths average from 0.1 to 0.3 foot (30 to 100 mm) with scattered fragmented intervals. Core recovered mostly in lengths less than 0.3 foot (100 mm).

VERY INTENSELY TO INTENSELY FRACTURED (FD8) *

VERY INTENSELY FRACTURED (FD9): Core recovered mostly as chips and fragments with a few scattered short core lengths.

---

* Combinations of fracture densities (e.g., Very Intensely to Intensely Fractured or Moderately to Slightly Fractured) are used where equal distribution of both fracture density characteristics are present over a significant interval of exposure, or where characteristics are "in between" the descriptor definitions.

FRACTURE SPACING

JOINT SET, OR FRACTURE SPACING DESCRIPTOR	TRUE SPACING
EXTREMELY WIDELY SPACED (SP1)	Greater than 10 ft (>3 m)
VERY WIDELY SPACED (SP2)	3 to 10 ft (1 to 3 m)
WIDELY SPACED (SP3)	1 to 3 ft (300 mm to 1 m)
MODERATELY SPACED (SP4)	0.3 to 1 m (100 to 300 mm)
CLOSELY SPACED (SP5)	0.1 to 0.3 ft (30 to 100 mm)
VERY CLOSELY SPACED (SP6)	less than 0.1 ft (<30 mm)

FRACTURE CONTINUITY

CONTINUITY DESCRIPTOR	DISCONTINUITY LENGTH
DISCONTINUOUS (C1)	Less than 3 ft (<1 m)
SLIGHTLY CONTINUOUS (C2)	3 to 10 ft (1 to 3 m)
MODERATELY CONTINUOUS (C3)	10 to 30 ft (1 to 3 m)
HIGHLY CONTINUOUS (C4)	30 to 100 ft (10 to 30 m)
VERY CONTINUOUS (C5)	Greater than 100 ft (>30 m)

FRACTURE ENDS (JOINT SURVEYS)

FRACTURE ENDS DESCRIPTOR	DESCRIPTIVE CRITERIA
E0	Zero ends leave the exposure (both ends can be seen).
E1	One end of the fracture terminates in the exposure (one end can be seen).
E2	Two fracture ends do not terminate in the exposure (both ends cannot be seen).

FRACTURE OPENNESS OR FILLING THICKNESS

FILLING THICKNESS DESCRIPTOR	THICKNESS/OPENNESS	OPENNESS DESCRIPTOR
CLEAN (T0)	No film or coating.	
	No visible separation.	TIGHT (O0)
VERY THIN (T1)	Less than 0.003 ft [1/32 in] (<1 mm).	SLIGHTLY OPEN (O1)
MODERATELY THIN (T2)	0.003 to 0.01 ft [1/32 to 1/8 in] 91 to 3 mm.	MODERATELY OPEN (O2)
THIN (T3)	0.01 to 0.03 ft [1/8 to 3/8 in] (3 to 10 mm).	OPEN (O3)
MODERATELY THICK (T4)	0.03 ft [3/8 in] to 0.1 ft (10 to 30 mm).	MODERATELY WIDE (O4)
THICK (T5)	Greater than 0.1 ft (>30 mm). Actual thickness or openings recorded.	WIDE (O5)

FRACTURE MOISTURE CONDITIONS

MOISTURE DESCRIPTOR	DESCRIPTIVE CRITERIA
M1	The fracture is dry. It is tight or filling (where present) is of sufficient density or composition to impede waterflow. Waterflow along the fracture does not appear possible.
M2	The fracture is dry with no evidence of previous waterflow. Waterflow appears possible.
M3	The fracture is dry, but shows evidence of waterflow such as staining, leaching and/or vegetation.
M4	The fracture or filling (where present) is damp, but no free water is present.
M5	The fracture shows seepage. It is wet with occasional drops of water.
M6	The fracture emits a continuous flow (estimate flow rate) under low pressure. Filling materials (where present) may show signs of leaching or piping.
M7	The fracture emits a continuous flow (estimate flow rate) under moderate to high pressure. Water is squirting and/or filling material (where present) may be substantially washed out.

FRACTURE ROUGHNESS

Refers to small scale asperities of surfaces, not large scale undulations or waviness.

STEPPED (R1): Near-normal steps and ridges occur on the fracture surface.
ROUGH (R2): Large, angular asperities can be seen.
MODERATELY ROUGH (R3): Asperities are clearly visible and fracture surface feels abrasive.
SLIGHTLY ROUGH (R4): Small asperities on the fracture surface are visible and can be felt.
SMOOTH (R5): No asperities, smooth to the touch.
POLISHED (R6): Extremely smooth and shiny.

FRACTURE SURFACE AND/OR FILLING ALTERATION AND HARDNESS

Descriptors for weathering or alteration of fracture surfaces and fracture fillings (excluding soil materials) are the same as those used for weathering and alteration of rock.

Descriptors for hardness/strength of fillings and/or fracture surfaces are the same as those presented for hardness of rock and consistency of soils.

DISCONTINUITY HEALING

TOTALLY HEALED (HL1) – All fragments bonded, discontinuity is completely healed or recemented to a degree at least as hard as surrounding rock.

MODERATELY HEALED (HL3) – Greater than 50 percent of fractured or sheared material, discontinuity surfaces or filling is healed or recemented; and/or strength of healing agent is less hard than surrounding rock.

PARTLY HEALED (HL5) – Less than 50 percent of fractured or sheared material, discontinuity surface or filling is healed or recemented.

NOT HEALED (HL6) – Discontinuity surface, fractured zone, sheared material or filling is not healed or recemented, rock fragments or filling (if present) held in place by their own angularity and/or cohesiveness.

SHEAR/FAULT DESCRIPTORS

DESCRIPTOR	DESCRIPTIVE CRITERIA
VERY HARD	Gouge cannot be broken with finger pressure; cannot be indented with fingernail.
HARD	Gouge can be broken with firm finger pressure, can be indented with fingernail; cannot be indented with thumb.
FIRM	Gouge can be easily crumbled; can be indented with thumb 1 to 5 mm.
SOFT	Gouge can be easily molded; can be penetrated with thumb 5 to 25 mm.
VERY SOFT	Gouge can be penetrated with thumb more than 25 mm.

SHEAR/FAULT MOISTURE DESCRIPTORS

The apparent moisture content of gouge is described as WET (visible free water); MOIST (damp, but no visible water); and DRY (absence of moisture, dusty, dry to the touch). Moisture descriptors M1 through M7 may be used to describe the shear or shear zone.

BRECCIA SHAPES

Angular
Subangular
Subrounded
Rounded
Platy
Lens-shaped
Wedge-shaped
Contorted



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X	CHECKED
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X	APPROVED

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STANDARD DESCRIPTORS AND DESCRIPTIVE CRITERIA FOR DISCONTINUITIES

FIGURE G-10

SHEET 1

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CAD FILENAME: GEOLOGIC LEGEND.DWG

WEATHERING

FRESH (W1): Body of rock is not oxidized or discolored; fracture surfaces are not oxidized or discolored*; no separation of grain boundaries; no change of texture and no solutioning. Hammer rings when crystalline rocks are struck.

SLIGHTLY WEATHERED TO FRESH (W2):**

SLIGHTLY WEATHERED (W3): Discoloration or oxidation is limited to surface of surface of, or short distance from fractures; some feldspar crystals are dull; fracture surfaces have minor to complete discoloration or oxidation; no visible separation of grain boundaries; texture preserved and minor leaching of soluble minerals may be present. Hammer rings when crystalline rocks are struck, body of rock is not weakened by weathering.

MODERATELY TO SLIGHTLY WEATHERED (W4):**

MODERATELY WEATHERED (W5): Discoloration or oxidation extends from fractures, usually throughout body of rock; ferromagnesian minerals are "rusty", feldspar crystals are "cloudy"; all fracture surfaces are discolored or oxidized; partial opening of grain boundaries visible; texture generally preserved, but soluble minerals may be mostly leached. Hammer does not ring when rock is struck, body of rock is slightly weakened.

INTENSELY TO MODERATELY WEATHERED (W6):**

INTENSELY WEATHERED (W7): Body of rock is discolored or oxidized throughout; all feldspars and ferromagnesian minerals are altered to clay to some extent. All fracture surfaces are discolored or oxidized, surfaces friable; partial separation of grain boundaries, rock is friable, in situ disaggregation of granitics common in semi-arid regions; texture altered and leaching of soluble minerals may be complete. Rock has dull sound when struck with hammer; rock is weakened, usually can be broken with moderate to heavy manual pressure or by light hammer blow without reference to planes of weakness.

