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TECHNOLOGY APPLICATIONS LABORATORIES PROJECT REPORT

Stabilization of the Contaminated Tuff and Sediment
at the Los Alamos National Laboratory

prepared by:

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TECHNOLOGY APPLICATIONS LABORATORIES PROJECT REPORT

For:

Washington Group International, Inc.

IT Project No. 831775
Revision 0

Approved by:

_____ Date:_____
IT Project Manager

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LIST OF ACRONYMS

APHIS	Animal and Plant health Inspection Services
ASTM	American Society for Testing and Materials
BMP	Best Management Practice
cpm	counts per minute
CHP	Chemical Hygiene Plan
DOE	Department of Energy
DOT	U.S. Department of Transportation
ETDC	Environmental Technology Development Center
HASP	Health and Safety Plan
HEPA	High efficiency particulate air
IA	Interim action

IT	IT Corporation
LANL	Los Alamos National Laboratory
LDR	Land Disposal Restrictions
NPDES	National Pollution Discharge Emission Standards
OSHA	Occupational Safety and Health Administration
OU	Operable Unit
PC	Portland cement
PPE	Personal Protective Equipment
ppm	Parts per million
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
SEP	Sequential Extraction Procedure
SOP	Standard Operating Procedure
SRPAR	Tennessee State Regulations for Protection Against Radiation
S/S	Stabilization/Solidification
TCLP	Toxicity Characteristic Leaching Procedure
TDRH	Tennessee Division of Radiological Health
TDL	Technology Development Laboratory
UTS/UHC	Universal Treatment Standards/Underlying Hazardous Constituents
WGI	Washington Group International, Inc.
WMP	Waste Management Plan

EXECUTIVE SUMMARY

TA-21 is the former plutonium processing facility at LANL. At TA-21, PRS 21-011(k) was the outfall for industrial wastewater from Building TA-21-257, the new industrial wastewater treatment plant. The wastewater treated at Building TA-21-257 consisted of liquids remaining after plutonium extraction. An interim action (IA) was conducted at PRS 021-011(k) site in 1996 and 1997, removing a significant portion of the radionuclide source term and install storm water control measures as a best management practice (BMP). A corrective measure for the remaining tuff and sediment at the PRS 21-011(k) site is under consideration.

The purpose of this corrective measure is to return the site to a condition safe for human recreational use and be acceptable from an ecological risk evaluation perspective. The tuff and sediment at the PRS 21-011(k) site was exposed to treated liquid radioactive waste effluent for a number of years. Radionuclides of concern in the treated effluent included: Cs-137, Sr-90, Pu-239, and Am-241. The cesium and strontium are the most prevalent contaminants with trace and localized "hot spots" of the heavier isotopes. In-situ S/S of the tuff and sediment material is required to reduce the mobility of the radiological contaminants of concern and to produce a durable and relatively impervious treated material.

A stabilization treatability study was conducted on the sediment, tuff, soil, and sediment/tuff material from PRS 21-011(k) site. The objective of this study was to develop stabilization/solidification (S/S) mix designs for the contaminated tuff and sediment material. A S/S grout mix design will be required, as appropriate, for both the tuff and sediment materials. Formulation development testing on the tuff , sediment, soil, and tuff/sediment composite materials involved eight formulations involving Portland cement, bentonite, and soluble silicates in various combinations. Performance testing was conducted on these formulations to determine if the treated material met the anticipated performance criteria.

The Portland cement (low)/bentonite (low) formulation should be used for the full-scale S/S treatment. This formulation met all the performance criteria for the stabilized material with the tuff and sediment/tuff composite materials and should meet all the performance criteria for the sediment and Soil 564 material with increased curing time. No other formulation had such consistent performance on all of the materials.

1.0 PROJECT DESCRIPTION

1.1 BACKGROUND

TA-21 is the former plutonium processing facility at LANL. TA-21 began plutonium operations in 1945 and ceased operations in 1978. At TA-21, PRS 21-011(k) was the outfall for industrial wastewater from Building TA-21-257, the new industrial wastewater treatment plant. This plant began operations in 1967 and treated wastes from DP West and DP East until the early 1990's. The wastewater treated at Building TA-21-257 consisted of liquids remaining after plutonium extraction. The treatment process in Building TA-21-257 mixed the raw waste with lime, ferric sulfate, and coagulant aids. The waste was then pumped to a flocculator and on to a settling tank. Settled effluent was pumped through a pressure filter and sampled, to verify treatment. If the effluent was determined to be adequately treated, it was pumped to two final effluent holding tanks (presumably tanks TA-21-112 and TA-21-113). From tanks TA-21-112 and TA-21-113, the wastewater was piped northeast toward DP Canyon and discharged on the north side of DP Mesa. This wastewater contained a variety of radioactive and chemical constituents.

PRS 21-011(k) was investigated by the ER Project in 1992 and 1993 and reported on in 1995 in the Final Draft for the OU 1106 Addendum to Phase 1B, 1C Report. The initial radiation survey and soil sampling performed at PRS 21-011(k) in FY92 indicated the presence of radionuclide contamination. Additional soil sampling and a radiation survey were performed during the FY93 field season to further define the extent of contamination found in FY92. An interim action (IA) plan was prepared in 1996. The IA was conducted in 1996 and 1997 and reported on in the Interim Action Report for Potential Release Site 21-011(k) 1997.

The objectives of the IA was to remove a significant portion of the radionuclide source term and install storm water control measures as a best management practice (BMP). The results of a post-excavation radiological survey indicate that the soil activity was reduced from greater than 500,000 counts per minute (cpm) to less than 100,000 cpm over the entire upper drainage area. The 100,000 cpm is equivalent to between 400 and 500 pCi/g. In addition, storm water controls were installed in 1997 and upgraded in August 1999.

Soil excavated from PRS 21-011(k) during the 1996 IA (390 cubic yards) was characterized in the field to document that it contained greater than 100,000 cpm of contamination. It was then transported to Area G for disposal.

A corrective measure for the remaining tuff and sediment at the PRS 21-011(k) site is under

consideration. The purpose of this corrective measure is to return the site to a condition safe for human recreational use and be acceptable from an ecological risk evaluation perspective. The tuff and sediment at the PRS 21-011(k) site was exposed to treated liquid radioactive waste effluent for a number of years. Radionuclides of concern in the treated effluent included: Cs-137, Sr-90, Pu-239, and Am-241. The cesium and strontium are the most prevalent contaminants with trace and localized "hot spots" of the heavier isotopes. In-situ S/S of the tuff and sediment material is required to reduce the mobility of the radiological contaminants of concern and to produce a durable and relatively impervious treated material.

1.2 EQUIPMENT

The equipment used in the laboratory-scale S/S treatability testing included:

- 5 quart planetary mixer,
- Stainless steel mixing bowls,
- 3"x6" right cylinder plastic molds,
- 2"x4" right cylinder plastic molds,
- Stainless steel spatulas,
- Laboratory balances, and
- Graduated cylinders.

1.3 MATERIALS

The reagents used during the laboratory-scale S/S treatability testing included:

- Type I Portland cement,
- Sodium bentonite, and
- Type N soluble silicates.

The personnel protective equipment used during the treatability study includes:

- Nitrile gloves,
- Tyvek coveralls, and
- Tyvek boot covers.

1.4 FACILITIES

IT conducted the laboratory-scale S/S treatability testing at it's Technology Development Laboratory (TDL) in Knoxville, TN. Geotechnical testing on the tuff and sediment samples and the S/S treated materials were conducted at IT's Environmental Technology Development Center (ETDC) in Oak Ridge, TN.

The TDL, at 304 Directors Drive, Knoxville, TN 37923, is the main facility for performing bench-scale treatability studies and sample chemical analyses. This facility maintains a Radioactive Materials License from the State of Tennessee and operates under the treatability exemption in 40 CFR 261.4.

The ETDC at 1570 Bear Creek Road, Oak Ridge, TN 37831, houses the Geotechnical Laboratory. The TDL uses this facility. ETDC maintains a Radioactive Materials License and operates under the treatability exemption.

Both facilities have an U.S. Dept. of Agriculture Animal and Plant Health Inspection Services (APHIS) agreement for the importation of foreign and domestic soils. Both facilities are monitored by a security company. Access to each facility is strictly controlled.

Treatability studies and other activities were performed under the relevant permits, licenses, or exemptions.

1.5 SAMPLE TRANSPORTATION

Washington Group International, Inc. (WGI) coordinated with LANL for the collection of four 5-gallon buckets of the contaminated tuff and four 5-gallon buckets of the sediment material. The tuff sample buckets contained material less than 3-inches in diameter. WGI also arranged for a licensed shipper to transfer the soils from LANL to IT's ETDC. WGI prepared chains of custody following established protocols to ensure that these samples were properly identified.

Upon receipt at the ETDC, the samples were each be given a unique sample number and logged into the ETDC sample inventory system. The unique sample number was used to track materials such as samples, test-residues, test products and reagents throughout the project.

1.6 SAMPLE CHAIN-OF-CUSTODY

A strict chain of custody record was maintained for all samples received at the TDL in Knoxville, Tennessee or the ETDC in Oak Ridge, Tennessee. Sample transfers external to the treatability facility were accompanied by an IT combined Analysis Request and Chain of Custody Record. Samples transferred to the treatability analytical department or Geotechnical Laboratory were also accompanied by an Analysis Request and Chain of Custody Record. Copies of all Analysis Request and Chain of Custody Records are maintained in the project file.

1.7 SAMPLE LABELING

Samples collected had a unique sample identification which describes or relates to specific information about the sample, including at a minimum, description of sample, date of collection,

name of sample collector and an indication of hazards associated with the sample.

Samples generated by the TDL in the course of testing were noted in laboratory notebooks with a description of the sample and a sample number or designation. The sample number applied to the sample included the laboratory notebook number followed by the notebook page number on which the sample is described and designated, and in turn followed by the sample designation, as described below.

laboratory notebook no. - notebook page no. - sample number or designation

For example, a stabilized sample designated as sample number 3 on page 36 of laboratory book number 1610 had the following sample number:

1610-36-3.

2.0 STUDY AND TEST OBJECTIVES

2.1 OBJECTIVES

The purpose of this study was to perform bench-scale (laboratory-scale) testing to develop soil stabilization/solidification (S/S) mix designs for the contaminated tuff and sediment material. A S/S grout mix design will be required, as appropriate, for both the tuff and sediment materials. The grout mix developed and recommended during this task will be used for in-situ stabilization/solidification.

Formulation development testing on the tuff and sediment materials involved eight formulations involving Portland cement, bentonite, and soluble silicates in various combinations.

2.2 STUDY PERFORMANCE STANDARDS

The primary goal of the S/S treatment is to minimize the mobility of the radionuclides. S/S is a performance-based remedial approach since it does not reduce the total mass of the radionuclides and cannot in itself achieve concentration-based remedial objectives. The anticipated performance standards for the S/S treatment of the tuff and sediment are given in Table 2-1

Table 2.1 Anticipated Performance Criteria for the LANL S/S Treated Material

Parameter	Criteria	Standard Test Method
Unconfined Compressive Strength at 14 days Cure	>50 psi	ASTM D 2166
Unconfined Compressive Strength at 28 days Cure	>50 psi	ASTM D 2166
Hydraulic Conductivity at 28 days Cure	<1x10E-06 cm/sec	ASTM D 5084
Leachability Indices for Gross Alpha, Nonvolatile Beta	>8.0	ANS 16.1 modified
Temperature at Core and Surface	<100 °F	ASTM C 1064
pH	>10.0	ASTM D 4972
Bleed Fluid	<0.5%	ANS 55.1 or EPA 9095
Volume Increase	<50%	None
Freeze/Thaw Durability	<15% loss	ASTM D4842
Initial Set Time	> 6 hours	ASTM C 191
Final Set Time	< 180 days	ASTM C 191
False Set	Prohibitied	ASTM C 191
Flash Set	Prohibited	ASTM C 191
Reactivity	Non-reactive	SW-846 Method 1040
Ignitability	>140°C	SW-846 Method 1050

3.0 TEST OBSERVATIONS AND RESULTS

3.1 SAMPLE CHARACTERIZATION TESTING

The tuff container were opened and the contaminated tuff as dumped into a three foot wide by six foot long metal tray. Tuff pieces greater than 1/2-inch in diameter were size-reduced with a 5 kg drop hammer. Six geotechnical samples of the tuff were collected (Table 3.1). An attempt will be made to select samples which represent the variability of geotechnical and physical properties present in the tuff. The remaining contaminated tuff material was transferred to a 30-gallon plastic container and mixed using a double helical mixer until it is visually uniform.

Table 3.1 Description of the Six Tuff Samples for Geotechnical Testing

Geotechnical Composite	Description
Tuff #1	Moist aggregates of tuff material
Tuff #2	Random 10 point composite of the tuff material
Tuff #3	Darker colored aggregates of tuff material
Tuff #4	Random 10 point composite of the tuff material
Tuff #5	Lighter colored tuff material
Tuff #6	Whitish tuff material

A similar sampling and homogenization procedure was conducted on the containers of the sediment material. Six geotechnical samples of the sediment were collected (Table 3.2). The sediment containers for Soil 564 and Soil 554 sampling locations were individually sampled and homogenized. Geotechnical samples of these two sediment materials were also collected.

Six samples of the tuff material and eight samples of the sediment material were analyzed for grain size distribution (ASTM D422), Atterburg limits (ASTM D4138), moisture content (ASTM D2216), and bulk density (ASTM D5057) to determine the extent of variability of these parameters throughout each material (Tables 3.3 and 3.4).

The geotechnical testing indicated that the size-reduced tuff composite samples were dry, non-plastic gravelly sand in nature. The moisture contents varied from 14 to 20% on a dry weight basis. The non-plastic nature of the tuff material indicates that the material handling properties will not be adversely impacted under high moisture conditions. The particle size distribution was consistent across the tuff geothechnical composite samples, with moderate levels of silt and little clay contents. The limited variability in the tuff geotechnical composites suggests that it will have consistent material handling properties.

Table 3.2 Description of the Eight Sediment Samples for Geotechnical Testing

Geotechnical Composite	Description
Sediment #1	Moist aggregates of sediment material
Sediment #2	Drier and lighter colored aggregated sediment material
Sediment #3	Moist and lighter colored aggregated sediment material
Sediment #4	Drier and darker colored sediment material
Sediment #5	Moist and darker colored sediment material
Sediment #6	Random 10 point composite of the sediment material
Sediment #7	Random 10 point composite of sample Soil 564 ("hot soil")
Sediment #8	Random 10 point composite of sample Soil 554

Table 3.3 Physical Characterization of the Tuff and Sediment Geotechnical Composite Samples

Soil Fraction	Moisture Content (% dwb[1])	Liquid Limit	Plastic Limit	Plasticity Index	Wet Density (lb/ft^3)
		Moisture Content (%)			
Tuff #1	14.5	NP[2]	NP	NP	71.4
Tuff #2	18.5	NP	NP	NP	72.9
Tuff #3	12.3	NP	NP	NP	77.8
Tuff #4	20.0	NP	NP	NP	71.9
Tuff #5	14.5	NP	NP	NP	71.3
Tuff #6	14.5	NP	NP	NP	74.5
Sediment #1	14.3	28	27	1	71.0
Sediment #2	5.7	27	27	0	66.2
Sediment #3	7.4	26	26	0	70.3
Sediment #4	5.1	NP	NP	NP	72.9
Sediment #5	6.4	23	25	-2	72.9
Sediment #6	6.9	25	26	-1	71.2
Sediment #7	17.2	32	36	-4	74.9
Sediment #8	5.7	38	39	-1	66.2

[1] determined on a dry weight basis
[2] NP = non-plastic

Table 3.4 Particle Size Distribution of the Tuff and Sediment Geotechnical Composite Samples

Particle Size Fraction	Tuff #1	Tuff #2	Tuff #3	Tuff #4	Tuff #5
	Percent Solids by Weight				
Gravel	17.1	24.2	22.5	24.7	31.5
Sand	56.6	52.1	52.7	51.7	49.6
Silt	23.1	20.2	20.9	20.4	17.1
Clay	3.3	3.4	3.8	3.2	1.8
Particle Size Fraction	Tuff #6	Sediment #1	Sediment #2	Sediment #3	Sediment #4
	Percent Solids by Weight				
Gravel	34.9	3.2	2.4	1.0	0.4
Sand	46.3	52.9	34.3	41.1	48.5
Silt	17.0	33.8	60.9	44.8	41.6
Clay	1.9	10.1	12.4	13.2	9.4
Particle Size Fraction	Sediment #5	Sediment #6	Sediment #7	Sediment #8	
	Percent Solids by Weight				
Gravel	2.8	1.5	2.7	7.8	
Sand	47.7	43.6	61.0	47.4	
Silt	38.9	44.4	27.0	38.8	
Clay	10.6	10.5	9.2	6.0	

The geotechnical testing on sediment composite samples (Sediment 1 through Sediment 6) indicated that the sediment is dry, loam or sandy loam soil. The moisture contents varied from 5 to 7% on a dry weight basis. Low plasticity index of the sediment composite material confirms its sandy nature. Therefore, the material handling properties of the sediment material should not be adversely affected by high moisture conditions. The particle size distribution was consistent across the sediment composite samples, with moderate levels of silt and low clay contents. The limited variability in the sediment geotechnical composite samples suggests that it will have consistent material handling properties.

The geotechnical testing results for the Soil 564 ("hot soil") and Soil 554 composite samples indicate that these materials are similar in nature to the sediment material. The Soil 564 material did have a higher moisture content (17%) and greater portion of sand-sized particles in its particle size distribution, as compared to the sediment composite samples. These materials would have similar material handling properties to the sediment.

3.2 STABILIZATION FORMULATION DEVELOPMENT

Stabilization formulation development was conducted on the sediment composite, the tuff composite, Soil 564 ("hot soil") sample, and a 60/40 blend of the sediment/tuff composites. The stabilization formulation involved treating 4-kg aliquots of soil with four S/S grout mix designs (Table 3.5). Each formulation was mixed in a planetary mixer. A 4,000 g aliquot of reactor soil was added to the mixing bowl. The dry reagents were weighed out, blended, and mixed into an equal weight of water. Soluble silicate or an additional 200 mL of water was then added to the reagent slurry. The reagent slurry was then be added to the soil in the mixing bowl. Additional water was added to the formulation as necessary to produce a moist soil-like consistency. The soil and reagent slurry was mixed at 30-40 rpm for 1 to 2 minutes to produce a homogeneous treated material.

The treated material was poured into appropriate molds for performance testing, vibrated to remove air pockets, and capped to minimize moisture loss. The molded material was allowed to cure at ambient laboratory temperature (approximately 72°F) in sealed coolers.

3.3 PERFORMANCE TESTING

The cured treated material was subjected to the performance criteria testing listed in Table 3.6 through 3.9. The testing listed in these tables are the same as anticipated performance criteria (Table 2.1) for the final stabilized waste material.

Table 3.5 Grout Design Mixes for the LANL Tuff and Sediment Materials

Contaminated Material	Formulation ID Number	Soil (g)	Portland Cement (g)	Sodium Bentonite (g)	Sodium Silicate (g)	Water (g)
Tuff	110814	4,000	400	125	0	975
	110815	4,000	400	0	100	900
	110816	4,000	400	125	50	1025
	110817	4,000	400	125	100	1025
	110818	4,000	800	250	0	1300
	110819	4,000	800	0	200	1050
	110820	4,000	800	250	100	1300
	110821	4,000	800	250	200	1300
Sediment	110806	4,000	400	125	0	725
	110807	4,000	400	0	100	400
	110808	4,000	400	125	50	525
	110809	4,000	400	125	100	525
	110810	4,000	800	250	0	1050
	110811	4,000	800	0	200	800
	110812	4,000	800	250	100	1050
	110813	4,000	800	250	200	1050
Soil 564 "Hot Spot"	110823	3,000	300	93.8	0	744
	110824	1,500	150	0	37.5	300
	110825	1,500	150	46.9	18.8	345
	110826	2,500	250	78.1	62.5	628
	110827	2,500	500	156	0	940
	110828	1,500	300	0	75.3	350
	110829	1,500	300	93.8	37.6	450
	110830	2,500	500	156	125	735
Soil/Tuff Composite 60/40 (w:w)	110832	4,000	400	125	0	945
	110833	4,000	400	0	100	900
	110834	4,000	400	125	50	1026
	110835	4,000	400	125	100	1097
	110836	4,000	800	250	0	1250
	110837	4,000	800	0	200	1100
	110838	4,000	800	250	100	1250
	110839	4,000	800	250	200	1350

Table 3.6 Performance of the LANL Sediment Formulations

Parameter	Criteria	Formulation Number			
		110806	110807	110808	110809
Unconfined Compressive Strength at 14 days Cure (psi)	>50	165	63	36	39
Unconfined Compressive Strength at 28 days Cure (psi)	>50	177	65	28	29
Hydraulic Conductivity at 28 days Cure (cm/sec)	<1x10E-06	4.2x10E-07	1.4x10E-06	4.5x10E-04	1.6x10E-05
Leachability Indices for Gross Alpha/Nonvolatile Beta	>8.0	11.3/10.5	11.3/10.8	11.2/10.8	11.0/10.3
Temperature at Core and Surface (°F)	<100	25	25	25	25
pH (s.u.)	>10.0	11.9	12.1	12.0	12.0
Bleed Fluid (%)	<0.5	<0.5	<0.5	<0.5	<0.5
Volume Increase (%)	<50	-19.5	-17.3	-9.19	-10.9
Freeze/Thaw Durability (% loss)	<15	25.6	SC[1]	SC	SC
Initial Set Time (hours)	> 6	> 6	> 6	> 6	> 6
Final Set Time (days)	< 180	< 180	< 180	< 180	< 180
False Set	Prohibited	NO	NO	NO	NO
Flash Set	Prohibited	NO	NO	NO	NO

[1] SC = Sample crumbled

Table 3.6 (cont) Performance of the LANL Sediment Formulations

Parameter	Criteria	Formulation Number			
		110810	110811	110812	110813
Unconfined Compressive Strength at 14 days Cure (psi)	>50	348	286	184	277
Unconfined Compressive Strength at 28 days Cure (psi)	>50	583	320	275	347
Hydraulic Conductivity at 28 days Cure (cm/sec)	<1x10E-06	2.9x10E-06	9.4x10E-09	8.5x10E-07	5.0x10E-06
Leachability Indices for Gross Alpha/Nonvolatile Beta	>8.0	11.0/10.3	11.0/10.2	10.9/10.2	10.4/10.1
Temperature at Core and Surface (°F)	<100	25	25	24	24
pH (s.u.)	>10.0	12.0	12.5	12.3	12.4
Bleed Fluid (%)	<0.5	<0.5	<0.5	<0.5	<0.5
Volume Increase (%)	<50	-4.42	-9.14	-1.27	0.59
Freeze/Thaw Durability (% loss)	<15	9.63	26.7	SC[1]	SC
Initial Set Time (hours)	> 6	> 6	> 6	> 6	> 6
Final Set Time (days)	< 180	< 180	< 180	< 180	< 180
False Set	Prohibited	NO	NO	NO	NO
Flash Set	Prohibited	NO	NO	NO	NO

[1] SC = Sample crumbled

Table 3.7 Performance of the LANL Tuff Formulations

Parameter	Criteria	Formulation Number			
		110814	110815	110816	110817
Unconfined Compressive Strength at 14 days Cure (psi)	>50	332	251	323	326
Unconfined Compressive Strength at 28 days Cure (psi)	>50	370	426	376	427
Hydraulic Conductivity at 28 days Cure (cm/sec)	<1x10E-06	1.9x10E-06	1.8x10E-05	5.8x10E-06	3.4x10E-07
Leachability Indices for Gross Alpha/Nonvolatile Beta	>8.0	10.9/10.3	11.2/10.6	10.5/10.6	10.2/10.7
Temperature at Core and Surface (°F)	<100	23	23	22	22
pH (s.u.)	>10.0	12.1	12.3	12.2	12.3
Bleed Fluid (%)	<0.5	<0.5	<0.5	<0.5	<0.5
Volume Increase (%)	<50	-13.3	-14.6	-10.4	-8.12
Freeze/Thaw Durability (% loss)	<15	5.51	6.81	7.97	7.53
Initial Set Time (hours)	> 6	> 6	> 6	> 6	> 6
Final Set Time (days)	< 180	< 180	< 180	< 180	< 180
False Set	Prohibited	NO	NO	NO	NO
Flash Set	Prohibited	> 6	> 6	> 6	> 6

Table 3.7 (cont) Performance of the LANL Tuff Formulations

Parameter	Criteria	Formulation Number			
		110818	110819	1 10820	110821
Unconfined Compressive Strength at 14 days Cure (psi)	>50	705	578	386	578
Unconfined Compressive Strength at 28 days Cure (psi)	>50	771	736	612	467
Hydraulic Conductivity at 28 days Cure (cm/sec)	<1x10E-06	1.9x10E-07	6.8x10E-07	5.7x10E-06	2.3x10E-06
Leachability Indices for Gross Alpha/Nonvolatile Beta	>8.0	10.2/10.4	11.0/10.9	10.6/10.7	11.1/10.7
Temperature at Core and Surface (°F)	<100	22	22	22	23
pH (s.u.)	>10.0	12.1	12.4	12.3	12.4
Bleed Fluid (%)	<0.5	<0.5	<0.5	<0.5	<0.5
Volume Increase (%)	<50	0.59	-3.62	5.08	10.4
Freeze/Thaw Durability (% loss)	<15	4.60	5.69	8.02	13.11
Initial Set Time (hours)	> 6	> 6	> 6	> 6	> 6
Final Set Time (days)	< 180	< 180	< 180	< 180	< 180
False Set	Prohibited	NO	NO	NO	NO
Flash Set	Prohibited	> 6	> 6	> 6	> 6

Table 3.8 Performance of the LANL Soil 564 "Hot Soil" Formulations

Parameter	Criteria	Formulation Number			
		110823	110824	110825	110826
Unconfined Compressive Strength at 14 days Cure (psi)	>50	209	316	293	291
Unconfined Compressive Strength at 28 days Cure (psi)	>50	224	281	299	290
Hydraulic Conductivity at 28 days Cure (cm/sec)	<1x10E-06	1.5x10E-06	2.2x10E-06	9.2x10E-06	1.8x10E-06
Leachability Indices for Gross Alpha/ Nonvolatile Beta	>8.0	11.0/10.0	11.0/10.3	10.8/10.0	11.2/10.3
Temperature at Core and Surface (°F)	<100	23	23	23	24
pH (s.u.)	>10.0	12.2	12.4	12.3	12.3
Bleed Fluid (%)	<0.5	<0.5	<0.5	<0.5	<0.5
Volume Increase (%)	<50	-14.1	-16.7	-11.6	-9.48
Freeze/Thaw Durability (% loss)	<15	6.32	nd	nd	19.7
Initial Set Time (hours)	> 6	> 6	> 6	> 6	> 6
Final Set Time (days)	< 180	< 180	< 180	< 180	< 180
False Set	Prohibited	NO	NO	NO	NO
Flash Set	Prohibited	NO	NO	NO	NO

nd = not determined

Table 3.8 (cont) Performance of the LANL Soil 564 "Hot Soil" Formulations

Parameter	Criteria	Formulation Number			
		110827	110828	110829	110830
Unconfined Compressive Strength at 14 days Cure (psi)	>50	489	499	422	410
Unconfined Compressive Strength at 28 days Cure (psi)	>50	449	356	473	347
Hydraulic Conductivity at 28 days Cure (cm/sec)	<1x10E-06	2.1x10E-06	1.4x10E-06	1.1x10E-07	7.0x10E-09
Leachability Indices for Gross Alpha, Nonvolatile Beta	>8.0	11.0/9.9	10.9/10.0	11.0/9.8	11.0/10.2
Temperature at Core and Surface (°F)	<100	23	23	23	24
pH (s.u.)	>10.0	12.2	12.5	12.3	12.3
Bleed Fluid (%)	<0.5	<0.5	<0.5	<0.5	<0.5
Volume Increase (%)	<50	5.90	-5.28	3.89	4.07
Freeze/Thaw Durability (% loss)	<15	7.96	nd	nd	SC
Initial Set Time (hours)	> 6	> 6	> 6	> 6	> 6
Final Set Time (days)	< 180	< 180	< 180	< 180	< 180
False Set	Prohibited	NO	NO	NO	NO
Flash Set	Prohibited	NO	NO	NO	NO

Table 3.9 Performance of the LANL Sediment/Tuff Composite Formulations

Parameter	Criteria	Formulation Number			
		110832	110833	110834	110835
Unconfined Compressive Strength at 14 days Cure (psi)	>50	215	183	181	186
Unconfined Compressive Strength at 28 days Cure (psi)	>50	276	291	223	209
Hydraulic Conductivity at 28 days Cure (cm/sec)	<1x10E-06	3.4x10E-06	2.0x10E-06	1.1x10E-05	2.1x10E-06
Leachability Indices for Gross Alpha/Nonvolatile Beta	>8.0	11.4/9.2	11.4/9.1	10.7/9.1	10.6/9.2
Temperature at Core and Surface (°F)	<100	25	24	24	25
pH (s.u.)	>10.0	11.9	12.2	12.1	12.2
Bleed Fluid (%)	<0.5	<0.5	<0.5	<0.5	<0.5
Volume Increase (%)	<50	-15.1	-14.2	-9.98	-6.96
Freeze/Thaw Durability[1] (% loss)	<15	9.50	11.93	11.97	18.0
Initial Set Time (hours)	> 6	< 180	< 180	< 180	< 180
Final Set Time (days)	< 180	NO	NO	NO	NO
False Set	Prohibited	NO	NO	NO	NO
Flash Set	Prohibited	> 6	> 6	> 6	> 6

[1] Freeze/Thaw Durability - only through 10 cycles

Table 3.9 (cont) Performance of the LANL Sediment/Tuff Composite Formulations

Parameter	Criteria	Formulation Number			
		110836	110837	110838	110839
Unconfined Compressive Strength at 14 days Cure (psi)	>50	509	245	297	252
Unconfined Compressive Strength at 28 days Cure (psi)	>50	607	355	380	244
Hydraulic Conductivity at 28 days Cure (cm/sec)	<1x10E-06	4.7x10E-07	2.6x10E-06	4.5x10E-05	2.6x10E-06
Leachability Indices for Gross Alpha/Nonvolatile Beta	>8.0	10.4/8.9	10.5/9.0	10.4/9.1	10.2/9.1
Temperature at Core and Surface (°F)	<100	25	23	23	23
pH (s.u.)	>10.0	12.3	12.5	12.5	12.7
Bleed Fluid (%)	<0.5	<0.5	<0.5	<0.5	<0.5
Volume Increase (%)	<50	0.18	0.23	5.74	9.34
Freeze/Thaw Durability[1] (% loss)	<15	7.34	14.89	10.42	27.4
Initial Set Time (hours)	> 6	< 180	< 180	< 180	< 180
Final Set Time (days)	< 180	NO	NO	NO	NO
False Set	Prohibited	NO	NO	NO	NO
Flash Set	Prohibited	> 6	> 6	> 6	> 6

[1] Freeze/Thaw Durability - only through 10 cycles

All of the formulations had initial set times of greater than 6 hours and less the 180 hours. There was no sign of false or flash set for any of the formulations. This suggests that the treated material will remain soil-like for at least 6 hours and provide an adequate window for obtaining and preparing samples for verification testing during full-scale treatment activities. There was also no bleed water associated with the stabilized material from any of the formulations. This indicates that the treated material will not produce free liquids during full-scale placement and initial setting.

The low cement formulations (110806 through 110809) for the sediment material did not develop unconfined compressive strength (UCS) as quickly as the higher cement formulations (110810 through 110813) formulations. Two of the low cement formulations (110808 and 110809) did not attain the 50 psi UCS criteria, while all of the other sediment formulations exceed the 50 psi criteria. Several of the sediment formulations had hydraulic conductivities near or below the $1x10^{-6}$ cm/s criteria. The highest hydraulic conductivities were for sediment formulations 110808 and 110809. The UCS and hydraulic conductivity results for these formulations suggest that the amount of water added in these formulations was not sufficient.

The ANS 16.1 modified leach indices for the sediment formulations exceed the criteria of 8. This indicates that the release of the radionuclides from the stabilized material by diffusion is limited. The pH of the sediment formulations were all above the criteria of 10.0, but were below the RCRA hazardous characterization level of 12.5

Several of the sediment formulations crumbled during freeze/thaw durability testing and others exceed the 15% weight loss criteria. Only formulation 110810 met the freeze/thaw durability criteria of less than 15% weight loss.

All of the formulations for the tuff material developed UCS quickly and exceed the 50 psi criteria. Several of the sediment formulations had hydraulic conductivities near or below the $1x10^{-6}$ cm/s criteria. The ANS 16.1 modified leach indices for the tuff formulations exceed the criteria of 8. This indicates that the release of the radionuclides from the stabilized material by diffusion is limited. The pH of the tuff formulations were all above the criteria of 10.0, but were below the RCRA hazardous characterization level of 12.5. None of the formulations on the tuff material crumbled during freeze/thaw durability testing and all met the less than 15% weight loss criteria.

All of the formulations for the Soil 564 "hot soil" material developed UCS quickly and exceed the 50 psi criteria. Several of the sediment formulations had hydraulic conductivities near or

below the $1x10^{-6}$ cm/s criteria. The ANS 16.1 modified leach indices for the Soil 564 formulations exceed the criteria of 8. This indicates that the release of the radionuclides from the stabilized material by diffusion is limited. The pH of the Soil 564 formulations were all above the criteria of 10.0, and were generally below the RCRA hazardous characterization level of 12.5. Due to limited sample volume, freeze/thaw durability testing was only conducted on a 4 of the 8 Soil 564 formulations. One of the Soil 564 formulations (110830) crumbled during freeze/thaw durability testing and another (110826) exceed the 15% weight loss criteria. Formulations 110823 and 110827 met the freeze/thaw durability criteria of less than 15% weight loss.

All of the formulations for the sediment/tuff composite material developed UCS quickly and exceed the 50 psi criteria. Several of the sediment formulations had hydraulic conductivities near or below the $1x10^{-6}$ cm/s criteria. The ANS 16.1 modified leach indices for the sediment/tuff composite formulations exceed the criteria of 8. This indicates that the release of the radionuclides from the stabilized material by diffusion is limited. The pH of the sediment/tuff composite formulations were all above the criteria of 10.0, but were below the RCRA hazardous characterization level of 12.5. None of the formulations on the tuff material crumbled during freeze/thaw durability testing and most met the less than 15% weight loss criteria.

Volume increase for each formulation was calculated using the equation:

$$Volume\ Increase\ (\%) = [\{(BD_i/BD_f)*(1+tmr)\}-1]*100$$

where BD_i was the average bulk density of the material from geotechnical testing, BD_f was the bulk density reported for the 28 day UCS testing on the treated material from the formulation, and tmr is the total mix ratio [mix ratio = (weight reagent)/(weight material) of all reagents, including water, used in the formulation. The low volume increases for most of the stabilization formulations indicate that the treated material is more compact than the untreated material. This is due to the water added as part of the stabilization formulations. Up to the optimum moisture content, the densities of soil materials increase with increased moisture content. The added water increases the moisture content and allows for more efficient compaction of the treated material.

3.4 SEQUENTIAL EXTRACTION TESTING

Sequential extraction procedures (SEPs) are used to characterize metal immobilization mechanisms and to aid in estimating bioavailability. Numerous SEPs have been developed to characterize metal fractionation into various binding phases. While these procedures cannot be used to identify the actual form of a given metal in a soil, they are useful in grouping metals into phases or fractions. The distribution of the metal among the SEP fractions can provide

information on the likely binding phases and characterize the relative stability of metal immobilization processes.

The SEP approach used for untreated and treated sediment, tuff and sediment/tuff composite samples is a form of the consensus method for extraction being calibrated by the National Institute of Standards and Technology. The following description identifies the metal immobilization phase with a description of how the metals present in each of these phases is extracted during the SEP process.

Exchangeable Phase - metals that are reversibly sorbed to soil minerals, amorphous solids, and/or organic material by electrostatic forces. These forces are overcome by using a concentrated electrolyte leach (1M $MgCl_2$) that displaces the metal ions from solid surfaces. The metals solubilized by this extraction are analyzed to determine metals present in the exchangeable phase.

Acid Extractable Phase- metals that are irreversibly sorbed or otherwise bound in carbonate minerals. These forces are overcome by using a mild acid to (1M NaOAc solution in 25% HOAc at pH 5) to dissolve carbonate minerals. The metals solubilized by this extraction are analyzed to determine metals associated with the carbonate phase or other metals that are solubilized by acidic conditions.

Reducible Phase - metals bound to hydroxides of iron, manganese, and/or aluminum and easily solubilized oxides. These forces are overcome by using a solution of 0.1 M hydroxylamine hydrochloride in pH 2 nitric acid to reduce the soil or sediment sample. The metals solubilized by this extraction are analyzed to determine metals associated with the reducible phase.

Organic Phase - metals bound to soil organic matter (e.g., stable humus). These forces are overcome by oxidizing the soil organic matter with a pH 8.5, 5% NaOCl solution. The metals solubilized by this extraction are analyzed to determine metals associated with the organic matter.

Oxidizeable Phase – metals bound to sulfide minerals. The forces binding metals to sulfides are overcome by leaching with a 4M HNO_3 solution at 95°C. The metals solubilized in this extraction are analyzed to determine metals associated with sulfide minerals.

Residual Phase - The remaining metals are distributed between silicates, phosphates, and refractory oxides. SW846 Method 3052 (HNO_3/HCL/HF acid mixture) is used to extract the remaining metals.

The results of the SEP testing are summarized in Tables 3.10 and 3.11.

Table 3.10 Sequential Extraction of Cesium from Untreated and Treated LANL Materials

Phase	Sediment Composite		Tuff Composite		Sediment/Tuff Composite		
	Untreated	Formulation 110820	Untreated	Formulation 110812	Untreated	Formulation 110836	Formulation 118038
	Fraction of Cs-137 in each Phase (%)						
Exchangeable	<0.2	3.7	0.6	<0.2	0.3	1.0	1.0
Acid Extractable	<0.2	8.9	1.9	2.1	1.9	2.3	2.7
Reducible	0.9	2.3	1.2	<0.2	<0.2	0.5	1.0
Organic	2.5	11.9	4.4	3.3	3.2	4.8	4.4
Oxidizable	44.2	4.7	41.3	57.5	48.4	52.1	55.1
Residual	52.4	68.5	50.6	37.1	46.1	39.3	35.9

Table 3.11 Sequential Extraction of Strontium from Untreated and Treated LANL Materials

Phase	Sediment Composite		Tuff Composite		Sediment/Tuff Composite		
	Untreated	Formulation 110820	Untreated	Formulation 110812	Untreated	Formulation 110836	Formulation 118038
	Fraction of Sr-90 in each Phase (%)						
Exchangeable	55.4	23.1	71.3	22.7	63.6	34.7	34.1
Acid Extractable	1.3	16.8	4.6	11.9	<0.2	15.1	18.0
Reducible	1.4	9.4	3.7	7.9	2.1	7.6	8.2
Organic	1.3	2.7	0.5	2.1	0.9	2.2	2.2
Oxidizable	1.3	3.1	0.9	2.5	1.1	4.3	2.5
Residual	39.3	44.8	19.0	52.9	32.4	36.2	35.0

The SEP results indicate that the stabilization treatment on sediment material appears to respeciate Cs-137 from the oxidizable fraction to the exchangeable, acid extractable, reducible, organic, and residual phases, as compared to the untreated sediment material, and respeciate Sr-90 from the exchangeable phase to the acid extractable, reducible, organic, oxidizable, and residual phases. The stabilization treatment on the tuff material appeared to respeciate Cs-137 from the residual to the oxidizable phase, as compared to the untreated tuff material, and respeciate Sr-90 from the exchangeable phase to the acid extractable, reducible, organic, oxidizable, and residual phases. The stabilization treatment on the sediment/tuff composite material appeared to respeciate Cs-137 from the residual to the oxidizable phase, as compared to

the untreated sediment/tuff composite material, and respeciate Sr-90 from the exchangeable phase to the acid extractable, reducible, organic, and oxidizable, and residual phases.

Comparison between the SEP results for the Portland cement (high)/bentonite (high) and Portland cement (high)/bentonite (high)/silicate (mod) indicates that the silicate has little effect on the respeciation of Cs-137 and Sr-90. Most of the respeciation is probably due to the Portland cement in the stabilization formulation.

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 UNTREATED MATERIAL CHARACTERIZATION

4.1.1 Tuff Composite Material

The geotechnical testing of six samples from the size-reduced tuff composite samples indicated that the tuff material is a dry, non-plastic gravelly sand in nature. The non-plastic nature of the tuff material indicates that the material handling properties will not be adversely impacted under high moisture conditions. The limited variability in the tuff geotechnical composites suggests that it will have consistent material handling properties.

4.1.2 Sediment Composite Material

The geotechnical testing on sediment composite samples indicated that the sediment is dry, loam or sandy loam soil. Low plasticity index of the sediment composite material confirms its sandy nature. Therefore, the material handling properties of the sediment material should not be adversely affected by high moisture conditions. The limited variability in the sediment geotechnical composite samples suggests that it will have consistent material handling properties.

4.1.3 Soil 564 and Soil 554 Samples

The geotechnical testing results for the Soil 564 ("hot soil") and Soil 554 composite samples indicate that these materials are similar in nature to the sediment composite material. The Soil 564 material did have a higher moisture content (17%) and greater portion of sand-sized particles in its particle size distribution, as compared to the sediment composite samples. These materials would have similar material handling properties to the sediment material.

4.2 S/S TESTING

The bench-scale treatability testing was conducted to demonstrate how the treated material from the selected S/S grout mix designs performed with respect to the performance criteria for the final stabilized waste material. The results from the performance testing provide information on the leachability, durability, hydraulic conductivity, strength, and long-term durability of the S/S treated soil material.

4.2.1 Tuff Composite Material

With the exception of the hydraulic conductivity, the treated material from all formulations on the tuff composite material met the performance criteria (Table 2.1). The hydraulic conductivity

after 28 days of curing ranged from $1.8x10^{-5}$ to $1.9x10^{-7}$ cm/s for the treated material from the tuff composite material. The Portland cement (low)/bentonite (low)/silicate (mod) (110817), Portland cement (high)/bentonite (high) (110818), and Portland cement (high)/silicate (high) (110819) formulations met the hydraulic conductivity criteria. The hydraulic conductivities for the Portland cement (low)/bentonite (low) (110814) and Portland cement (high)/bentonite (high)/silicate (high) (110821) were close to the $1x10^{-6}$ cm/s criteria. Over time, the hydraulic conductivity of these formulations should decrease and be below the performance criteria.

4.2.2 Sediment Composite Material

With the exception of the hydraulic conductivity and freeze/thaw durability, the treated material from all formulations met the performance criteria (Table 2.1).

The hydraulic conductivity after 28 days of curing ranged from $4.5x10^{-4}$ to $9.4x10^{-9}$ cm/s for the treated material from the sediment composite material. The Portland cement (low)/bentonite (low) (110806), Portland cement (high)/silicate (high) (110811), and Portland cement (high)/bentonite (high)/silicate (mod) (110812) formulations met the hydraulic conductivity criteria. The hydraulic conductivities for the Portland cement (low)/silicate (mod) (110807) and Portland cement (high)/bentonite (high) (110810) were close to the $1x10^{-6}$ cm/s criteria. Over time, the hydraulic conductivity of these formulations should decrease and be below the performance criteria.

Several of the sediment formulations crumbled during freeze/thaw durability testing and others exceed the 15% weight loss criteria. Only the Portland cement (low)/bentonite (low) (110810) formulation met the freeze/thaw durability criteria of less than 15% weight loss.

4.2.3 Soil 564 ("Hot Soil") Material

With the exception of the hydraulic conductivity and freeze/thaw durability, the treated material from all formulations met the performance criteria (Table 2.1). The hydraulic conductivity after 28 days of curing ranged from $9.2x10^{-6}$ to $7.0x10^{-9}$ cm/s for the treated material from the Soil 564 material. The Portland cement (high)/bentonite (high)/silicate (mod) (110829), and Portland cement (high)/bentonite (high)/silicate (high) (110830) formulations met the hydraulic conductivity criteria. The hydraulic conductivities for the Portland cement (low)/bentonite (low) (110823), Portland cement (low)/silicate (mod) (110824), Portland cement (low)/bentonite (low)/silicate (mod) (110826), Portland cement (high)/bentonite (high) (110827) and Portland cement (high)/silicate (high) (110828) were close to the $1x10^{-6}$ cm/s criteria. Over time, the hydraulic conductivity of these formulations should decrease and be below the performance criteria.

Due to limited sample volume, freeze/thaw durability testing was only conducted on a 4 of the 8 Soil 564 formulations. The Portland cement (low)/bentonite (low) (110823) and Portland cement (high)/bentonite (high) formulations met the freeze/thaw durability criteria of less than 15% weight loss.

4.2.4 Sediment/Tuff Composite Material

With the exception of the hydraulic conductivity and freeze/thaw durability, the treated material from all formulations met the performance criteria (Table 2.1).

The hydraulic conductivity after 28 days of curing ranged from 4.5×10^{-5} to 4.7×10^{-7} cm/s for the treated material from the sediment/tuff composite material. Only the Portland cement (high)/bentonite (high) (110836) formulation met the hydraulic conductivity criteria. The hydraulic conductivities for the Portland cement (low)/bentonite (low) (110832), Portland cement (low)/silicate (mod) (110833), Portland cement (low)/bentonite (low)/silicate (mod) (110835), Portland cement (high)/silicate (high) (110837) and Portland cement (high)/bentonite (high)/silicate (high) (110839) were close to the 1×10^{-6} cm/s criteria. Over time, the hydraulic conductivity of these formulations should decrease and be below the performance criteria.

The Portland cement (low)/bentonite (low) (110832), Portland cement (low)/silicate (mod) (110833), Portland cement (low)/ bentonite (low)/silicate (low) (110834), Portland cement (high)/bentonite (high) (110836), and Portland cement (high)/bentonite(high)/silicate (mod) (110838) met the freeze/thaw durability criteria of less than 15% weight loss.

4.3 FULL-SCALE S/S TREATMENT

4.3.1 S/S Formulation

The Portland cement (low)/bentonite (low) formulation should be used for the full-scale S/S treatment. This formulation met all the performance criteria for the stabilized material with the tuff and sediment/tuff composite materials and should meet all the performance criteria for the sediment and Soil 564 material with increased curing time. No other formulation had such consistent performance on all of the materials.

4.3.2 Contaminated Material Compositing

Though the selected stabilization formulation should be adequate to treat the sediment, tuff or sediment/tuff composite material, the sediment and tuff material should be composited and stockpiled prior to beginning full-scale stabilization treatment. The sediment/tuff composite material produced the most consistent treated material during bench-scale tresting and should produce the most consistent treated material during full-scale processing.

4.3.3 Process Mixing Constraints

The major process mixing constraint for the Portland cement/bentonite grout mix is that the grout mix must be thoroughly mixed with the contaminated sediment, tuff, or sediment/tuff composite material. The primary source of failure during full-scale treatment is often the lack of thorough mixing of the reagent grout and the contaminated material. The sediment and tuff are sandy loam/loam materials. While the sandy nature of the these materials make mixing of the grout and contaminated material easier, high speed, high shear mixing should be utilized for full-scale treatment. Commercially-available pugmills can provide the high speed, high shear mixing required.

Mixing by excavators or rake-like attachments on excavators may not produce the high energy, high shear mixing required to thoroughly blend the grout and the contaminated materials. Jet-grouting has been effective in sandy soils and debris, but has had incomplete or inadequate mixing results in some soils. Auger mixer mounted either on crane bodies or excavators, may be sufficient to produce the high speed, high shear mixing required.

4.3.4 Construction Tolerances

The grout should be produced in a batch plant capable of providing an individual grout batch for stabilization batch. The weights of Portland cement and bentonite and the volume of water should be recorded for each grout batch. The weights should be controlled to within ±1% of the desired value. The metering pump for the water should also control the water addition to within ±1% of the required value. The desired weights of the Portland cement and bentonite in each grout batch should be calculated from the volume of soil to be treated in the batch, the density of the stockpiled contaminated material, and the recommended S/S formulation. The amount of water should also be determined in a similar fashion, but can be modified to adjust the viscosity of the grout to match the S/S vendor's grout pumping and handling equipment.

Each grout batch should be used within a maximum of 2 hours of batching. If a set retarder is used to prolong the time between batching and injection of the grout, testing should be conducted to determine the effect of the set retarder on the performance of the treated material.

Appendix A – Geothechnical Testing Report

INTERNATIONAL TECHNOLOGY CORPORATION

GEOTECHNICAL LABORATORY

CERTIFICATE OF ANALYSIS

Paul Lear
IT Corporation
304 Directors Drive
Knoxville TN 37923

January 28, 2002

This is the Certificate of Analysis for the following samples:

Project ID:	**LANL**
Project Number:	**831775**
Date Received by Lab:	December 17 and 20, 2001
Number of Samples:	Ten (10)
Sample Type:	Soil

I. Introduction/Case Narrative

Five soil samples were received by the IT Geotechnical Laboratory beginning on December 17, 2001. Five additional soil samples were received on December 20, 2001. Chain-of-custody documents were not included with the samples. Test (stabilized) specimens were issued unique identification numbers that do not correspond with the raw samples received, so laboratory sample number are not referenced on the test results sheets.

Soils were combined and stabilized by treatability staff. Soils mixes were numbered sequentially for a series of sediments and a series of tuffs. Numerous stabilized cylindrical specimens were designated for various physical tests. This certificate reports the results of sample characterization tests: particle-size distribution, Atterberg limits, moisture content, and bulk density screening.

Please see Appendix A, Sample Number Cross-Reference List; Appendix B, Analysis Results; and Appendix C, Variance/Nonconformance Reports.

Reviewed and Approved:

Ralph Cole
Laboratory Manager, Geotechnical Services

IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
(865) 482-6497

- Maintenance of all past calibration records - calibration records and certification documents of all instruments, gauges and equipment are updated routinely and maintained in the Quality Control Coordinators Quality/Operations files.

- Certified and trained personnel - all technicians are certified by the National Institute for Certification of Engineering Technicians (NICET) in geotechnical soil testing, and are trained in the application of standard laboratory procedures for geotechnical analyses as well as the quality assurance measures implemented by IT.

IV. Data Qualification

None.

Appendix A
Sample Cross-Reference List

Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
(865) 482-6497

ATTERBERG LIMITS
ASTM D 4318

PROJECT NAME: LANL

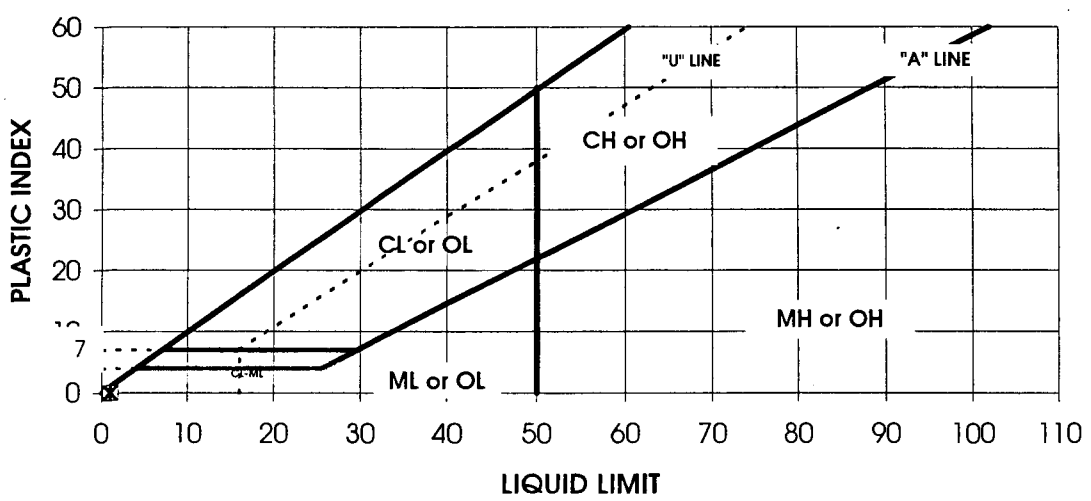
PROJECT NO. 831775.00000000

ATTERBERG LIMITS RESULTS

LAB SAMPLE NO.	FIELD SAMPLE NO.	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	USCS SYMBOL
●	Tuff 1	NP	NP	NP	NP
◆	Tuff 2	NP	NP	NP	NP
□	Tuff 3	NP	NP	NP	NP
◇	Tuff 4	NP	NP	NP	NP
+	Tuff 5	NP	NP	NP	NP
○	Tuff 6	NP	NP	NP	NP
■					
x					
▲					
★					

*NP=Nonplastic

PLASTICITY CHART



Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
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PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name LANL

Client Sample No. Sediment #1

Project No. 831775.00000000

IT Lab Sample No. None

Specific Gravity : 2.65
assumed for calculations

Moisture Content = 14.3%
based on dry sample weight

SIEVE ANALYSIS

	Sieve No.	Diameter mm	Percent Finer
COARSE	3"	75.000	100.0%
	1.5"	37.500	100.0%
	0.75"	19.000	100.0%
	0.375"	9.500	98.5%
	#4	4.750	96.8%
	#10	2.000	90.0%

	Sieve No.	Diameter mm	Percent Finer
FINE	#20	0.850	71.8%
	#40	0.425	60.3%
	#60	0.250	54.8%
	#100	0.149	50.4%
	#140	0.106	47.6%
	#200	0.075	43.9%

HYDROMETER ANALYSIS

	Diameter mm	Percent Finer
HYDROMETER		
	0.04661	40.8%
	0.03420	32.2%
	0.02212	26.7%
	0.01170	18.8%
	0.00799	15.7%
	0.00671	14.1%
	0.00478	12.5%
	0.00328	11.8%
	0.00143	9.4%

3.2% Gravel 52.9% Sand 43.9% Silt/Clay

Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
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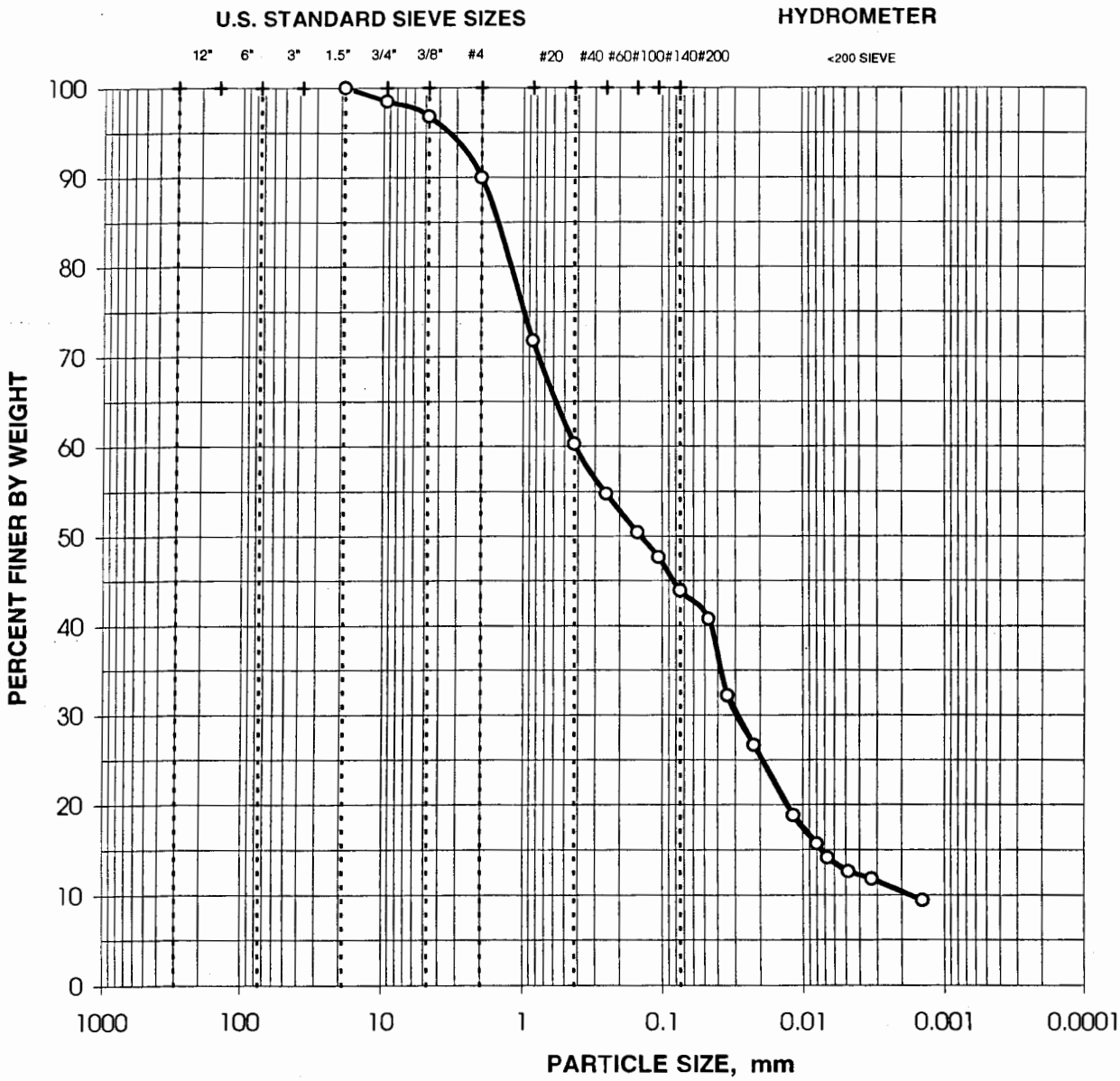

CLIENT SAMPLE NO.: Sediment #1

IT LAB SAMPLE NO.: None

BOULDERS	COBBLES	GRAVEL		SAND			
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT 2 - 75 microns CLAY <2 microns

Paul Lear
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January 28, 2002
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IT Project No.: 831775.00000000

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PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name LANL

Client Sample No. Sediment #2

Project No. 831775.00000000

IT Lab Sample No. None

Specific Gravity : 2.65
assumed for calculations

Moisture Content = 5.7%
based on dry sample weight

SIEVE ANALYSIS

COARSE	Sieve No.	Diameter mm	Percent Finer
	3"	75.000	100.0%
	1.5"	37.500	100.0%
	0.75"	19.000	100.0%
	0.375"	9.500	98.8%
	#4	4.750	97.6%
	#10	2.000	93.9%

FINE	Sieve No.	Diameter mm	Percent Finer
	#20	0.850	84.8%
	#40	0.425	78.1%
	#60	0.250	74.1%
	#100	0.149	70.5%
	#140	0.106	67.7%
	#200	0.075	63.3%

HYDROMETER ANALYSIS

HYDROMETER	Diameter mm	Percent Finer
	0.04346	57.4%
	0.03266	44.9%
	0.02163	34.1%
	0.01184	25.0%
	0.00826	20.8%
	0.00666	17.5%
	0.00474	15.8%
	0.00327	13.3%
	0.00142	10.8%

2.4% Gravel 34.3% Sand 63.3% Silt/Clay

Paul Lear
IT Corporation
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IT Project No.: 831775.00000000

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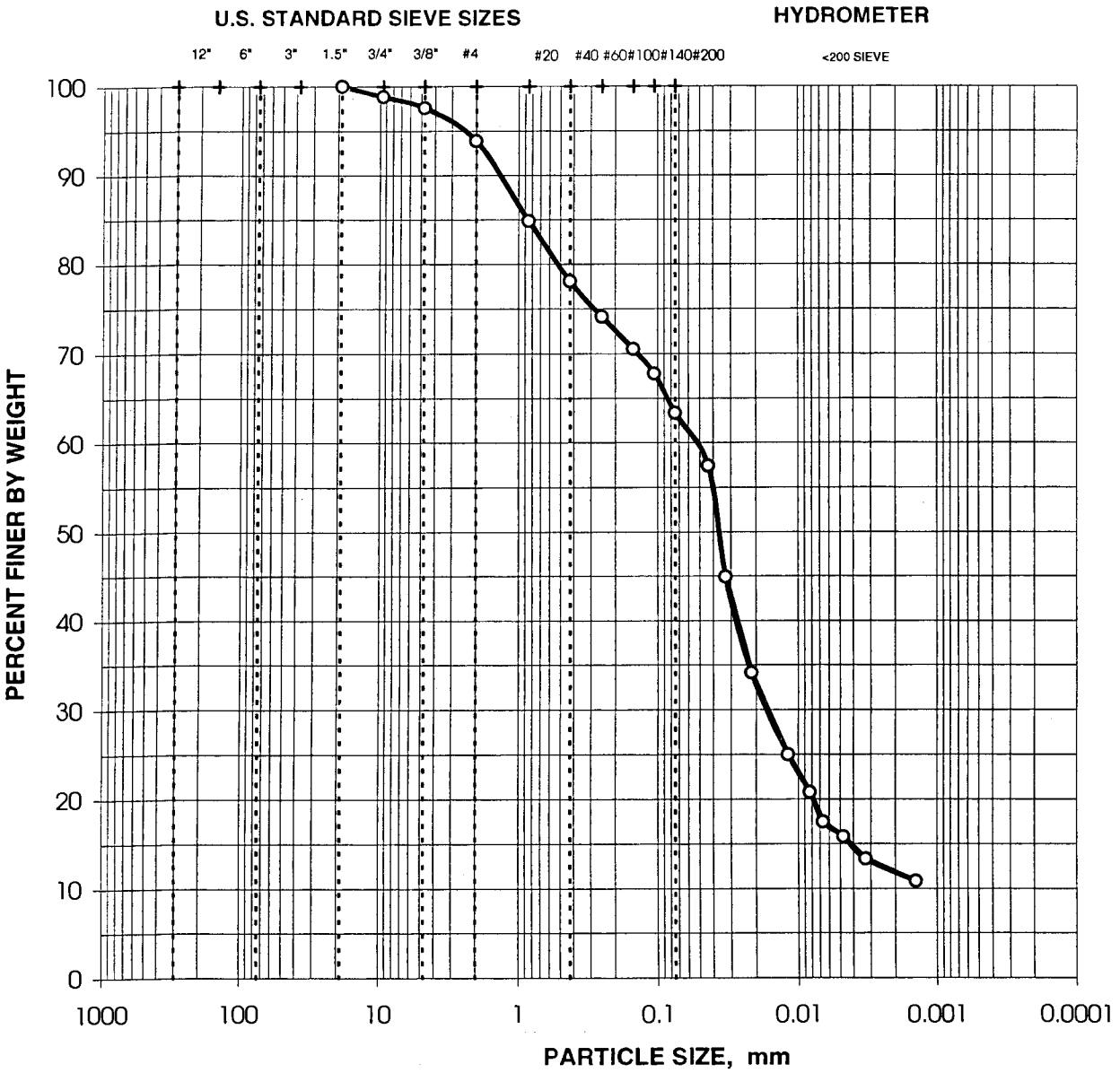

CLIENT SAMPLE NO.: Sediment #2

IT LAB SAMPLE NO.: None

BOULDERS	COBBLES	GRAVEL		SAND			
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT 2 - 75 microns CLAY <2 microns

Paul Lear
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IT GEOTECHNICAL LABORATORY
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PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name LANL

Client Sample No. Sediment #3

Project No. 831775.00000000

IT Lab Sample No. None

Specific Gravity : 2.65
assumed for calculations

Moisture Content = 7.4%
based on dry sample weight

SIEVE ANALYSIS

	Sieve No.	Diameter mm	Percent Finer
COARSE	3"	75.000	100.0%
	1.5"	37.500	100.0%
	0.75"	19.000	100.0%
	0.375"	9.500	99.8%
	#4	4.750	99.0%
	#10	2.000	94.9%

	Sieve No.	Diameter mm	Percent Finer
FINE	#20	0.850	84.4%
	#40	0.425	75.5%
	#60	0.250	70.6%
	#100	0.149	66.4%
	#140	0.106	63.0%
	#200	0.075	58.0%

HYDROMETER ANALYSIS

	Diameter mm	Percent Finer
HYDROMETER		
	0.04490	50.3%
	0.03311	41.2%
	0.02163	33.8%
	0.01180	25.5%
	0.00930	20.6%
	0.00664	18.1%
	0.00473	16.5%
	0.00326	14.0%
	0.00142	12.4%

1.0% Gravel 41.0% Sand 58.0% Silt/Clay

Paul Lear
IT Corporation
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IT Project No.: 831775.00000000

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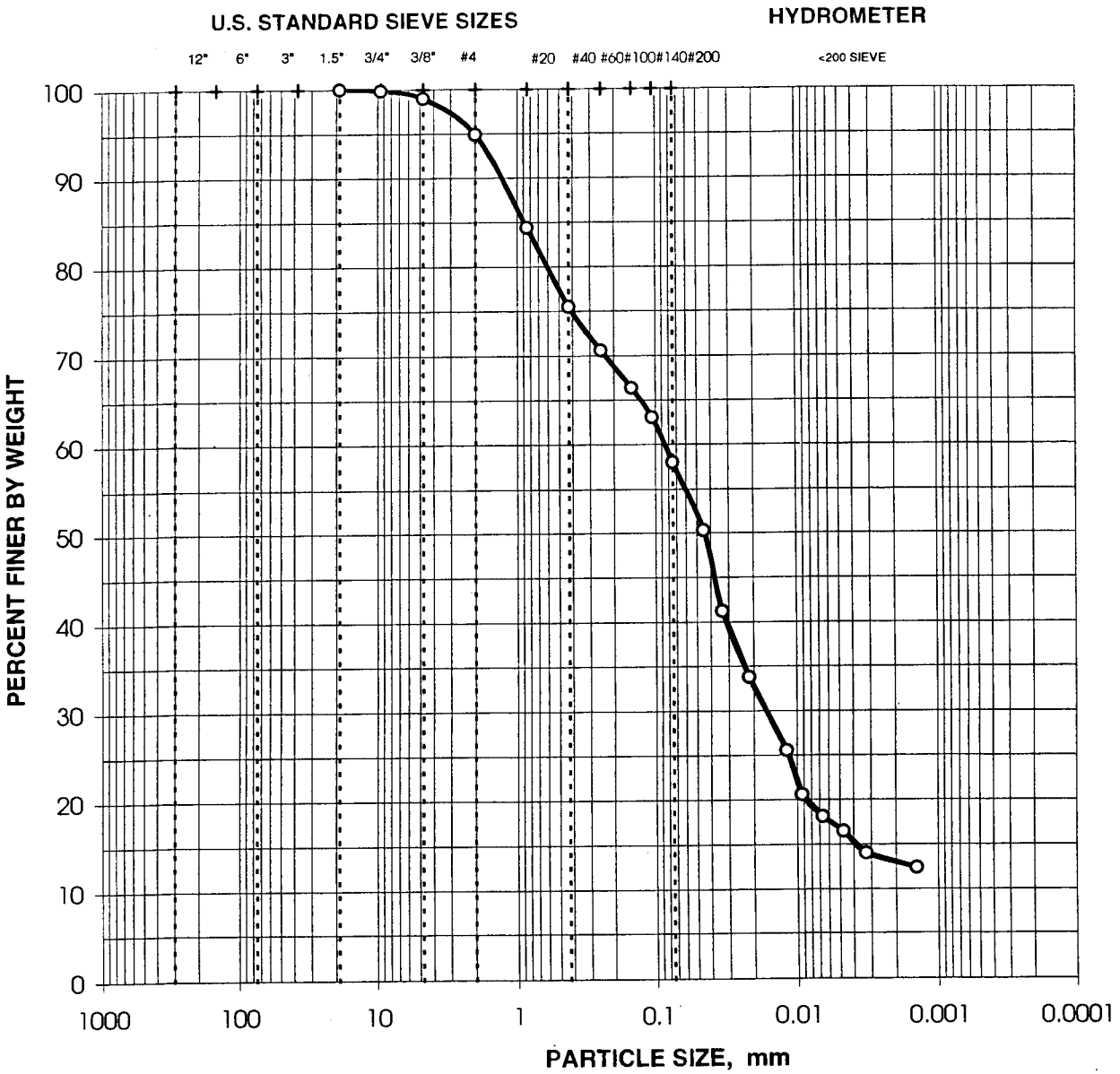

CLIENT SAMPLE NO.: Sediment #3

IT LAB SAMPLE NO.: None

BOULDERS	COBBLES	GRAVEL		SAND			
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT 2 - 75 microns CLAY <2 microns

Paul Lear
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IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
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PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name LANL

Client Sample No. Sediment #4

Project No. 831775.00000000

IT Lab Sample No. None

Specific Gravity : 2.65
assumed for calculations

Moisture Content = 5.1%
based on dry sample weight

SIEVE ANALYSIS

COARSE	Sieve No.	Diameter mm	Percent Finer
	3"	75.000	100.0%
	1.5"	37.500	100.0%
	0.75"	19.000	100.0%
	0.375"	9.500	100.0%
	#4	4.750	99.6%
	#10	2.000	96.9%

FINE	Sieve No.	Diameter mm	Percent Finer
	#20	0.850	80.6%
	#40	0.425	67.6%
	#60	0.250	62.4%
	#100	0.149	58.7%
	#140	0.106	55.8%
	#200	0.075	51.0%

HYDROMETER ANALYSIS

HYDROMETER	Diameter mm	Percent Finer
	0.04576	41.8%
	0.03296	38.8%
	0.02221	24.6%
	0.01049	16.4%
	0.00947	14.2%
	0.00673	12.7%
	0.00478	11.9%
	0.00328	9.7%
	0.00143	8.9%

0.4% Gravel 48.5% Sand 51.0% Silt/Clay

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IT Project ID: LANL
IT Project No.: 831775.00000000

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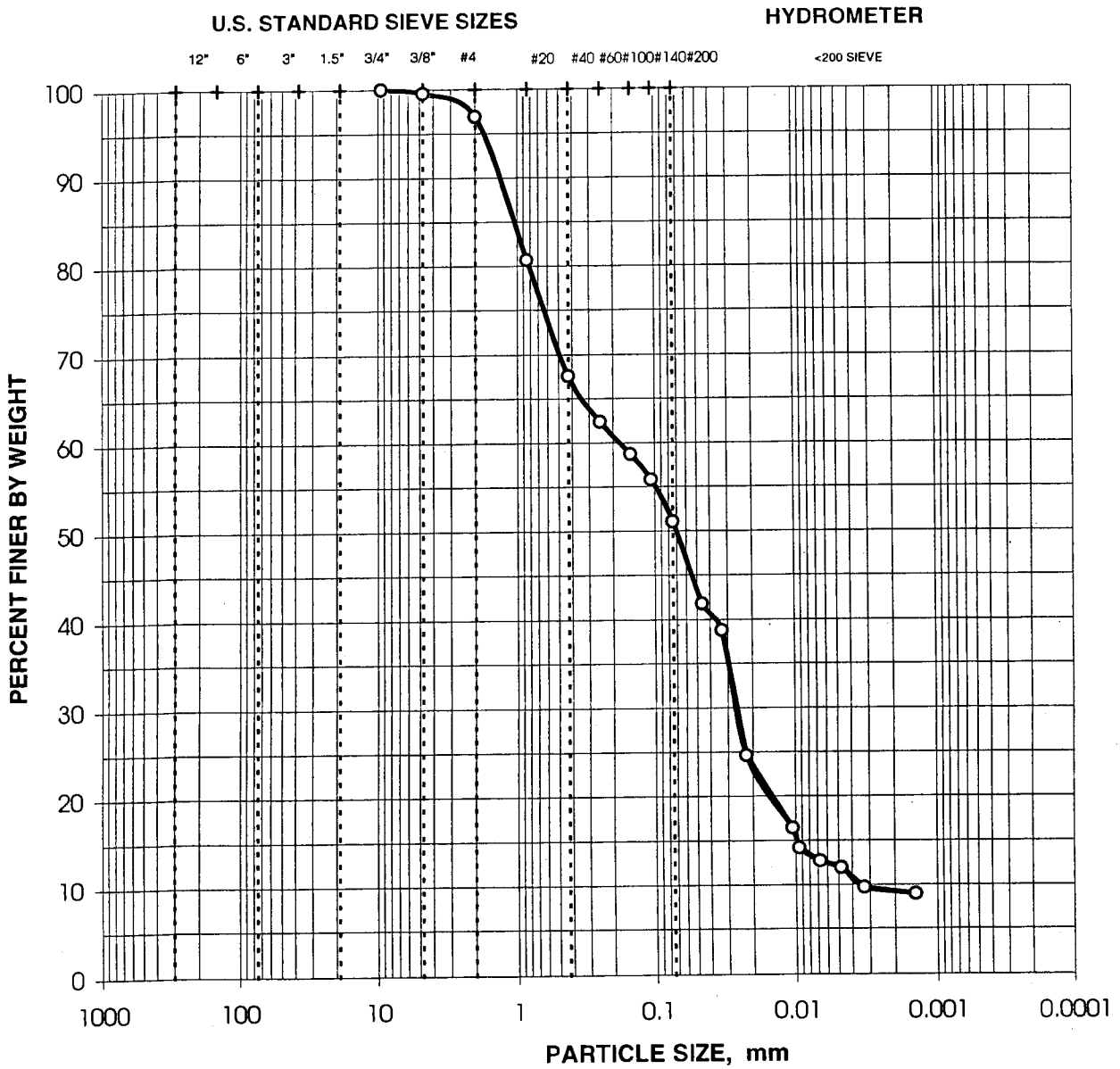

CLIENT SAMPLE NO.: Sediment #4

IT LAB SAMPLE NO.: None

BOULDERS	COBBLES	GRAVEL		SAND			
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT 2 - 75 microns CLAY <2 microns

Paul Lear
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January 28, 2002
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IT Project No.: 831775.00000000

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PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name LANL

Client Sample No. Sediment #5

Project No. 831775.00000000

IT Lab Sample No. None

Specific Gravity : 2.65
assumed for calculations

Moisture Content = 6.4%
based on dry sample weight

SIEVE ANALYSIS

	Sieve No.	Diameter mm	Percent Finer
COARSE	3"	75.000	100.0%
	1.5"	37.500	100.0%
	0.75"	19.000	100.0%
	0.375"	9.500	99.5%
	#4	4.750	97.2%
	#10	2.000	92.1%

	Sieve No.	Diameter mm	Percent Finer
FINE	#20	0.850	78.8%
	#40	0.425	68.1%
	#60	0.250	62.4%
	#100	0.149	57.7%
	#140	0.106	54.4%
	#200	0.075	49.5%

HYDROMETER ANALYSIS

	Diameter mm	Percent Finer
HYDROMETER		
	0.04619	42.6%
	0.03441	30.8%
	0.02230	25.3%
	0.01317	18.9%
	0.00938	17.4%
	0.00671	14.2%
	0.00478	12.6%
	0.00329	11.1%
	0.00142	10.3%

2.8% Gravel 47.7% Sand 49.5% Silt/Clay

Paul Lear
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January 28, 2002
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IT Project No.: 831775.00000000

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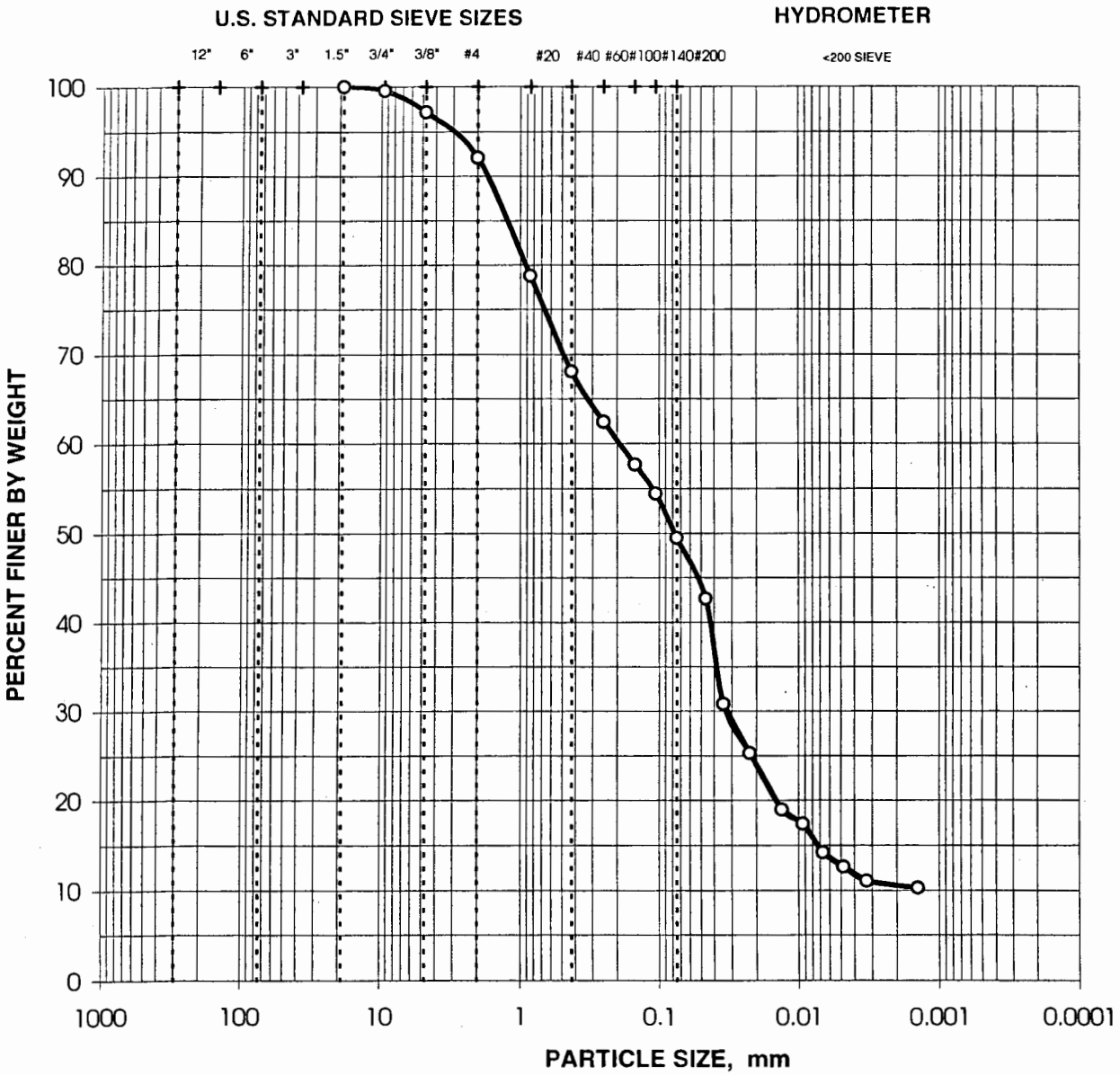

CLIENT SAMPLE NO.: Sediment #5

IT LAB SAMPLE NO.: None

BOULDERS	COBBLES	GRAVEL		SAND			
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT 2 - 75 microns CLAY <2 microns

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IT GEOTECHNICAL LABORATORY
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PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name LANL

Client Sample No. Sediment #6

Project No. 831775.00000000

IT Lab Sample No. None

Specific Gravity : 2.65
assumed for calculations

Moisture Content = 6.9%
based on dry sample weight

SIEVE ANALYSIS

	Sieve No.	Diameter mm	Percent Finer
COARSE	3"	75.000	100.0%
	1.5"	37.500	100.0%
	0.75"	19.000	100.0%
	0.375"	9.500	100.0%
	#4	4.750	98.5%
	#10	2.000	93.7%

	Sieve No.	Diameter mm	Percent Finer
FINE	#20	0.850	81.7%
	#40	0.425	72.4%
	#60	0.250	67.1%
	#100	0.149	62.5%
	#140	0.106	59.4%
	#200	0.075	54.9%

HYDROMETER ANALYSIS

	Diameter mm	Percent Finer
HYDROMETER		
	0.04446	48.9%
	0.03311	38.2%
	0.02194	28.3%
	0.01300	22.2%
	0.00932	18.4%
	0.00666	16.1%
	0.00474	13.8%
	0.00328	11.5%
	0.00142	9.9%

1.5% Gravel 43.6% Sand 54.9% Silt/Clay

Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

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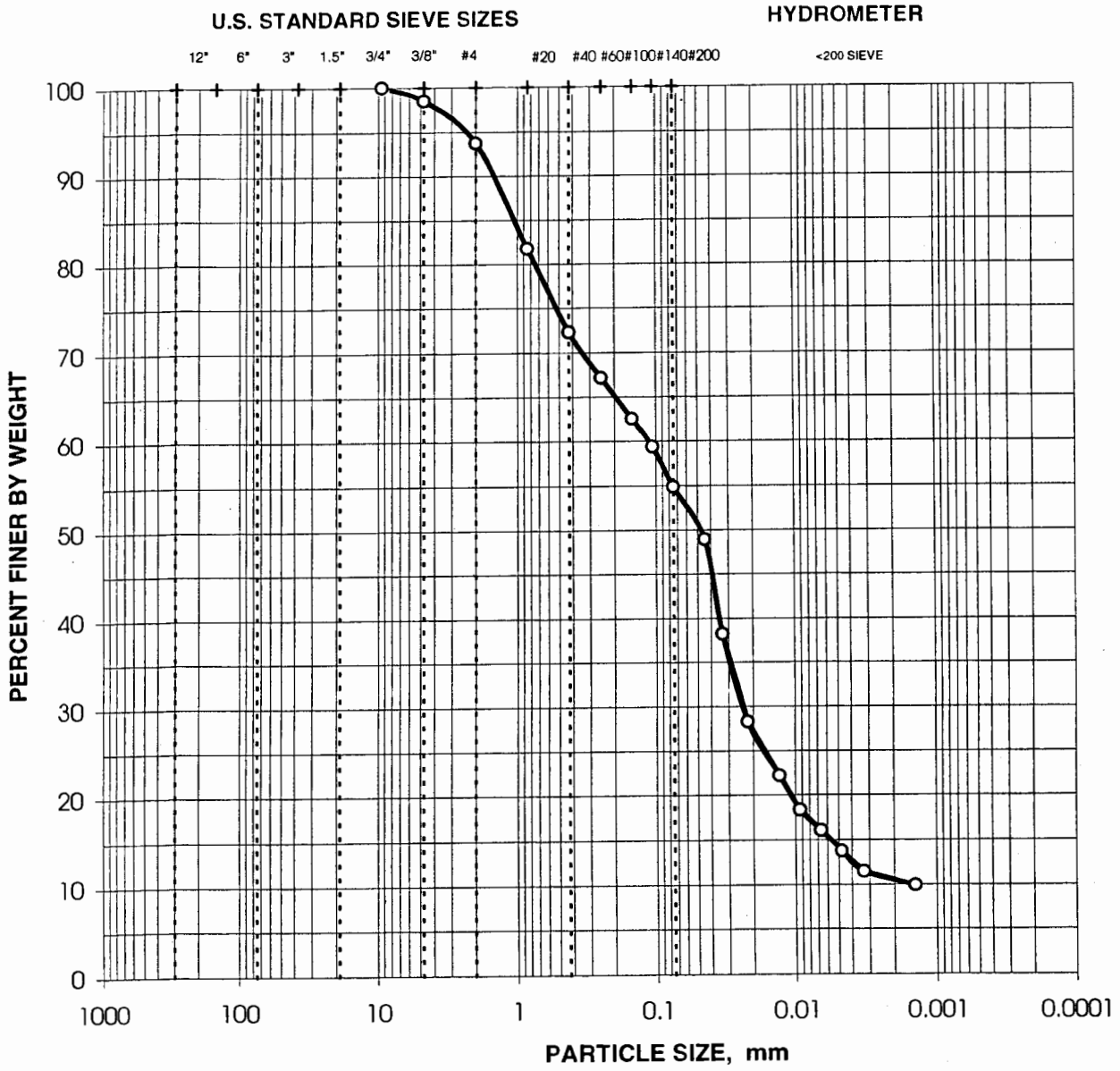