VERY INTENSELY WEATHERED (W8):**

DECOMPOSED (W9): Body of rock is discolored or oxidized throughout, but resistant minerals such as quartz may be unaltered; all feldspars and ferromagnesian minerals are completely altered to clay; complete separation of grain boundaries (disaggregated), partial or complete remnant rock structure may be preserved, but resembles a soil.

NOTE: Weathering categories are established primarily for crystalline rocks and those with ferromagnesian minerals, weathering in various sedimentary rocks will not always fit the categories established – weathering categories may be modified for particular site conditions or alteration such as hydrothermal alteration. Where modified criteria are established, they are identified and described.

* Characteristics of fracture surfaces do not include directional weathering along shears or faults and their associated fracture zones; for example a shear that carries weathering to great depths in a fresh rock mass would not require the whole rock mass to be classified as weathered.

** Combination descriptors are used when equal distribution of both weathering characteristics are present over significant intervals or where characteristics noted are "in between" the diagnostic characteristics.

DURABILITY INDEX

DURABILITY DESCRIPTOR	DESCRIPTIVE CRITERIA
D10	Rock specimen or exposure remains intact with no deleterious cracking after exposure longer than 1 year.
D11	Rock specimen or exposure develops hairline cracking on surfaces within 1 month, but no disaggregation within 1 year of exposure.
D12	Rock specimen or exposure develops hairline cracking on surfaces within 1 week, and/or disaggregation within 1 month of exposure.
D13	Specimen or exposure may develop hairline cracks in 1 day and displays pronounced separation of bedding and/or disaggregation within 1 week of exposure.
D14	Specimen or exposure displays pronounced cracking and disaggregation within 1 day (24 hours) of exposure. Generally ravels and degrades to small fragments.

COLOR

The Munsell color system (Geologic Society of America Rock Color Chart) was used. This system defines wet color by its hue, value, and chroma. Color symbols used (i.e., 5 YR 5/6 may be included).

SEDIMENTARY AND PYROCLASTIC ROCK PARTICLE SIZES

Size in mm	Sedimentary: Rounded, subrounded, subangular — Particle or fragment	Sedimentary: Rounded, subrounded, subangular — Lithified product	Pyroclastic — Fragment	Pyroclastic — Lithified product
256	Boulder	Boulder conglomerate	Block* or Bomb**	Volcanic breccia* or volcanic agglomerate**
64	Cobble	Cobble conglomerate		
4	Pebble	Pebble conglomerate	Lapilli	Lapillistone and Lapilli Tuff
2	Granule	Granule conglomerate		
1	Very coarse sand	Sandstone (Very coarse, coarse, medium, fine, or very fine)	Coarse ash	Coarse ash
0.5	Coarse sand			
0.25	Medium sand			
0.125	Fine sand			
0.0625	Very fine sand			
0.00391	Silt	Siltstone/ Shale	Fine ash	Fine ash
	Clay	Claystone Shale		

* Broken from previous igneous rock, block shaped (angular to subangular).
** Solidified from plastic material while in flight; rounded clasts.

IGNEOUS AND METAMORPHIC ROCK TEXTURE

TEXTURE DESCRIPTOR	AVERAGE GRAIN DIAMETER
VERY COARSE GRAINED OR PEGMATITIC	>10 mm [>3/8 in]
COARSE GRAINED	5–10 mm [3/16 – 3/8 in]
MEDIUM GRAINED	1–5 mm [1/32 – 3/16 in]
FINE GRAINED	0.1–1 mm [0.004 – 1/32 in]
APHANITIC (Cannot be seen with the unaided eye)	<0.1 mm [<0.004 in]

ADDITIONAL TEXTURAL ADJECTIVES

PIT (pitted) – pinhole to 0.03 ft [3/8 in] (<1 to 10 mm) openings.

VUG (vuggy) – Small openings (usually lined with crystals) ranging in diameter from 0.03 ft [3/8 in] to 0.33 ft [4 in] (10 to 100 mm).

CAVITY – An opening larger than 0.33 ft [4 in] (100 mm), size descriptions are required, and adjectives such as small, large, etc., may be used.

HONEYCOMBED – If numerous enough that only thin walls separate individual pits or vugs, this term further describes the preceding nomenclature to indicate cell-like form.

VESICLE (vesicular) – Small openings in volcanic rocks of variable shape and size formed by entrapped gas bubbles during solidification.

BEDDING FOLIATION OR FLOW TEXTURE

DESCRIPTORS	THICKNESS/SPACING
MASSIVE	Greater than 10 ft (>3 m)
VERY THICKLY (bedded, foliated or banded)	3 to 10 ft (1 to 3 m)
THICKLY	1 to 3 ft (300 mm to 1 m)
MODERATELY	0.3 to 1 ft (100 to 300 mm)
THINLY	0.1 to 0.3 ft (30 to 100 mm)
VERY THINLY	0.03 to 0.1 ft (10 to 30 mm)
LAMINATED (Intensely foliated or banded)	Less than 0.03 ft [3/8 in] (<10 mm)

BED ROCK HARDNESS/STRENGTH

EXTREMELY HARD (H1): Core, fragment or exposure cannot be scratched with knife or sharp pick; can only be chipped with repeated heavy hammer blows.

VERY HARD (H2): Cannot be scratched with knife or sharp pick. Core or fragment breaks with repeated heavy hammer blows.

HARD (H3): Can be scratched with knife or sharp pick with difficulty (heavy pressure). Heavy hammer blow required to break specimen.

MODERATELY HARD (H4): Can be scratched with knife or sharp pick with light or moderate pressure. Core or fragment breaks with moderate hammer blow.

MODERATELY SOFT (H5): Can be grooved 1/16 inch (2 mm) deep by knife or sharp pick with moderate or heavy pressure. Core or fragment breaks with light hammer blow or heavy manual pressure.

SOFT (H6): Can be grooved or gouged easily by knife or sharp pick with light pressure, can be scratched with fingernail. Breaks with light to moderate manual pressure.

VERY SOFT (H7): Can be readily indented, grooved or gouged with fingernail, or carved with a knife. Breaks with light manual pressure.

Any bedrock unit softer than H7, Very Soft, is to be described using USBR 5000 (soils) consistency characteristics.

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X	CHECKED
X	TECH. APPR.
X	APPROVED (SIGN, ARNOLD, TITLE)

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STANDARD DESCRIPTORS AND DESCRIPTIVE CRITERIA FOR ROCK

FIGURE G-11

SHEET 1

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CAD FILENAME: GEOLOGIC LEGEND.DWG

GENERAL GEOLOGIC LEGEND

Quaternary

Fill — *Fill consists of various materials that have been placed or dumped by human activities; includes road construction.*

Qal — *Alluvium consists of clay, silt, sand, gravel, cobbles and boulders that have been deposited by streams and intermittent washes.*

Qe — *Eluvium deposits consist primarily of silt and fine sand laid down by wind. Eluvium forms a mantle of variable thickness over most of the landscape with the exception of river channels and active washes.*

Qcol — *Colluvium consists of unconsolidated accumulation of generally unsorted clay- to boulder-size material deposited by rainwash, sheetwash or downslope creep on or at the base of gentle slopes. Colluvium may include bedrock that has disaggregated in place.*

Neogene

Tsy — *Tsy is interbedded sandstone and conglomerate.*
Sandstone consists of fine to coarse, subrounded sand with occasional rounded gravels that are variably cemented with calcium carbonate. Sandstone exposures are usually intensely weathered and soft, fragments crumble with manual pressure; becoming slightly harder with depth. Color is grayish orange.

Conglomerate consists of variable amounts of subrounded sand, gravel and cobbles moderately to strongly cemented with calcium carbonate. Color is variable due to clast color, but the matrix is usually light gray.