CLIENT SAMPLE NO.: Sediment #6

IT LAB SAMPLE NO.: None

BOULDERS	COBBLES	GRAVEL		SAND			
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT 2 - 75 microns CLAY <2 microns

Paul Lear
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January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
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PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name LANL

Client Sample No. Sediment #7

Project No. 831775.00000000

IT Lab Sample No. None

Specific Gravity = 2.65
assumed for calculations

Moisture Content = 17.2%
based on dry sample weight

SIEVE ANALYSIS

	Sieve No.	Diameter mm	Percent Finer
COARSE	3"	75.000	100.0%
	1.5"	37.500	100.0%
	0.75"	19.000	100.0%
	0.375"	9.500	99.1%
	#4	4.750	97.3%
	#10	2.000	91.4%

	Sieve No.	Diameter mm	Percent Finer
FINE	#20	0.850	73.2%
	#40	0.425	58.8%
	#60	0.250	51.3%
	#100	0.149	45.0%
	#140	0.106	40.8%
	#200	0.075	36.2%

HYDROMETER ANALYSIS

	Diameter mm	Percent Finer
HYDROMETER		
	0.04402	32.3%
	0.03228	27.9%
	0.02140	21.5%
	0.01275	17.1%
	0.00917	14.7%
	0.00654	13.2%
	0.00467	11.2%
	0.00324	9.8%
	0.00140	8.8%

2.7% Gravel 61.0% Sand 36.2% Silt/Clay

Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

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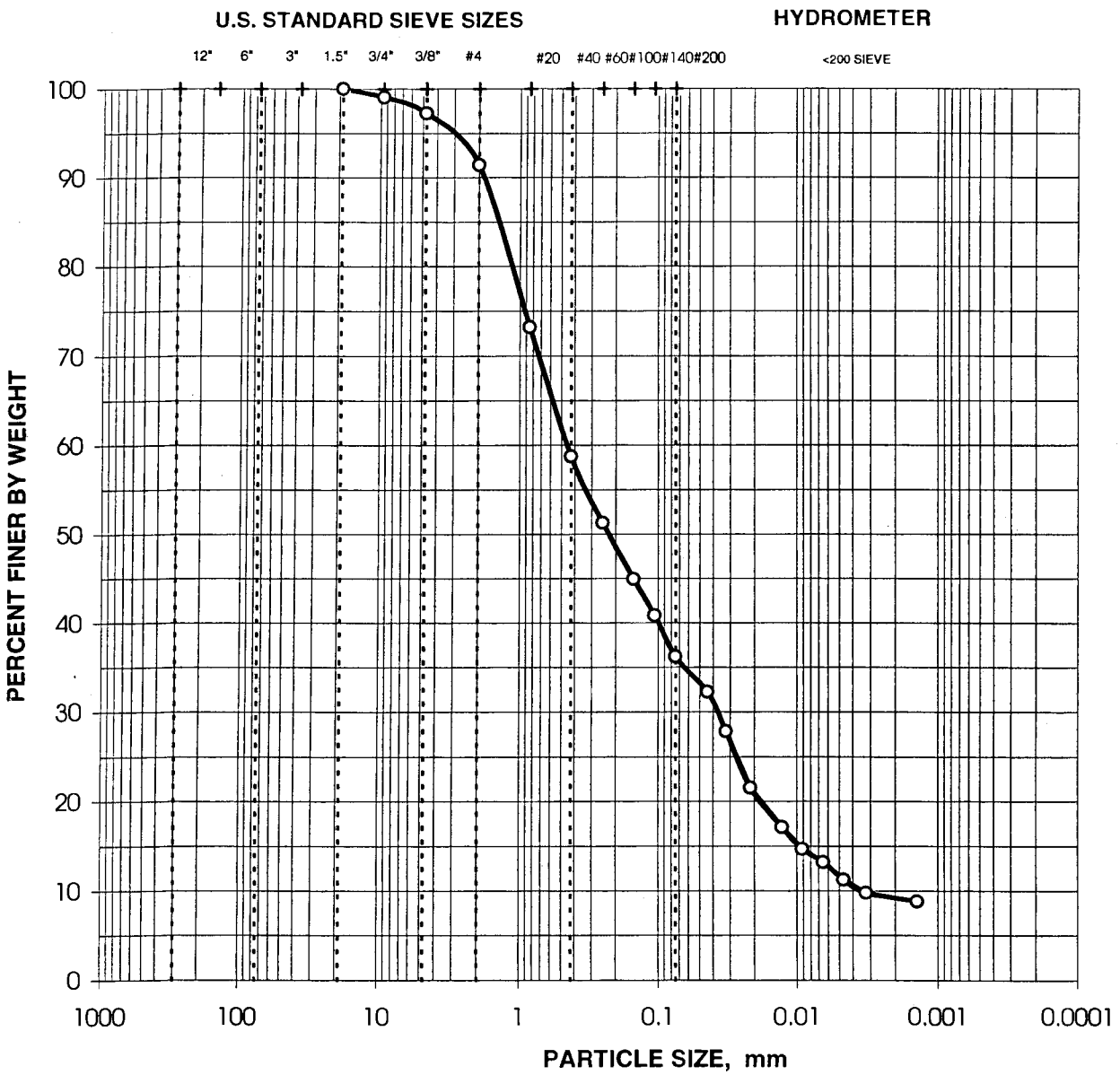

CLIENT SAMPLE NO.: Sediment #7

IT LAB SAMPLE NO.: None

BOULDERS	COBBLES	GRAVEL		SAND			
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT 2 - 75 microns CLAY <2 microns

Paul Lear
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January 28, 2002
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PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name LANL

Client Sample No. Sediment #8

Project No. 831775.00000000

IT Lab Sample No. None

Specific Gravity : 2.65
assumed for calculations

Moisture Content = 5.7%
based on dry sample weight

SIEVE ANALYSIS

	Sieve No.	Diameter mm	Percent Finer
COARSE	3"	75.000	100.0%
	1.5"	37.500	100.0%
	0.75"	19.000	95.2%
	0.375"	9.500	95.0%
	#4	4.750	92.2%
	#10	2.000	85.9%

	Sieve No.	Diameter mm	Percent Finer
FINE	#20	0.850	73.4%
	#40	0.425	63.6%
	#60	0.250	58.1%
	#100	0.149	52.8%
	#140	0.106	49.0%
	#200	0.075	44.8%

HYDROMETER ANALYSIS

	Diameter mm	Percent Finer
HYDROMETER		
	0.04576	35.5%
	0.03311	31.7%
	0.02176	24.7%
	0.01287	20.3%
	0.00930	15.8%
	0.00666	13.3%
	0.00480	9.5%
	0.00331	7.6%
	0.00145	5.1%

7.8% Gravel 47.4% Sand 44.8% Silt/Clay

Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

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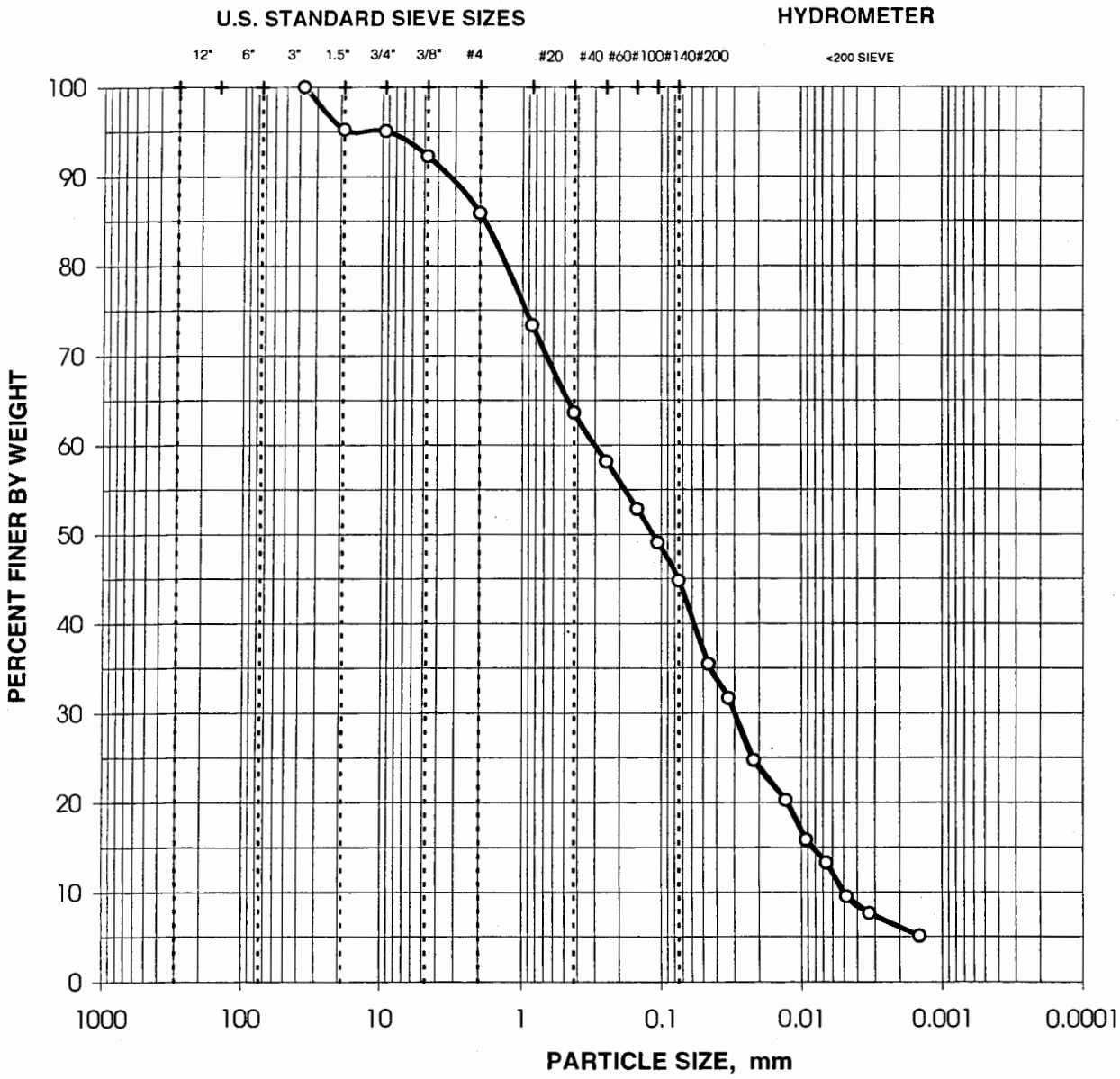

CLIENT SAMPLE NO.: Sediment #8

IT LAB SAMPLE NO.: None

BOULDERS	COBBLES	GRAVEL		SAND			
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT 2 - 75 microns CLAY <2 microns

Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
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PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name LANL

Client Sample No. Tuff #1

Project No. 831775.00000000

IT Lab Sample No. ETDC-

Specific Gravity : 2.65
assumed for calculations

Moisture Content = 11.1%
based on dry sample weight

SIEVE ANALYSIS

	Sieve No.	Diameter mm	Percent Finer
COARSE	3"	75.000	100.0%
	1.5"	37.500	100.0%
	0.75"	19.000	98.9%
	0.375"	9.500	92.6%
	#4	4.750	82.9%
	#10	2.000	72.6%

	Sieve No.	Diameter mm	Percent Finer
FINE	#20	0.850	54.7%
	#40	0.425	43.7%
	#60	0.250	38.2%
	#100	0.149	33.1%
	#140	0.106	29.9%
	#200	0.075	26.4%

HYDROMETER ANALYSIS

	Diameter mm	Percent Finer
HYDROMETER		
	0.04542	24.4%
	0.03371	18.6%
	0.02203	14.2%
	0.01201	9.3%
	0.00922	8.0%
	0.00670	6.7%
	0.00475	6.2%
	0.00334	4.0%
	0.00140	3.1%

17.1% Gravel 56.6% Sand 26.4% Silt/Clay

Paul Lear
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January 28, 2002
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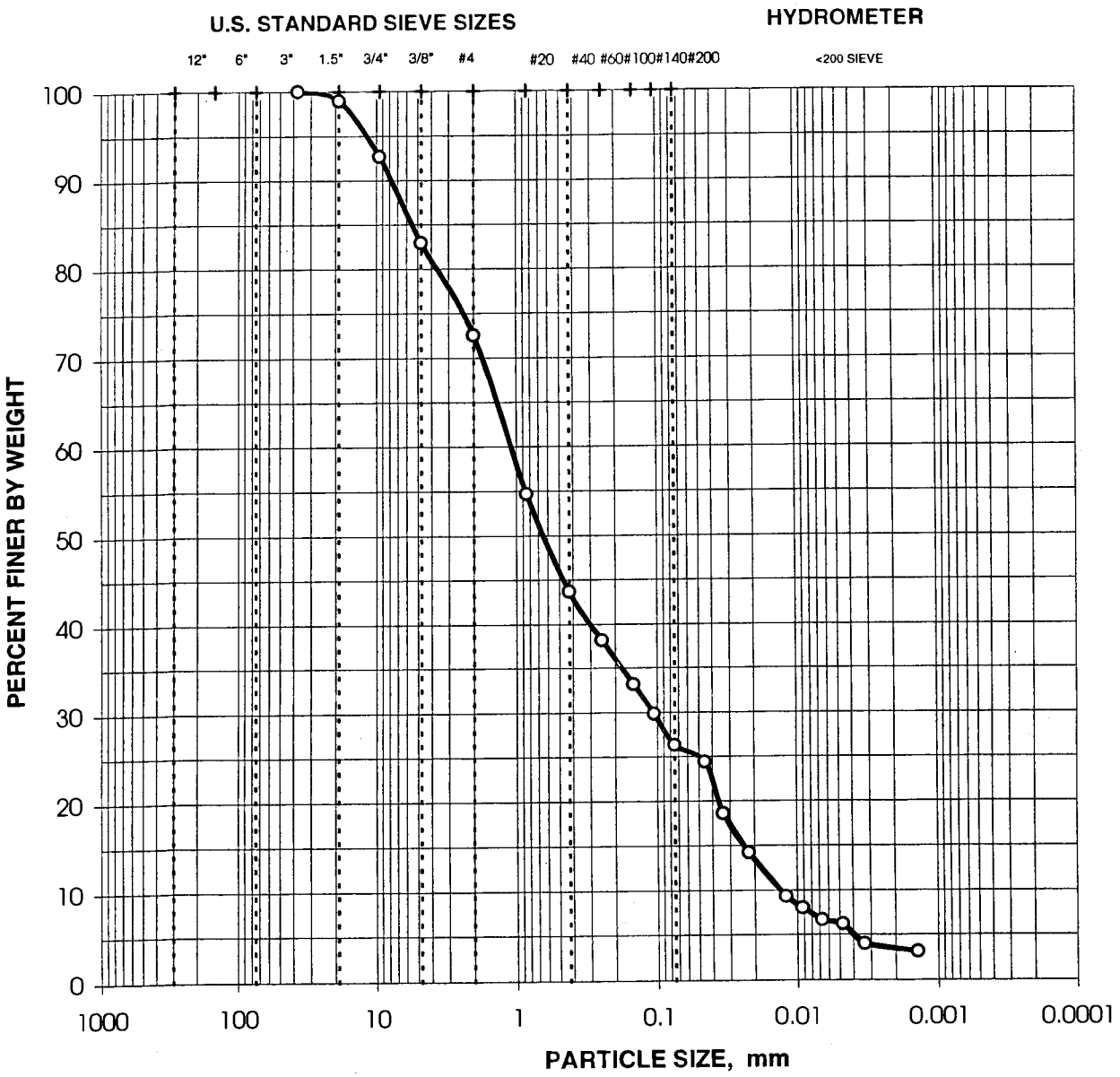

CLIENT SAMPLE NO.: Tuff #1

IT LAB SAMPLE NO.: ETDC-

BOULDERS	COBBLES	GRAVEL		SAND			
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT 2 - 75 microns CLAY <2 microns

Paul Lear
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January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
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PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name LANL

Client Sample No. Tuff #2

Project No. 831775.00000000

IT Lab Sample No. ETDC-

Specific Gravity : 2.65
assumed for calculations

Moisture Content = 3.1%
based on dry sample weight

SIEVE ANALYSIS

COARSE	Sieve No.	Diameter mm	Percent Finer
	3"	75.000	100.0%
	1.5"	37.500	100.0%
	0.75"	19.000	97.0%
	0.375"	9.500	87.6%
	#4	4.750	75.8%
	#10	2.000	63.6%

FINE	Sieve No.	Diameter mm	Percent Finer
	#20	0.850	48.4%
	#40	0.425	38.8%
	#60	0.250	34.0%
	#100	0.149	29.7%
	#140	0.106	26.8%
	#200	0.075	23.6%

HYDROMETER ANALYSIS

HYDROMETER	Diameter mm	Percent Finer
	0.04414	21.7%
	0.03270	17.5%
	0.02176	12.6%
	0.01222	8.4%
	0.00904	7.0%
	0.00665	5.9%
	0.00475	4.9%
	0.00331	4.2%
	0.00139	3.1%

24.2% Gravel 52.1% Sand 23.6% Silt/Clay

Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

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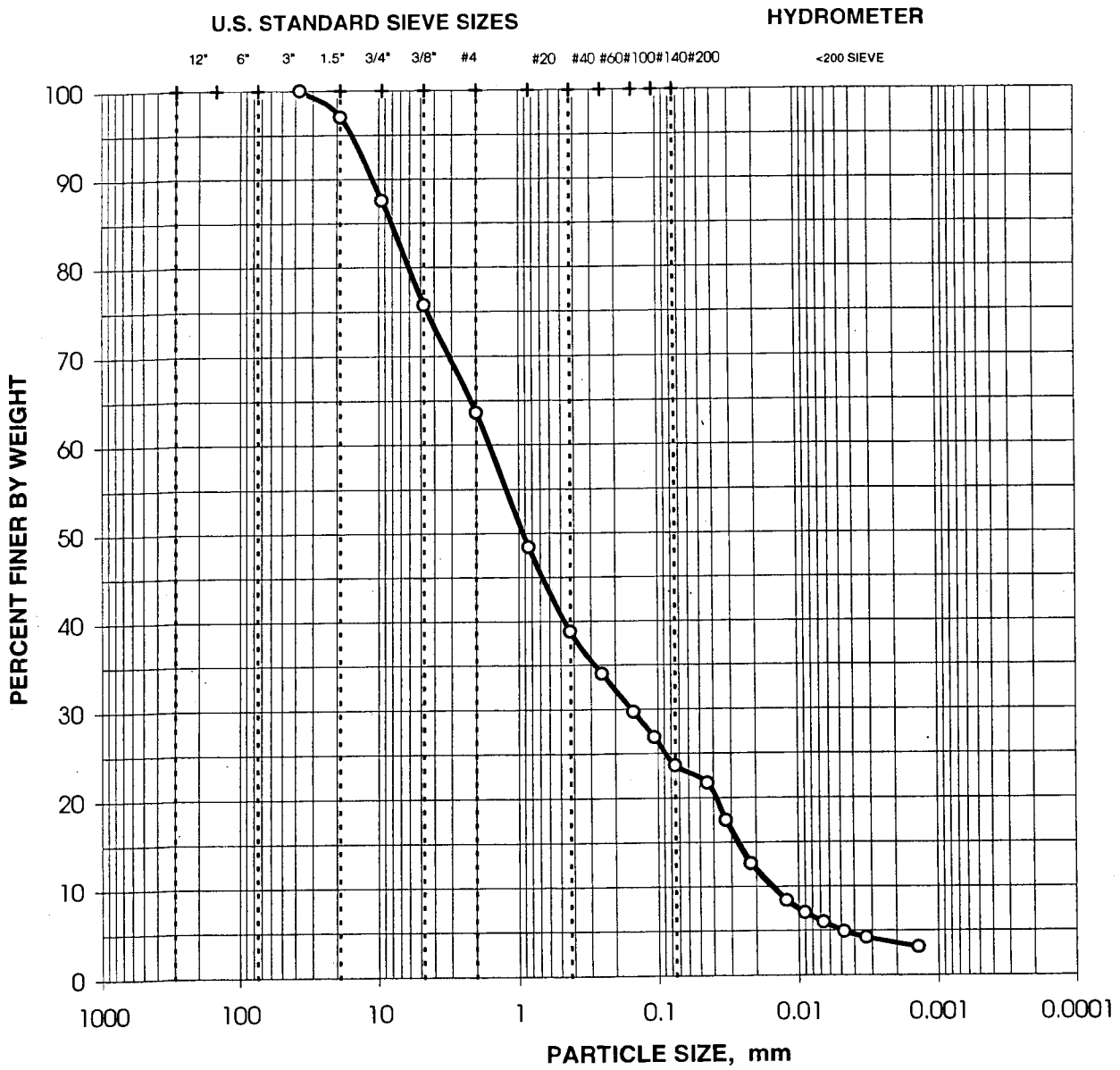

CLIENT SAMPLE NO.: Tuff #2

IT LAB SAMPLE NO.: ETDC-

BOULDERS	COBBLES	GRAVEL		SAND			
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT 2 - 75 microns CLAY <2 microns

Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
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PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name LANL

Client Sample No. Tuff #3

Project No. 831775.00000000

IT Lab Sample No. ETDC-

Specific Gravity : 2.65
assumed for calculations

Moisture Content = 2.1%
based on dry sample weight

SIEVE ANALYSIS

	Sieve No.	Diameter mm	Percent Finer
COARSE	3"	75.000	100.0%
	1.5"	37.500	100.0%
	0.75"	19.000	100.0%
	0.375"	9.500	88.8%
	#4	4.750	77.5%
	#10	2.000	66.9%

	Sieve No.	Diameter mm	Percent Finer
FINE	#20	0.850	50.6%
	#40	0.425	40.4%
	#60	0.250	35.2%
	#100	0.149	30.7%
	#140	0.106	27.8%
	#200	0.075	24.7%

HYDROMETER ANALYSIS

	Diameter mm	Percent Finer
HYDROMETER		
	0.04563	23.0%
	0.03343	18.8%
	0.02185	14.5%
	0.01188	10.2%
	0.00879	8.1%
	0.00668	6.8%
	0.00475	6.0%
	0.00332	4.7%
	0.00140	3.4%

22.5% Gravel 52.7% Sand 24.7% Silt/Clay

Paul Lear
IT Corporation
January 28, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
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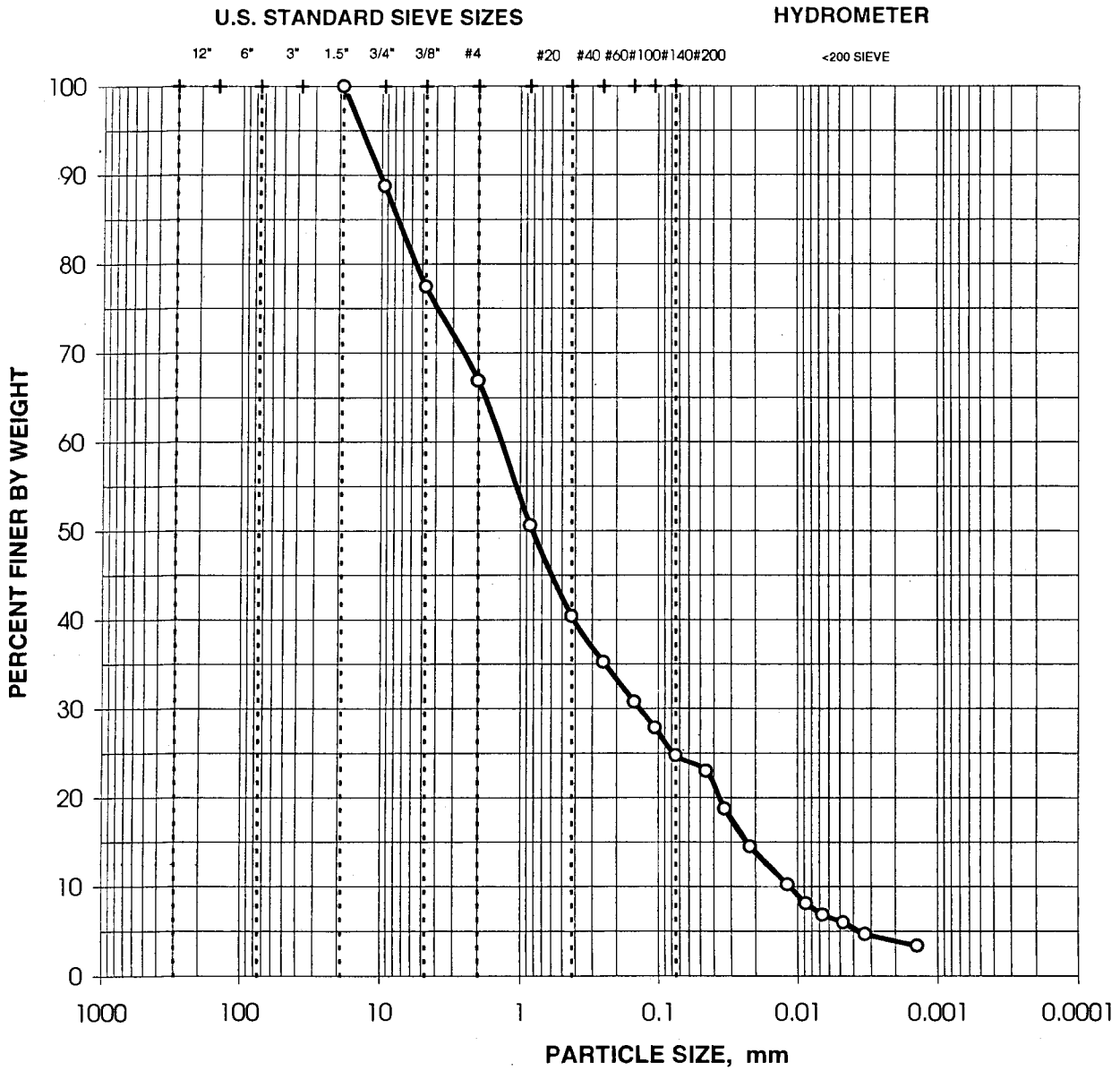

CLIENT SAMPLE NO.: Tuff #3

IT LAB SAMPLE NO.: ETDC-

BOULDERS	COBBLES	GRAVEL		SAND			
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT 2 - 75 microns CLAY <2 microns

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PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name LANL

Client Sample No. Tuff #4

Project No. 831775.00000000

IT Lab Sample No. ETDC-

Specific Gravity : 2.65
assumed for calculations

Moisture Content = 2.4%
based on dry sample weight

SIEVE ANALYSIS

	Sieve No.	Diameter mm	Percent Finer
COARSE	3"	75.000	100.0%
	1.5"	37.500	100.0%
	0.75"	19.000	100.0%
	0.375"	9.500	89.2%
	#4	4.750	75.3%
	#10	2.000	62.1%

	Sieve No.	Diameter mm	Percent Finer
FINE	#20	0.850	47.2%
	#40	0.425	37.9%
	#60	0.250	33.5%
	#100	0.149	29.4%
	#140	0.106	26.6%
	#200	0.075	23.6%

HYDROMETER ANALYSIS

	Diameter mm	Percent Finer
HYDROMETER		
	0.03343	17.9%
	0.02194	13.4%
	0.01227	9.4%
	0.00941	6.9%
	0.00675	4.9%
	0.00479	4.5%
	0.00333	4.1%
	0.00140	2.9%

24.7% Gravel 51.7% Sand 23.6% Silt/Clay

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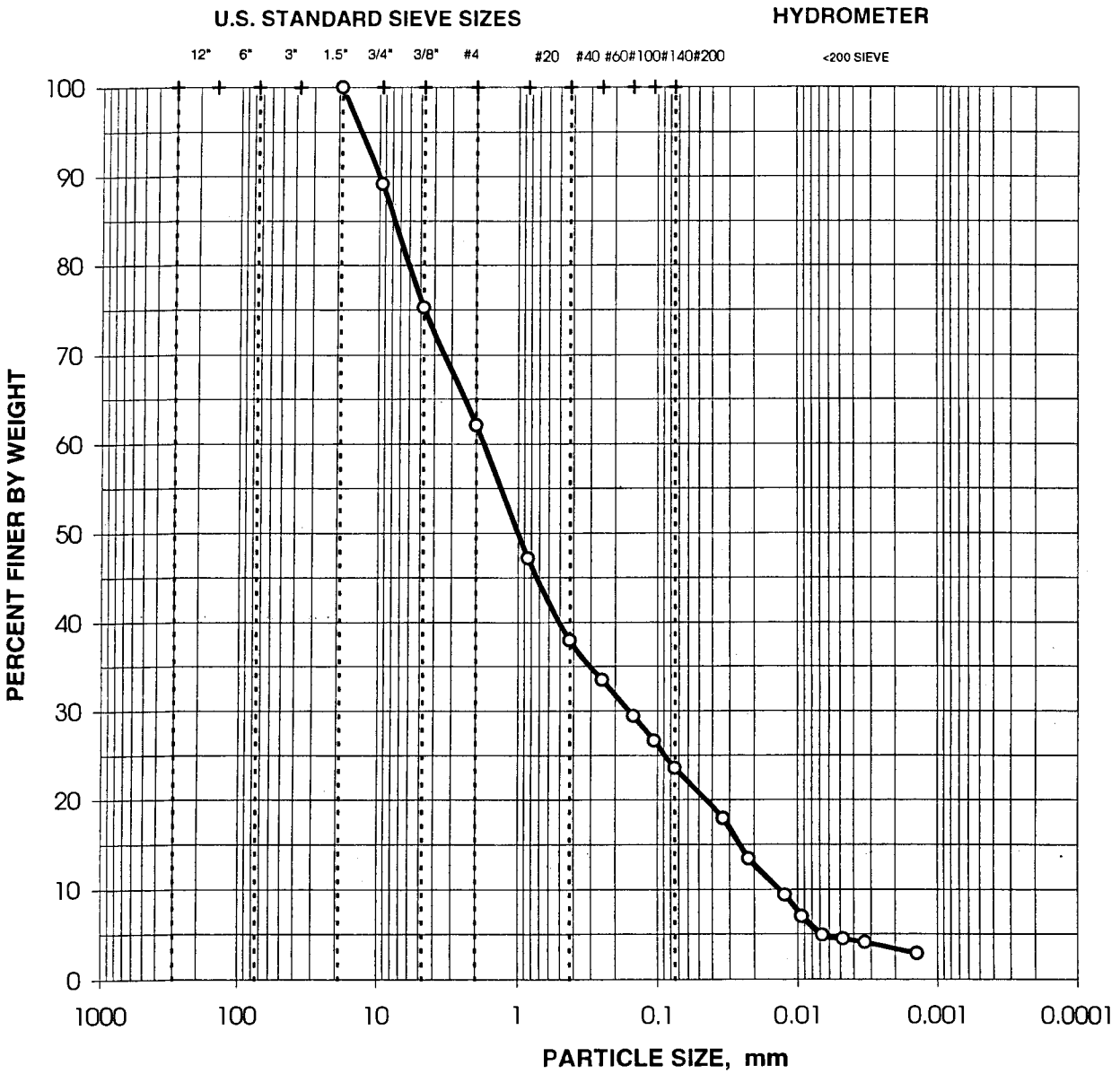

CLIENT SAMPLE NO.: Tuff #4

IT LAB SAMPLE NO.: ETDC-

BOULDERS	COBBLES	GRAVEL		SAND			
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT 2 - 75 microns CLAY <2 microns

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PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name LANL

Client Sample No. Tuff #5

Project No. 831775.00000000

IT Lab Sample No. ETDC-

Specific Gravity : 2.65
assumed for calculations

Moisture Content = 1.5%
based on dry sample weight

SIEVE ANALYSIS

COARSE	Sieve No.	Diameter mm	Percent Finer
	3"	75.000	100.0%
	1.5"	37.500	100.0%
	0.75"	19.000	98.6%
	0.375"	9.500	83.6%
	#4	4.750	68.5%
	#10	2.000	54.6%

FINE	Sieve No.	Diameter mm	Percent Finer
	#20	0.850	41.0%
	#40	0.425	32.0%
	#60	0.250	27.9%
	#100	0.149	24.1%
	#140	0.106	21.6%
	#200	0.075	18.9%

HYDROMETER ANALYSIS

HYDROMETER	Diameter mm	Percent Finer
	0.04542	18.0%
	0.03328	14.7%
	0.02194	10.8%
	0.01321	6.5%
	0.00947	4.9%
	0.00670	4.2%
	0.00482	2.9%
	0.00336	2.3%
	0.00141	1.6%

31.5% Gravel 49.6% Sand 18.9% Silt/Clay

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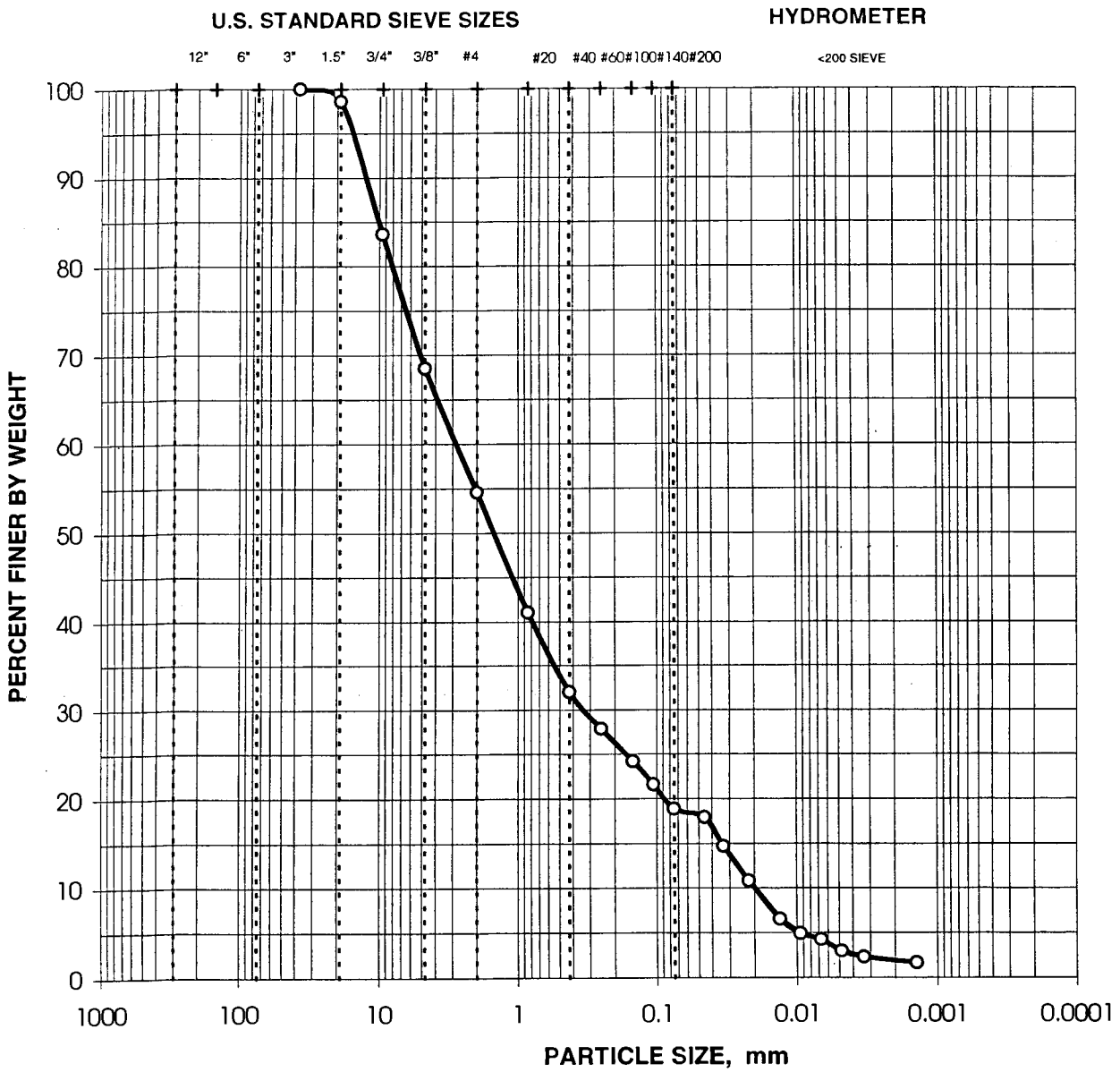

CLIENT SAMPLE NO.: Tuff #5

IT LAB SAMPLE NO.: ETDC-

BOULDERS	COBBLES	GRAVEL		SAND			
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT 2 - 75 microns CLAY <2 microns

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PARTICLE-SIZE ANALYSIS
ASTM D 422

Project Name LANL

Client Sample No. Tuff #6

Project No. 831775.00000000

IT Lab Sample No. ETDC-

Specific Gravity : 2.65
assumed for calculations

Moisture Content = 1.4%
based on dry sample weight

SIEVE ANALYSIS

COARSE	Sieve No.	Diameter mm	Percent Finer
	3"	75.000	100.0%
	1.5"	37.500	100.0%
	0.75"	19.000	98.4%
	0.375"	9.500	81.1%
	#4	4.750	65.1%
	#10	2.000	52.5%

FINE	Sieve No.	Diameter mm	Percent Finer
	#20	0.850	38.7%
	#40	0.425	30.6%
	#60	0.250	26.9%
	#100	0.149	23.6%
	#140	0.106	21.4%
	#200	0.075	18.9%

HYDROMETER ANALYSIS

HYDROMETER	Diameter mm	Percent Finer
	0.04625	17.1%
	0.03371	14.4%
	0.02224	9.9%
	0.01321	6.9%
	0.00944	5.5%
	0.00672	4.8%
	0.00480	3.4%
	0.00336	2.4%
	0.00141	1.7%

34.9% Gravel 46.3% Sand 18.9% Silt/Clay

Paul Lear
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January 28, 2002
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IT Project No.: 831775.00000000

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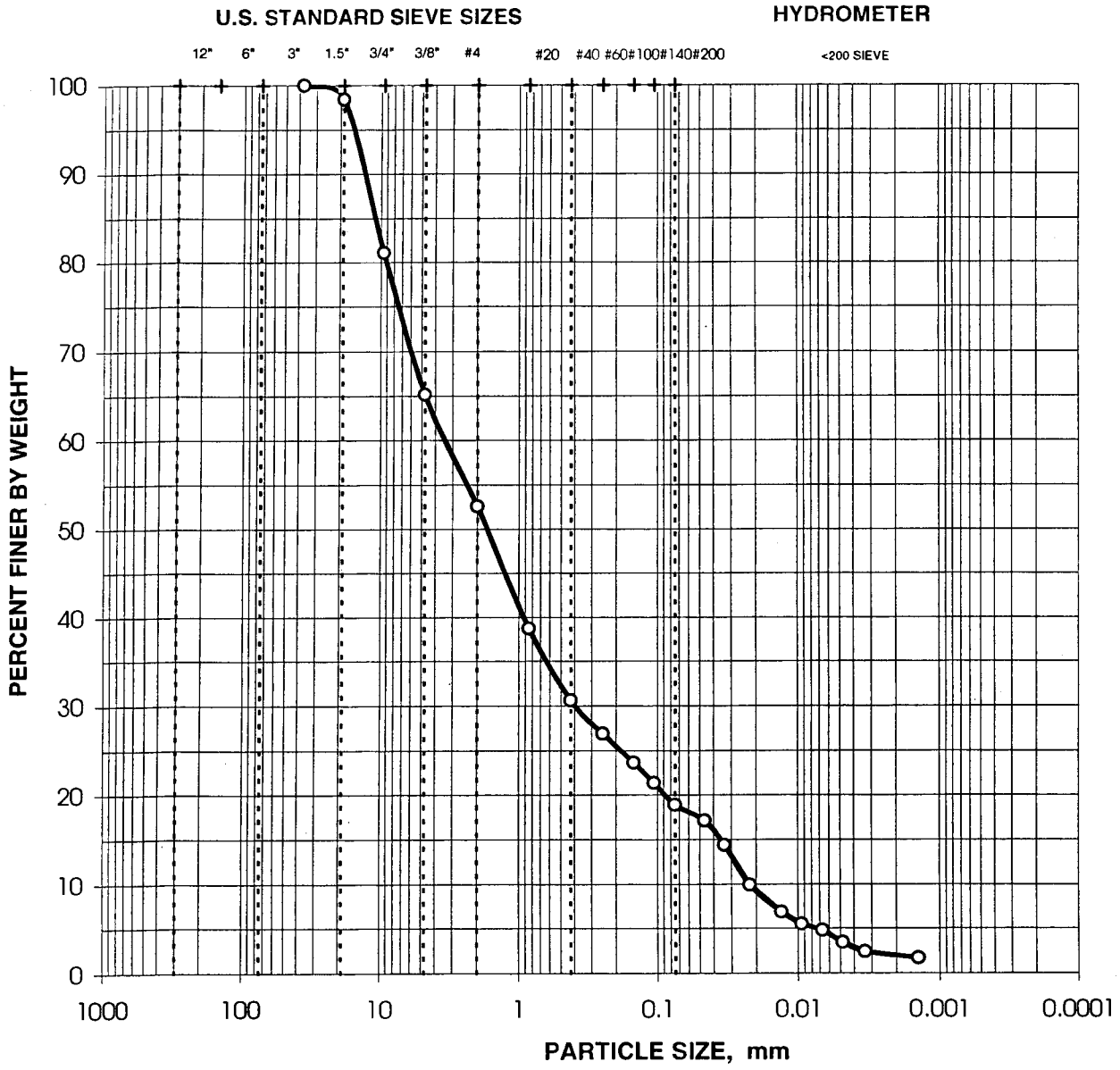


CLIENT SAMPLE NO.: Tuff #6

IT LAB SAMPLE NO.: ETDC-

BOULDERS	COBBLES	GRAVEL		SAND			
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT 2 - 75 microns CLAY <2 microns

Appendix C

Nonconformance / Variance Reports

NONCONFORMANCE/VARIANCE REPORT

NONCONFORMANCE or VARIANCE (circle one)	Project Name: LANL	Date: 1/3/02	Page 1 of 1
	Project No. ~~817~~ 831775		Report No. ETDC-115-02-N

Nonconformance/Variance Description (include requirement violated

SAMPLE SHIPMENTS OF RAW SOIL AND TUFF RECEIVED WITHOUT CHAIN-OF-CUSTODY DOCUMENTS.