Cretaceous

Kmv — *Kmv - Mesaverde Group*
- *Upper Sandstone Member - light gray, fine to coarse grained, generally conglomeratic sandstone with interbedded soft, greenish gray shale.*
- *Middle Carbonaceous Member - dark gray to brown moderately soft shale, coal and yellowish gray, fine- to coarse-grained, moderately hard sandstone.*
- *Lower Sandstone Member - light brown, fine- to medium-grained, moderately hard cliff forming sandstone.*

Km — *Km - Mancos Shale. The Mancos Shale consists of medium to dark gray, soft to moderately soft shale interbedded with thin layers of moderately hard, fine-grained siltstone and sandstone.*

Kd — *Kd- Dakota Formation.*
- *The Upper Sandstone Member consists of fine-grained sandstone and siltstone forming a series of thin to thick sandstone ledges and intercalated shaly beds. The unit is locally crossbedded at a low angle.*
- *The Middle Carbonaceous Member consists of carbonaceous siltstone and coal in flat, very thin beds. The siltstone is composed of silt, clay and fine-grained quartz grains. Gypsum crystals and stringers are present throughout the unit and weather out on the surface. The unit erodes into slopes capped by the Upper Sandstone Member.*
- *The Lower Sandstone Member consists of very pale orange, fine- to medium-grained, sub-rounded sandstone containing iron rich concretions. The sandstone is irregularly bedded and lenticular; containing crossbedded low angle sets. Conglomerate is locally present at the base of the unit in eroded channels. The sandstone is well cemented and forms blocky, vertical cliffs.*

Jurassic

Jsc — *Jsc - San Rafael Group.*
The San Rafael Group is not broken out into formations and consists of a series of resistant ledge-forming sandstone beds separated by slope-forming siltstone and shale. The sandstone is composed of fine-grained, subangular quartz with minor amounts of mica cemented with calcium carbonate. Sandstone beds are about 1 to 3 feet thick, but some, especially in the upper part of the formation, are as much as 20 feet thick. The sandstone is moderately soft to moderately hard, forming either ledges or long dip slopes and is white to light greenish gray and weathers to pale yellowish brown. In most places outcrops are stained dark red by debris from the overlying siltstone units. The shale is very fine-grained, fissile, weakly cemented with calcium carbonate and flat bedded; beds are up to 20 feet thick, but generally less than 5 feet thick and weather to slopes. The color is dark reddish brown, micaceous, and at places silty and sandy. The siltstone is grayish red and weathers to pale reddish brown.

Glen Canyon Group.

Jn — *(Jn) Navajo Sandstone. The Navajo Sandstone is composed of medium- to fine-grained, subrounded quartz grains cemented with calcium carbonate, silica and iron oxides. Crossbedding is characteristic of the unit and bedding ranges from less than 1 to 10 inches apart. The sandstone is moderately soft to moderately hard depending on the degree of weathering and cementation and weathers into rounded hills and domes in which the crossbedding is etched out by erosion. For the most part, the Navajo Sandstone has two contrasting colors; reddish brown in the lower portion and light gray in the upper, but considerable variation occurs within those colors ranging from white to very pale orange to pale reddish brown. The unit contains lenticular beds of cherty limestone one to two feet thick which are resistant to erosion and typically form ledges or flat-topped ridges.*

Jkn — *(Jkn) Kayenta-Navajo Transition Zone. The Kayenta-Navajo Transition Zone is composed of interbedded sandstone, mudstone and siltstone. The sandstone is fine-grained, soft to moderately hard and intensely to moderately weathered; cemented with calcium carbonate. Color ranges from is reddish brown, medium dark purple to light gray. Layers of very hard chert up to 0.5-foot thick are present as discontinuous, intensely fractured lenses, usually within or in association with sandstone.*

The mudstone consists of approximately 60% clay and/or silt and 40% very fine sand. The mudstone is weakly indurated, nonfissile, moderately hard and moderately weathered. Color is medium purplish gray with light gray bands.

The siltstone is very fine-grained, moderately hard to hard and moderately weathered. Bedding ranges from 1/8 inch to 1.5 feet thick. Color is reddish brown to pale red.

Jk — *(Jk) Kayenta Formation. The Kayenta Formation typically consists of fluvial siltstone and sandstone. In the vicinity of Tuba City, the Kayenta formation is dissimilar in appearance to the type locality formation and is referred to as the silty facies of the Kayenta. The silty facies consists of fine-grained sandstone and mudstone. The bedding is lenticular, and crossbedding is common in the sandy units. The unit weathers into irregular badlands. Outcrops form rounded hills and earth pillars (hoodoos) having resistant cap rocks.*

The sandstone is fine-grained and locally silty with thin interbeds of purplish red, soft shale. The sandstone is moderately hard and moderately weathered. Bedding is spaced ½ inch to 1.5 feet apart. Color is pale red. The mudstone occurs as weakly indurated, nonfissile to fissile, thinly- to very thinly-bedded layers consisting of approximately 70% clay, and 30% fine sand. The mudstone is moderately weathered and moderately soft to moderately hard; fragments break with manual pressure, thicker portion requires moderate hammer blow to break. Color is medium reddish brown. Locally, thin limestone ledges occur in the upper part of the member. The entire unit is banded pale red and grayish red.

GENERAL GEOLOGIC LEGEND

Jurassic

Jm — ***Glen Canyon Group (continued)***
- *(Jm) Moenave Formation. The Moenave Formation consists of reddish-orange to light-brown sandstones, siltstones and mudstones of mainly fluvial and eolian origin.*

The sandstone is mostly fine- to coarse-grained, moderately hard and moderately weathered. Bedding ranges from 0.1 to 6.0 feet thick and is locally crossbedded. The siltstone is very fine-grained, moderately hard to hard and moderately weathered. Bedding ranges from 1/8 inch to 1.5 feet thick. Mudstone is very fine-grained (clay and silt-size particles), weakly indurated and moderately soft to moderately hard.

Triassic

Chinle Formation. The Chinle Formation consists primarily of mudstone with layers of sandstone, conglomerate and limestone.

TRco
- *(TRco) Owl Rock Member. The Owl Rock Member consists of pale red to yellowish gray siltstone and shale interbedded with gray lenses of limestone. The siltstone is fine-grained, moderately hard and moderately weathered. Bedding is spaced 0.1 to 1.2 feet apart and the thickness of the layers range from a few inches to 4 feet. The shale is soft to moderately soft, moderately weathered and fissile. Shale layers range from a few inches to 5 feet thick. The limestone is hard, slightly weathered and moderately fractured; fractures and bedding are typically spaced 0.3 to 1 foot apart. Limestone layers range from 0.5 to 3 feet thick.*

TRcp
- *(TRcp) Petrified Forest Member. The Petrified Forest Member is characterized by bentonitic mudstone interbedded with siltstone, sandstone and limestone.*

The mudstone is a weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting mostly of clay, but may contain up to 40% fine sand and a trace of lenticular gravel up to 10 mm in size. The mudstone is moderately soft to moderately hard, hand-size fragments break with manual pressure; thicker portion requires moderate hammer blow to break. Mudstone is variably cemented with calcium carbonate and has no to strong reaction with HCl. Color ranges from grayish red purple, medium to dark gray, with localized white and grayish red mottling and/or light greenish gray spots. Bedding is not discernible in test pit excavations, but when observed, bedding is spaced 1 to 4 inches apart in outcrops.

The sandstone beds are composed predominately of fine- to medium-grained, subrounded to subangular sand variably cemented with calcium carbonate and/or silica. The sandstone is moderately soft and locally friable, breaks with manual pressure near the surface, but generally becomes harder with depth requiring a moderate hammer blow to break. Sandstone is slightly to moderately weathered; contains rust colored grains. Bedding ranges from 1 to 3 inches thick. Color is very light gray to brownish gray.

TRcs
- *(TRcs) Shinarump Member. The Shinarump Member consists of sandstone, conglomerate and lenses of mudstone and shale.*

The sandstone is comprised of subangular to subrounded, fine to predominantly medium and coarse grains of mostly quartz and feldspar. Most of the sandstone units contain less argillaceous material as compared to the conglomerate. Calcium carbonate is the most common cementing agent, but silica and some ferruginous cement may be present. The sandstone is predominantly crossbedded, bedding is generally thinly to moderately bedded (spaced 0.1 to 1 feet apart), but can be massively bedded (greater than 10 feet) in some areas near the Little Colorado River. The sandstone is moderately hard to hard (can be scratched with a sharp pick with moderate pressure, requires heavy hammer blow to break), slightly to moderately weathered (oxidation limited to surfaces, some ferro-magnesium minerals are "rusty") and moderately fractured (fractures spaced 0.3 to 1 foot apart) mostly due to the presence of bedding joints.

Conglomerate consists of hard, subrounded, predominantly pebble to coarse gravel and cobble-size fragments in a matrix of sand and calcareous cement. Most of the gravel is composed of chert, quartz and/or quartzite. Conglomerate is moderately hard to very hard (can be scratched with a sharp pick with moderate pressure, requires repeated heavy hammer blow to break), slightly to moderately weathered (oxidation limited to surfaces, some ferro-magnesium minerals are "rusty") and generally moderately to slightly fractured (fractures spaced 0.5 to 3 feet apart).

Mudstone consists of weakly indurated, nonfissile, conchoidally fracturing sedimentary rock consisting of approximately 70% clay, and 30% fine sand cemented with calcium carbonate. The mudstone is slightly weathered and moderately soft to moderately hard (fragments break with manual pressure, thicker fragments requires moderate hammer blow to break). The shale interbeds are similar to the mudstone, but is fissile and bedding is laminated.

TRm — *(TRm) Moenkopi Formation. The Moenkopi Formation consists of reddish brown, interbedded shale, siltstone and sandstone.*

The shale is very fine-grained, fissile and moderately soft. Bedding is very thinly bedded to laminated (bedding spaced 3/8 inch to less than 1/8 inch). The siltstone is fine-grained, moderately hard and typically intensely to moderately fractured depending on the spacing of bedding planes. Bedding ranges from 0.1 to 1.3 feet apart. Sandstone is predominantly fine- to coarse-grained, moderately hard and moderately fractured. Bedding ranges from 0.1 to 4 feet apart. Limestone layers are 0.5 to 2 feet thick, hard and laminated to moderately bedded (bedding ranges from 1/8 to 4 inches thick).

Permian

Pk — *(Pk) Kaibab Limestone. The Kaibab Limestone is primarily a sandy limestone or calcareous sandstone.*

The limestone is aphanic to fine grained, strongly cemented with calcium carbonate and moderately hard in hand specimen (breaks with moderate hammer blow), but hard to very hard in outcrop (requires repeated heavy blow to break). The limestone is slightly weathered and moderately bedded; bedding planes are spaced 1 inch to 1 foot apart. Outcrops are moderately to slightly fractured, with fractures spaced 0.4 to 2 feet apart. Color is very light gray to very pale orange.

The sandstone is fine- to coarse-grained, calcareous, hard to very hard and slightly weathered. Bedding is spaced 1/2 to 8 inches apart and locally crossbedded. Color is light gray to yellowish gray.

GENERAL GEOLOGIC EXPLANATION

TP-6
0.0-4.0 (SP)cb
4.0-10.0 (SM)g
10.0-13.5 Ls (Pk)
— ***Test pit location showing depth of material encountered and classification.***

TT-15
0.0-4.5 Ss
— ***Test trench location showing depth of material encountered and classification.***

— ***Contact***

U
D — F — ***Fault***

30° — ***Strike and dip of contact***

RECLAMATION
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RECLAMATION RURAL WATER SUPPLY
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NORTH CENTRAL ARIZONA WATER SUPPLY
FEASIBILITY STUDY

X DESIGNED
X DRAWN
X CHECKED
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X APPROVED
SUPT. MINERAL TITLE
PHOENIX AREA OFFICE, ARIZONA 2016-06-24

GENERAL GEOLOGIC LEGEND, EXPLANATION AND NOTES

NORTH CENTRAL ARIZONA PIPELINE

FIGURE G-12

SHEET 1

CAD SYSTEM AutoCAD Rel. 19.1S
CAD FILENAME GEOLOGIC LEGEND.DWG

DATE AND TIME PLOTTED: JUNE 30, 2016 15:45
PLOTTED BY: WHILLER

Station to	Station	Map Unit	Description	Test Pits	Test Pit Log	Excavation type
Lake Powell Intake to LeChee						
10+00	37+55	Jn	Navajo Sandstone at or near the ground surface. Loose windblown sand may overlie sandstone up to 5 ft. thick.			common/rock
37+55	52+50	Qe	Loose, windblown sand may range from 5 to 20 ft. thick overlying Navajo Sandstone.			common/rock
52+50	223+00	Jn	Navajo Sandstone at or near the ground surface. Windblown sand up to 5 ft. thick.			common/rock
223+00	244+20	Qe	Loose, windblown sand may range from 5 to 20 ft. thick overlying Navajo Sandstone.			common/rock
244+20	302+00	Qe	Loose, windblown sand (sand dunes) may range from 20 to 40 ft. thick overlying Navajo Sandstone.			common
302+00	320+00	Jn	Navajo Sandstone at or near the ground surface.			rock
320+00	360+00	Jn	Loose, windblown sand up to 5 ft. thick overlying Navajo Sandstone.			common/rock
360+00	414+00	Jn	Loose, windblown sand ranges from 5 to 10 ft. thick overlying Navajo Sandstone.			common/rock
414+00	425+50	Jsc	Navajo Sandstone at or near the ground surface.			common/rock
425+50	518+62.66	Jsc	San Rafael Group (Carmel Sandstone) at or near the surface. Windblown sand up to 5 ft. thick.			common/rock
LeChee to The Gap						
1002+00	1014+80		About 5' of wind blown sand overlying sandstone of San Rafael Group (Carmel Sandstone).			common/rock
1014+80	1026+75	Jsc	San Rafael Group (Carmel Sandstone) at or near the ground surface. Windblown sand up to 5 ft. thick.			common/rock
1026+75	1113+00	Jsc	Carmel Sandstone at or near the ground surface. Windblown sand up to 5 ft. thick. Sandstone at surface is moderately hard, forms ledges and short cliffs. Shales interbeds are moderately soft, 1 ft. to 6 in. thick and spaced 3 to 8 ft. apart. Small (1-2 in.) concretions present. Outcrops are moderate reddish orange to moderate reddish brown.	TT-3	0.0-7.0 Ss (Jsc)	common/rock
1113+00	1540+00	Jsc	Carmel Sandstone at or near the ground surface. Windblown sand up to 5 ft. thick. Sandstone at surface is moderately soft, becomes harder with depth; slightly fractured to unfractured; bedding in sandstone spaced >10 ft. The Carmel Sandstone outcrop that overlies the Navajo Sandstone near station 1540+00 is light gray and cross-bedded with reddish brown sandstone and siltstone interbeds. Sandstone outcrops further upstream are moderate reddish brown.	TP-63	0.0-5.0 SP 5.0-10.0 Ss (Jsc)	common/rock
1540+00	1573+25	Qe	About 5 to 12' of wind blown sand overlying hard, Navajo Sandstone.	TP-62	0.0-3.5 (SP)cb 3.5-7.0 Ss (Jn)	common
1573+25	1800+00	Jn	Navajo Sandstone at or near the ground surface. Windblown sand up to 5 ft. thick. Localized sand dunes may be 20 ft. deep. Sandstone is hard.	TP-59	0.0-5.5 SP 5.5 Ss (Jn)	common/rock
				TP-60	0.0-6.5 SP 6.5 Ss (Jn)	
				TP-61	0.0-3.5 (SP)cb 3.5-7.0 Ss (Jn)	
				TT-5	0.0-8.5 Ss (Jn)	
1800+00	1837+80	Qe	About 10 to 15' of wind blown sand overlying Navajo Sandstone.	TP-58	0-13.0 SP	common
1837+80	1875+10	Jn	Navajo Sandstone at or near the ground surface. Windblown sand up to 5 ft. thick. Localized sand dunes may be 20 ft. deep. Sandstone is soft to moderately soft, gouges with geologic pick.			common/rock
1875+10	1911+50	Qe	About 10' of wind blown sand overlying hard, Navajo Sandstone.	TP-57	0.0-10.0 SP 10.0 Ss (Jn)	common
1911+50	2367+00	Jn	Navajo Sandstone at or near the ground surface. Windblown sand up to 5 ft. thick. Localized sand dunes may be 20 ft. deep. Sandstone is moderately hard.	TP-63	0-5.0 SP 5.0-10.0 Ss (Jn)	common/rock
				TP-67	0.0-7.0 SP 7.0-9.0 Ss (Jn)	common/rock
				TT-7	0.0-2.0 Ss (Jn)	common/rock
2367+00	2519+40	Qe	About 10 to 15' of wind blown sand overlying Navajo Sandstone.	TP-55	0.0-14.5 SP	common
				TP-56	0.0-15.0 SP	common
2519+40	2794+00	Jn	Navajo Sandstone at or near the ground surface. Windblown sand up to 5 ft. thick. Sandstone is soft to moderately hard.	TP-52	0.0-2.0 SP 2.0-3.8 (SP)g 3.8-7.0 Ss (Jn)	common/rock
				TP-53	0.0-3.0 SP 3.0-3.5 (SP)g 3.5-8.0 Ss (Jn)	
				TP-54	0.0-2.4 SP 2.4-6.5 Ss (Jn)	
				TP-68	0.0-3.3 SP 3.3-5.5 Ss (Jn)	
2794+00	2855+00	Qe	About 5 to 15' of wind blown sand overlying soft to moderately soft Navajo Sandstone.	TP-51	0.0-4.5 (SP) 4.5-6.5 CL 6.5-10.4 SP 10.4-13.0 Ss (Jn)	common