SHIPMENTS RECEIVED 12-17-01, 12-20,01

TEN SAMPLES TOTAL: MD21-01-0545, MD21-01-054401, MD21-01-0546, MD21-01-054901, MD21-01-054701, TUFF 595, TUFF 593, TUFF564, MD21-01-0548, 564 SOIL

Identified by [signature]

Root Cause

N/A

Corrective Action (include expected completion date)

NOTIFY CLIENT

To be completed by — Expected Completion Date

Action taken to preclude recurrence

N/A

To be performed by — Expected Completion Date

Client notified (include client name, how notified, and response)

PAUL LOAR NOTIFIED VERBALLY

Notified by [signature] — Date 1/3/02

Corrective action completed by — Date

Corrective action approved by

Laboratory Supervisor _____ Date _____

Project Manager [signature] Date 1/3/02

QA Comments

QAO Approval — Date

Use back of page for additional space. Attach additional pages if necessary.

INTERNATIONAL TECHNOLOGY CORPORATION

GEOTECHNICAL LABORATORY

CERTIFICATE OF ANALYSIS

Paul Lear
IT Corporation
304 Directors Drive
Knoxville TN 37923

March 22, 2002

This is the Certificate of Analysis for the following samples:

Project ID:	**LANL**
Project Number:	**831775**
Date Received by Lab:	December 17 and 20, 2001
Number of Samples:	Ten (10)
Sample Type:	Soil

I. Introduction/Case Narrative

Five soil samples were received by the IT Geotechnical Laboratory beginning on December 17, 2001. Five additional soil samples were received on December 20, 2001. Chain-of-custody documents were not included with the samples. Raw sample material was used in stabilization mixtures and cylindrical test specimens were molded. Replicate specimens were designated for various testing programs, including: unconfined compressive strength, permeability (hydraulic conductivity), and freeze/thaw resistance.

A previous certificate reported the results of sample characterization tests: particle-size distribution, Atterberg limits, moisture content, and bulk density screening.

Please see Appendix A, Sample Number Cross-Reference List; Appendix B, Analysis Results; and Appendix C, Variance/Nonconformance Reports.

Reviewed and Approved:

Ralph Cole
Laboratory Manager, Geotechnical Services

IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
(865) 482-6497

II. Analytical Results/Methodology

REFERENCES: United States Army Corps of Engineers (USACE), Engineer Manual 1110-2-1906, *Laboratory Soils Testing*, appendix II, 1970; United States Environmental Protection Agency, SW846, *Test Methods for Examining Solid Waste, Physical/Chemical Methods*, 3rd ed., Nov 1986 (EPA SW-846). Annual Book of ASTM Standards, Section 4, Construction, Volume 04.08, *Soil and Rock (I)*, and Volume 04.09, *Soil and Rock (II)*, 2000.

Unconfined Compressive Strength of Soils . . . . . **ASTM D 2166**
Laboratory Determination of Water (Moisture) Content of Soil and Rock . **ASTM D 2216**
Freeze/Thaw of Solid Wastes . . . . . **ASTM D 4842**
Hydraulic Conductivity of Porous Materials . . . . . **ASTM D 5084**

III. Quality Control

Quality control checks such as duplicates and spikes (QC samples), are not normally applicable to geotechnical testing. This is due largely to the inability of obtaining samples with known characteristics, the heterogenous nature of the samples, and quality control procedures built-in to the analytical method.

QC measures to ensure accuracy and precision of test results include the following:

- 100% verification of all numerical results - raw data entries, transcriptions and calculations entered by lab technicians are checked, recalculated and verified. Most data calculations are performed by computer programs.

- Data validation through test reasonableness - summaries of all test results for individual reports are reviewed to determine the overall reasonableness of data and to determine the presence of any data that may be considered outliers.

- Quality control procedures are built into most standardized geotechnical procedures. For example, liquid limit and plastic limit analyses call for re-analyses and specify acceptance criteria.

- Routine instrument calibration - instruments, gauges and equipment used in testing are calibrated on a routine basis. All instrument calibration follows ASTM or

manufacturer guidelines.

- Maintenance of all past calibration records - calibration records and certification documents of all instruments, gauges and equipment are updated routinely and maintained in the Quality Control Coordinators Quality/Operations files.

- Certified and trained personnel - all technicians are certified by the National Institute for Certification of Engineering Technicians (NICET) in geotechnical soil testing, and are trained in the application of standard laboratory procedures for geotechnical analyses as well as the quality assurance measures implemented by IT.

IV. Data Qualification

Freeze/thaw testing was not complete for the tuff/sediment mix at the time of this report. The results for this series are complete through ten cycles (except specimen eight, which failed at seven cycles). Complete results for the tuff/sediment mix freeze/thaw test will be reported when available.

Freeze/thaw specimens underwent twelve test cycles. Some samples deteriorated prior to the end of twelve cycles, and the tests for these samples was terminated early.

Certain freeze/thaw results are calculated as negative values. This occurs when the control specimen has greater material loss than the corresponding test specimen.

The moisture content of hydraulic conductivity and freeze/thaw samples was assumed to be equal to the moisture content of unconfined compressive strength samples of the same series.

Appendix A
Sample Cross-Reference List

Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
(865) 482-6497

SAMPLE NUMBER CROSS-REFERENCE LIST

LAB SAMPLE NO.	CLIENT SAMPLE NO.	MATRIX
1108-06	Sediment mix 1	Solid
1108-07	Sediment mix 2	Solid
1108-08	Sediment mix 3	Solid
1108-09	Sediment mix 4	Solid
1108-10	Sediment mix 5	Solid
1108-11	Sediment mix 6	Solid
1108-12	Sediment mix 7	Solid
1108-13	Sediment mix 8	Solid
1108-14	Tuff mix 1	Solid
1108-15	Tuff mix 2	Solid
1108-16	Tuff mix 3	Solid
1108-17	Tuff mix 4	Solid
1108-18	Tuff mix 5	Solid
1108-19	Tuff mix 6	Solid
1108-20	Tuff mix 7	Solid
1108-21	Tuff mix 8	Solid
1108-23	Soil mix 1	Solid
1108-24	Soil mix 2	Solid
1108-25	Soil mix 3	Solid
1108-26	Soil mix 4	Solid
1108-27	Soil mix 5	Solid
1108-28	Soil mix 6	Solid
1108-29	Soil mix 7	Solid
1108-30	Soil mix 8	Solid
1108-32	Tuff/Sediment mix 1	Solid
1108-33	Tuff/Sediment mix 2	Solid
1108-34	Tuff/Sediment mix 3	Solid
1108-35	Tuff/Sediment mix 4	Solid
1108-36	Tuff/Sediment mix 5	Solid
1108-37	Tuff/Sediment mix 6	Solid
1108-38	Tuff/Sediment mix 7	Solid
1108-39	Tuff/Sediment mix 8	Solid

Appendix B
Sample Test Results

14-Day UCS Tests

Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

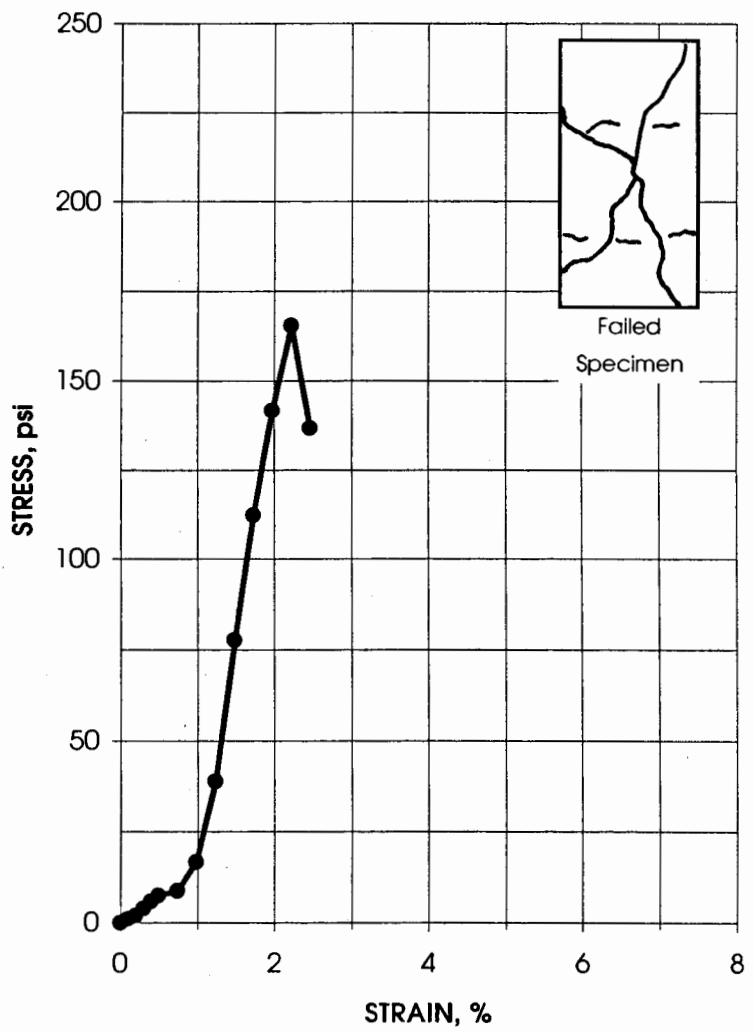
IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

Project	LANL	Client Sample No.	1108-06-01
Project No.	831775.00000000	IT Lab No.	Sediment mix 1

Specimen Mold Date	12/19/01	Specimen Height, in.	4.0547
Specimen Test Date	1/2/02	Specimen Diameter, in.	2.0108
		Specimen Weight, g.	390.95
STRESS AT FAILURE, psi	**165**	Moisture Content, %	20.4
STRAIN AT FAILURE, %	**2.2**	Wet Unit Weight, pcf.	115.7
		Dry Unit Weight, pcf.	96.1
		Rate of Strain, in./min.	0.0450

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	1
0.20	2
0.30	4
0.39	6
0.49	8
0.74	9
0.99	17
1.23	39
1.48	78
1.73	112
1.97	142
2.22	165
2.47	137



Paul Lear
IT Corporation
March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

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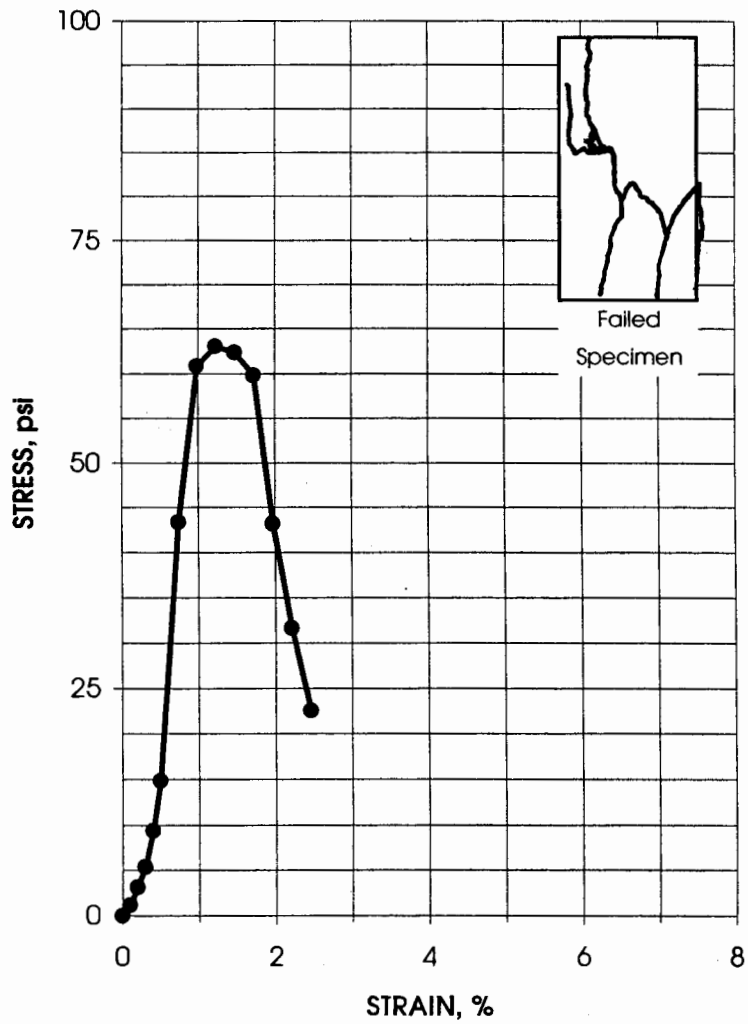
UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

Project	LANL	Client Sample No.	1108-07-01
Project No.	831775.00000000	IT Lab No.	Sediment mix 2

Specimen Mold Date	12/19/01	Specimen Height, in.	4.0585
Specimen Test Date	1/2/02	Specimen Diameter, in.	2.0095
		Specimen Weight, g.	353.46
STRESS AT FAILURE, psi	**63**	Moisture Content, %	15.1
STRAIN AT FAILURE, %	**1.2**	Wet Unit Weight, pcf.	104.6
		Dry Unit Weight, pcf.	90.9
		Rate of Strain, in./min.	0.0700

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	1.1
0.20	3.1
0.30	5.3
0.39	9.4
0.49	14.8
0.74	43.3
0.99	60.8
1.23	63.0
1.48	62.4
1.72	59.8
1.97	43.2
2.22	31.6
2.46	22.5



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March 22, 2002
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IT Project No.: 831775.00000000

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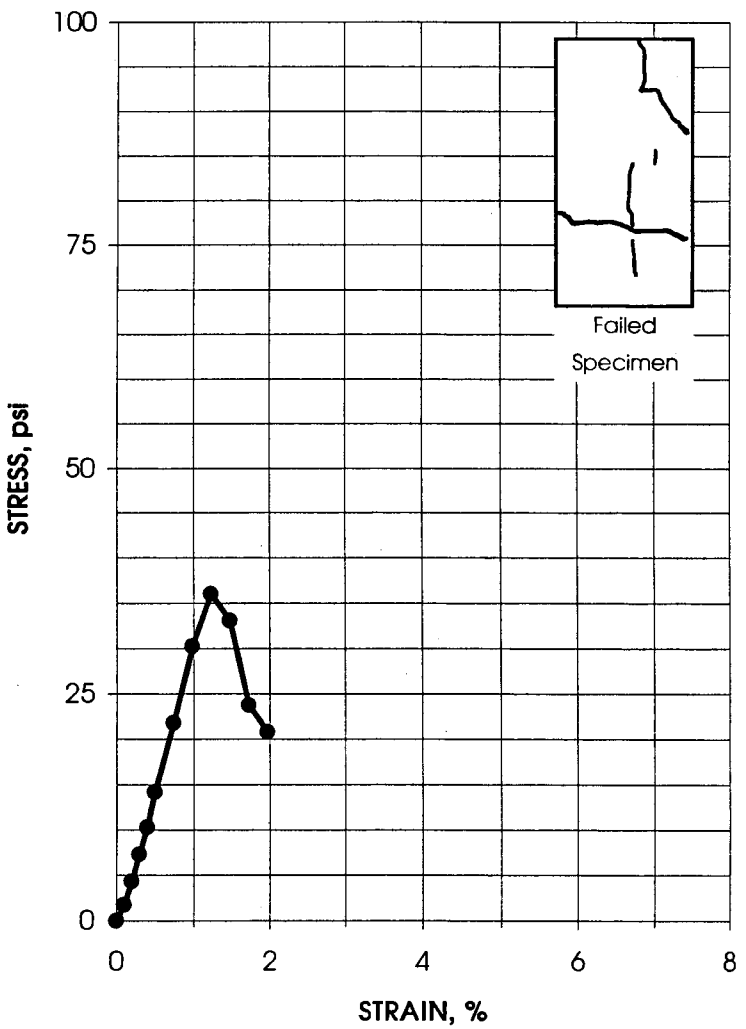
UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

Project	LANL	Client Sample No.	1108-08-01
Project No.	831775.00000000	IT Lab No.	Sediment mix 3

Specimen Mold Date	12/19/01	Specimen Height, in.	4.0615
Specimen Test Date	1/2/02	Specimen Diameter, in.	2.0070
		Specimen Weight, g.	338.14
STRESS AT FAILURE, psi	**36**	Moisture Content, %	17.3
STRAIN AT FAILURE, %	**1.2**	Wet Unit Weight, pcf.	100.3
		Dry Unit Weight, pcf.	85.5
		Rate of Strain, in./min.	0.0450

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	1.7
0.20	4.3
0.30	7.3
0.39	10.3
0.49	14.2
0.74	21.8
0.98	30.2
1.23	36.0
1.48	33.1
1.72	23.8
1.97	20.8



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March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

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UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

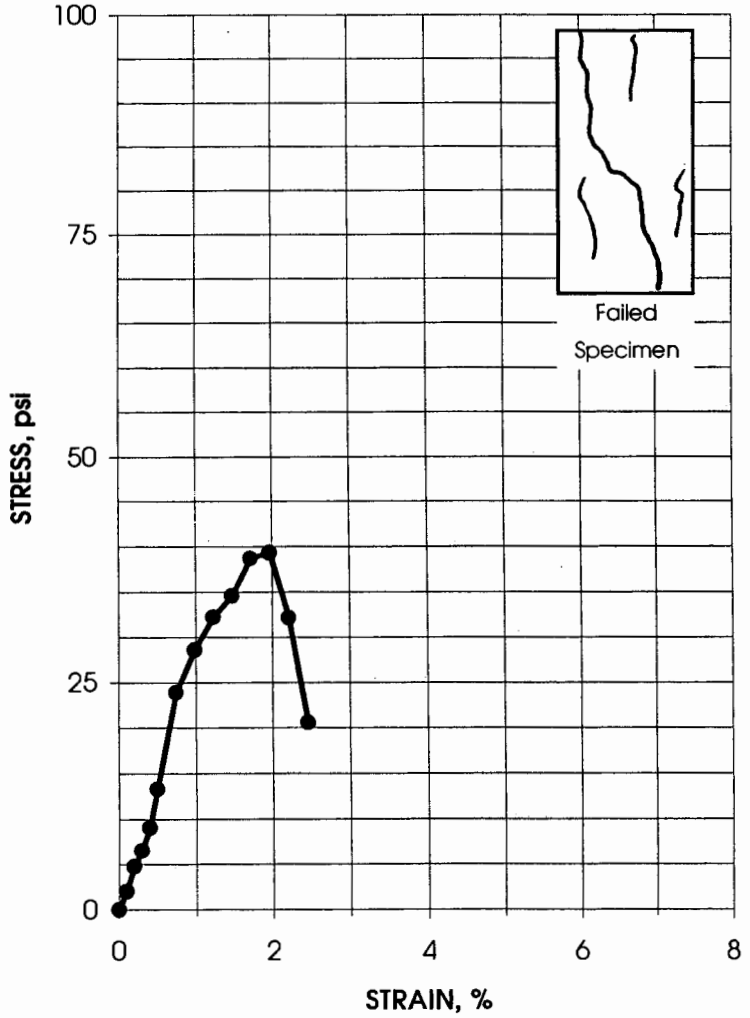
Project LANL
Project No. 831775.00000000

Client Sample No. 1108-09-01
IT Lab No. Sediment mix 4

Specimen Mold Date	12/19/01
Specimen Test Date	1/2/02
STRESS AT FAILURE, psi	**39**
STRAIN AT FAILURE, %	**2.0**

Specimen Height, in.	4.0582
Specimen Diameter, in.	2.0050
Specimen Weight, g.	355.96
Moisture Content, %	18.1
Wet Unit Weight, pcf.	105.9
Dry Unit Weight, pcf.	89.6
Rate of Strain, in./min.	0.0450

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0.0
0.10	2.0
0.20	4.8
0.30	6.5
0.39	9.1
0.49	13.3
0.74	23.9
0.99	28.6
1.23	32.2
1.48	34.6
1.72	38.7
1.97	39.3
2.22	32.1
2.46	20.6



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IT Project ID: LANL
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UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

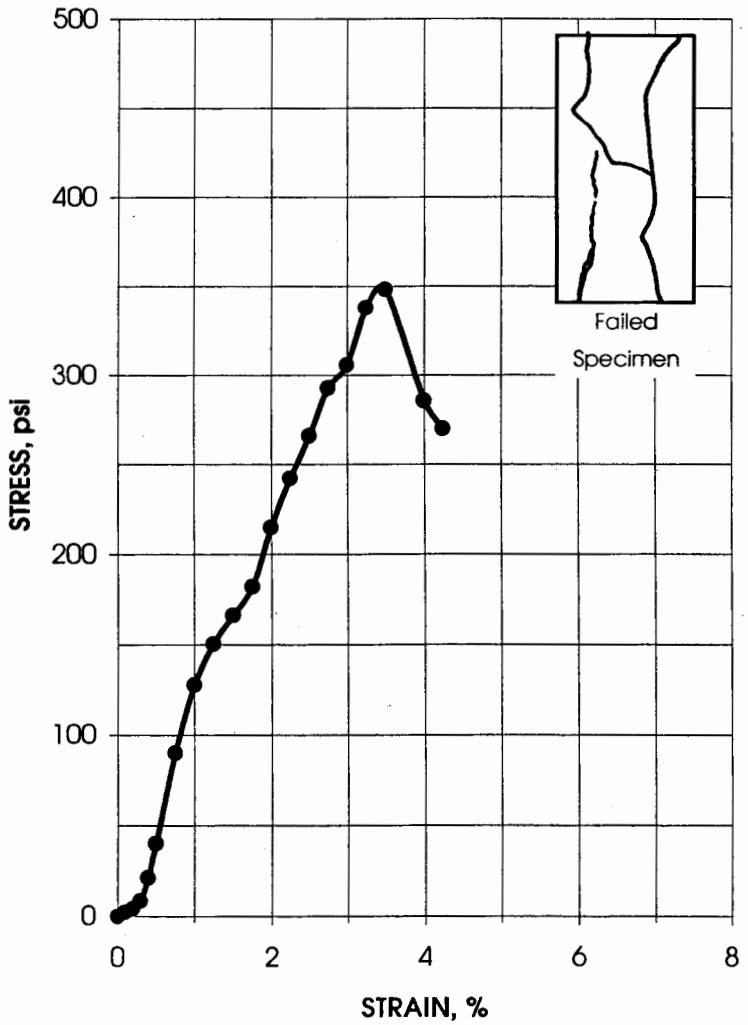
Project LANL
Project No. 831775.00000000

Client Sample No. 1108-10-01
IT Lab No. Sediment mix 5

Specimen Mold Date	12/19/01
Specimen Test Date	1/2/02
STRESS AT FAILURE, psi	**348**
STRAIN AT FAILURE, %	**3.5**

Specimen Height, in.	4.0037
Specimen Diameter, in.	2.0102
Specimen Weight, g.	373.53
Moisture Content, %	27.8
Wet Unit Weight, pcf.	112.0
Dry Unit Weight, pcf.	87.6
Rate of Strain, in./min.	0.0450

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	2
0.20	4
0.30	8
0.40	21
0.50	40
0.75	90
1.00	128
1.25	150
1.50	166
1.75	182
2.00	215
2.25	242
2.50	266
2.75	293
3.00	306
3.25	338
3.50	348
4.00	286
4.25	270



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IT Corporation
March 22, 2002
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UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

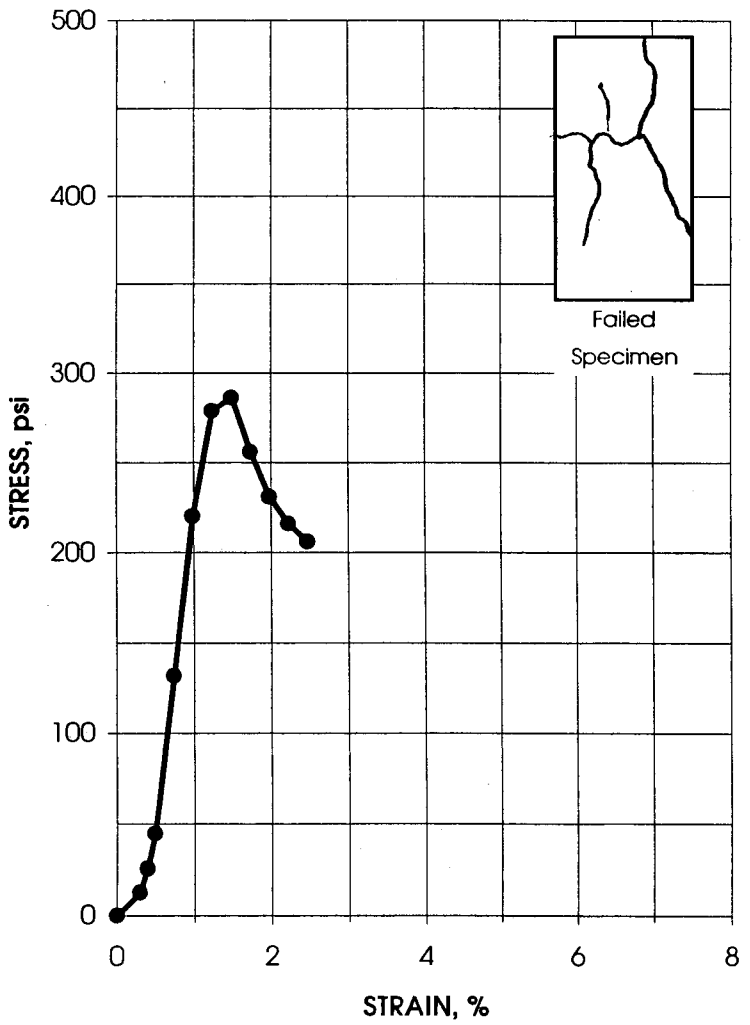
Project LANL
Project No. 831775.00000000

Client Sample No. 1108-11-01
IT Lab No. Sediment mix 6

Specimen Mold Date	12/19/01
Specimen Test Date	1/2/02
STRESS AT FAILURE, psi	**286**
STRAIN AT FAILURE, %	**1.5**

Specimen Height, in.	4.0420
Specimen Diameter, in.	2.0087
Specimen Weight, g.	384.95
Moisture Content, %	21.8
Wet Unit Weight, pcf.	114.5
Dry Unit Weight, pcf.	94.0
Rate of Strain, in./min.	0.0450

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.30	13
0.40	25
0.49	45
0.74	132
0.99	220
1.24	279
1.48	286
1.73	256
1.98	231
2.23	216
2.47	206



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March 22, 2002
IT Project ID: LANL
IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
OAK RIDGE, TN
(865) 482-6497

UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

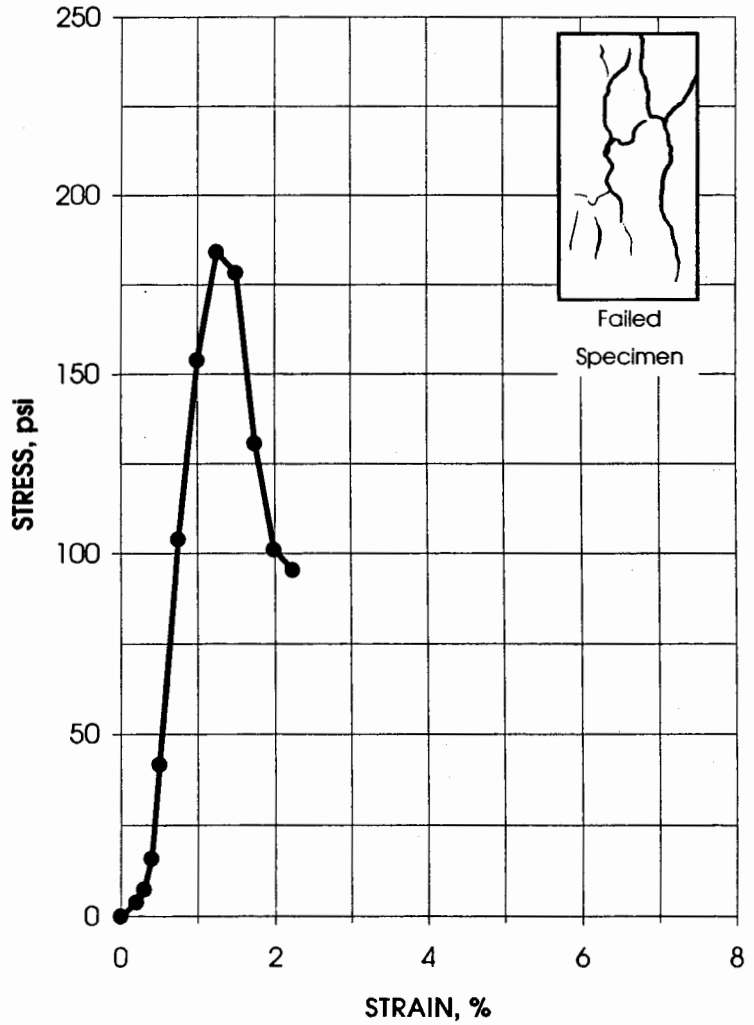
Project LANL
Project No. 831775.00000000

Client Sample No. 1108-12-01
IT Lab No. Sediment mix 7

Specimen Mold Date	12/19/01
Specimen Test Date	1/2/02
STRESS AT FAILURE, psi	**184**
STRAIN AT FAILURE, %	**1.2**

Specimen Height, in.	4.0232
Specimen Diameter, in.	2.0043
Specimen Weight, g.	365.18
Moisture Content, %	23.8
Wet Unit Weight, pcf.	109.6
Dry Unit Weight, pcf.	88.5
Rate of Strain, in./min.	0.0450

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.20	4
0.30	7
0.40	16
0.50	42
0.75	104
0.99	154
1.24	184
1.49	178
1.74	130
1.99	101
2.24	95



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14-DAY CURE

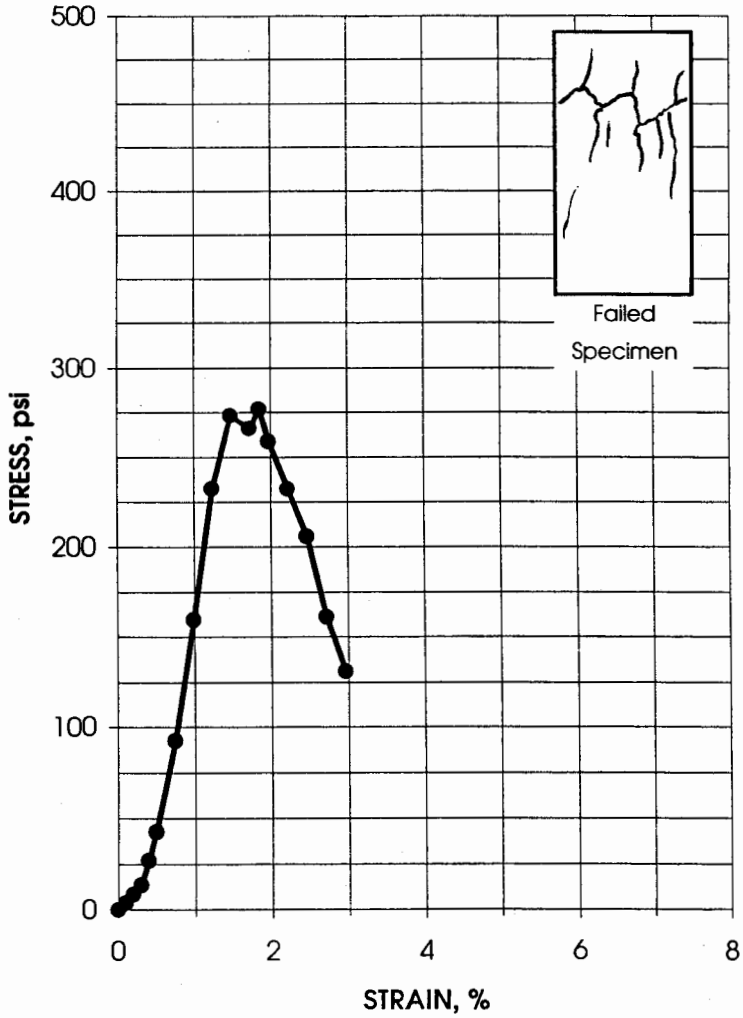
Project No. LANL
Project No. 831775.00000000

Client Sample No. 1108-13-01
IT Lab No. Sediment mix 8

Specimen Mold Date	12/19/01
Specimen Test Date	1/2/02
STRESS AT FAILURE, psi	**277**
STRAIN AT FAILURE, %	**1.9**

Specimen Height, in.	4.0487
Specimen Diameter, in.	2.0110
Specimen Weight, g.	371.68
Moisture Content, %	26.1
Wet Unit Weight, pcf.	110.1
Dry Unit Weight, pcf.	87.3
Rate of Strain, in./min.	0.0450

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	4
0.20	8
0.30	13
0.40	27
0.49	43
0.74	93
0.99	160
1.23	233
1.48	273
1.73	266
1.85	277
1.98	259
2.22	232
2.47	206
2.72	161
2.96	131



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14-DAY CURE

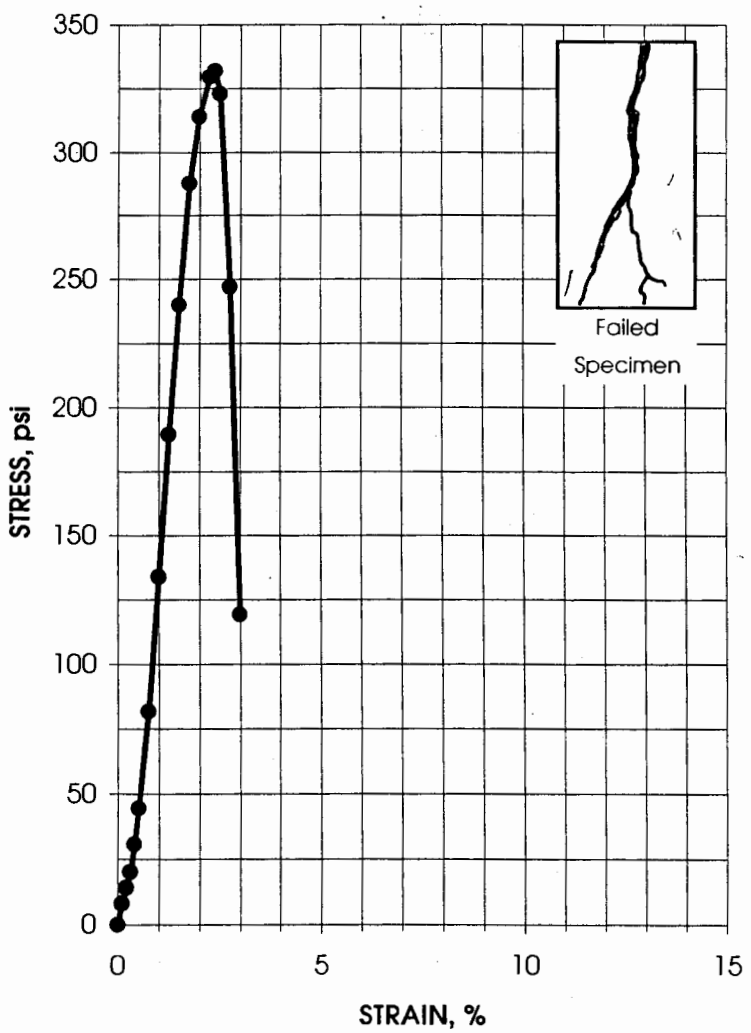
Project Name LANL
Project No. 831775.00000000

Client Sample No. 1108-14-01
IT Lab Specimen N Tuff mix 1

Specimen Mold Date	12/27/02
Specimen Test Date	1/10/02
STRESS AT FAILURE, psi	**332**
STRAIN AT FAILURE, %	**2.4**

Specimen Height, in.	4.0277
Specimen Diameter, in.	2.0102
Specimen Weight, g.	390.07
Moisture Content, %	21.1
Wet Unit Weight, pcf.	116.3
Dry Unit Weight, pcf.	96.0
Rate of Strain, in./min.	0.0650

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0
0.10	8
0.20	14
0.30	20
0.40	31
0.50	45
0.74	82
0.99	134
1.24	190
1.49	240
1.74	288
1.99	314
2.23	330
2.36	332
2.48	323
2.73	247
2.98	119



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14-DAY CURE

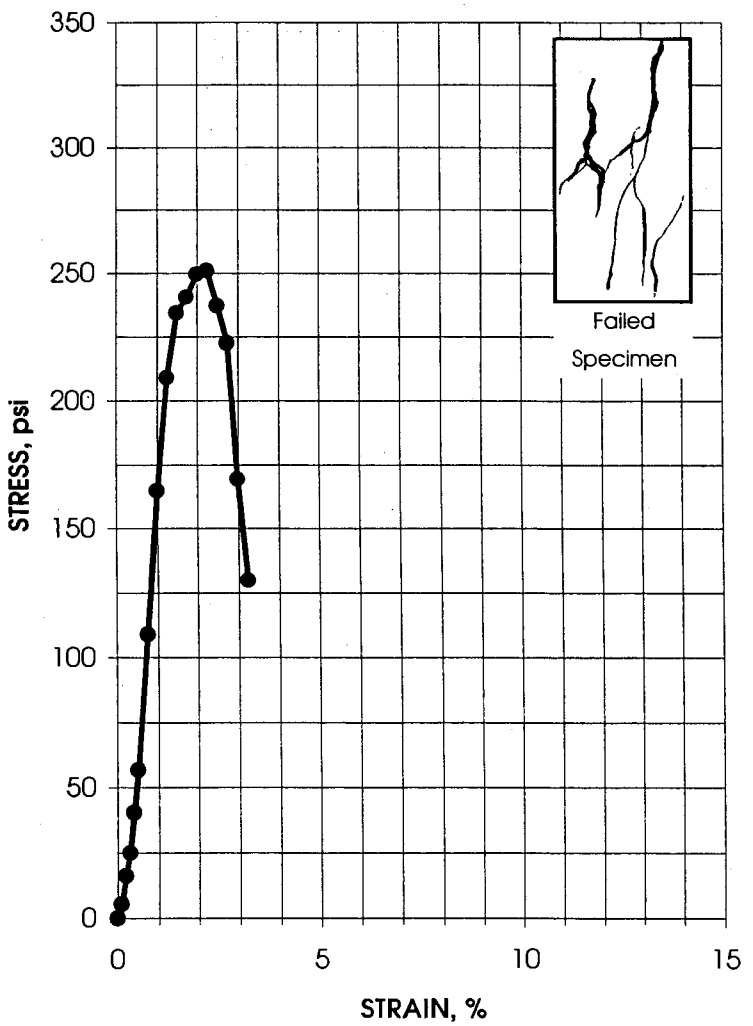
Project Name LANL
Project No. 831775.00000000

Client Sample No. 1108-15-01
IT Lab Specimen No. Tuff mix 2

Specimen Mold Date	12/27/02
Specimen Test Date	1/10/02
STRESS AT FAILURE, psi	**251**
STRAIN AT FAILURE, %	**2.2**

Specimen Height, in.	4.0340
Specimen Diameter, in.	2.0042
Specimen Weight, g.	386.18
Moisture Content, %	20.7
Wet Unit Weight, pcf.	115.6
Dry Unit Weight, pcf.	95.8
Rate of Strain, in./min.	0.0600

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0
0.10	5
0.20	16
0.30	25
0.40	40
0.50	57
0.74	109
0.99	165
1.24	209
1.49	234
1.74	240
1.98	249
2.23	251
2.48	237
2.73	223
2.97	169
3.22	130



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UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