Station to	Station	Map Unit	Description	Test Pits	Test Pit Log	Excavation type
2855+00	3086+70	Jn	Navajo Sandstone at or near the ground surface. Windblown sand up to 5 ft. thick. Sandstone is soft to moderately hard.	TP-49	0.0-3.2 SP 3.2-7.0 Ss (Jn)	common/rock
				TP-50	0.0-5.0 SM 5.0 Ss (Jn)	common/rock
				TT-10	0.0-4.0 Ss (Jn)	common/rock
3086+70	3123+00	Jkn	Kayenta-Navajo transition zone. Interbedded red and white, crossbedded sandstone ledges and cliffs with shale, mudstone and siltstone. Sandstone is moderately hard to hard; siltstone is moderately hard; shale beds are 0.5 to 5 ft. thick and moderately soft.			common/rock
3123+00	3125+90	Jk	Kayenta Formation - siltstone, mudstone and sandstone - slope-forming siltstone and sandstone. Mudstone occurs as flat, thinly- to very thinly-bedded units.			common/rock
3125+90	3129+40	Jm	Moenave Formation - Siltstone and sandstone - reddish-orange to light-brown			common/rock
3129+40	3131+60	Trco	Owl Rock Member- hard , slightly weathered limestone up to 4 ft. thick bed. Bedding is 1 in. to 3 ft. thick, moderately fractured where thickly bedded. Shale/ mudstone interbeds are soft, 6 in. to 2 ft. thick			common/rock
3131+60	3137+16	TRcp	Chinle Formation, Petrified Forest Member. Moderately soft to moderately hard mudstone.			common
3137+16	3139+06	Qal	Alluvium consists of loose clay, silt, sand, gravel, cobbles and boulders.			common
3139+06	3142+11	TRcp	3 to 5 ft. colluvium over mudstone of the Chinle Formation, Petrified Forest Member. Mudstone is moderately soft to moderately hard.			common
The Gap to Gray Mountain						
3142+11	3225+64	TRcp	3 to 5 ft. colluvium over mudstone of the Chinle Formation, Petrified Forest Member. Mudstone is moderately soft to moderately hard.	TP-21	0.0-3.0 SM 3.0-8.5 (GC)sc 8.5-14.0 Mdst (TRcp)	common
3225+64	3236+76	Qal	Alluvium consists of loose sand, gravel, cobbles and boulders.	TP-22	0.0-4.0 SM 4.0-7.0 (GM)sc 7.0-14.0 (SC)gcb	common
3236+76	3240+70	TRcp	Mudstone is moderately soft to moderately hard.			common
3240+70	3285+23	Qal	Alluvium consists of loose sand, gravel, cobbles and boulders. Excavation may encounter moderately soft mudstone (TRcp) at depth.	TP-23	0.0-4.0 SM 4.0-14.0 (GC-GM)scb	common
3285+23	3361+16	TRcp	Mudstone at or near surface with a veneer of loose Col or Qal. Mudstone is moderately soft to moderately hard. Alignment crosses a few shallow washes filled with Qal.	TP-24	0.0-4.0 (SC)b 4.0-10.0 (GM)s 10.0-15.0 (GM)sc	common
3361+16	3381+54	Qal	Alignment runs along edge of wash. Alluvium consists of loose sand, gravel, cobbles and boulders. Excavation may encounter moderately soft mudstone, and 6 inch to 3 ft. thick layers of moderately hard interbedded sandstone, siltstone and conglomerate(TRcs and TRcp) at depth.	TP-25	0.0-5.0 SP 5.0-8.0 (SP)g 8.0-12.0 SP-SC	common
3381+54	3534+22	TRcp	Alignment runs along edge of wash. Alluvium and colluvium up to a few ft. thick overlys moderately soft mudstone and soft to moderately hard interbedded sandstone and siltstone. Ground water may be near the surface in the alluvium filling the wash east of the alignment from Sta. 3480+00 to 3495+00 (encountered water at 4.5 ft. in TP-27, located about 80 ft. east of alignment at Sta. 3482+77).	TP-26	0.0-3.5 (SP)g 3.5-10.5 Ss (TRcp)	common
				TP-27	0.0-6.0 SM	common
3534+22	3549+40	Qal	Alluvium consists of loose sand, gravel, cobbles and boulders. Excavation may encounter moderately soft mudstone (TRcp) at depth.	TP-28	0.0-13.5 (SM)gcb	common
3549+40	3705+62	TRcp	Alignment runs along edge of wash. Moderately soft mudstone at surface, may encounter moderately soft to moderately hard interbedded sandstone and siltstone at depth.	TP-29	0.0-0.5 SM 0.5-10.0 Mdst (TRcp)	common
				TP-30	0.0-2.3 SP 2.3-14.0 Mdst (TRcp)	
				TP-31	0.0-1.0 (SC)g 1.0-5.0 Ss (TRcp)	
3705+62	3745+48	Qal	Alluvium consists mostly of silty sand and gravel with occasional cobbles and boulders.	TP-32	0.0-14.0 (SM)g	common
3745+48	3946+01	TRcp	Moderately soft to moderately hard mudstone with layers of moderately soft sandstone.	TT-16	0.0-5.5 Ss (TRcs)	common
				TP-33	0.0-3.3 SC 3.3-5.5 Ss (TRcs)	common
				TP-34	0.0-1.5 SC 1.5-13.0 Mdst (TRcp)	common
				TP-35	0.0-6.0 SC 6.0-9.5 Mdst (TRcp)	common
3946+01	3980+00	Qal	Alluvium consists mostly of silty sand and gravel with occasional cobbles and boulders.	TP-36	0.0-7.0 SM 7.0-13.5 SP-SC	common

Station to	Station	Map Unit	Description	Test Pits	Test Pit Log	Excavation type
3980+00	4224+07	TRcp	Moderately soft to moderately hard mudstone with layers of moderately soft sandstone.	TP-37	0.0-4.5 SM 4.5-10.5 Ss (TRcp)	common
				TP-38	0.0-1.0 SP 1.0-4.0 Ss (TRcp)	common
				TP-39	0.0-3.5 SC 3.5-7.5 Ss (TRcp)	common
				TP-40	0.0-5.0 CL 5.0-5.5 SP 5.5-13.0 Mdst (TRcp)	common
				TP-41	0.0-1.5 SM 1.5-3.0 SC 3.0-8.0 Mdst (TRcp) 8.0-12.0 Ss (TRcp)	common
4224+07	4249+37	Qal	Alluvium is silty sand and clayey sand with occasional gravel, cobbles and boulders.			common
4249+37	4276+94	TRcp	Moderately soft to moderately hard mudstone with layers of moderately soft sandstone.			common
4276+94	4287+72	Qal	Alluvium is clayey sand with occasional gravel, cobbles and boulders.	TP-42	0.0-14.5 SC	common
4287+72	4709+97	TRcp	Moderately soft to moderately hard mudstone with interbedded siltstone and sandstone. Siltstone is moderately soft; sandstone is moderately soft to moderately hard. From about Sta 4668+00 to 4680+00 the alignment runs along the western edge of the area disturbed by uranium mining operations.	TP-43	0.0-6.0 SC 6.0-13.0 Mdst (TRcp)	common
				TT-18	0.0-10.0 Sh (TRcp)	common
				TP-44	0.0-0.8 SM 0.8-8.5 Mdst/Ss (TRcp)	common
				TP-45	0.0-1.0 SP-SM 1.0-4.5 Slst (TRcp) 4.5-13.4 Mdst (TRcp)	common
				TP-46	0.0-8.0 Mdst (TRcp)	common
				TP-47	0.0-8.0 (SP-SM)b 8.0-13.5 Mdst (TRcp)	common
				TP-48	0.0-1.8 SC 1.8-7.5 Mdst (TRcp)	common
4709+97	4789+30	TRcs	Moderately hard to hard sandstone and hard conglomerate alternating with shale. Some of the sandstone beds are 20 ft. thick. Shale beds are up to 15 ft. thick			rock
4789+30	4793+27	Qal	Alignment crosses the Little Colorado River. Alluvium is assumed to be silty sand and clayey sand with occasional gravel, cobbles and boulders.			common
4793+27	5122+16	TRcs	Sandstone and conglomerate with lenses of mudstone and shale. Sandstone is moderately hard-hard, bedding usually spaced 1"-1' ft. apart, but can be massively bedded especially near the Little Colrado River. Conglomerate is moderately hard to very hard, slightly to moderately weathered and moderately to slightly fractured (fractures spaced 0.5 to 3 feet apart). Mudstone and shale interbeds are slightly weathered and moderately soft to moderately hard.	TT-20	0.0-4.5 Ss (TRcs)	rock
5122+16	5216+14	TRm	Shale with interbedded lenses of siltstone, sandstone and infrequent limestone. The shale is very fine-grained, fissile and moderately soft. Bedding is very thinly bedded to laminated (bedding spaced 3/8 inch to less than 1/8 inch). The siltstone is fine-grained, moderately hard and typically intensely to moderately fractured depending on the spacing of bedding planes. Bedding ranges from 0.1 to 1.3 feet apart. Sandstone is predominantly fine- to coarse-grained, moderately hard and moderately fractured. Bedding ranges from 0.1 to 4 feet apart. Limestone layers are 0.5 to 2 feet thick, hard and laminated to moderately bedded (bedding ranges from 1/8 to 4 inches thick).			common/rock
5216+14	5288+19	Pk	Limestone is hard to very hard, slightly weathered and moderately bedded; bedding planes are spaced 1 inch to 1 foot apart.			rock
The Gap to Bitter Springs						
10+00	20+75	TRcp	Soft mudstone; covered with 1-4 feet of slope wash Col.			common
20+75	46+55	Col	Silty sand with cobbles	TP-20	0.0-8.7 (SM)c 8.7-9.5 (GP)sc 9.5-12.0 mdst	common
46+55	58+96	TRcp	Soft mudstone; covered with 1-4 feet of slope wash Col.			common
58+96	73+60	Col	Silty sand with gravel, cobbles and boulders	TP-19	0.0-10.0 (SP-SC)gcb 10.0-14.0 mdst	common
73+60	75+80	Qal	Predominantly sand to boulders, unconsolidated			common
75+80	90+25	Col	Silty sand with cobbles			common
90+25	92+63	Qal	Predominantly sand to boulders, unconsolidated			common
92+63	100+00	Col	Silty sand with cobbles			common

Station to	Station	Map Unit	Description	Test Pits	Test Pit Log	Excavation type
100+00	111+22	TRcp	Chinle Petrified Forest Member, reddish brown siltstone and gray mudstone, shale and sandstone interbeds. Sandstone is medium grained, intensely weathered and very soft at surface. Mudstone and shale form small hills. Covered with 2-4 feet of slope wash Col.	TT-12	0.0-4.0 Ss (TRcs)	common
111+22	112+61	Qal	Predominantly sand to boulders, unconsolidated			common
112+61	160+94	TRcp	Chinle Petrified Forest Member, reddish brown siltstone and gray mudstone, shale and sandstone interbeds. Sandstone is medium grained, intensely weathered and very soft at surface. Mudstone and shale form small hills. Covered with 2-4 feet of slope wash Col.			common
160+90	162+08	Qal	Predominantly sand to boulders, unconsolidated.			common
162+08	237+20	TRcp	Chinle Petrified Forest Member, reddish brown siltstone and gray mudstone, shale and sandstone interbeds. Sandstone is medium grained, intensely weathered and very soft at surface. Mudstone and shale form small hills. Covered with 2-4 feet of slope wash Col.	TP-18	0.0-2.5 (CL)s 2.5-9.5 mdst	common
225+83			Fault mapped from US89; not seen at surface where it crosses alinement.			
237+20	241+57	TRcs	Shinarump Ss. Contact betw. Chinle and Shinarump strikes N5°W, 85°SE,			common/ rock
241+57	252+34	TRm	Moenkopi shale and siltstone. Contact between Shinarump and Moenkopi strikes N25°E, 30°SE.			common
252+34	268+60	Pk	Kaibab limestone. Contact between Moenkopi and Kaibab strikes NS, 10°E. Limestone is hard to very hard, bedding 1"-1" thick, mod-int fractured at surface, may be rippable 1-3' deep in this area, but usually rock ex.; below 2' limestone is not as jointed, hard to rip			rock
268+60	278+00		limestone beds are up to 5' thick, slightly fractured			
278+00	282+50		Moenkopi shale and siltstone over Kaibab limestone. Contact is close and outcrops are only a few feet thick; most of excavation will be in Kaibab ls.			
282+50	292+00		Kaibab limestone. Top of unit.			
291+97	315+80	TRm	Moenkopi shale, siltstone and sandstone layers. Few feet of Col overlying.			common
315+80	336+75		Moenkopi shale, siltstone and sandstone layers. Few feet of Col overlying. Moderately hard to hard Kaibab limestone may be within 10 ft. of ground surface.			common/ rock
315+80	374+63		Moenkopi shale, siltstone and sandstone layers. Few feet of Col overlying.			common
374+63	396+07	TRcs	Shinarump not exposed, but near surface. Moenkopi float at surface. Sandstone or sandy limestone- hard, fine to medium grained, mod to slightly fractured, bedding not apparent, but appears 0.3-2' thick. May be able to rip surface 1-3' deep. Existing waterline running along proposed alignment exposes chunks of sandstone from excavation. 1-3' thick overburden Col (SM). Sandstone outcrops in washes are very variable. Some sandstone beds 2' thick, hard, interbedded with siltstone and shale. Other Ss outcrop in wash is calcareous, medium- to coarse-grained, thin lense of pebble conglomerate 1-3" thick. Purplish gray, tan, slight cross bedding, mod hard. 2-3' shaley overburden.	TP-16	0.0-3.5 s(CL) 3.5-6.0 Ss (TRcs)	common/ rock
396+07	428+97	Col	Mostly unconsolidated sand and gravel.			common
428+97	543+45	Qal	Approx. 5 to 10 ft. of predominantly sand to boulders overlying sandstone. Sandstone is moderately soft to moderately hard. Backhoe could only excavate about 1 to 2.5 ft. after encountering sandstone in test pits	TP-15	0.0-0.9 (SP)g 0.9-5.5 SM 5.5-7.0 Ss (TRcs)	common
				TP-14	0.0-8.0 SM 8.0-10.0 (SP)g 10.0-11.0 Ss (TRcs)	common
543+45	575+00	TRcp	Mudstone is moderately soft and moderately to intensely weathered near surface becoming moderately hard and moderately weathered below about 4 ft.	TP-13	0.0-4.0 SC 4.0-11.0 Mdst (TRcp)	common
575+00	694+10	Qal	Unconsolidated sand, gravel and cobbles with an occasional boulder. Qal ranges from 5 to 15 ft. thick and overlies TRcp mudstone and sandstone.	TP-12	0.0-3.8 (SP)c 3.8-11.5 SC	common
				TP-11	0.0-6.0 (SC)g 6.0-7.5 (GP)s 7.5-11.5 Ss (TRcp)	common
694+10	709+44	TRcp	Mudstone is soft to moderately soft becoming moderately hard with depth.			common
709+44	734+26	Qal	Unconsolidated sand, gravel, cobbles, and boulders. Qal ranges from 5 to 15 ft. thick and overlys TRcp mudstone and sandstone.	TP-10	0.0-9.4 (SM)gcb 9.4-13.0 Mdst (TRcp)	common
734+26	756+58	TRcs	Mudstone is soft to moderately soft becoming moderately hard with depth.			common