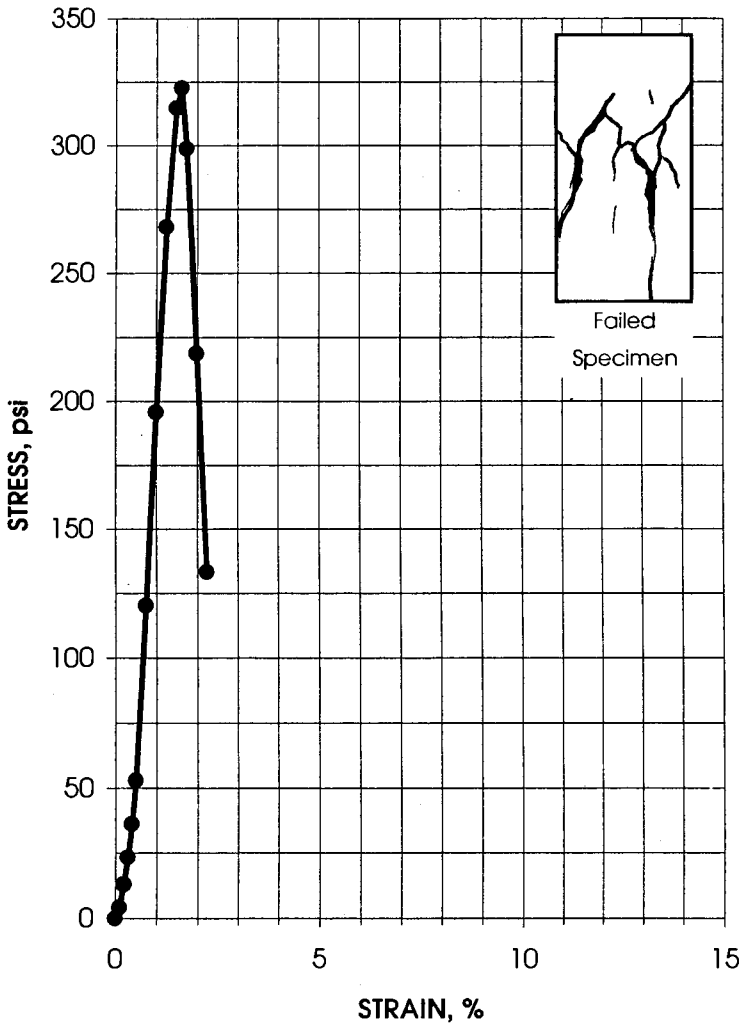
Project Name LANL
Project No. 831775.00000000

Client Sample No. 1108-16-01
IT Lab Specimen No. Tuff mix 3

Specimen Mold Date	12/27/02
Specimen Test Date	1/10/02
STRESS AT FAILURE, psi	**323**
STRAIN AT FAILURE, %	**1.6**

Specimen Height, in.	4.0378
Specimen Diameter, in.	2.0115
Specimen Weight, g.	388.78
Moisture Content, %	22.4
Wet Unit Weight, pcf.	115.4
Dry Unit Weight, pcf.	94.3
Rate of Strain, in./min.	0.0500

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0
0.10	4
0.20	13
0.30	23
0.40	36
0.50	53
0.74	120
0.99	196
1.24	268
1.49	315
1.61	323
1.73	299
1.98	219
2.23	133



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UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

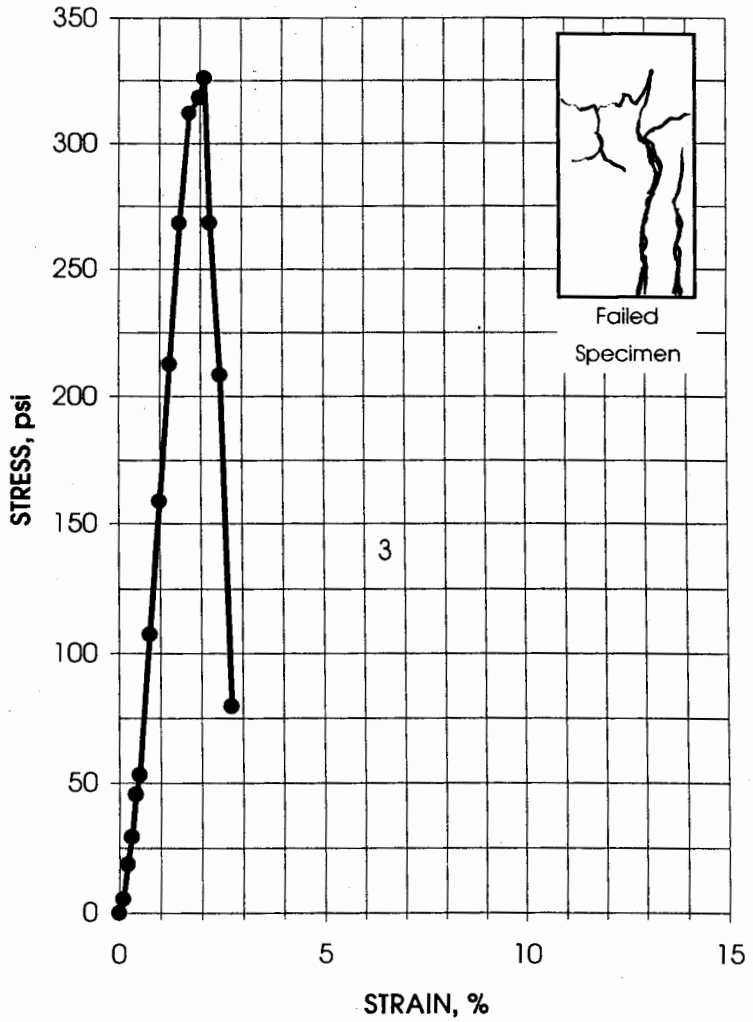
Project Name LANL
Project No. 831775.00000000

Client Sample No. 1108-17-01
IT Lab Specimen N Tuff mix 4

Specimen Mold Date	12/27/02
Specimen Test Date	1/10/02
STRESS AT FAILURE, psi	**326**
STRAIN AT FAILURE, %	**2.1**

Specimen Height, in.	4.0400
Specimen Diameter, in.	2.0123
Specimen Weight, g.	379.93
Moisture Content, %	23.1
Wet Unit Weight, pcf.	112.7
Dry Unit Weight, pcf.	91.6
Rate of Strain, in./min.	0.0600

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0
0.10	5
0.20	19
0.30	29
0.40	46
0.50	53
0.74	107
0.99	159
1.24	213
1.49	268
1.73	312
1.98	318
2.10	326
2.23	268
2.48	209
2.72	80



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UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

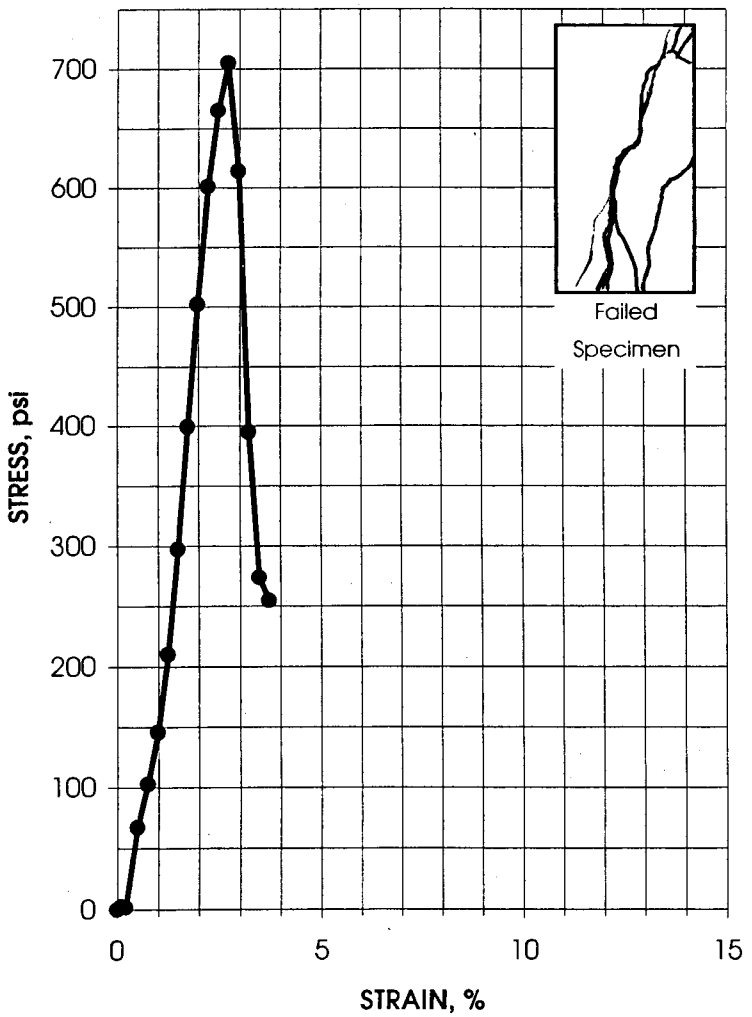
Project Name LANL
Project No. 831775.00000000

Client Sample No. 1108-18-01
IT Lab Specimen N Tuff mix 5

Specimen Mold Date	12/27/02
Specimen Test Date	1/10/02
STRESS AT FAILURE, psi	**705**
STRAIN AT FAILURE, %	**2.7**

Specimen Height, in.	4.0437
Specimen Diameter, in.	2.0103
Specimen Weight, g.	389.11
Moisture Content, %	23.1
Wet Unit Weight, pcf.	115.5
Dry Unit Weight, pcf.	93.8
Rate of Strain, in./min.	0.0600

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0
0.10	3
0.20	2
0.49	67
0.74	103
0.99	146
1.24	210
1.48	297
1.73	399
1.98	502
2.23	601
2.47	665
2.72	705
2.97	614
3.21	395
3.46	274
3.71	255



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UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

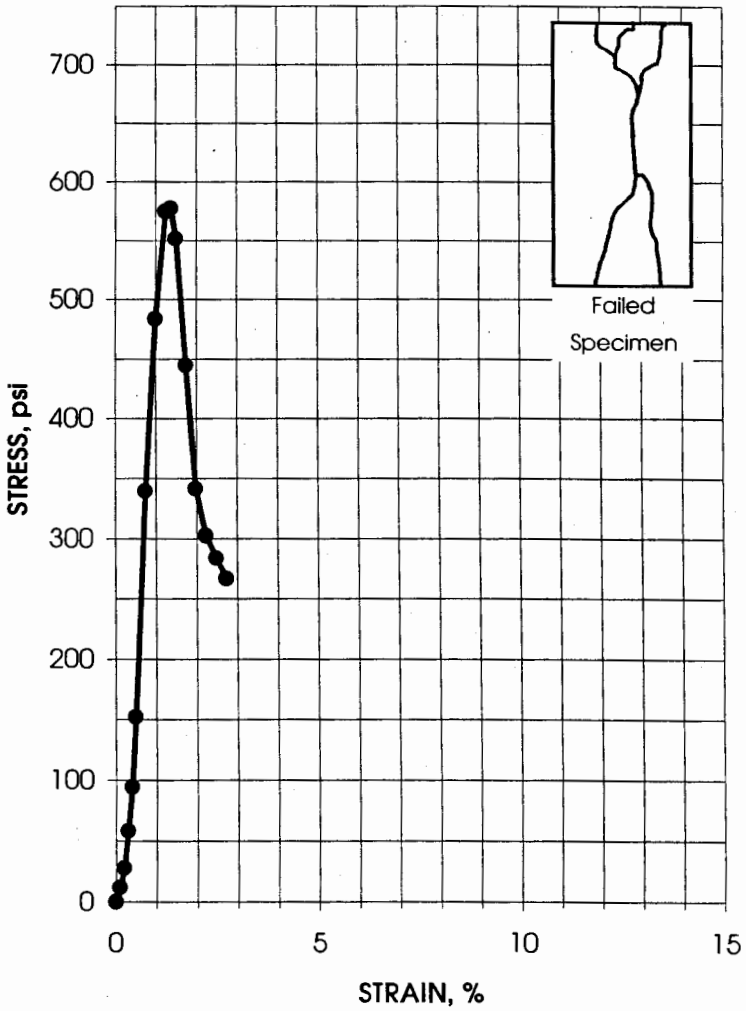
Project Name LANL
Project No. 831775.00000000

Client Sample No. 1108-19-01
IT Lab Specimen N Tuff mix 6

Specimen Mold Date	12/27/02
Specimen Test Date	1/10/02
STRESS AT FAILURE, psi	**578**
STRAIN AT FAILURE, %	**1.4**

Specimen Height, in.	4.0433
Specimen Diameter, in.	2.0045
Specimen Weight, g.	384.51
Moisture Content, %	21.1
Wet Unit Weight, pcf.	114.8
Dry Unit Weight, pcf.	94.8
Rate of Strain, in./min.	0.6500

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0.00	0
0.10	12
0.20	28
0.30	58
0.40	94
0.49	152
0.74	339
0.99	484
1.24	575
1.36	578
1.48	552
1.73	445
1.98	341
2.23	302
2.47	284
2.72	267



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UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

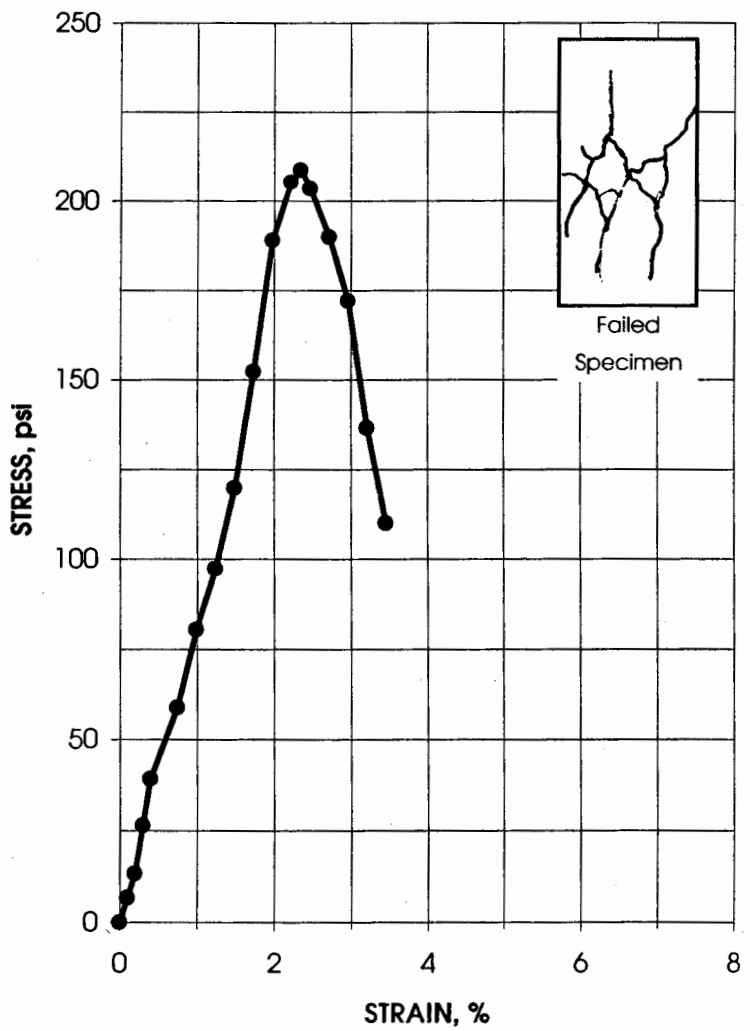
Project Name LANL
Project No. 831775.00000000

Client Sample No. 1108-23-05
IT Lab No. Soil mix 1

Specimen Mold Date	12/27/02
Specimen Test Date	1/24/02
STRESS AT FAILURE, psi	**209**
STRAIN AT FAILURE, %	**2.3**

Specimen Height, in.	4.0503
Specimen Diameter, in.	2.0110
Specimen Weight, g.	373.06
Moisture Content, %	23.4
Wet Unit Weight, pcf.	110.5
Dry Unit Weight, pcf.	89.6
Rate of Strain, in./min.	0.0600

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	7
0.20	13
0.30	26
0.40	39
0.74	59
0.99	80
1.23	97
1.48	120
1.73	152
1.98	189
2.22	205
2.35	209
2.47	204
2.72	190
2.96	172
3.21	137
3.46	110



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UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

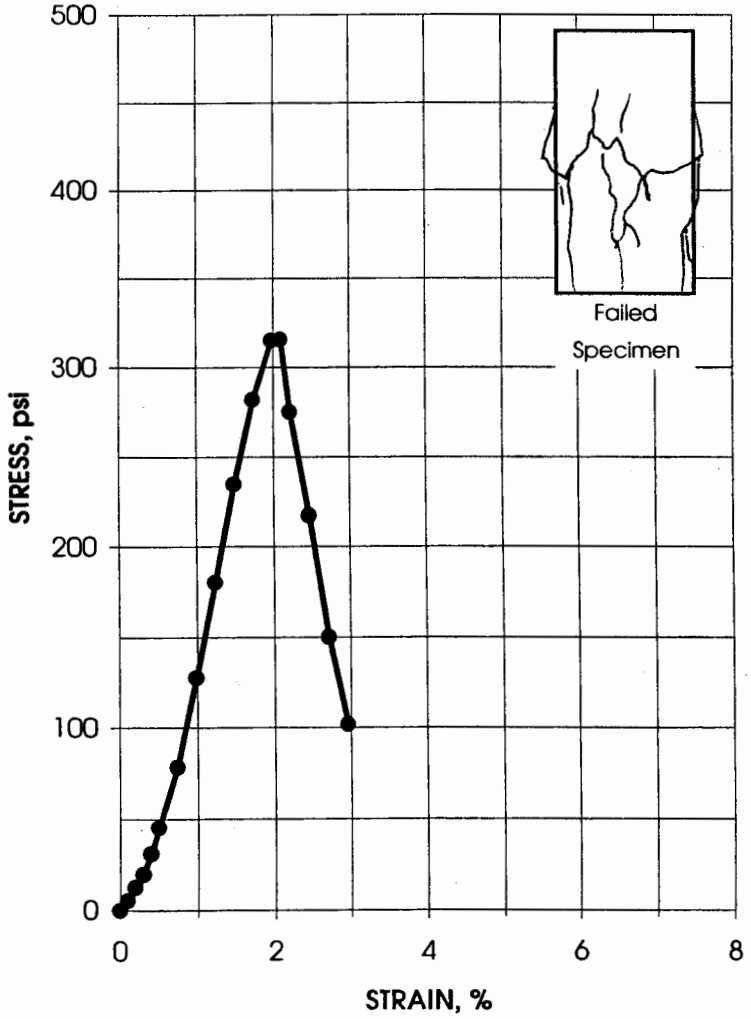
Project Name LANL
Project No. 831775.00000000

Client Sample No. 1108-24-01
IT Lab No. Soil mix 2

Specimen Mold Date	12/27/02
Specimen Test Date	1/24/02
STRESS AT FAILURE, psi	**316**
STRAIN AT FAILURE, %	**2.1**

Specimen Height, in.	4.0493
Specimen Diameter, in.	2.0100
Specimen Weight, g.	380.64
Moisture Content, %	21.4
Wet Unit Weight, pcf.	112.9
Dry Unit Weight, pcf.	93.0
Rate of Strain, in./min.	0.0800

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	5
0.20	13
0.30	19
0.40	31
0.49	45
0.74	78
0.99	128
1.23	180
1.48	235
1.73	282
1.98	315
2.10	316
2.22	275
2.47	217
2.72	150
2.96	102



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UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

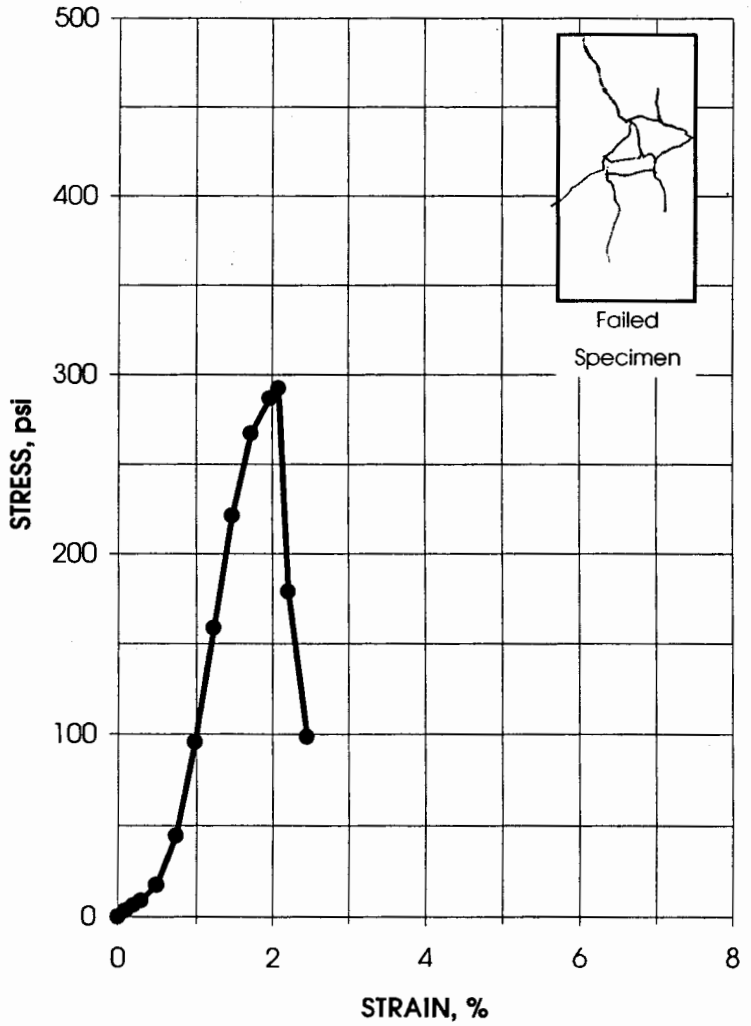
Project Name LANL
Project No. 831775.00000000

Client Sample No. 1108-25-02
IT Lab Specimen No. Soil mix 3

Specimen Mold Date	12/27/02
Specimen Test Date	1/24/02
STRESS AT FAILURE, psi	**293**
STRAIN AT FAILURE, %	**2.1**

Specimen Height, in.	4.0708
Specimen Diameter, in.	2.0047
Specimen Weight, g.	372.69
Moisture Content, %	22.5
Wet Unit Weight, pcf.	110.5
Dry Unit Weight, pcf.	90.2
Rate of Strain, in./min.	0.0500

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	3
0.20	6
0.29	9
0.49	17
0.74	44
0.98	96
1.23	159
1.47	221
1.72	267
1.97	287
2.09	293
2.21	179
2.46	99



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UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

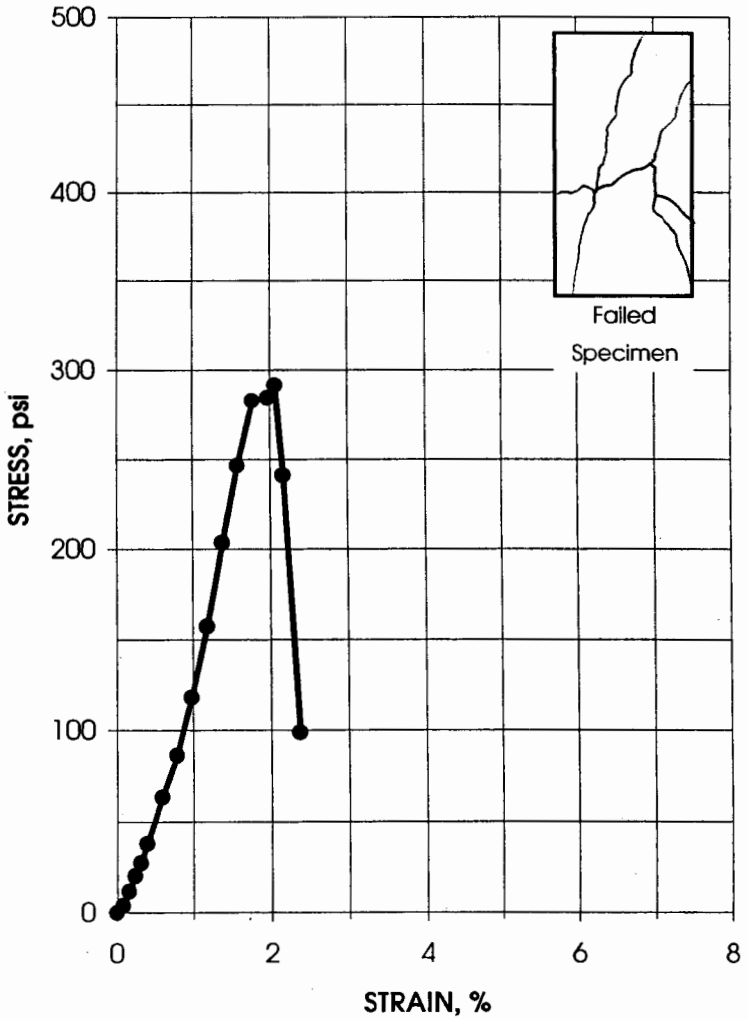
Project Name LANL
Project No. 831775.00000000

Client Sample No. 1108-26-01
IT Lab No. Soil mix 4

Specimen Mold Date	12/27/02
Specimen Test Date	1/24/02
STRESS AT FAILURE, psi	**291**
STRAIN AT FAILURE, %	**2.1**

Specimen Height, in.	5.0730
Specimen Diameter, in.	2.0032
Specimen Weight, g.	371.08
Moisture Content, %	24.9
Wet Unit Weight, pcf.	88.4
Dry Unit Weight, pcf.	70.8
Rate of Strain, in./min.	0.0800

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.08	4
0.16	11
0.24	20
0.32	27
0.39	38
0.59	63
0.79	86
0.99	118
1.18	157
1.38	203
1.58	246
1.77	283
1.97	284
2.07	291
2.17	241
2.37	99



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UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

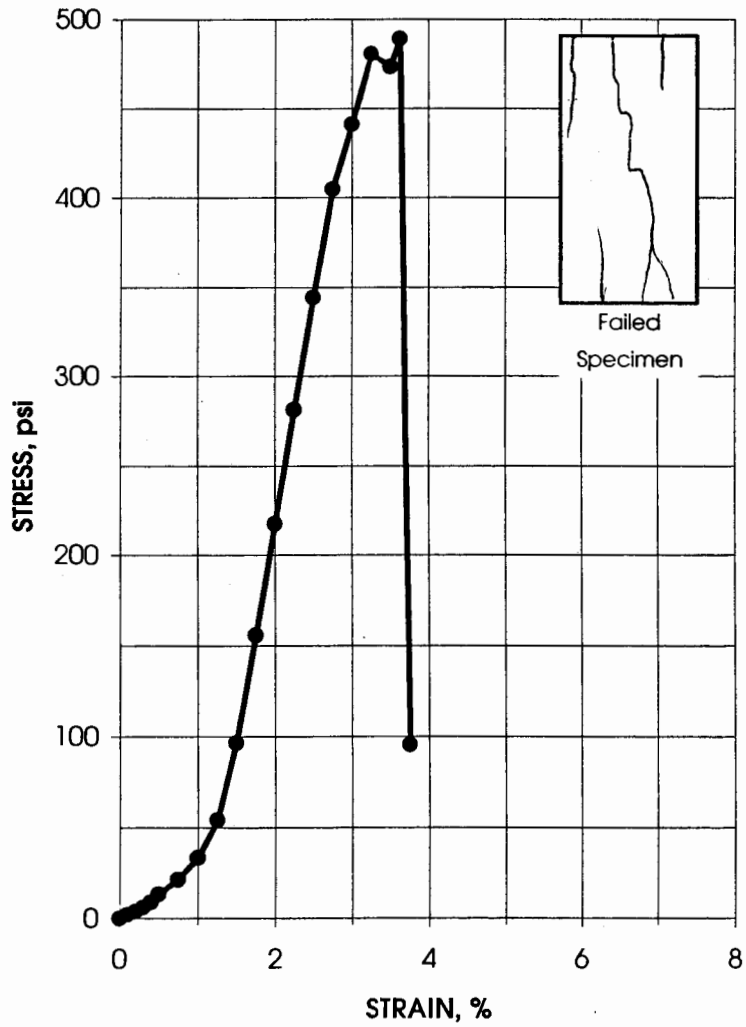
Project Name LANL
Project No. 831775.00000000

Client Sample No. 1108-27-05
IT Lab No. Soil mix 5

Specimen Mold Date	12/27/02
Specimen Test Date	1/24/02
STRESS AT FAILURE, psi	**489**
STRAIN AT FAILURE, %	**3.6**

Specimen Height, in.	3.9983
Specimen Diameter, in.	2.0110
Specimen Weight, g.	367.02
Moisture Content, %	28.8
Wet Unit Weight, pcf.	110.1
Dry Unit Weight, pcf.	85.5
Rate of Strain, in./min.	0.0800

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	2
0.20	4
0.30	6
0.40	9
0.50	13
0.75	21
1.00	33
1.25	54
1.50	96
1.75	156
2.00	217
2.25	281
2.50	344
2.75	405
3.00	441
3.25	481
3.50	473
3.63	489
3.75	95



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UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

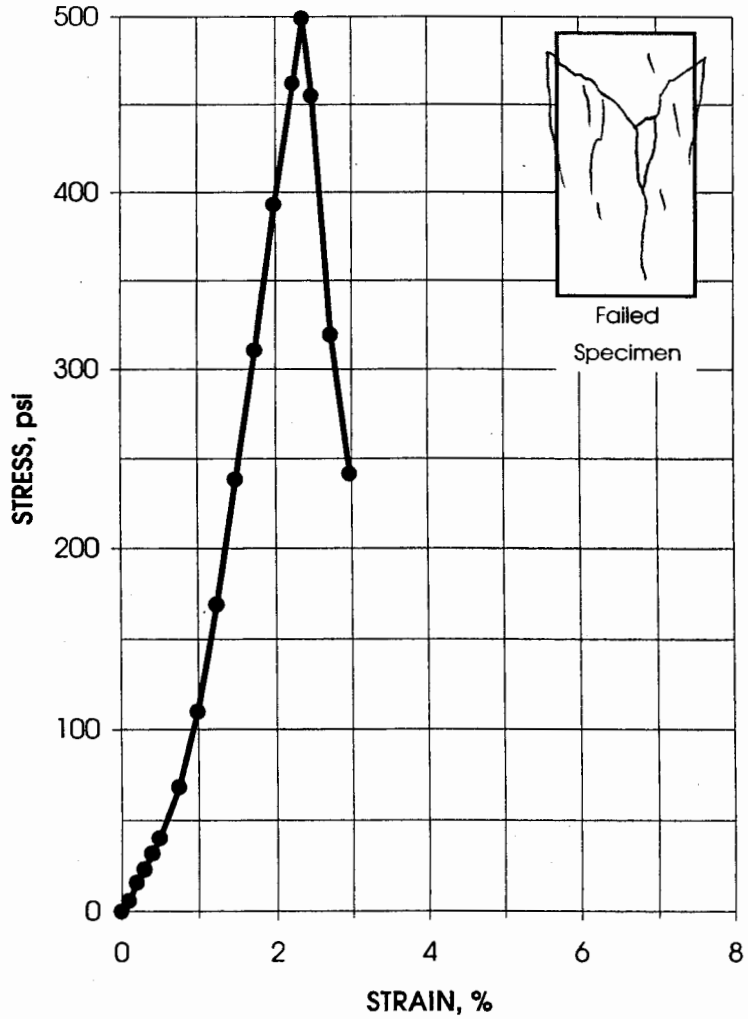
Project Name LANL
Project No. 831775.00000000

Client Sample No. 1108-28-04
IT Lab No. Soil mix 6

Specimen Mold Date	12/27/02
Specimen Test Date	1/24/02
STRESS AT FAILURE, psi	**499**
STRAIN AT FAILURE, %	**2.4**

Specimen Height, in.	4.0327
Specimen Diameter, in.	2.0123
Specimen Weight, g.	377.08
Moisture Content, %	21.2
Wet Unit Weight, pcf.	112.0
Dry Unit Weight, pcf.	92.4
Rate of Strain, in./min.	0.0700

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	6
0.20	16
0.30	23
0.40	32
0.50	40
0.74	68
0.99	110
1.24	169
1.49	238
1.74	311
1.98	393
2.23	462
2.36	499
2.48	455
2.73	319
2.98	241



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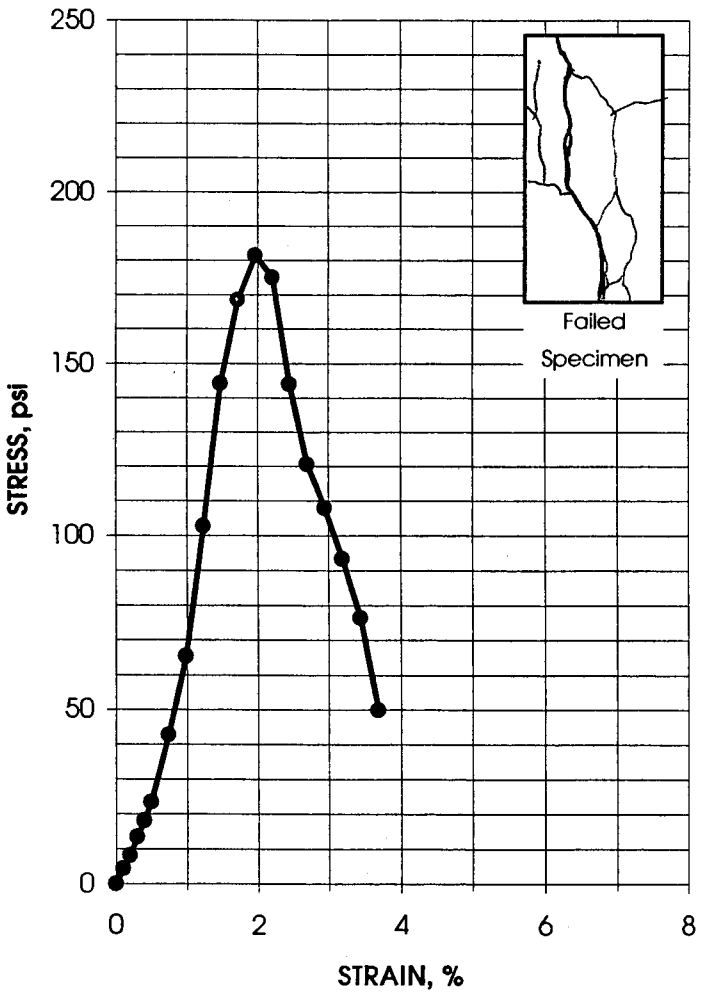
UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

Project	LANL	Client Sample No.	1108-34-08
Project No.	831775.00000000	IT Lab No.	Tuff/Sed Mix 3

Specimen Mold Date	1/24/02	Specimen Height, in.	4.0723
Specimen Test Date	2/8/02	Specimen Diameter, in.	2.0133
		Specimen Weight, g.	383.58
STRESS AT FAILURE, psi	**181**	Moisture Content, %	25.0
STRAIN AT FAILURE, %	**2.0**	Wet Unit Weight, pcf.	112.7
		Dry Unit Weight, pcf.	90.2
		Rate of Strain, in./min.	0.0600

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	4
0.20	8
0.29	13
0.39	18
0.49	23
0.74	43
0.98	65
1.23	103
1.47	144
1.72	169
1.96	181
2.21	175
2.46	144
2.70	121
2.95	108
3.19	93
3.44	76
3.68	50



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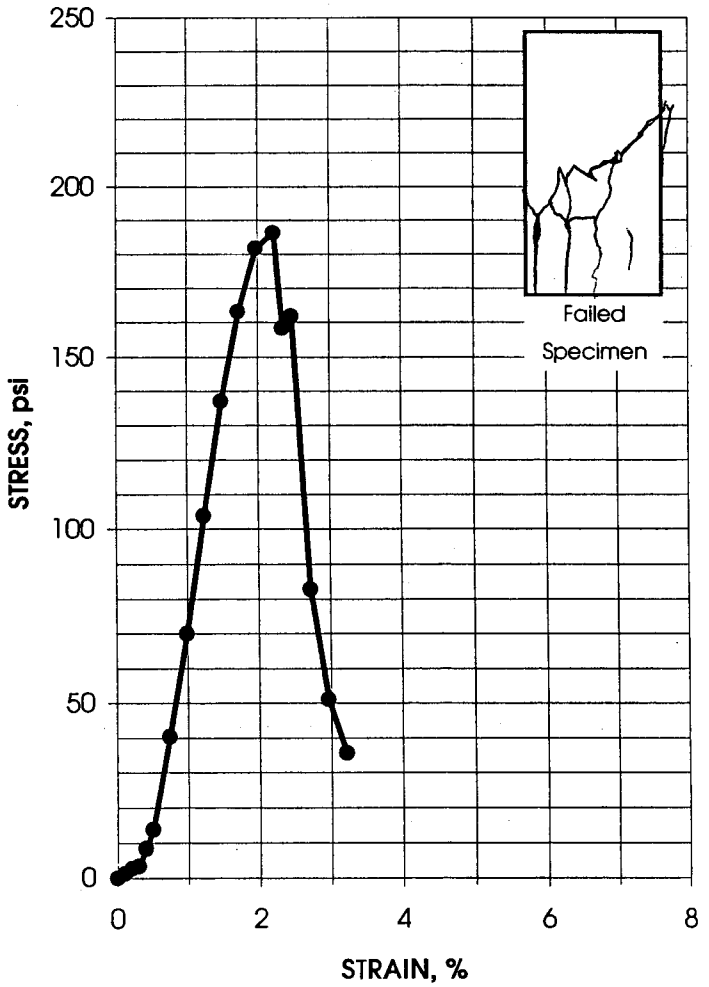
UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
14-DAY CURE

Project	LANL	Client Sample No.	1108-35-09
Project No.	831775.00000000	IT Lab No.	Tuff/Sed Mix 4

Specimen Mold Date	1/24/02	Specimen Height, in.	4.0480
Specimen Test Date	2/8/02	Specimen Diameter, in.	2.0092
		Specimen Weight, g.	372.69
STRESS AT FAILURE, psi	**186**	Moisture Content, %	26.0
STRAIN AT FAILURE, %	**2.2**	Wet Unit Weight, pcf.	110.6
		Dry Unit Weight, pcf.	87.8
		Rate of Strain, in./min.	0.0550

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	1
0.20	3
0.30	3
0.40	8
0.49	14
0.74	40
0.99	70
1.24	104
1.48	137
1.73	163
1.98	182
2.22	186
2.35	158
2.47	162
2.72	83
2.96	51
3.21	36



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UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project LANL
Project No. 831775.00000000

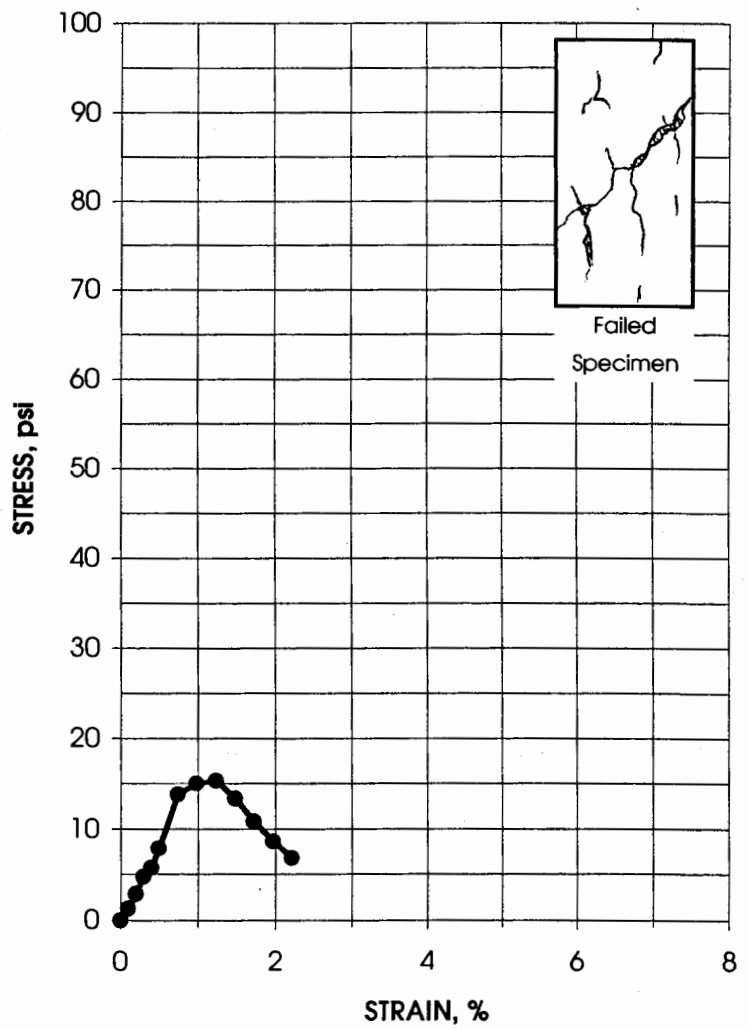
Client Sample No. 1108-09-11
IT Lab No. Sediment mix 4 (b)

Specimen Mold Date
Specimen Test Date 1/17/02

STRESS AT FAILURE, psi **15**
STRAIN AT FAILURE, % **1.2**

Specimen Height, in.	4.0588
Specimen Diameter, in.	2.0097
Specimen Weight, g.	328.47
Moisture Content, %	16.9
Wet Unit Weight, pcf.	97.2
Dry Unit Weight, pcf.	83.2
Rate of Strain, in./min.	0.0500

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	1
0.20	3
0.30	5
0.39	6
0.49	8
0.74	14
0.99	15
1.23	15
1.48	13
1.72	11
1.97	9
2.22	7



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28-DAY CURE

Project LANL
Project No. 831775.00000000

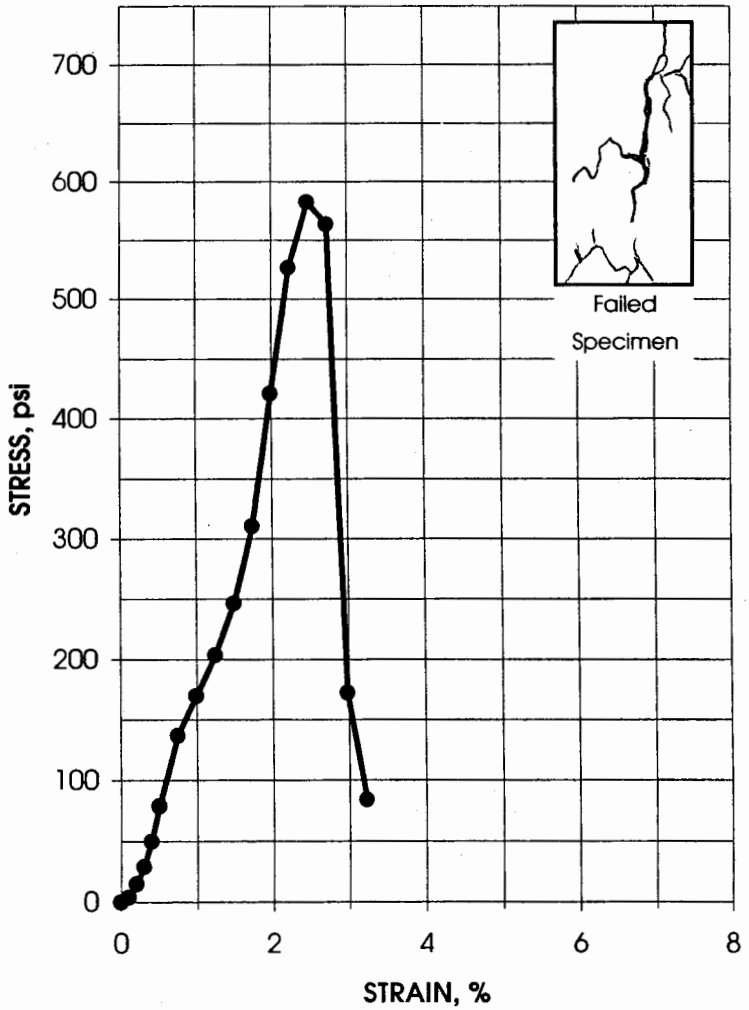
Client Sample No. 1108-10-02
IT Labn No. Sediment mix 5

Specimen Mold Date
Specimen Test Date 1/16/02

STRESS AT FAILURE, psi **583**
STRAIN AT FAILURE, % **2.5**

Specimen Height, in.	4.0272
Specimen Diameter, in.	2.0152
Specimen Weight, g.	383.08
Moisture Content, %	25.9
Wet Unit Weight, pcf.	113.6
Dry Unit Weight, pcf.	90.2
Rate of Strain, in./min.	0.0500

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	4
0.20	15
0.30	29
0.40	50
0.50	79
0.74	137
0.99	169
1.24	203
1.49	246
1.74	310
1.99	421
2.23	527
2.48	583
2.73	564
2.98	172
3.23	84



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UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project LANL
Project No. 831775.00000000

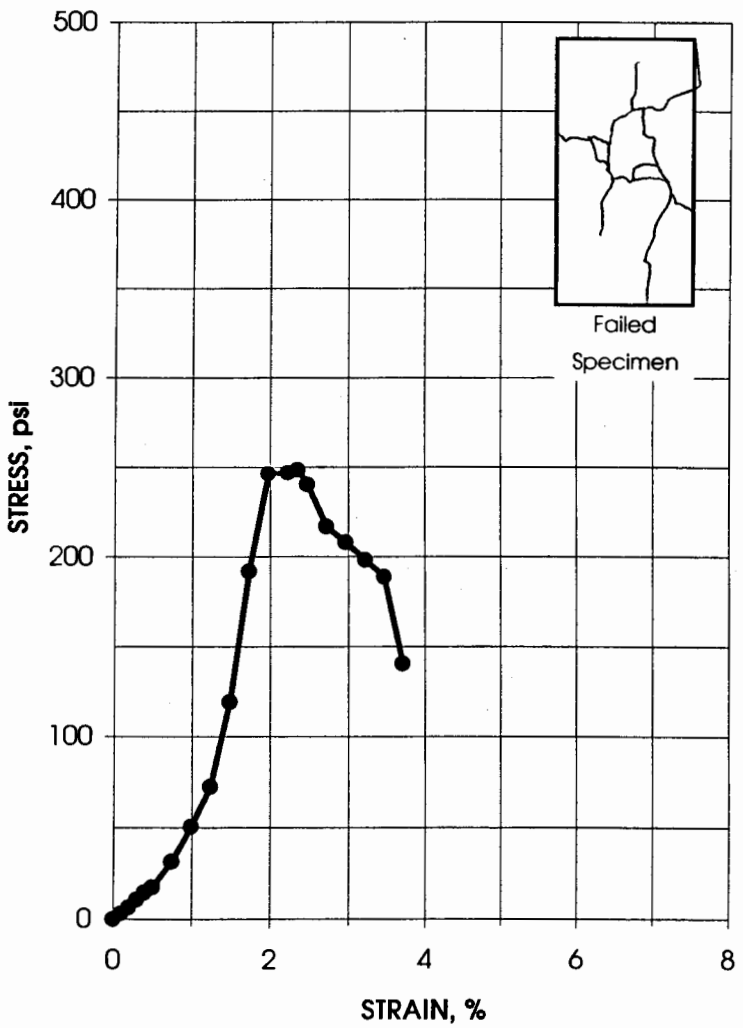
Client Sample No. 1108-11-02
IT Lab No. Sediment 6 (a)

Specimen Mold Date
Specimen Test Date 1/16/02

STRESS AT FAILURE, psi **248**
STRAIN AT FAILURE, % **2.3**

Specimen Height, in.	4.0435
Specimen Diameter, in.	2.0145
Specimen Weight, g.	375.18
Moisture Content, %	20.9
Wet Unit Weight, pcf.	110.9
Dry Unit Weight, pcf.	91.8
Rate of Strain, in./min.	0.0500

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	3
0.20	6
0.30	11
0.40	14
0.49	17
0.74	31
0.99	50
1.24	73
1.48	119
1.73	192
1.98	246
2.23	247
2.35	248
2.47	240
2.72	217
2.97	208
3.22	198
3.46	189
3.71	140



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Project LANL
Project No. 831775.00000000

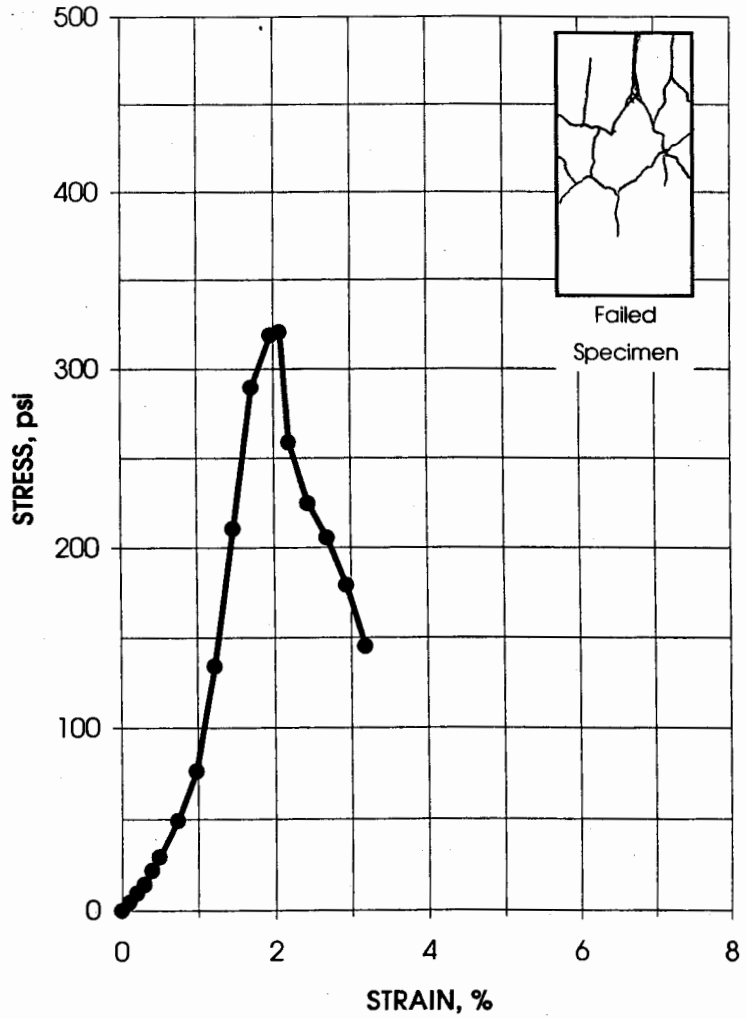
Client Sample No. 1108-11-11
IT Lab No. Sediment 6 (b)

Specimen Mold Date
Specimen Test Date 1/17/02

STRESS AT FAILURE, psi **320**
STRAIN AT FAILURE, % **2.1**

Specimen Height, in.	4.0792
Specimen Diameter, in.	2.0117
Specimen Weight, g.	384.70
Moisture Content, %	20.9
Wet Unit Weight, pcf.	113.1
Dry Unit Weight, pcf.	93.5
Rate of Strain, in./min.	0.0500

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	4
0.20	9
0.29	14
0.39	22
0.49	29
0.74	49
0.98	76
1.23	134
1.47	210
1.72	289
1.96	319
2.08	320
2.21	259
2.45	225
2.70	205
2.94	179
3.19	145



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UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project LANL
Project No. 831775.00000000

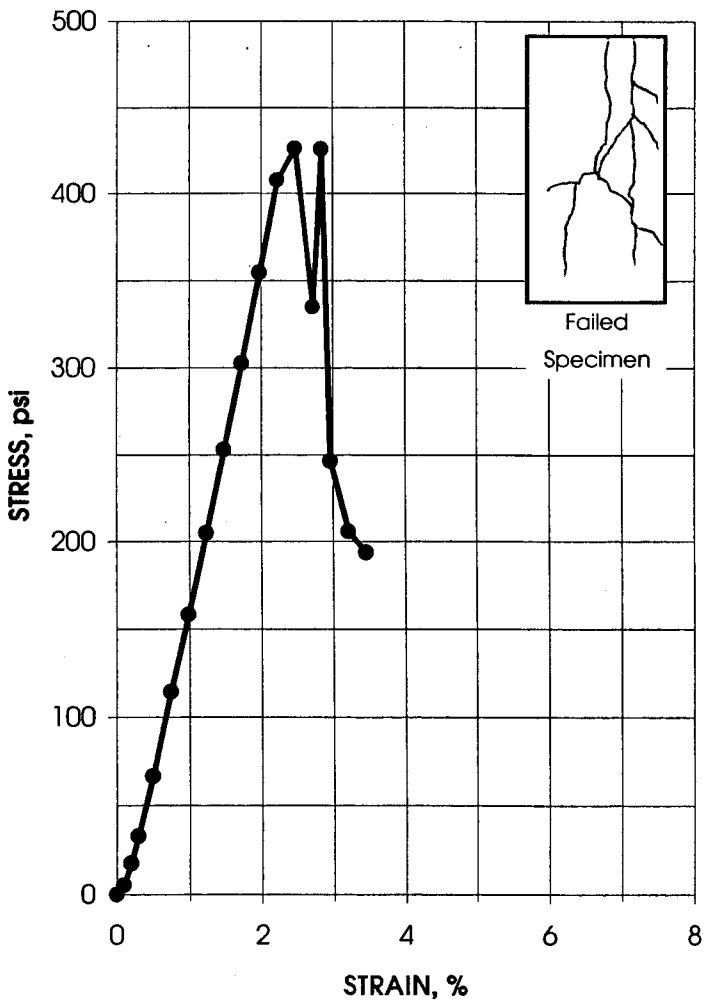
Client Sample No. 1108-15-11
IT Lab No. Tuff Mix 2

Specimen Mold Date
Specimen Test Date 1/24/02

STRESS AT FAILURE, psi **426**
STRAIN AT FAILURE, % **2.5**

Specimen Height, in.	4.0433
Specimen Diameter, in.	2.0037
Specimen Weight, g.	388.67
Moisture Content, %	20.0
Wet Unit Weight, pcf.	116.2
Dry Unit Weight, pcf.	96.8
Rate of Strain, in./min.	0.0500

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	5
0.20	18
0.30	33
0.49	67
0.74	114
0.99	158
1.24	205
1.48	253
1.73	303
1.98	355
2.23	408
2.47	426
2.72	335
2.84	426
2.97	246
3.22	206
3.46	194



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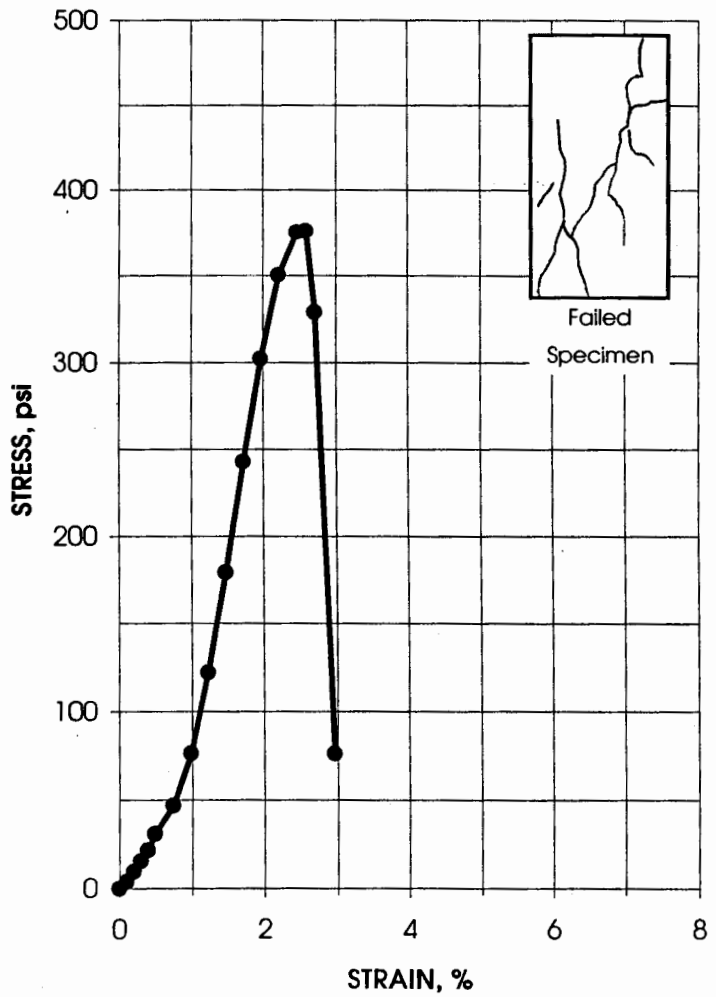
28-DAY CURE

Project	LANL	Client Sample No.	1108-16-11
Project No.	831775.00000000	IT Lab No.	Tuff-Mix 3

Specimen Mold Date		Specimen Height, in.	4.0577
Specimen Test Date	1/24/02	Specimen Diameter, in.	2.0107
		Specimen Weight, g.	383.82
STRESS AT FAILURE, psi	**376**	Moisture Content, %	21.8
STRAIN AT FAILURE, %	**2.6**	Wet Unit Weight, pcf.	113.5
		Dry Unit Weight, pcf.	93.2
		Rate of Strain, in./min.	0.0500

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	4
0.20	9
0.30	15
0.39	21
0.49	31
0.74	47
0.99	76
1.23	122
1.48	179
1.73	243
1.97	302
2.22	350
2.46	375
2.59	376
2.71	329
2.96	76



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UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project LANL
Project No. 831775.00000000

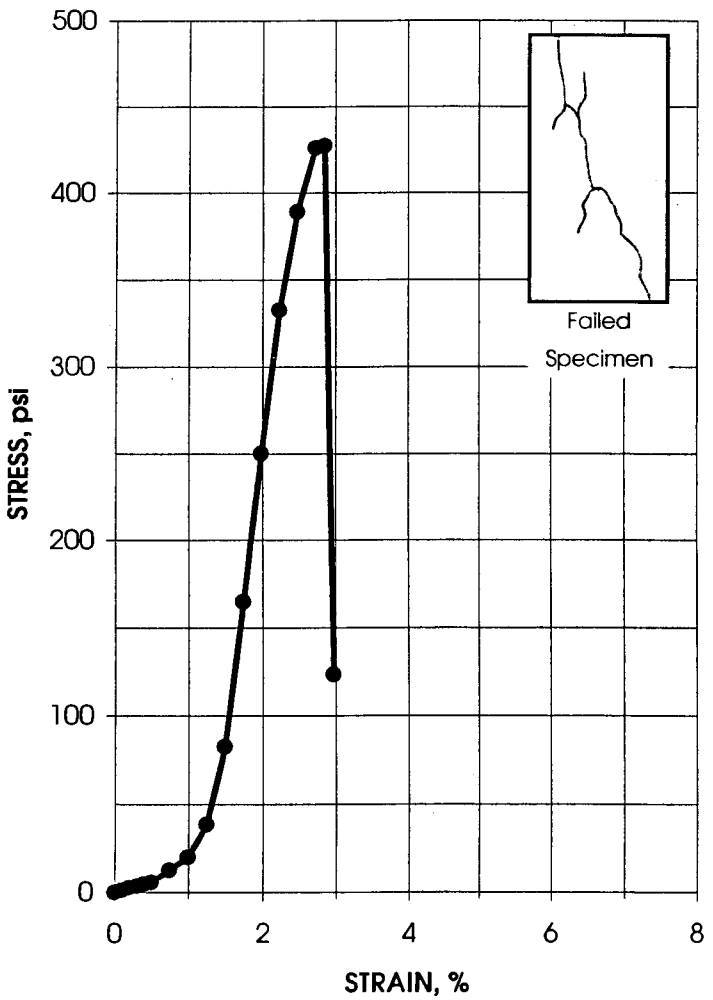
Client Sample No. 1108-17-11
IT Lab No. Tuff Mix 4

Specimen Mold Date
Specimen Test Date 1/24/02

STRESS AT FAILURE, psi **427**
STRAIN AT FAILURE, % **2.8**

Specimen Height, in.	4.0380
Specimen Diameter, in.	2.0108
Specimen Weight, g.	379.13
Moisture Content, %	22.5
Wet Unit Weight, pcf.	112.7
Dry Unit Weight, pcf.	92.0
Rate of Strain, in./min.	0.0500

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	1
0.20	3
0.30	3
0.40	5
0.50	6
0.74	13
0.99	20
1.24	39
1.49	82
1.73	165
1.98	250
2.23	333
2.48	389
2.72	426
2.85	427
2.97	123



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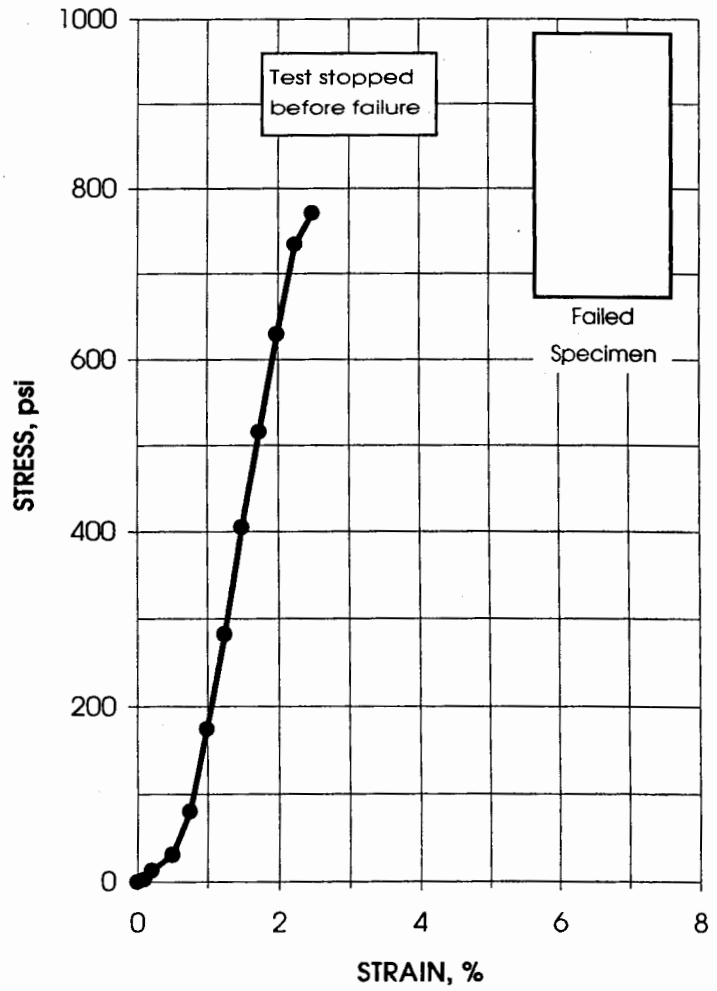
UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project	LANL	Client Sample No.	1108-18-11
Project No.	831775.00000000	IT Lab No.	Tuff Mix 5

Specimen Mold Date		Specimen Height, in.	4.0307
Specimen Test Date	1/24/02	Specimen Diameter, in.	2.0092
		Specimen Weight, g.	388.66
STRESS AT FAILURE, psi	**771**	Moisture Content, %	22.3
STRAIN AT FAILURE, %	**2.5**	Wet Unit Weight, pcf.	115.9
		Dry Unit Weight, pcf.	94.8
		Rate of Strain, in./min.	0.0500

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	3
0.20	13
0.50	30
0.74	80
0.99	174
1.24	282
1.49	405
1.74	515
1.98	629
2.23	734
2.48	771



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IT Project No.: 831775.00000000

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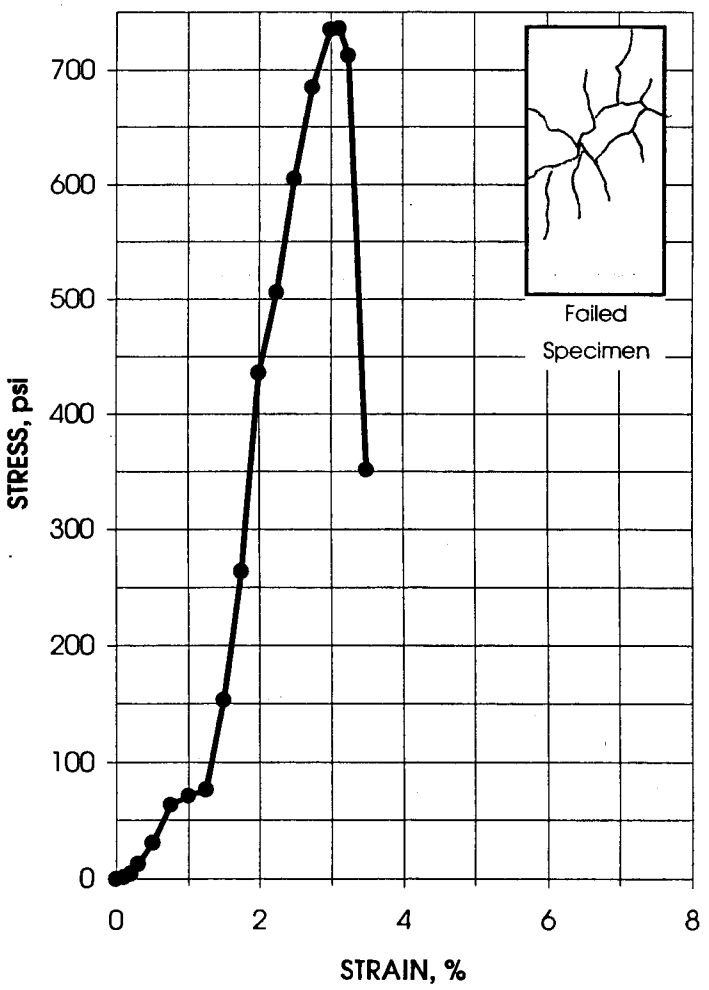
UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project	LANL	Client Sample No.	1108-19-11
Project No.	831775.00000000	IT Lab No.	Tuff Mix 6

Specimen Mold Date		Specimen Height, in.	4.0115
Specimen Test Date	1/24/02	Specimen Diameter, in.	2.0033
		Specimen Weight, g.	382.59
STRESS AT FAILURE, psi	**736**	Moisture Content, %	20.3
STRAIN AT FAILURE, %	**3.1**	Wet Unit Weight, pcf.	115.3
		Dry Unit Weight, pcf.	95.9
		Rate of Strain, in./min.	0.0500

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	1
0.20	4
0.30	13
0.50	31
0.75	63
1.00	71
1.25	76
1.50	153
1.74	264
1.99	436
2.24	506
2.49	605
2.74	685
2.99	735
3.12	736
3.24	712
3.49	351



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UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project LANL
Project No. 831775.00000000

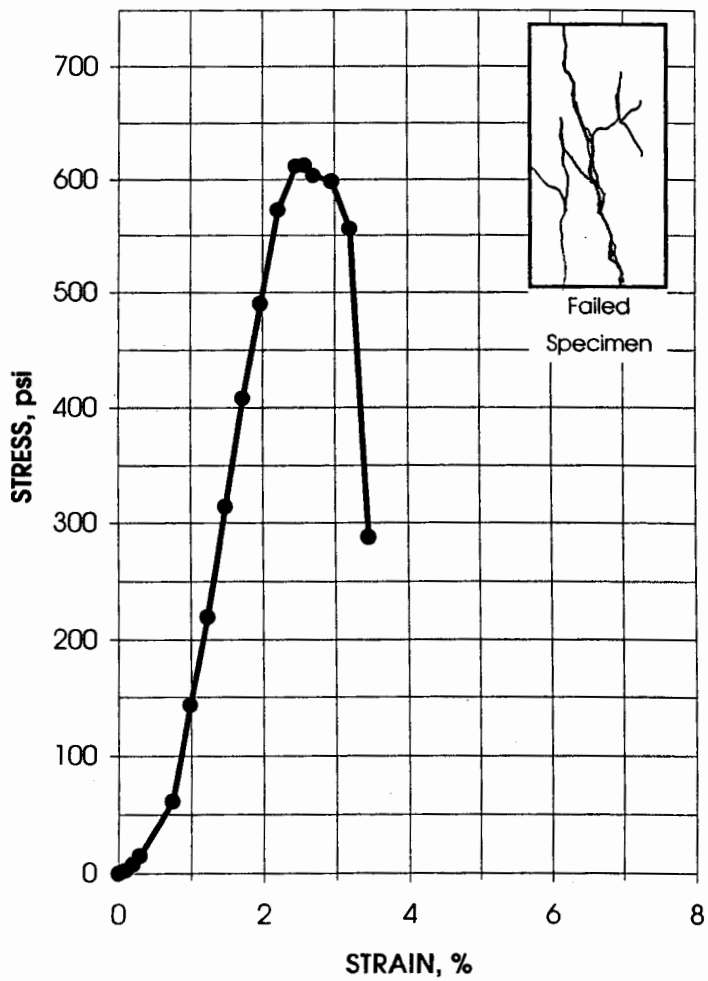
Client Sample No. 1108-20-11
IT Labn No. Tuff Mix 7

Specimen Mold Date
Specimen Test Date 1/24/02

STRESS AT FAILURE, psi **612**
STRAIN AT FAILURE, % **2.6**

Specimen Height, in.	4.0533
Specimen Diameter, in.	2.0135
Specimen Weight, g.	376.86
Moisture Content, %	23.0
Wet Unit Weight, pcf.	111.3
Dry Unit Weight, pcf.	90.4
Rate of Strain, in./min.	0.0500

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	3
0.20	8
0.30	15
0.74	61
0.99	143
1.23	219
1.48	314
1.73	408
1.97	490
2.22	573
2.47	611
2.59	612
2.71	603
2.96	598
3.21	556
3.45	288



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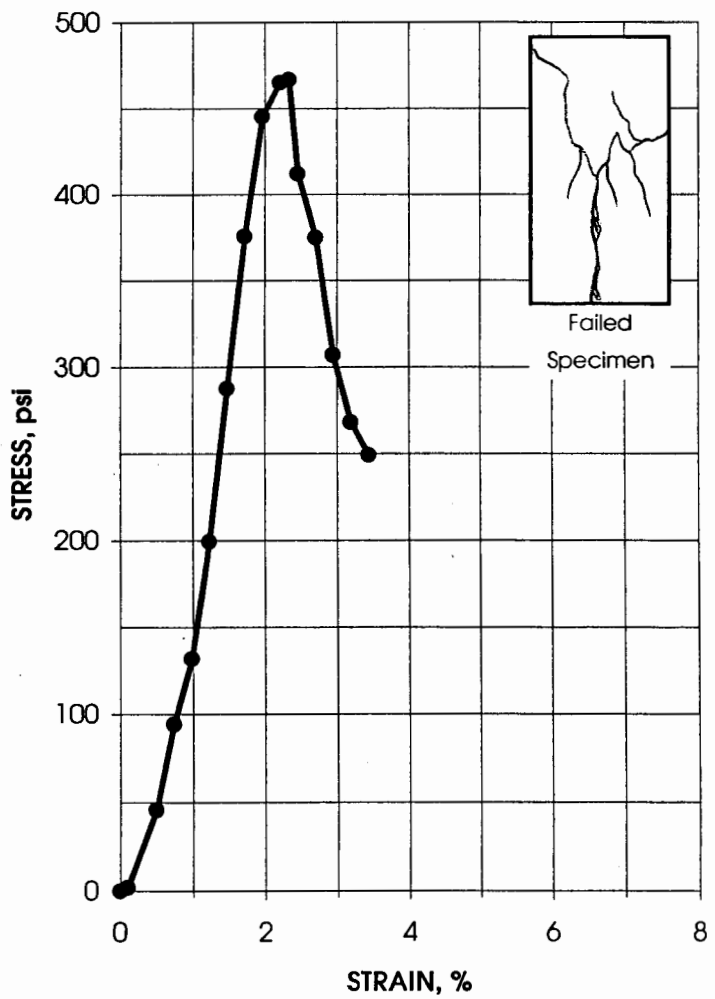
28-DAY CURE

Project	LANL	Client Sample No.	1108-21-11
Project No.	831775.00000000	IT Lab No.	Tuff Mix 8

Specimen Mold Date		Specimen Height, in.	4.0700
Specimen Test Date	1/24/02	Specimen Diameter, in.	2.0117
		Specimen Weight, g.	374.40
STRESS AT FAILURE, psi	**467**	Moisture Content, %	25.0
STRAIN AT FAILURE, %	**2.3**	Wet Unit Weight, pcf.	110.3
		Dry Unit Weight, pcf.	88.2
		Rate of Strain, in./min.	0.0500

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	2
0.49	46
0.74	94
0.98	132
1.23	199
1.47	288
1.72	375
1.97	445
2.21	465
2.33	467
2.46	412
2.70	375
2.95	307
3.19	268
3.44	249



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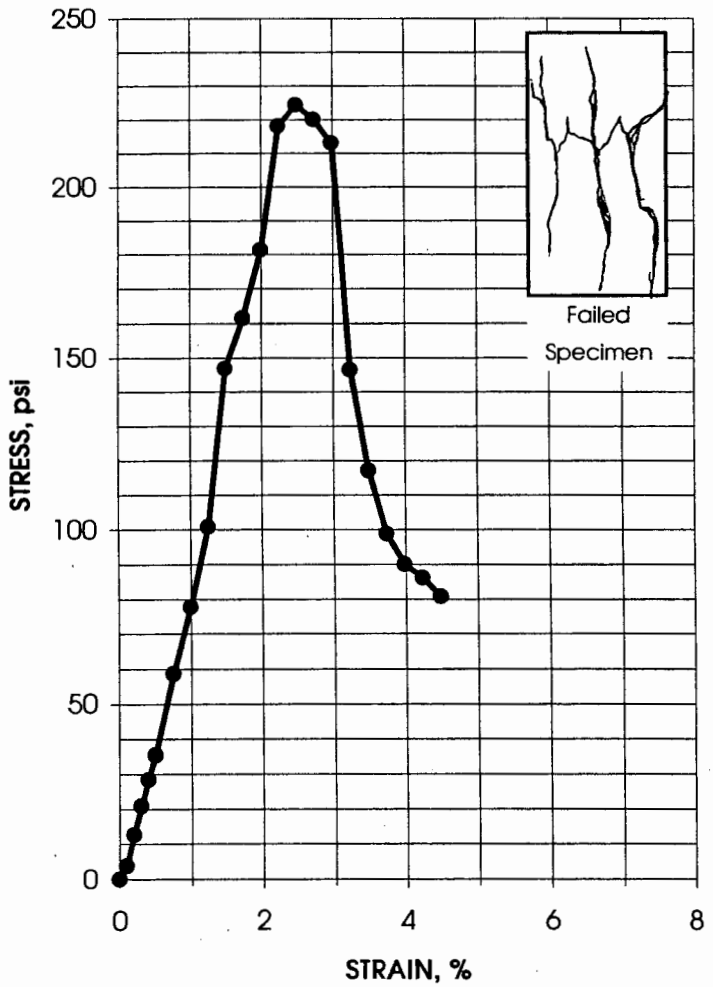
28-DAY CURE

Project	LANL	Client Sample No.	1108-23-08
Project No.	831775.00000000	IT Lab No.	Soil Mix 1

Specimen Mold Date		Specimen Height, in.	4.0168
Specimen Test Date	2/8/02	Specimen Diameter, in.	2.0015
		Specimen Weight, g.	372.56
STRESS AT FAILURE, psi	**224**	Moisture Content, %	24.4
STRAIN AT FAILURE, %	**2.5**	Wet Unit Weight, pcf.	112.3
		Dry Unit Weight, pcf.	90.3
		Rate of Strain, in./min.	0.0643

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	4
0.20	13
0.30	21
0.40	28
0.50	35
0.75	59
1.00	78
1.24	101
1.49	147
1.74	161
1.99	181
2.24	218
2.49	224
2.74	220
2.99	213
3.24	146
3.49	117
3.73	99
3.98	90
4.23	86
4.48	81



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UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project LANL
Project No. 831775.00000000

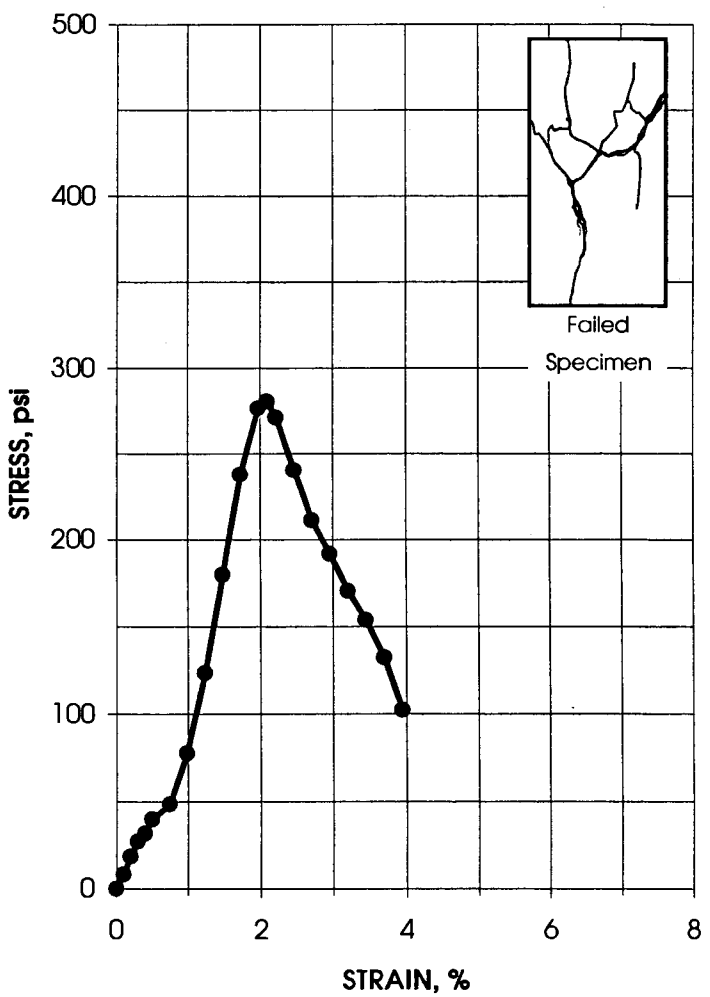
Client Sample No. 1108-24-02
IT Lab No. Soil Mix 2

Specimen Mold Date
Specimen Test Date 2/8/02

STRESS AT FAILURE, psi **281**
STRAIN AT FAILURE, % **2.1**

Specimen Height, in.	4.0573
Specimen Diameter, in.	2.0075
Specimen Weight, g.	380.45
Moisture Content, %	22.3
Wet Unit Weight, pcf.	112.9
Dry Unit Weight, pcf.	92.3
Rate of Strain, in./min.	0.0600

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	8
0.20	19
0.30	27
0.39	32
0.49	40
0.74	49
0.99	78
1.23	124
1.48	180
1.73	238
1.97	277
2.09	281
2.22	271
2.46	240
2.71	211
2.96	192
3.20	171
3.45	154
3.70	133
3.94	102



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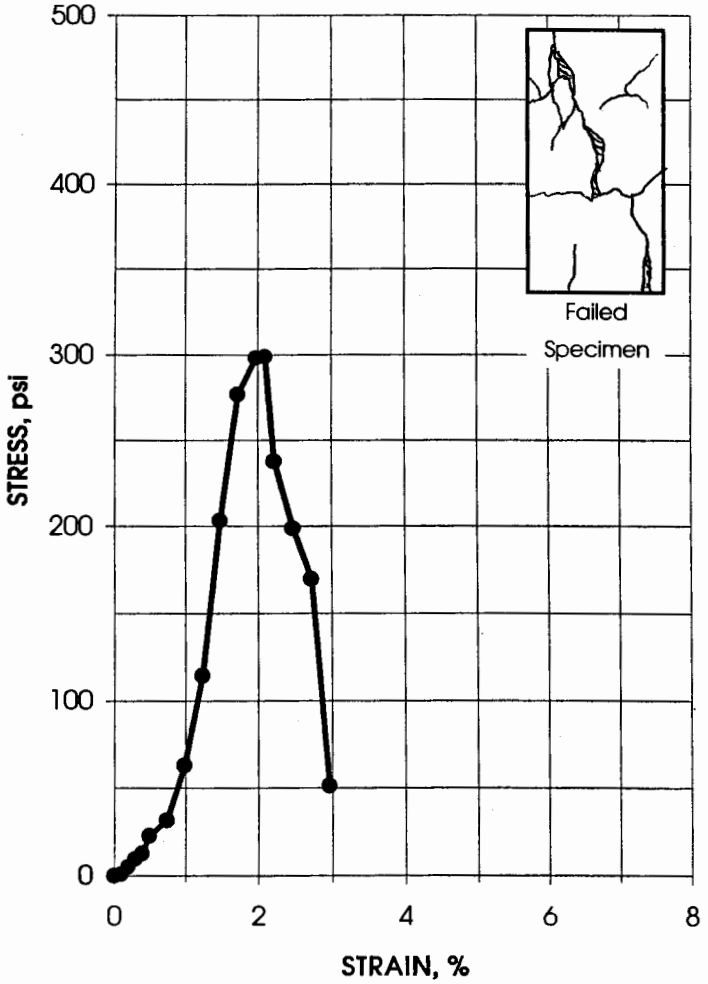
UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project	LANL	Client Sample No.	1108-25-03
Project No.	831775.00000000	IT Lab No.	Soil Mix 3

Specimen Mold Date		Specimen Height, in.	4.0545
Specimen Test Date	2/8/02	Specimen Diameter, in.	2.0093
		Specimen Weight, g.	372.23
STRESS AT FAILURE, psi	**299**	Moisture Content, %	23.2
STRAIN AT FAILURE, %	**2.1**	Wet Unit Weight, pcf.	110.3
		Dry Unit Weight, pcf.	89.5
		Rate of Strain, in./min.	0.0600

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	1
0.20	5
0.30	9
0.39	13
0.49	23
0.74	32
0.99	63
1.23	114
1.48	203
1.73	277
1.97	298
2.10	299
2.22	238
2.47	199
2.71	170
2.96	51



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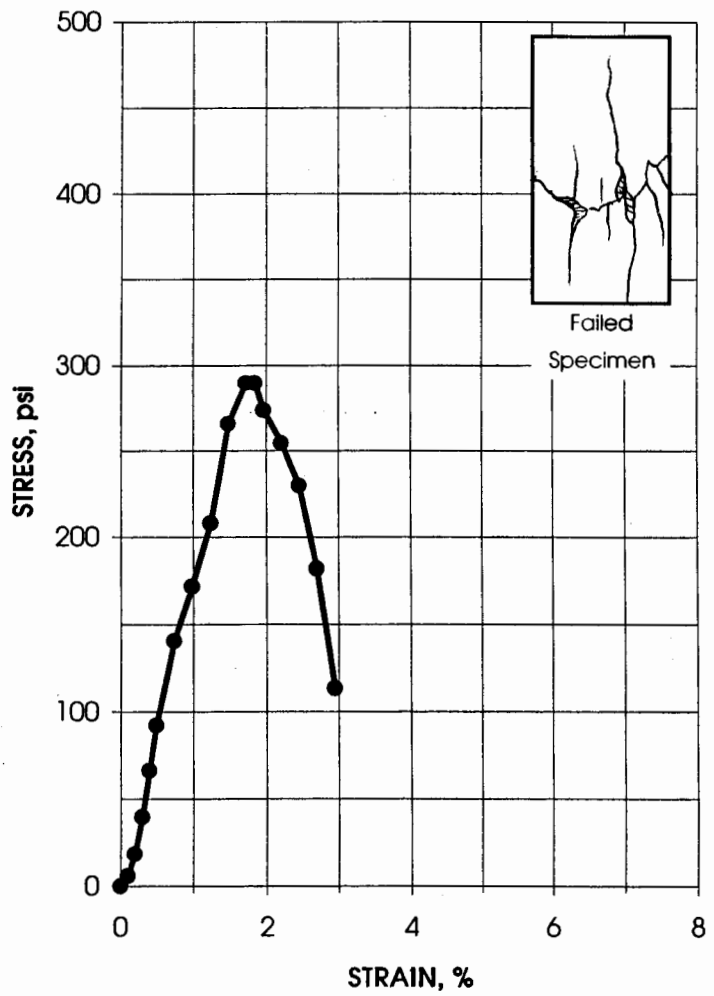
UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project	LANL	Client Sample No.	1108-26-06
Project No.	831775.00000000	IT Lab No.	Soil Mix 4