Station to	Station	Map Unit	Description	Test Pits	Test Pit Log	Excavation type
756+58	872+49	Qal	Unconsolidated sand, gravel, cobbles, and boulders. Qal ranges from 5 to 15 ft. thick and overlys TRcp mudstone and sandstone.	TP-9	0.0-4.0 (SM)g 4.0-5.8 (GP-GM)sc 5.8-10.0 (SC)g 10.0-12.0 Ss (TRcs)	common
				TP-8	0.0-6.0 (SC)c 6.0-7.5 Mdst (TRcp)	
				TT-14	0.0-1.0 Ss (TRcs)	
872+49	896+37	Qe/Col				common
896+37	898+13	Qal	Small wash filled with unconsolidated sand, gravel, cobbles, and boulders.			common
898+13	1148+12	Qe/Col	Alinement climbs up ridge between Tanner Wash and Echo Cliffs. Combination of wind blown silty sand (Qe) and Col at surface. Scattering of cobbles and boulders.			common
1148+12	1155+73	TRcs	Sandstone is moderately soft to moderately hard, moderately weathered.			common
1155+73	1207+19	Qe/Col	Combination of wind blown silty sand (Qe) and Col at surface. Scattering of cobbles and boulders.			common
1207+19	1223+43	TRm	Moderately soft shale with interbedded siltstone and sandstone.			common
1223+43	1290+43	Qe	Wind blown silty sand.			common
1290+43	1294+05	TRm	Moderately soft shale with interbedded siltstone and sandstone.			common
1294+05	1398+68	Qe	Wind blown silty sand.	TP-1	0.0-8.0 (SM)b 8.0-12.0 (SP-SM)cb	common
US Hwy 89 Tee to Tuba City						
10+00	30+59	Qal				common
30+59	64+21	Trco	Chinle Formation, Owl Rock Member. consists of pale red to yellowish gray siltstone and shale interbedded with gray lenses of limestone. The siltstone is fine-grained, moderately hard and moderately weathered. Bedding is spaced 0.1 to 1.2 feet apart and the thickness of the layers range from a few inches to 4 feet. The shale is soft to moderately soft, moderately weathered and fissile. Shale layers range from a few inches to 5 feet thick. The limestone is hard, slightly weathered and moderately fractured; fractures and bedding are typically spaced 0.3 to 1 foot apart. Limestone layers range from 0.5 to 3 feet thick.			common
64+21	282+66	Jm	Moenave Formation. The sandstone is predominantly fine- to coarse-grained, moderately hard and moderately weathered. Bedding ranges from 0.1 to 6.0 feet thick and is locally crossbedded.			rock
282+66	289+46	Jk		TP-69	0.0-4.5 Mdst (Jk)	common/rock
289+46	360+71	Qe	Wind blown sand up to 15 ft. thick over sandstone, siltstone or mudstone.	TP-70	0.0-13.0 SP-SM	common
				TP-71	0.0-9.0 SM 9.0-9.5 Mdst (Jkn)	common
				TP-72	0.0-12.0 SM	common
360+71	395+22	Jkn	Sandstone with interbedded mudstone. Sandstone is fine- to medium-grained, very soft and intensely weathered .Very hard, intensely fractured, chert layer present near bedrock surface. Mudstone is moderately hard, moderately weathered; unfractured. Could not excavate with backhoe beyond about 4 ft.	TP-73	0.0-2.5 SP-SM 2.5-3.8 Mdst/Ss (Jkn)	common/rock
				TP-74	0.0-0.9 SP-SM 0.9-2.4 Ss (Jkn)	common/rock
395+22	460+26	Qe	Wind blown sand up to 10 ft. thick over moderately soft to moderately hard sandstone. Difficult to excavate with a backhoe.	TP-75	0.0-8.6 SM 8.6-8.7 Ss (Jn)	common/rock
				TP-76	0.0-6.0 SM 6.0-6.5 Ss (Jn)	
460+26	470+67	Jn	Navajo Sandstone. Sandstone is moderately soft to moderately hard.			common/rock
470+67	489+96	Qe	Wind blown sand up to 10 ft. thick over moderately soft to moderately hard sandstone.	TP-77	0.0-5.5 SM 5.5-9.0 Ss (Jn)	common/rock
489+96	500+00	Jn	Navajo Sandstone; moderately soft to moderately hard.			common/rock
500+00	561+77	Qe	Wind blown sand 5 to 10 ft. thick over sandstone. Sandstone is moderately weathered and soft; laminated to very thinly bedded, bedding planes range from ¼ to 1 in. apart; flaggy. Backhoe could only scrape surface of sandstone where the sandstone is not thinly bedded.	TP-78	0.0-6.0 SM 6.0 Ss (Jn)	common/rock
				TP-79	0.0-7.7 SM 7.7-11.0 Ss (Jn)	
				TP-80	0.0-6.0 SM 9.0 Ss (Jn)	
561+77	589+37	Jn	Sandstone is moderately weathered and soft to moderately hard; laminated to very thinly bedded, bedding planes range from ¼ to 1 in. apart.			common/rock
589+37	598+38	Qe	Wind blown sand 5 to 10 ft. thick over sandstone.	TP-81	0.0-9.5 SP 9.5 Ss (Jn)	common/rock
598+38	625+07	Jn	Sandstone is moderately weathered and soft to moderately hard; laminated to very thinly bedded, bedding planes range from ¼ to 1 in. apart.			common/rock

Station to	Station	Map Unit	Description	Test Pits	Test Pit Log	Excavation type
Tuba City to Keams Canyon						
10+00	75+47	Jn	Sandstone consists of predominately fine, subrounded sand cemented with calcium carbonate. Moderately weathered and very soft at surface becoming harder with depth. In general backhoes could not excavate more than a few ft. into soft sandstone during test pit excavation.			common/rock
74+47	82+13	Qe	Wind blown sand 5 to 10 ft. thick over moderately soft to moderately hard sandstone.			common/rock
82+13	203+42	Jn	Sandstone is moderately soft to moderately hard.			common/rock
203+42	210+36	Qe	Wind blown sand 5 to 10 ft. thick over sandstone.			common/rock
210+36	261+06	Jn	Sandstone is moderately soft to moderately hard.			common/rock
261+06	271+86	Jkn	Sandstone with interbedded siltstone and mudstone. Sandstone is soft to moderately hard; siltstone is moderately hard to hard and usually occurs as 0.2 to 0.6 ft. thick beds; mudstone is moderately soft to moderately hard.			common/rock
271+86	274+75	Qal	Moenkopi Wash. Alluvium assumed to be unconsolidated silt, sand and gravel with occasional cobbles and boulders.			common
274+75	288+46	Jkn	Sandstone with interbedded siltstone and mudstone. Sandstone is soft to moderately hard; siltstone is moderately hard to hard and usually occurs as 0.2 to 0.6 ft. thick beds; mudstone is moderately soft to moderately hard.			common/rock
288+46	321+89	Jn	Sandstone is moderately soft to moderately hard.			common/rock
321+89	338+19	Qe	Wind blown sand 5 to 10 ft. thick over sandstone.			common/rock
339+19	355+46	Jn	Sandstone is moderately soft.			
355+46	377+04	Qe	Wind blown sand 5 to 10 ft. thick over sandstone.	TP-201	0.0-6.5 SM 6.5-12.5 Ss (Jn)	common
377+04	408+20	Jn	Sandstone is moderately soft.	TP-202	0.0-3.5 SP-SM 3.5-7.0 SP 7.0-9.0 Ss (Jn)	common
408+20	480+34	Qe	Wind blown sand 5 to 15 ft. thick over moderately soft sandstone.	TP-203	0.0-13.0 SM	common
480+20	515+24	Jn	Sandstone is moderately soft.	TT-26	0.0-9.0 Ss (Jn)	common
515+24	712+45	Qe	Wind blown sand 5 to 15 ft. thick over moderately soft sandstone.	TP-204	0.0-7.0 SM 7.0-9.5 SP 9.5-11.5 Ss (Jn)	common
				TP-205	0.0-11.0 SM 11.0-13.0 Ss (Jn)	common
				TP-206	0.0-15.0 SM	common
				TP-207	0.0-14.0 SM	common
712+45	726+05	Jn	Sandstone consists of predominantly fine, subrounded sand moderately cemented with silica; crossbedded, beds are 1/8 to 1 in. thick. Soft to moderately soft. Although sandstone can be broken with manual pressure in hand specimen, backhoe met refusal during test pit excavation.			common
726+05	868+66	Qe	Wind blown sand 5 to 10 ft. thick over moderately soft sandstone. JN/Jsc contact is buried; assumed to be at about Sta. 800+00.	TP-208	0.0-5.0 SM 5.0-6.5 SP 6.5-7.5 Ss (Jn)	common
				TP-209	0.0-4.5 SM 4.5-5.0 SP 5.0-8.0 Ss (Jn)	
				TP-210	0.0-6.0 SM 6.0-9.0 Ss (Jsc)	
868+66	875+25	Jsc	Sandstone is very fine grained, intensely weathered and soft. May become harder with depth.			common
875+25	950+00	Kd	Sandstone with siltstone. Sandstone consists of predominantly fine sand moderately cemented with CaCO3; soft to moderately soft. May be covered with up to 5 ft. of wind blown sand.	TP-211	0.0-3.0 s(CL) 3.0-3.5 Sltst 3.5-8.0 Ss (Kd)	common
				TP-212	0.0-2.0 SM 2.0-5.5 Ss (Kd)	common
950+00	988+05	Km	Soft shale.			common
988+05	1000+00	Col	Sandy lean clay filling slight depression to a depth of 5 to 10 ft.	TP-213	0.0-7.0 s(CL)	common
1000+00	1045+24	Km	Shale, soft to moderately soft; interbedded with thin layers of fine-grained siltstone and sandstone.			common
1045+23	1077+20	Tsy	Conglomerate and sandstone interbedded. Conglomerate is very intensely weathered to decomposed and very soft. Sandstone is intensely weathered and soft; becomes slightly harder with depth.	TP-215	0.0-2.0 SM 2.0-5.0 s(CL) 5.0-6.5 Cgl (Tsy) 6.5-9.0 Ss (Tsy)	common
1077+20	1127+32	Qe	Wind blown sand 5 to 10 ft. thick over soft sandstone and conglomerate (Tsy).	TP-216	0.0-6.0 SM 6.0-12.0 Ss (Tsy)	common

Station to	Station	Map Unit	Description	Test Pits	Test Pit Log	Excavation type
1127+32	1227+16	Tsy	Conglomerate and sandstone interbedded. Conglomerate is very intensely weathered to decomposed and very soft. Sandstone is intensely weathered and soft; becomes slightly harder with depth. The Tsy may be only 5 to 10 ft. thick and is underlain by soft shale (Km).	TP-217	0.0-3.0 s(ML) 3.0-12.0 Ss (Tsy)	common
1227+16	1242+98	Km	Localized window eroded through the Tsy into soft shale.	TP-218	0.0-3.0 SM 3.0-6.5 Sh (Km)	common
1242+98	1312+32	Qe	Wind blown sand 5 to 10 ft. thick over soft sandstone and conglomerate (Tsy).	TP-219	0.0-3.0 SC 3.0-6.0 SM 6.0-11.0 Ss (Tsy)	common
1312+32	1316+56	Tsy	Moderately soft sandstone and conglomerate.			common
1316+56	1413+20	Qe	Wind blown sand 5 to 10 ft. thick over soft shale and interbedded moderately soft to moderately hard siltstone.	TP-220	0.0-7.5 SM 7.5-12.0 Sh (Km)	common
				TP-221	0.0-7.5 SM 7.5-10.5 Sh (Km)	
1413+20	1431+74	Km	Shale is intensely weathered and soft, fragments crumble with manual pressure. Laminated, bedding less than 3/8 inch thick and fissile. Siltstone is very fine-grained, moderately soft to moderately hard; very thinly bedded, bedding ½ to 1 inch thick.			common
1431+74	1437+29	Qe	Wind blown sand 5 to 10 ft. thick over soft shale and interbedded moderately soft to moderately hard siltstone.			common
1437+29	1454+79	Km	Shale is intensely weathered and soft, fragments crumble with manual pressure. Laminated, bedding less than 3/8 inch thick and fissile. Siltstone is very fine-grained, moderately soft to moderately hard; very thinly bedded, bedding ½ to 1 inch thick.	TP-222	0.0-11.0 SM 11.0-12.0 Sh (Km)	common
1454+79	1476+61	Kmv	Sandstone is fine-grained, moderately soft to moderately hard and moderately weathered at the surface.			common/rock
1476+61	1482+35	Km	Erosional window back into Mancos Shale. Shale is intensely weathered and soft.			common
1482+35	1602+22	Kmv	Sandstone, shale and mudstone layers. Sandstone is moderately soft to moderately hard. Shale and mudstone are soft.	TP-224	0.0-4.8 SM 4.8-10.0 Mdst (Kmv)	common/rock
				TT-27	0.0-7.0 Ss (Kmv)	
1602+22	1710+34	Qe	Wind blown sand 5 to 10 ft. thick over moderately soft to moderately hard sandstone and soft mudstone and shale.	TP-225	0.0-8.0 SM 8.0-11.0 Mdst (Kmv)	common
				TP-226	0.0-5.5 SM 5.5-6.0 Ss (Kmv) 6.0-10.5 Mdst (Kmv)	
1710+34	1798+75	Kmv	Sandstone, shale and mudstone layers. Sandstone is moderately soft to moderately hard. Shale and mudstone are soft.			common
1798+75	1821+66	Qe	Wind blown sand 5 to 10 ft. thick over soft shale (Km).	TP-227	0.0-6.0 SM 6.0-12.0 Sh (Km)	common
1821+66	1856+68	Km	Shale is soft.			common
1856+68	1878+02	Kd	Sandstone consists of predominately fine, subrounded sand cemented with silica and iron oxide. Moderately weathered and soft to moderately soft; becomes slightly harder with depth. No reaction with HCl. Bedding spaced 1-3 inches apart. Iron oxide stained.	TP-228	0.0-6.0 SM 6.0-9.0 Ss (Kd)	common
1878+02	1940+19	Qe	Wind blown sand 5 to 10 ft. thick over soft shale with interbedded siltstone, sandstone.			common
1940+19	2028+36	Kd	Up to 5 ft. of silty sand over shale with interbedded siltstone, sandstone and coal. Shale is a very fine-grained, intensely weathered and soft. Bedding is laminated, less than 3/8 inch thick and fissile. Siltstone is very fine-grained, moderately soft to moderately hard. Bedding is 1/4 to ½ to inch thick. Sandstone is moderately weathered and soft to moderately soft.	TP-229	0.0-4.0 SC-SM 4.0-11.5 Sh (Kd)	common
2028+36	2350+08	Qe	Greater than 10 ft. of silty sand and sandy lean clay over soft shale (Km).	TP-230	0.0-11.0 s(CL)	common
				TP-231	0.0-12.0 SM	common
				TP-232	0.0-13.0 SC/CL	common
				TP-233	0.0-11.0 s(CL)	common
2350+08	2363+84	Qal	Dinnebito Wash. Alluvium is mostly lean clay with sand. Could contain gravel to boulders.	TP-234	0.0-13.0 (CL)s	common
2383+64	2510+16	Qe	5 to greater than 10 ft. of silty sand and sandy lean clay over soft shale (Km).	TP-235	0.0-15.0 SM	common
				TP-236	0.0-8.0 SP-SM 8.0-13.5 Ss (Km)	common
				TP-237	0.0-12.0 SM	common

Station to	Station	Map Unit	Description	Test Pits	Test Pit Log	Excavation type
The alignment from station 2510+16 to 4426+97 has not been mapped in detail and no test pits have been excavated along that section. The surface geology shown is based on limited mapping and statigraphic sections.						
2510+16	2594+21	Kmv	Alignment follows along highway through Hotevilla and Bacavi. Sandstone is moderately hard to hard with interbedded pebble conglomerate layers. Wind blown sand covers the ground surface up to 5 ft. deep.			rock
2594+21	2814+80	Qe	Wind blown silty sand forms deep dunes. Probably overlie soft shale.			common
2814+80	2817+12	Qal	Alignment crosses Oraibi Wash. Alluvium is mostly sandy lean clay. Could contain gravel to boulders.			common
2817+12	3026+53	Qe	Wind blown silty sand of unknown depth; probably overlies soft shale.			common
3026+53	3300+00	Kmv	Sandstone is moderately hard to hard with interbedded pebble conglomerate layers.			rock
3300+00	3324+85	Kmv & Km	Alignment follows the road, crossing a series of Toreva landslide blocks that have slid down the slope on the underlying shale. Soft shale (Km) and layers of moderately hard to hard sandstone (Kmv).			common
3324+85	3437+50	Km	Soft shale, may have layers of harder siltstone and sandstone.			common
3437+50	3585+09	Qe	Wind blown silty sand of unknown depth; probably overlies soft shale.			common
3585+09	3850+00	Qal	Alignment crosses a series of small washes and runs along the edge of Polacca Wash before crossing it at about Sta. 3800+00. Alluvium has not been sampled, but probably consists of unconsolidated clay, silt and sand with cobbles and boulders. Wind blown silty sand may cover portions to a depth of 5 ft. or more. Soft shale (Km) probably underlies the alluvium at an unknown depth.			common
3850+00	4050+00	Qe/ Qal	Alignment parallels Keams Canyon Wash. Surface is a mix of eolian deposits and alluvium; unsampled, but probably consists of wind blown silty sand and unconsolidated clay, silt and sand with cobbles and boulders. Soft shale (Km) underlies the top soil at an unknown depth.			common
4050+00	4426+97	Km	Alignment parallels Keams Canyon Wash, crossing the wash occasionally. Excavation will be in alluvium and soft shale (Km). Alluvium is unconsolidated clay, silt and sand with cobbles and boulders.			common