Specimen Mold Date		Specimen Height, in.	4.0728
Specimen Test Date	2/8/02	Specimen Diameter, in.	2.0020
		Specimen Weight, g.	371.98
STRESS AT FAILURE, psi	**290**	Moisture Content, %	25.9
STRAIN AT FAILURE, %	**1.7**	Wet Unit Weight, pcf.	110.5
		Dry Unit Weight, pcf.	87.8
		Rate of Strain, in./min.	0.0626

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	6
0.20	18
0.29	40
0.39	66
0.49	92
0.74	141
0.98	172
1.23	208
1.47	266
1.72	290
1.84	290
1.96	274
2.21	254
2.46	230
2.70	182
2.95	113



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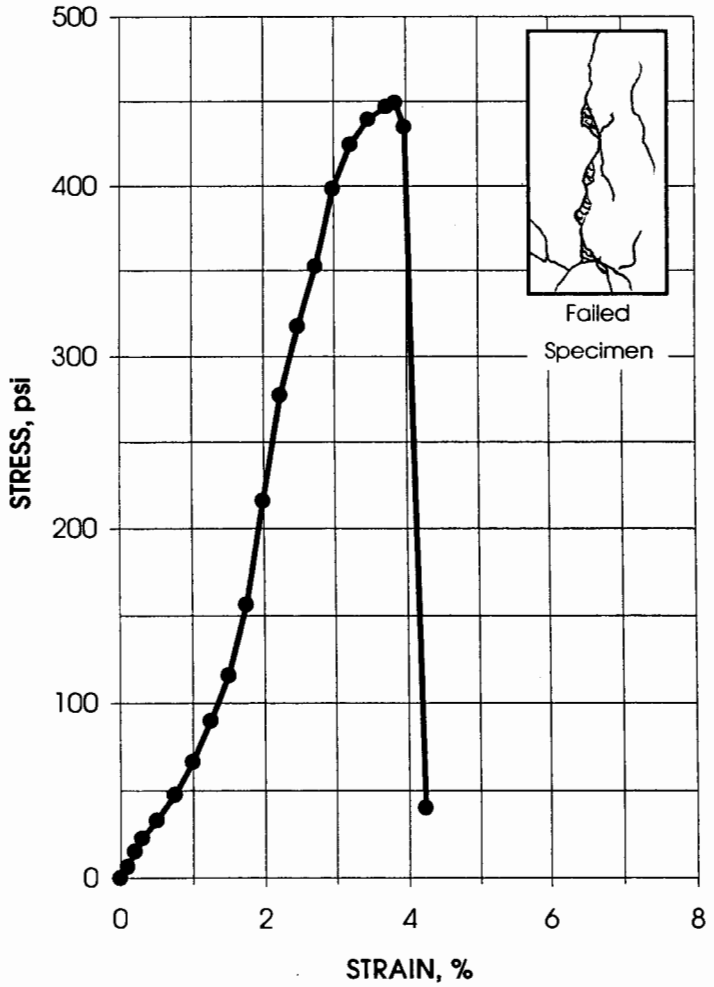
UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project	LANL	Client Sample No.	1108-27-02
Project No.	831775.00000000	IT Lab No.	Soil Mix 5

Specimen Mold Date		Specimen Height, in.	4.0217
Specimen Test Date	2/8/02	Specimen Diameter, in.	2.0103
		Specimen Weight, g.	367.22
STRESS AT FAILURE, psi	**449**	Moisture Content, %	30.2
STRAIN AT FAILURE, %	**3.9**	Wet Unit Weight, pcf.	109.6
		Dry Unit Weight, pcf.	84.2
		Rate of Strain, in./min.	0.0580

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	6
0.20	15
0.30	23
0.50	33
0.75	48
0.99	66
1.24	90
1.49	116
1.74	156
1.99	216
2.24	277
2.49	317
2.74	352
2.98	398
3.23	424
3.48	439
3.73	447
3.85	449
3.98	435
4.23	40



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UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project LANL
Project No. 831775.00000000

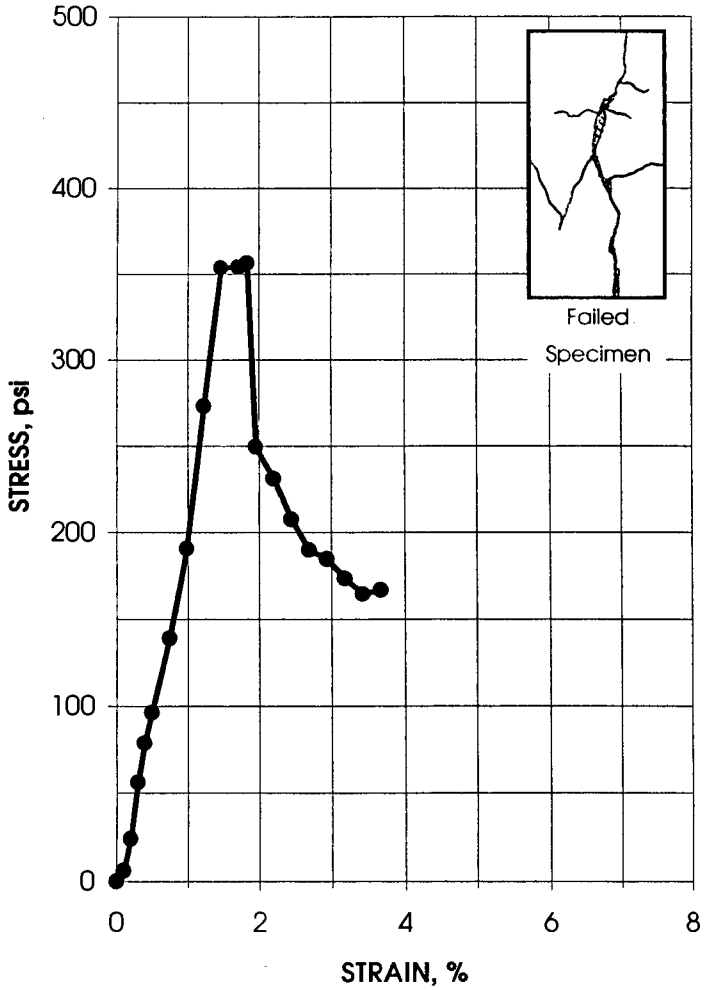
Client Sample No. 1108-28-01
IT Lab No. Soil Mix 6

Specimen Mold Date
Specimen Test Date 2/8/02

STRESS AT FAILURE, psi **356**
STRAIN AT FAILURE, % **1.8**

Specimen Height, in.	4.0867
Specimen Diameter, in.	2.0058
Specimen Weight, g.	374.18
Moisture Content, %	22.2
Wet Unit Weight, pcf.	110.4
Dry Unit Weight, pcf.	90.3
Rate of Strain, in./min.	0.0469

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	6
0.20	24
0.29	56
0.39	79
0.49	96
0.73	139
0.98	191
1.22	273
1.47	354
1.71	354
1.84	356
1.96	250
2.20	231
2.45	207
2.69	190
2.94	185
3.18	174
3.43	165
3.67	167



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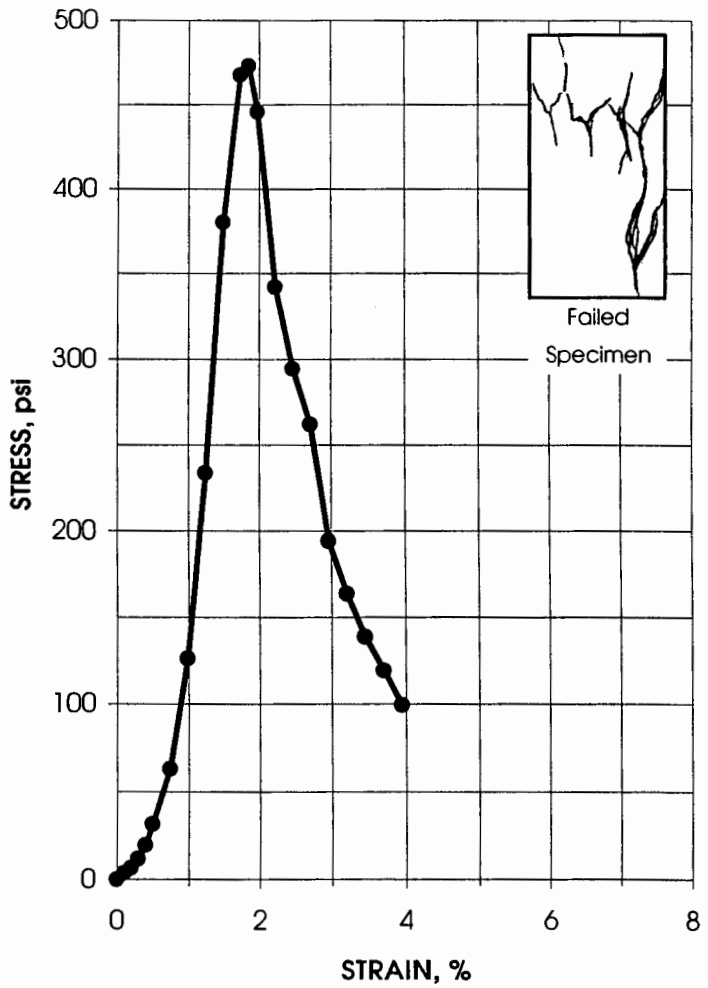
UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project	LANL	Client Sample No.	1108-29-01
Project No.	831775.00000000	IT Lab No.	Soil Mix 7

Specimen Mold Date		Specimen Height, in.	4.0533
Specimen Test Date	2/8/02	Specimen Diameter, in.	2.0133
		Specimen Weight, g.	365.98
STRESS AT FAILURE, psi	**473**	Moisture Content, %	25.6
STRAIN AT FAILURE, %	**1.9**	Wet Unit Weight, pcf.	108.1
		Dry Unit Weight, pcf.	86.0
		Rate of Strain, in./min.	0.0469

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	3
0.20	6
0.30	12
0.39	19
0.49	32
0.74	63
0.99	126
1.23	234
1.48	380
1.73	468
1.85	473
1.97	446
2.22	342
2.47	294
2.71	262
2.96	194
3.21	164
3.45	139
3.70	119
3.95	100



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UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project LANL
Project No. 831775.00000000

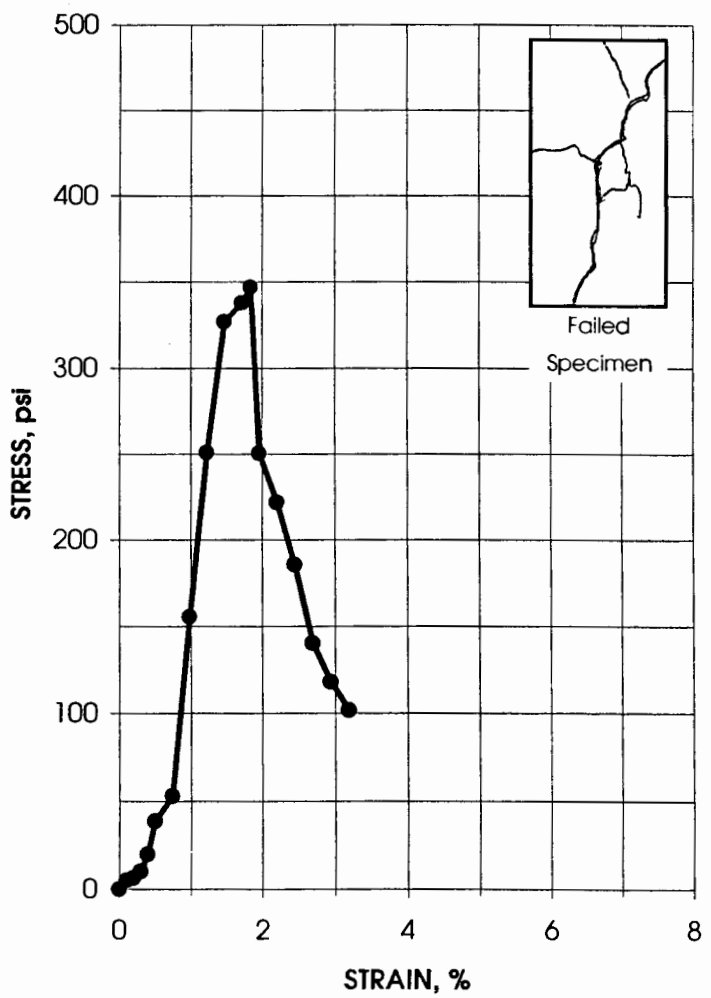
Client Sample No. 1108-30-02
IT Lab No. Soil Mix 8

Specimen Mold Date
Specimen Test Date 2/8/02

STRESS AT FAILURE, psi **347**
STRAIN AT FAILURE, % **1.8**

Specimen Height, in.	4.0807
Specimen Diameter, in.	2.0145
Specimen Weight, g.	373.80
Moisture Content, %	26.1
Wet Unit Weight, pcf.	109.5
Dry Unit Weight, pcf.	86.8
Rate of Strain, in./min.	0.0600

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	5
0.20	6
0.29	10
0.39	20
0.49	39
0.74	53
0.98	156
1.23	251
1.47	327
1.72	338
1.84	347
1.96	251
2.21	222
2.45	186
2.70	140
2.94	118
3.19	102



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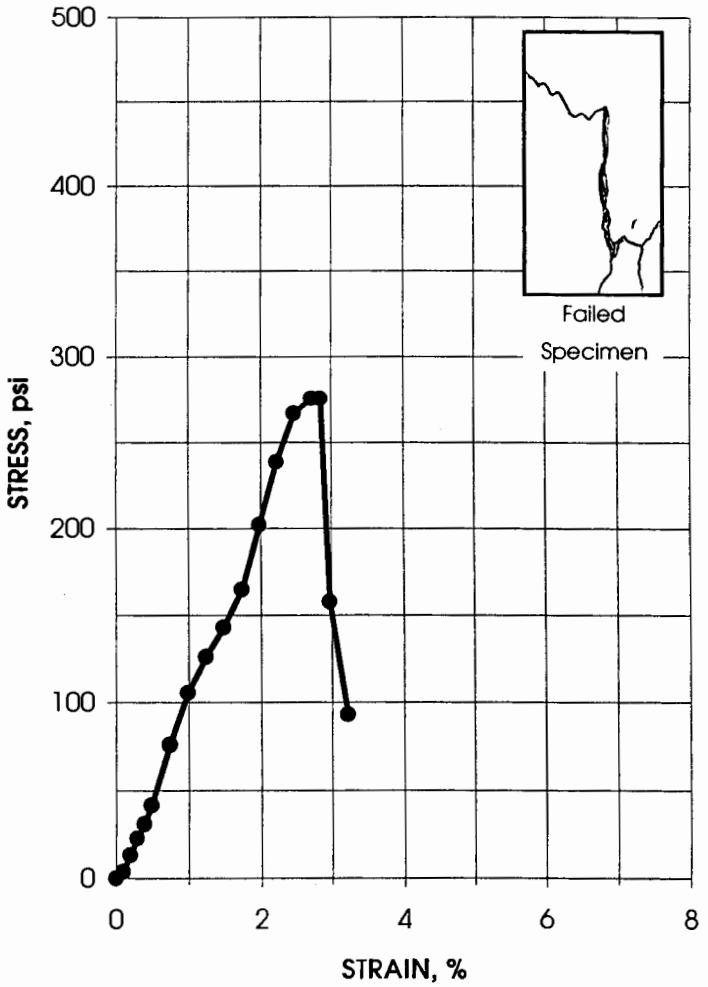
UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project	LANL	Client Sample No.	1108-32-02
Project No.	831775.00000000	IT Lab No.	Tuff/Sed Mix 1

Specimen Mold Date	1/24/02	Specimen Height, in.	4.0383
Specimen Test Date	2/21/02	Specimen Diameter, in.	2.0112
		Specimen Weight, g.	391.97
STRESS AT FAILURE, psi	**276**	Moisture Content, %	23.0
STRAIN AT FAILURE, %	**2.7**	Wet Unit Weight, pcf.	116.4
		Dry Unit Weight, pcf.	94.7
		Rate of Strain, in./min.	0.0796

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	4
0.20	13
0.30	23
0.40	31
0.50	42
0.74	76
0.99	106
1.24	126
1.49	143
1.73	165
1.98	202
2.23	239
2.48	267
2.72	276
2.85	276
2.97	158
3.22	93



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UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

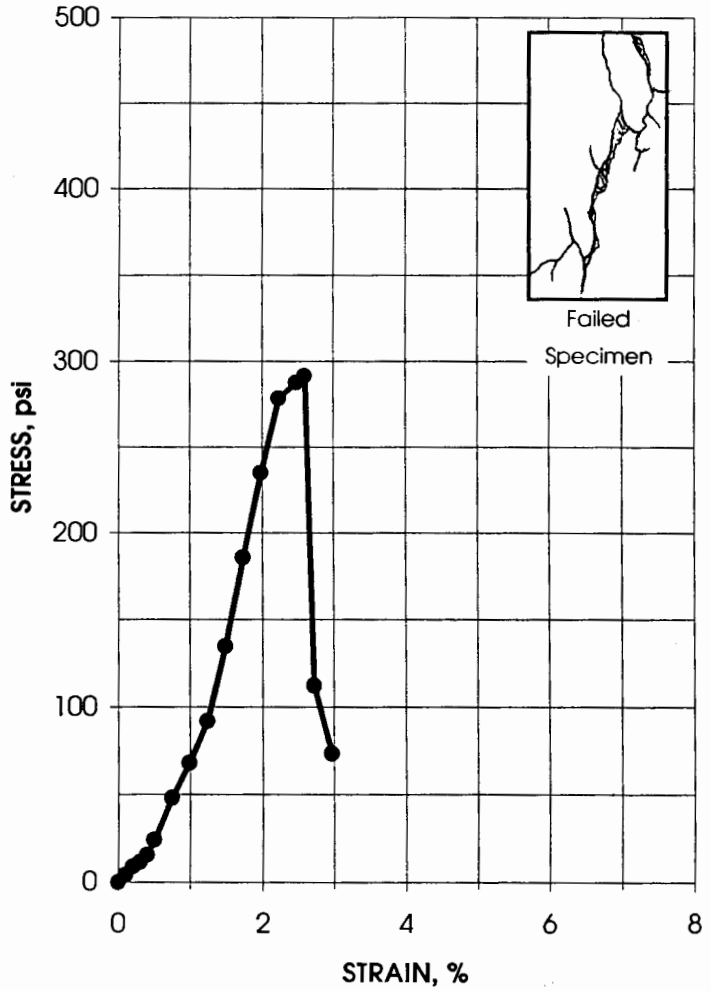
Project LANL
Project No. 831775.00000000

Client Sample No. 1108-33-02
IT Lab No. Tuff/Sed Mix 2

Specimen Mold Date	1/24/02
Specimen Test Date	2/21/02
STRESS AT FAILURE, psi	**291**
STRAIN AT FAILURE, %	**2.6**

Specimen Height, in.	4.0353
Specimen Diameter, in.	2.0087
Specimen Weight, g.	380.96
Moisture Content, %	24.7
Wet Unit Weight, pcf.	113.5
Dry Unit Weight, pcf.	91.0
Rate of Strain, in./min.	0.0735

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	4
0.20	9
0.30	11
0.40	15
0.50	24
0.74	48
0.99	68
1.24	92
1.49	135
1.73	186
1.98	235
2.23	278
2.48	287
2.60	291
2.73	112
2.97	73



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UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

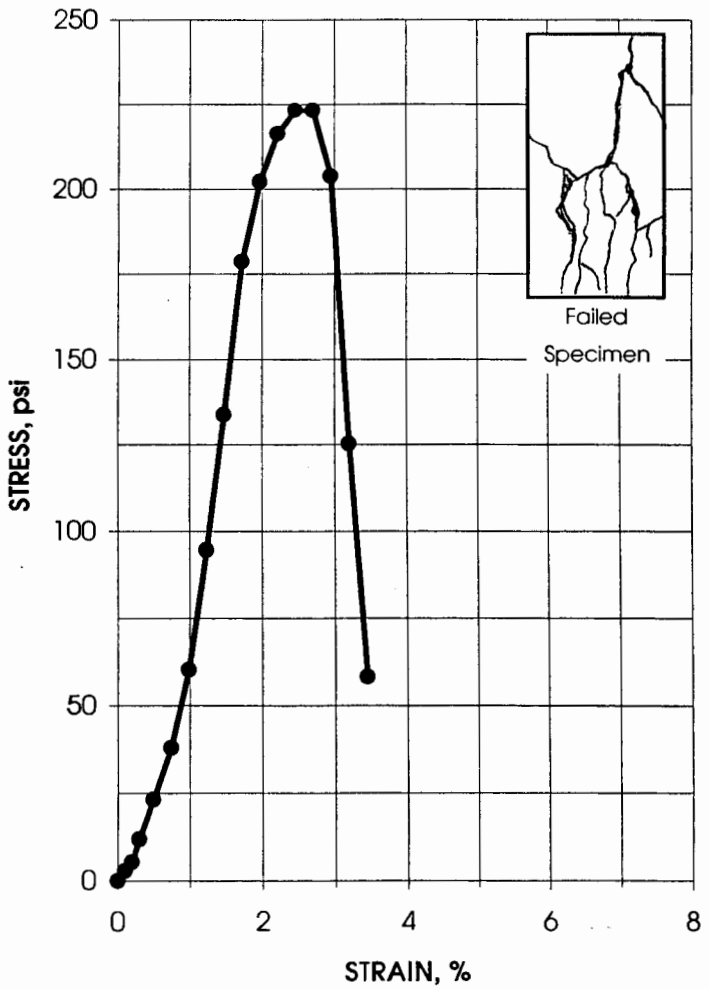
Project LANL
Project No. 831775.00000000

Client Sample No. 1108-34-02
IT Lab No. Tuff/Sed Mix 3

Specimen Mold Date	1/24/02
Specimen Test Date	2/21/02
STRESS AT FAILURE, psi	**223**
STRAIN AT FAILURE, %	**2.7**

Specimen Height, in.	4.0658
Specimen Diameter, in.	2.0127
Specimen Weight, g.	381.48
Moisture Content, %	25.2
Wet Unit Weight, pcf.	112.4
Dry Unit Weight, pcf.	89.8
Rate of Strain, in./min.	0.0735

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	3
0.20	5
0.30	12
0.49	23
0.74	38
0.98	60
1.23	95
1.48	134
1.72	179
1.97	202
2.21	216
2.46	223
2.71	223
2.95	204
3.20	125
3.44	58



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UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

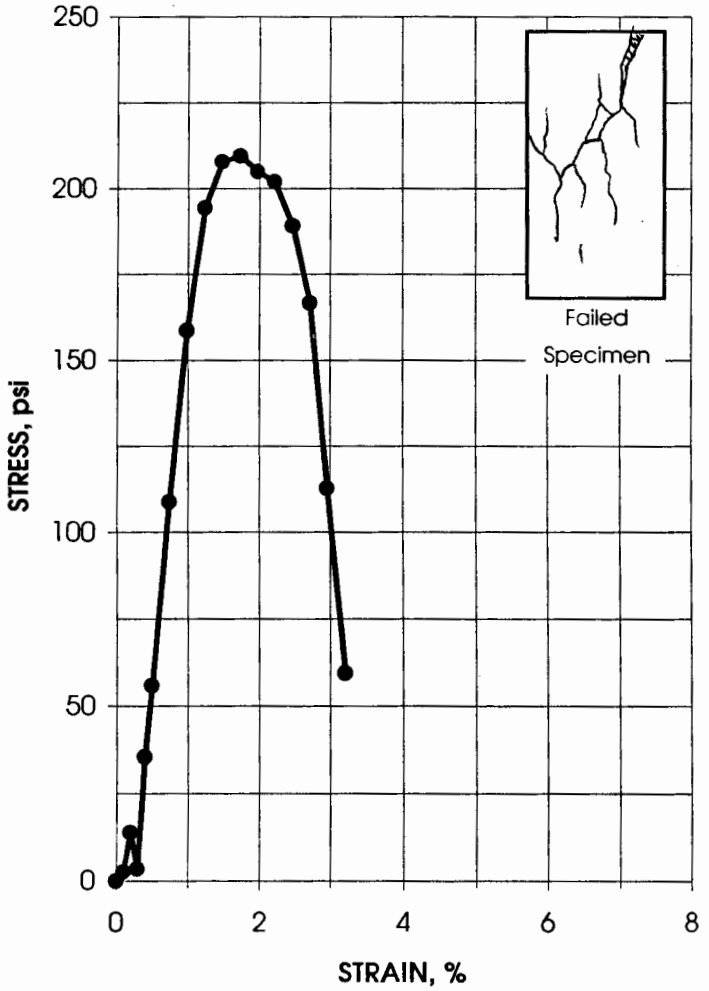
Project LANL
Project No. 831775.00000000

Client Sample No. 1108-35-02
IT Lab No. Tuff/Sed Mix 4

Specimen Mold Date	1/24/02
Specimen Test Date	2/21/02
STRESS AT FAILURE, psi	**209**
STRAIN AT FAILURE, %	**1.7**

Specimen Height, in.	4.0535
Specimen Diameter, in.	2.0095
Specimen Weight, g.	375.39
Moisture Content, %	27.8
Wet Unit Weight, pcf.	111.3
Dry Unit Weight, pcf.	87.1
Rate of Strain, in./min.	0.0867

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	3
0.20	14
0.30	3
0.39	35
0.49	56
0.74	109
0.99	159
1.23	194
1.48	208
1.73	209
1.97	205
2.22	202
2.47	189
2.71	167
2.96	113
3.21	60



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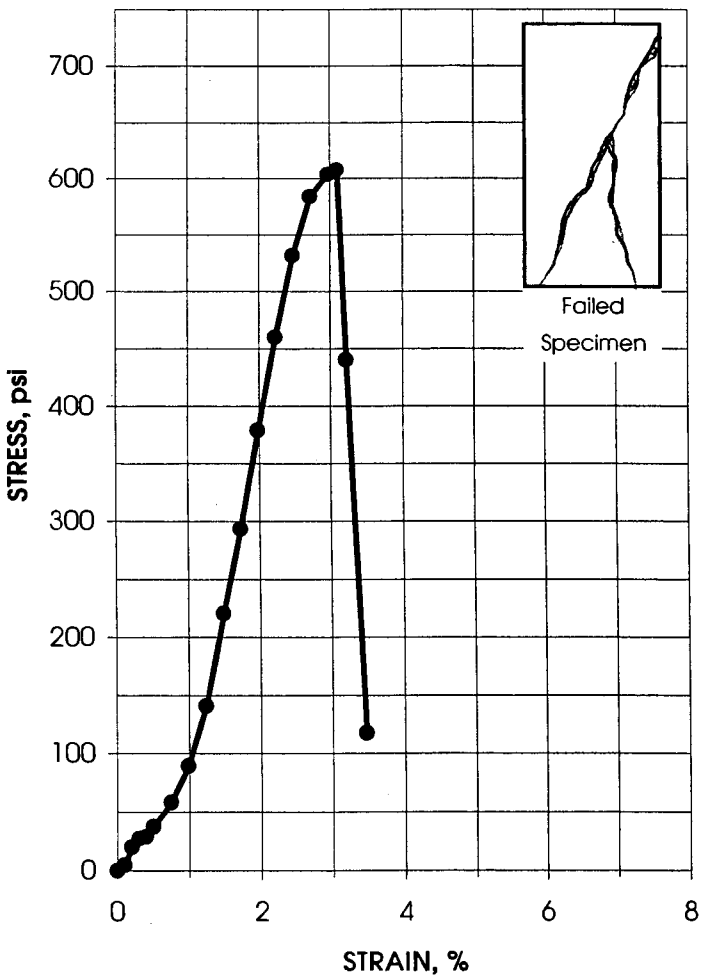
UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project	LANL	Client Sample No.	1108-36-02
Project No.	831775.00000000	IT Lab No.	Tuff/Sed Mix 5

Specimen Mold Date	1/24/02	Specimen Height, in.	4.0347
Specimen Test Date	2/21/02	Specimen Diameter, in.	2.0142
		Specimen Weight, g.	
STRESS AT FAILURE, psi	**607**	Moisture Content, %	25.0
STRAIN AT FAILURE, %	**3.1**	Wet Unit Weight, pcf.	
		Dry Unit Weight, pcf.	0.0
		Rate of Strain, in./min.	0.0730

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	5
0.20	20
0.30	27
0.40	29
0.50	37
0.74	58
0.99	89
1.24	141
1.49	220
1.73	293
1.98	379
2.23	460
2.48	532
2.73	584
2.97	604
3.10	607
3.22	440
3.47	118



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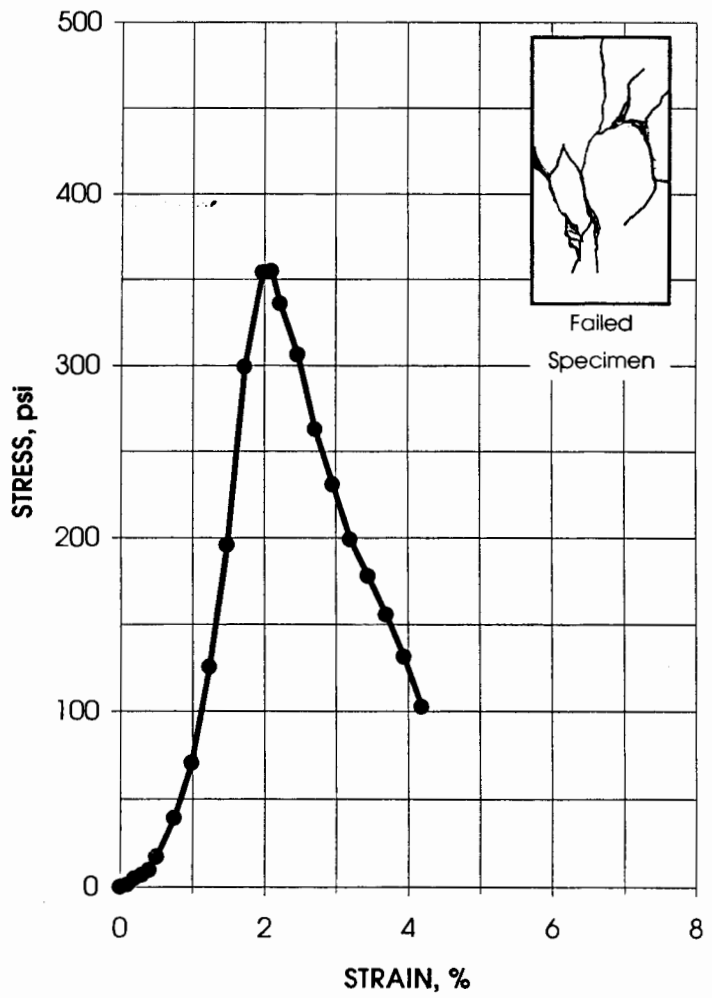
UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

Project	LANL	Client Sample No.	1108-37-02
Project No.	831775.00000000	IT Lab No.	Tuff/Sed Mix 6

Specimen Mold Date	1/24/02	Specimen Height, in.	4.0575
Specimen Test Date	2/21/02	Specimen Diameter, in.	2.0045
		Specimen Weight, g.	371.45
STRESS AT FAILURE, psi	**355**	Moisture Content, %	25.2
STRAIN AT FAILURE, %	**2.1**	Wet Unit Weight, pcf.	110.5
		Dry Unit Weight, pcf.	88.3
		Rate of Strain, in./min.	0.0729

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	1
0.20	5
0.30	7
0.39	9
0.49	17
0.74	39
0.99	71
1.23	126
1.48	196
1.73	299
1.97	354
2.09	355
2.22	336
2.46	306
2.71	263
2.96	231
3.20	199
3.45	178
3.70	156
3.94	131
4.19	103



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UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

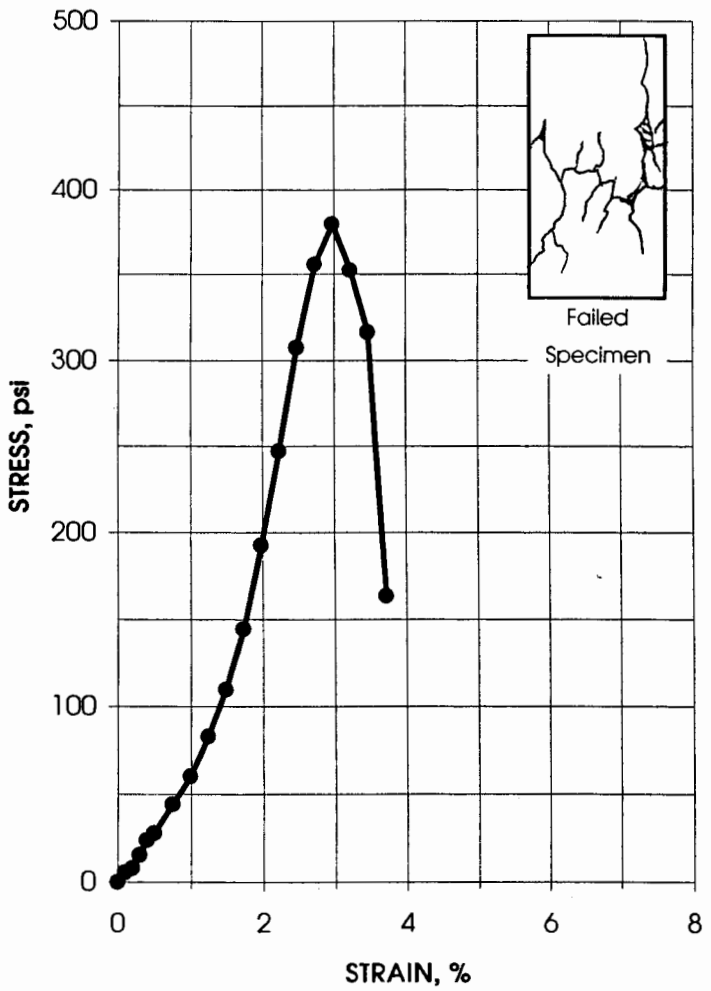
Project LANL
Project No. 831775.00000000

Client Sample No. 1108-38-02
IT Lab No. Tuff/Sed Mix 7

Specimen Mold Date	1/24/02
Specimen Test Date	2/21/02
STRESS AT FAILURE, psi	**380**
STRAIN AT FAILURE, %	**3.0**

Specimen Height, in.	4.0348
Specimen Diameter, in.	2.0150
Specimen Weight, g.	368.21
Moisture Content, %	26.0
Wet Unit Weight, pcf.	109.0
Dry Unit Weight, pcf.	86.5
Rate of Strain, in./min.	0.0700

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	5
0.20	8
0.30	15
0.40	24
0.50	28
0.74	44
0.99	60
1.24	83
1.49	110
1.73	145
1.98	193
2.23	247
2.48	307
2.73	356
2.97	380
3.22	352
3.47	316
3.72	164



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UNCONFINED COMPRESSIVE STRENGTH - ASTM D 2166
28-DAY CURE

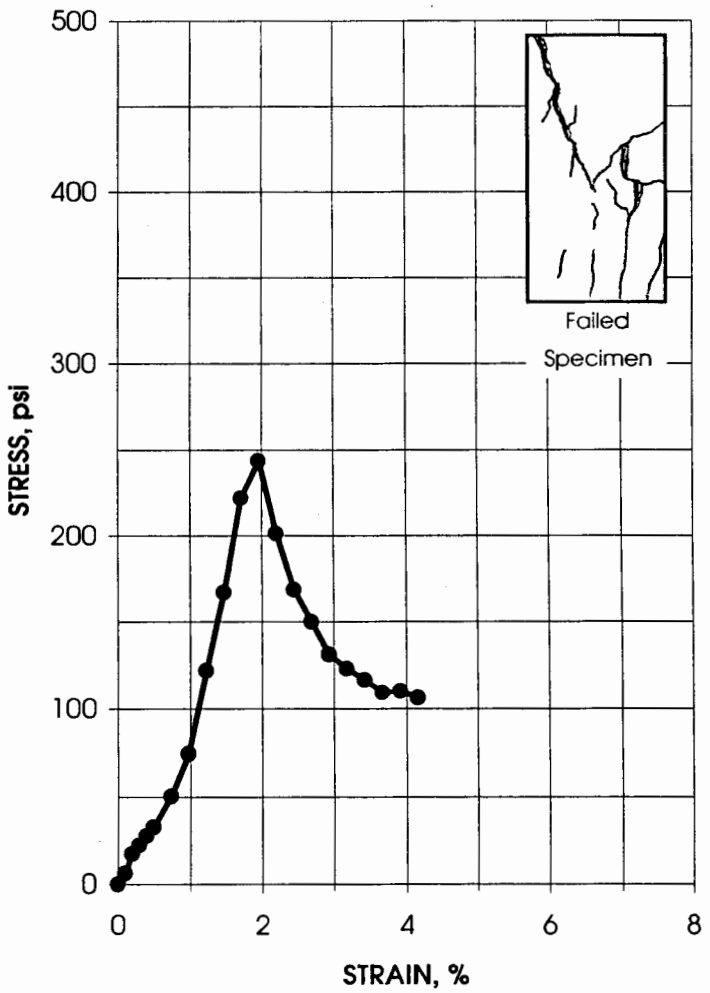
Project LANL
Project No. 831775.00000000

Client Sample No. 1108-39-02
IT Lab No. Tuff/Sed Mix 8

Specimen Mold Date	1/24/02
Specimen Test Date	2/21/02
STRESS AT FAILURE, psi	**244**
STRAIN AT FAILURE, %	**2.0**

Specimen Height, in.	4.0860
Specimen Diameter, in.	2.0225
Specimen Weight, g.	362.49
Moisture Content, %	29.0
Wet Unit Weight, pcf.	105.2
Dry Unit Weight, pcf.	81.5
Rate of Strain, in./min.	0.0944

AXIAL STRAIN, %	DEVIATOR STRESS, psi
0	0
0.10	6
0.20	17
0.29	22
0.39	28
0.49	33
0.73	50
0.98	75
1.22	122
1.47	167
1.71	221
1.96	244
2.20	201
2.45	169
2.69	150
2.94	131
3.18	123
3.43	117
3.67	109
3.92	110
4.16	106



Hydraulic Conductivity Tests

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HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

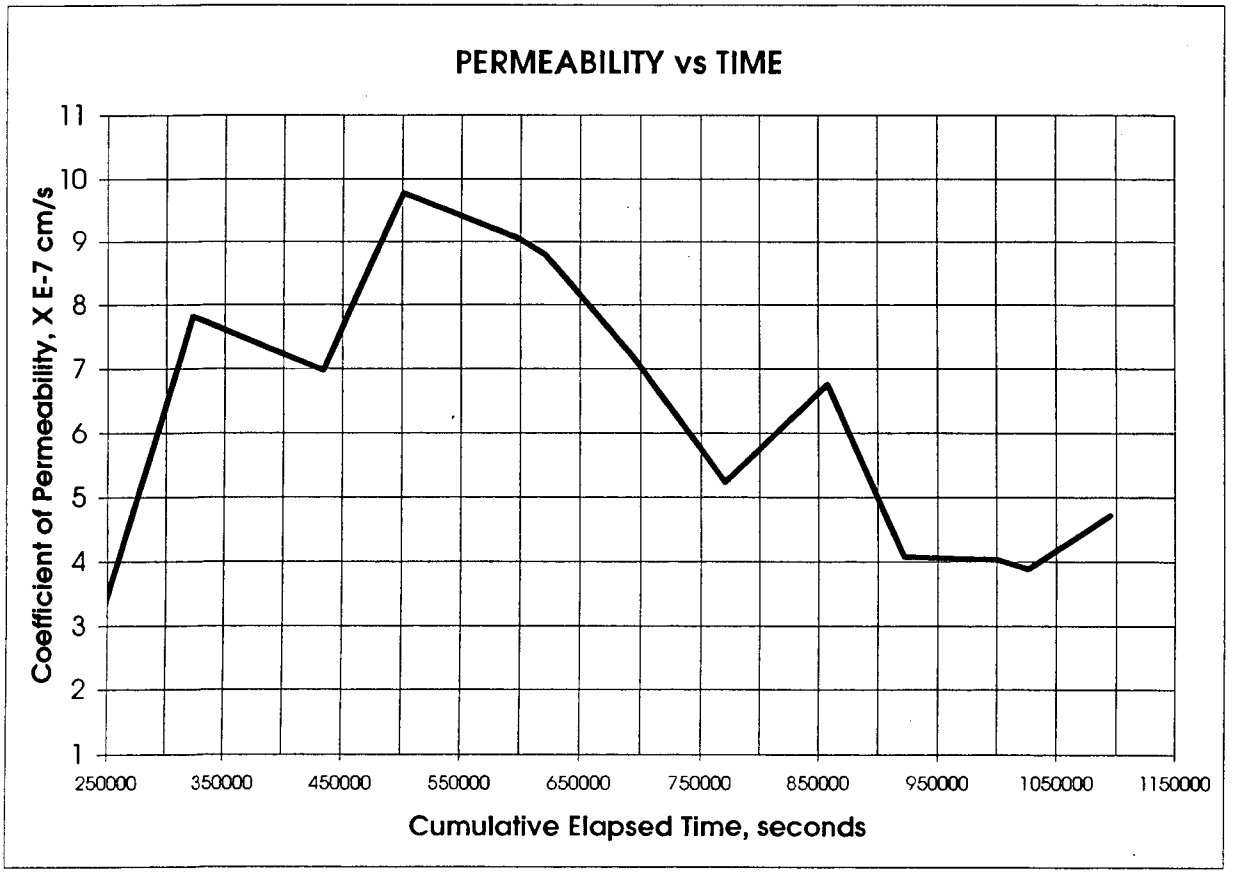
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-06-03
IT LAB SAMPLE NO. Sediment Mix 1

	INITIAL	FINAL
Specimen diameter, cm	5.15	
Specimen length, cm	10.17	
Wet weight of specimen, g.	384.15	395.1
Specimen cross-sect. area, cm	20.8706	
Water content, %	21.6	25.0
Wet unit weight, pcf	113.0	
Dry unit weight, pcf	92.9	
Estimated degree of saturatior	73.3	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	6.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	4.0
Total backpressure, psi	6.0
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 4.2E-07



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HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

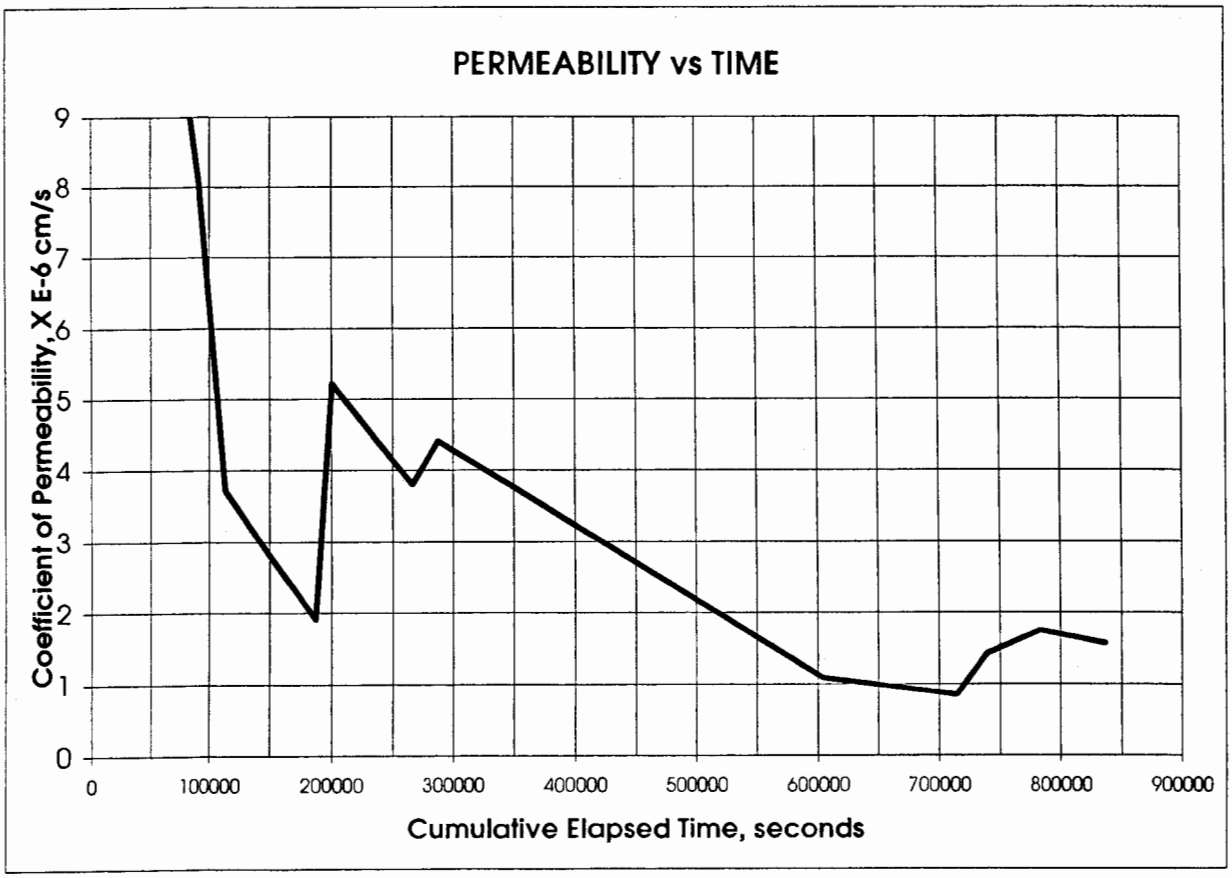
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-07-03
IT LAB SAMPLE NO. Sediment Mix 2

	INITIAL	FINAL
Specimen diameter, cm	5.11	
Specimen length, cm	10.28	
Wet weight of specimen, g.	343.28	382.1
Specimen cross-sect. area, cm	20.5089	
Water content, %	16.3	29.4
Wet unit weight, pcf	101.7	
Dry unit weight, pcf	87.4	
Estimated degree of saturatior	48.4	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	1.4
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	3.5
Total backpressure, psi	4.5
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 1.4E-06



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IT Project No.: 831775.00000000

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HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

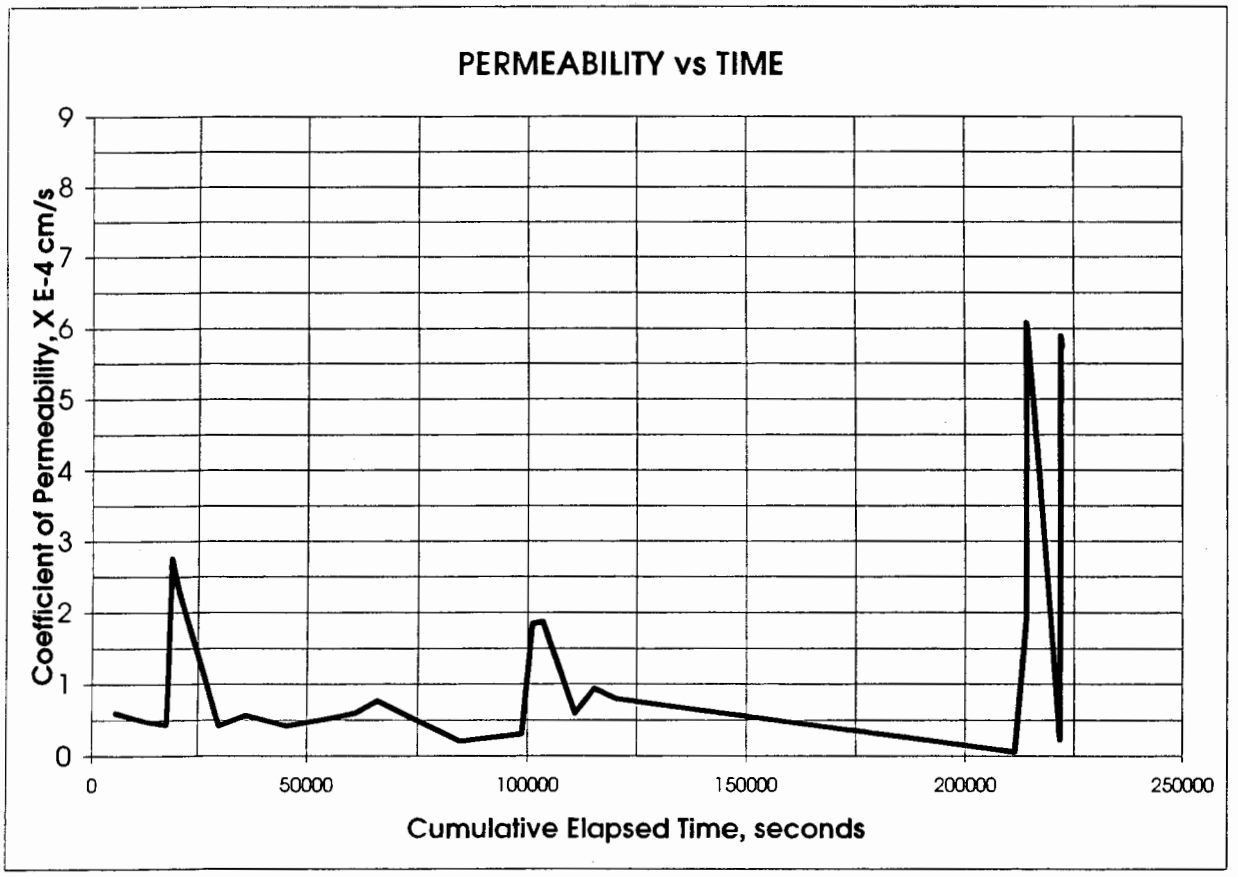
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-08-08
IT LAB SAMPLE NO. Sediment Mix 3

	INITIAL	FINAL
Specimen diameter, cm	5.11	
Specimen length, cm	6.07	
Wet weight of specimen, g.	197.7	221.78
Specimen cross-sect. area, cm	20.5224	
Water content, %	19.5	34.1
Wet unit weight, pcf	99.0	
Dry unit weight, pcf	82.8	
Estimated degree of saturatior	51.9	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	2.3
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	2.2
Total backpressure, psi	6.8
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 4.5E-04



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ASTM D 5084

PROJECT NAME: LANL
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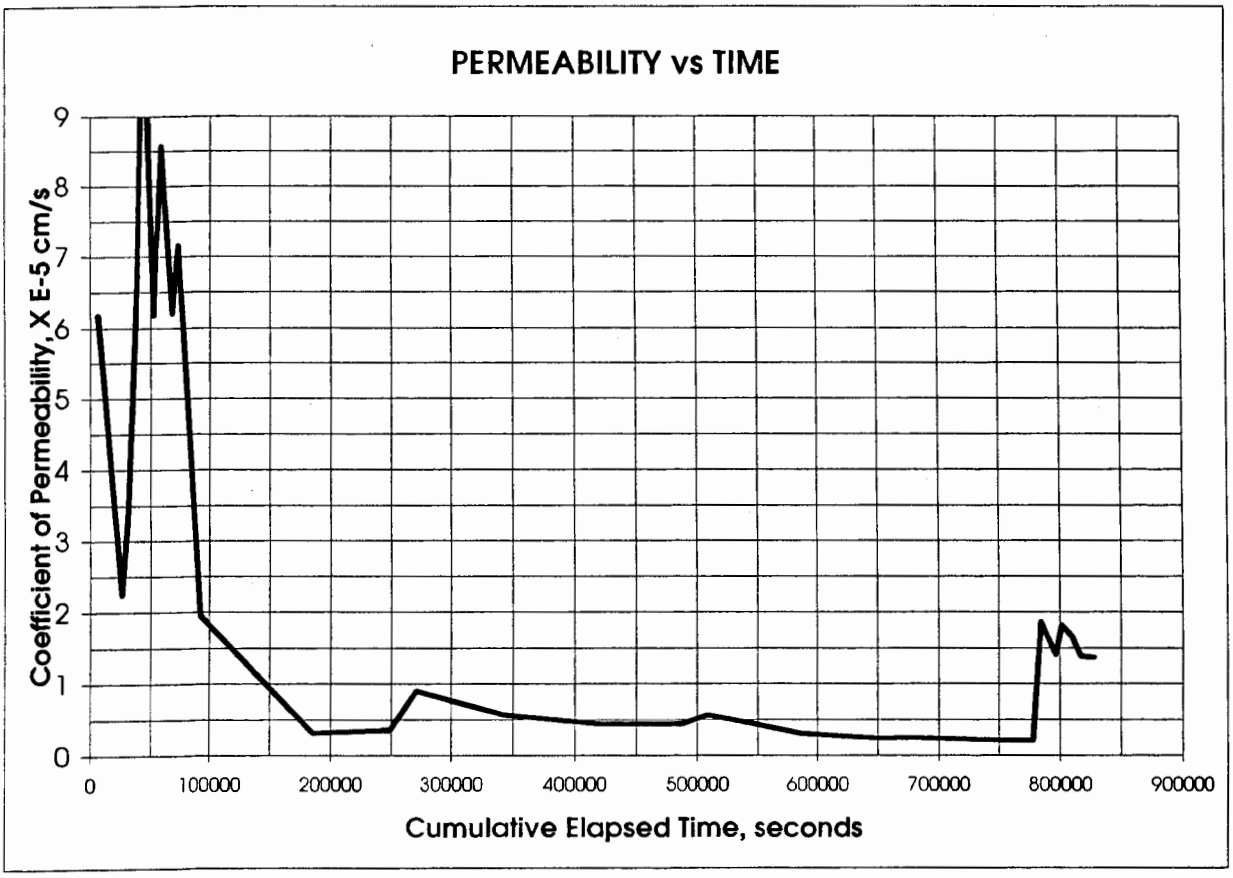
CLIENT SAMPLE NO. 1108-09-03
IT LAB SAMPLE NO. Sed Mix 4

	INITIAL	FINAL
Specimen diameter, cm	5.11	
Specimen length, cm	10.29	
Wet weight of specimen, g.	331	374.23
Specimen cross-sect. area, cm	20.4953	
Water content, %	19.0	34.6
Wet unit weight, pcf	98.0	
Dry unit weight, pcf	82.3	
Estimated degree of saturatior	49.9	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	2.1
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	3.0
Total backpressure, psi	6.0
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 1.6E-05



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ASTM D 5084

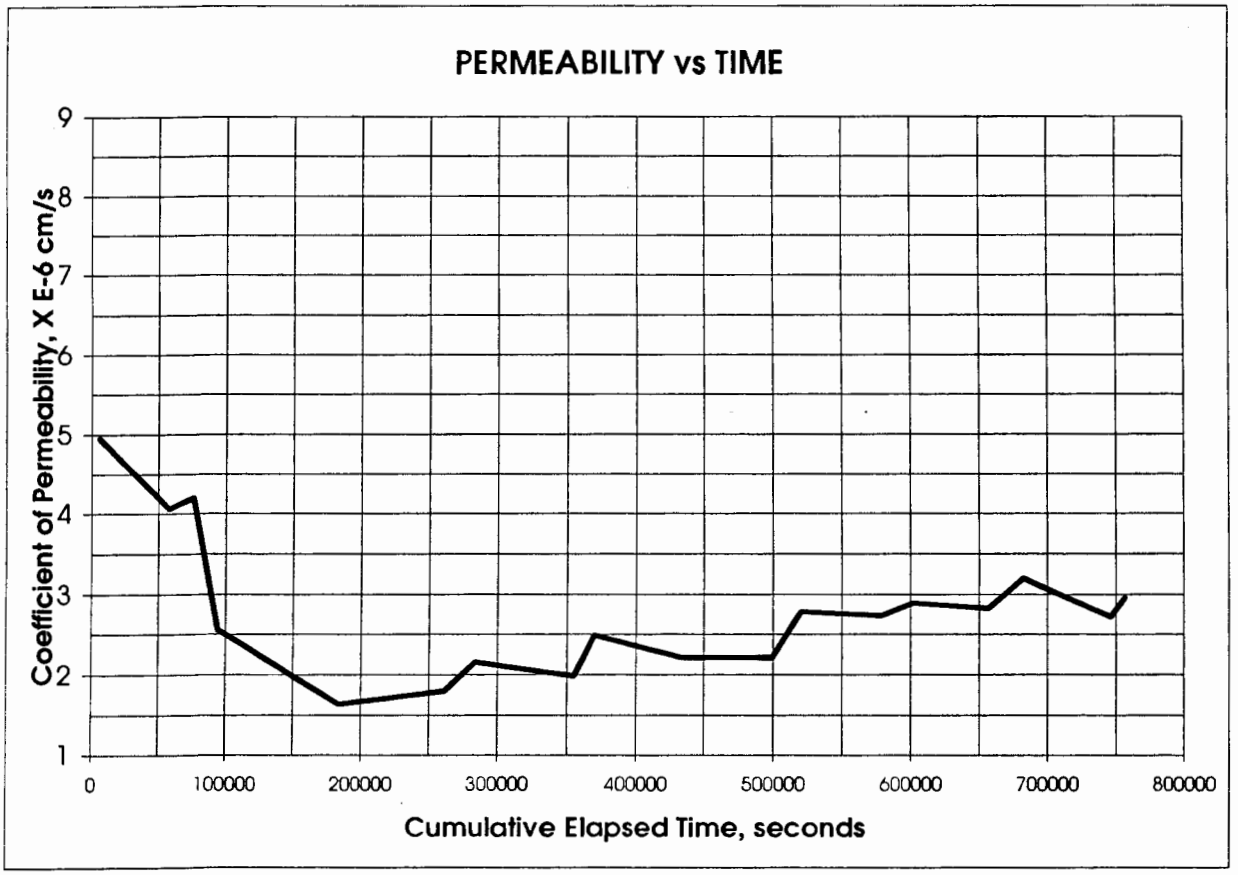
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-10-03
IT LAB SAMPLE NO. Sediment Mix 5

	INITIAL	FINAL
Specimen diameter, cm	5.11	
Specimen length, cm	10.20	
Wet weight of specimen, g.	376.11	384.13
Specimen cross-sect. area, cm	20.5021	
Water content, %	28.3	31.1
Wet unit weight, pcf	112.3	
Dry unit weight, pcf	87.5	
Estimated degree of saturatior	84.3	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	6.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	3.0
Total backpressure, psi	5.0
Permeant Fluid	Dealred DI Water

Coefficient of Permeability, cm/s 2.9E-06



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ASTM D 5084

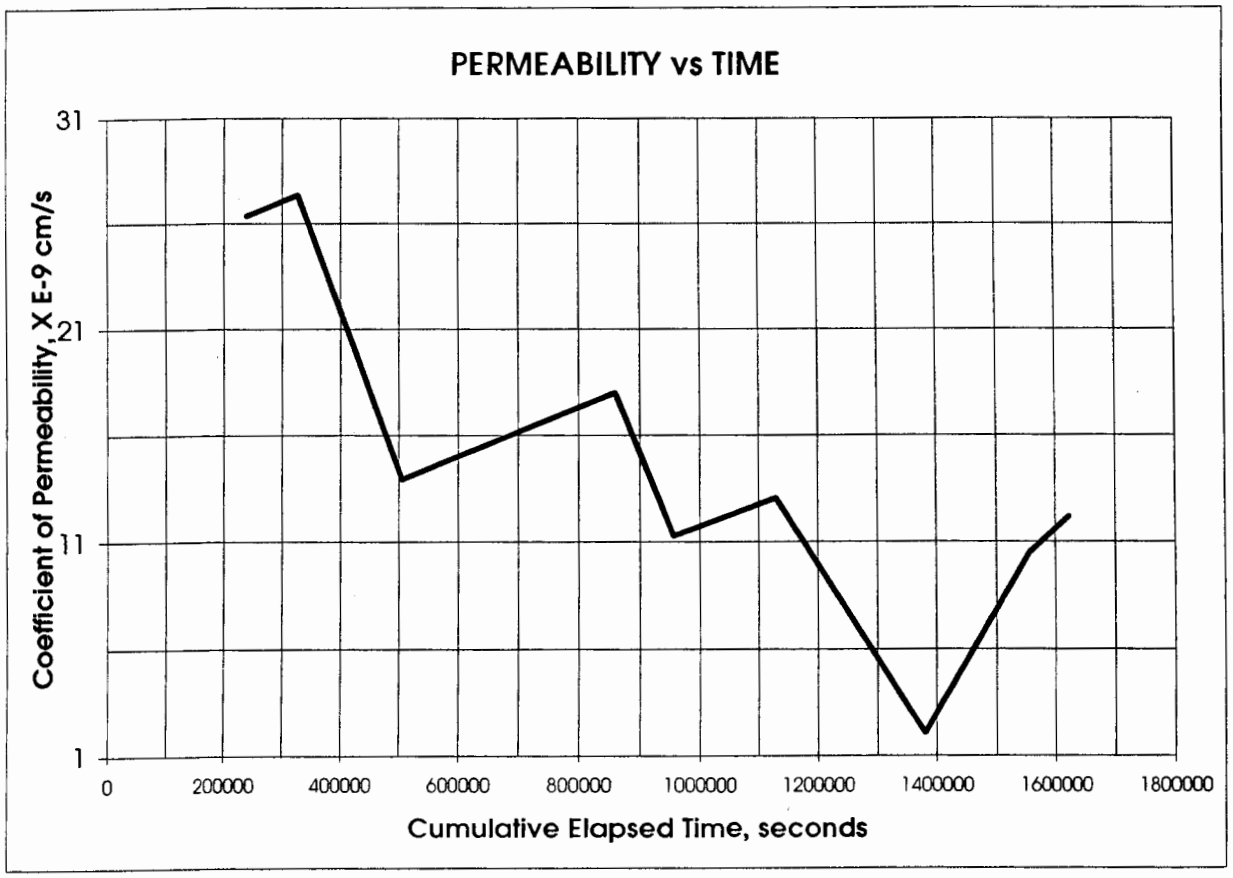
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-11-03
IT LAB SAMPLE NO. Sediment Mix 6

	INITIAL	FINAL
Specimen diameter, cm	5.11	
Specimen length, cm	10.28	
Wet weight of specimen, g.	389.59	397.84
Specimen cross-sect. area, cm	20.5394	
Water content, %	22.8	25.4
Wet unit weight, pcf	115.2	
Dry unit weight, pcf	93.8	
Estimated degree of saturatior	79.2	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	13.7
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	6.5
Total backpressure, psi	5.5
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 9.4E-09



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ASTM D 5084

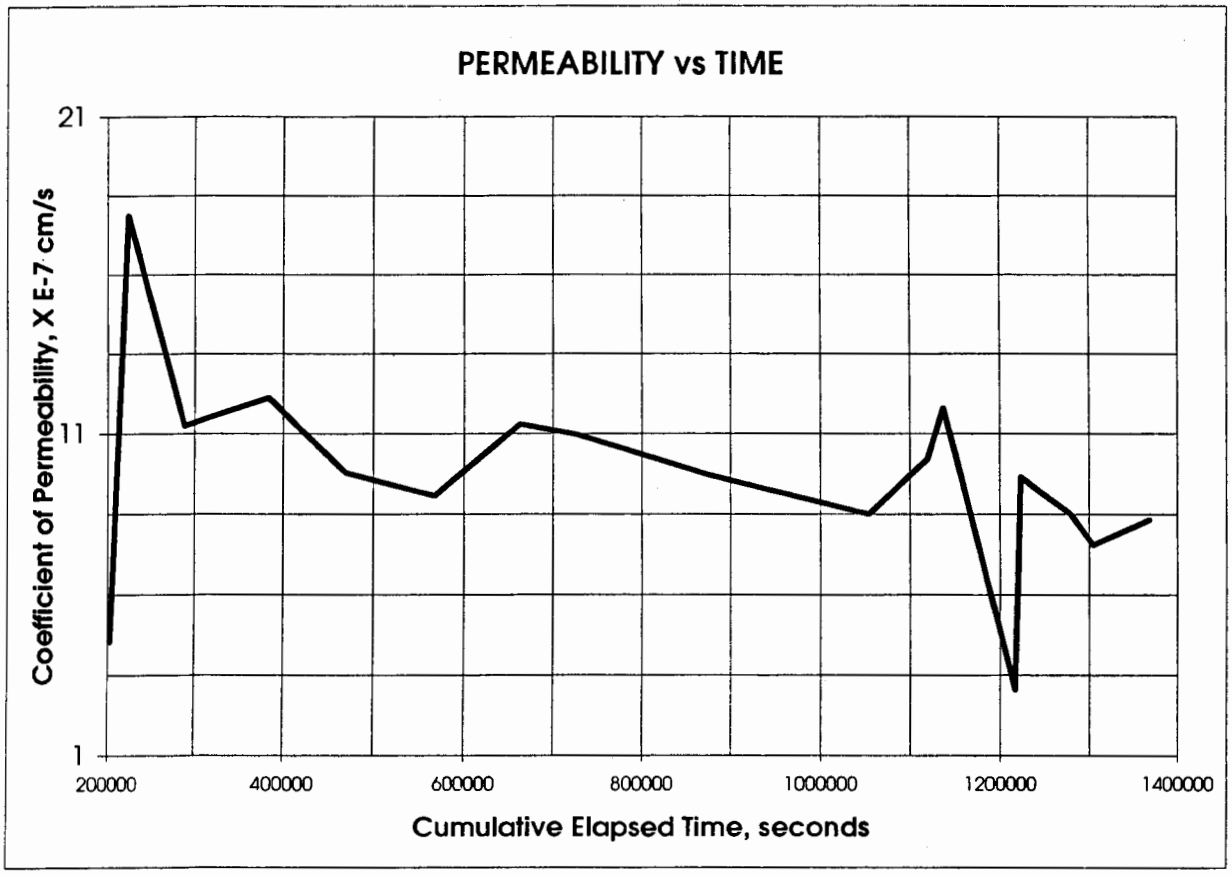
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-12-03
IT LAB SAMPLE NO. Sediment Mix 7

	INITIAL	FINAL
Specimen diameter, cm	5.11	
Specimen length, cm	10.24	
Wet weight of specimen, g.	366.72	378.52
Specimen cross-sect. area, cm	20.4987	
Water content, %	25.8	29.8
Wet unit weight, pcf	109.0	
Dry unit weight, pcf	86.7	
Estimated degree of saturatior	75.2	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	6.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	4.0
Total backpressure, psi	4.5
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 8.5E-07



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ASTM D 5084

PROJECT NAME: LANL
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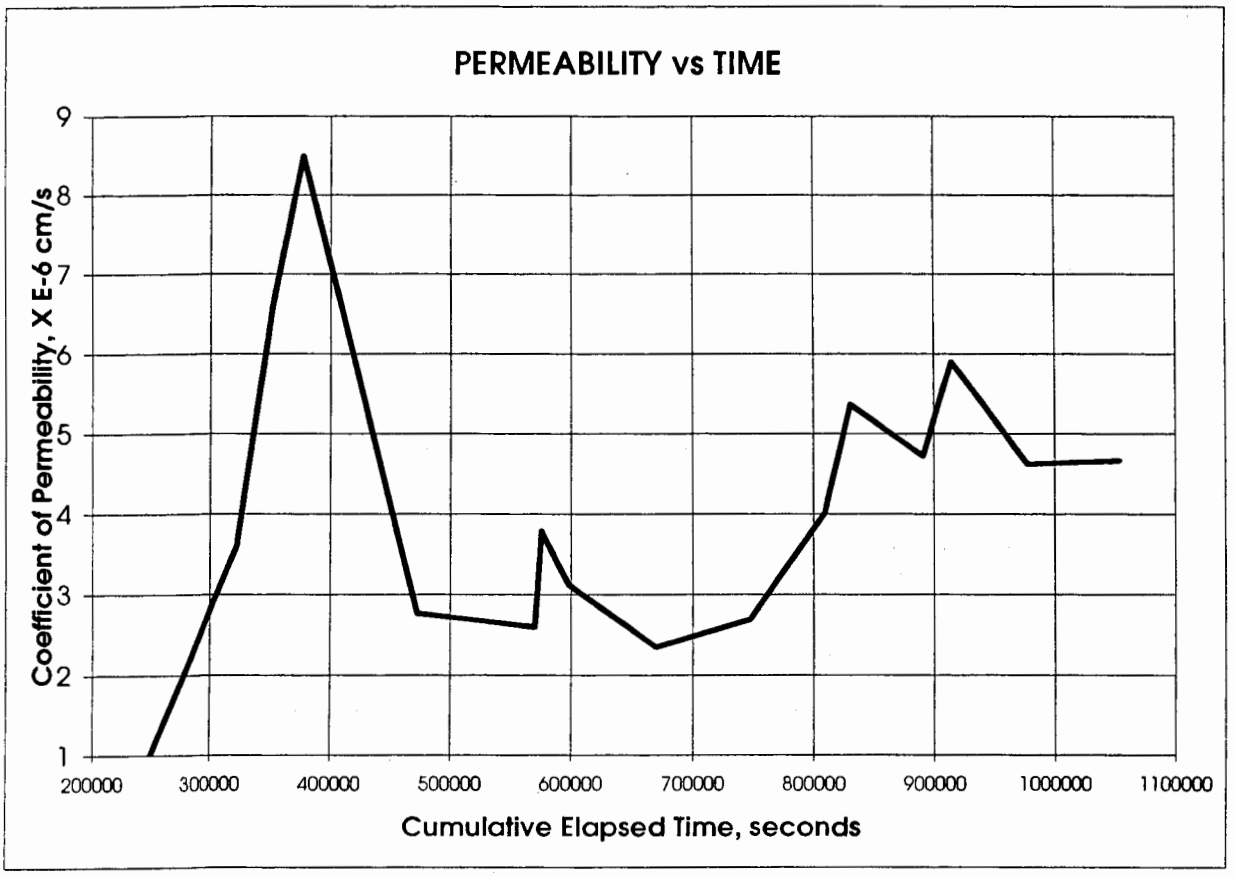
CLIENT SAMPLE NO. 1108-13-03
IT LAB SAMPLE NO. Sediment Mix 8

	INITIAL	FINAL
Specimen diameter, cm	5.12	
Specimen length, cm	10.33	
Wet weight of specimen, g.	377.76	383.5
Specimen cross-sect. area, cm	20.6041	
Water content, %	28.9	30.8
Wet unit weight, pcf	110.8	
Dry unit weight, pcf	85.9	
Estimated degree of saturatior	82.7	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	3.4
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	2.5
Total backpressure, psi	4.5
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 5.0E-06



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PROJECT NAME: LANL
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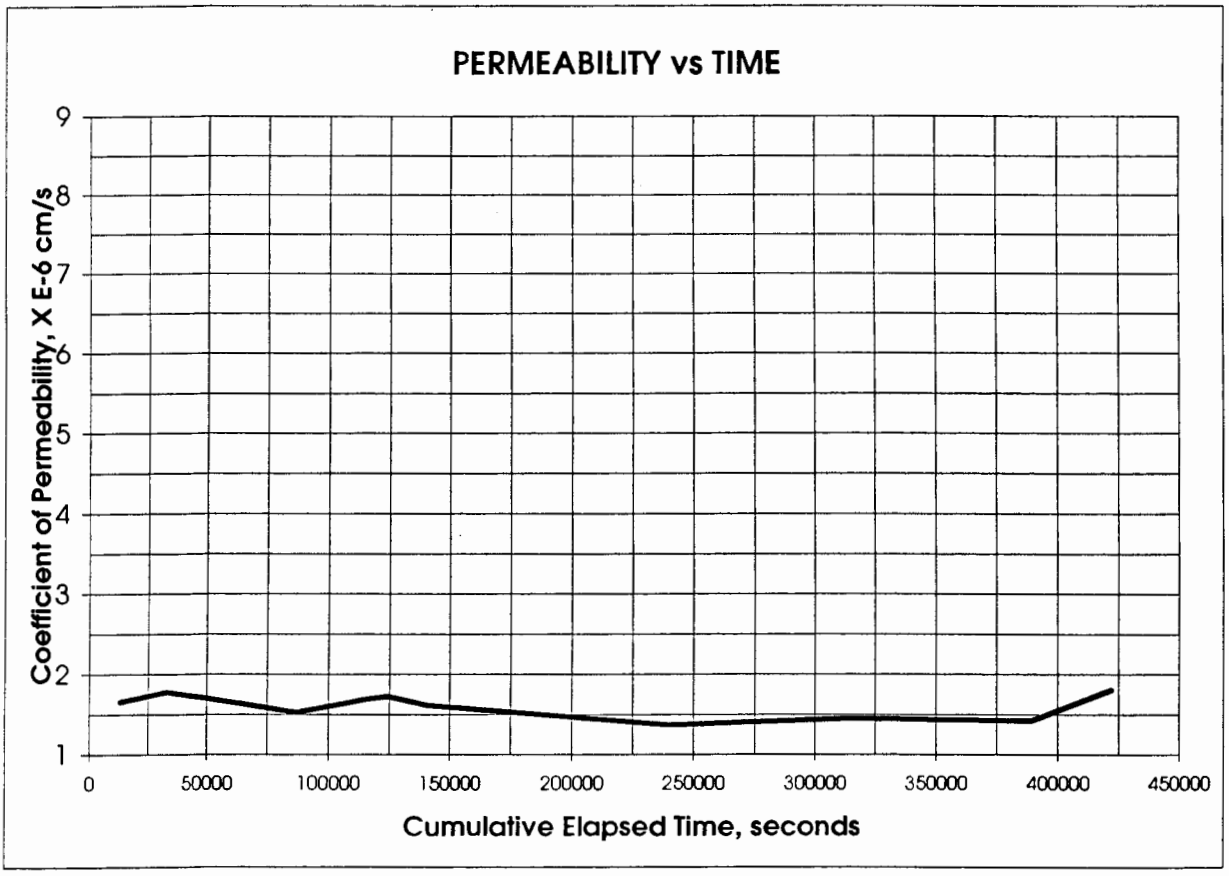
CLIENT SAMPLE NO. 1108-23-02
IT LAB SAMPLE NO. Soil Mix 1

	INITIAL	FINAL
Specimen diameter, cm	5.10	
Specimen length, cm	10.18	
Wet weight of specimen, g.	369.42	383.11
Specimen cross-sect. area, cm	20.4172	
Water content, %	20.9	25.4
Wet unit weight, pcf	111.0	
Dry unit weight, pcf	91.8	
Estimated degree of saturatior	69.1	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	6.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	3.0
Total backpressure, psi	5.0
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 1.5E-06



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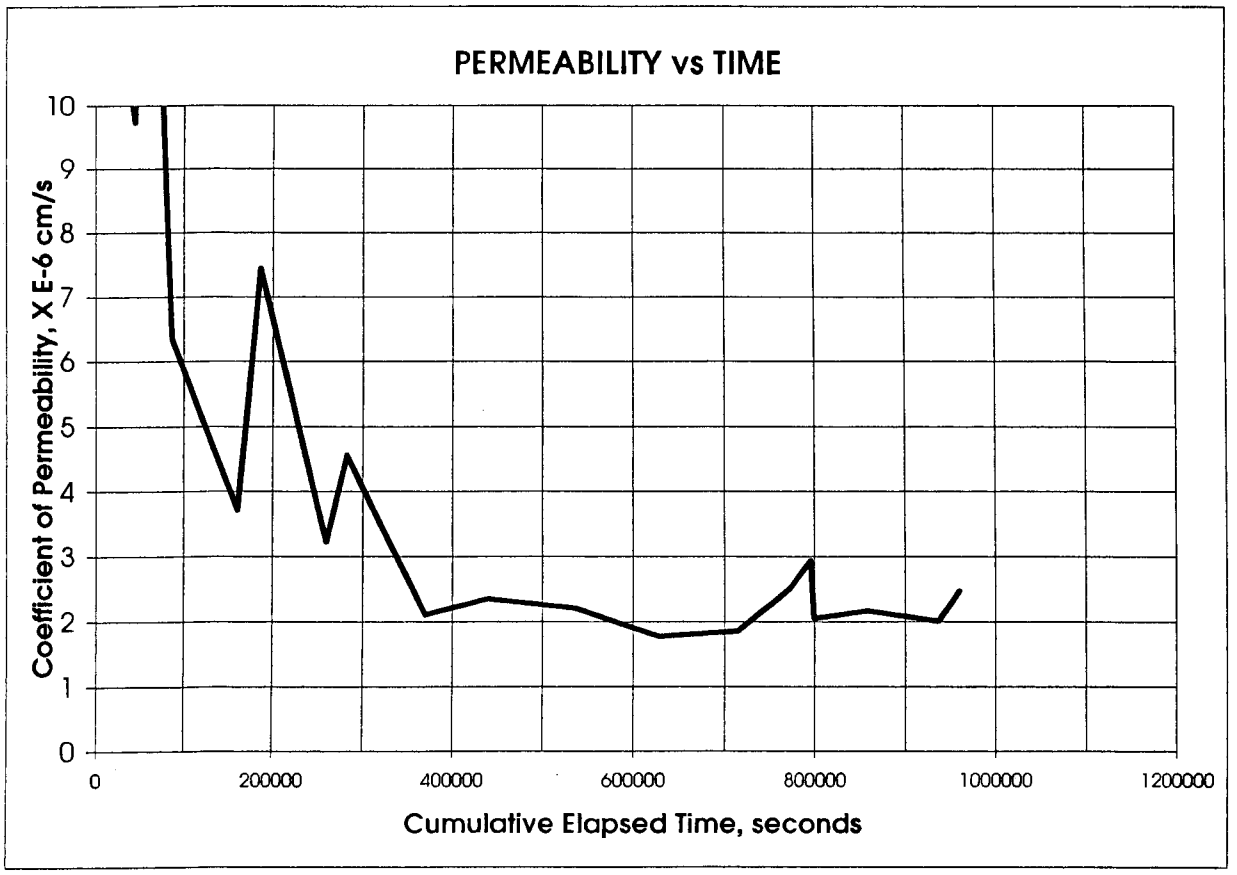
CLIENT SAMPLE NO. 1108-24-03
IT LAB SAMPLE NO. Soil Mix 2

	INITIAL	FINAL
Specimen diameter, cm	5.12	
Specimen length, cm	10.22	
Wet weight of specimen, g.	374.41	379.58
Specimen cross-sect. area, cm	20.6007	
Water content, %	26.4	28.2
Wet unit weight, pcf	111.0	
Dry unit weight, pcf	87.8	
Estimated degree of saturatior	79.2	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	3.4
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	3.0
Total backpressure, psi	5.5
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 2.2E-06



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PROJECT NAME: LANL
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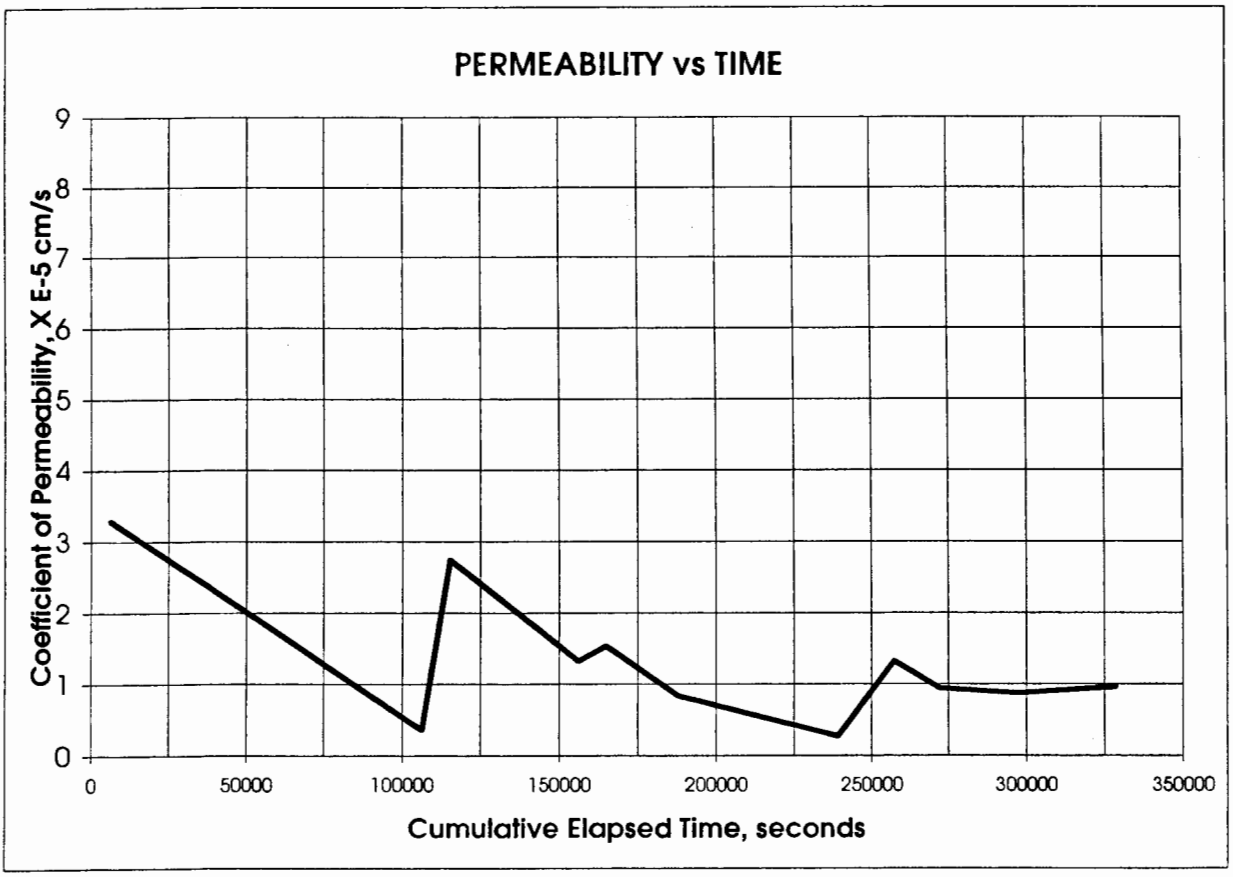
CLIENT SAMPLE NO. 1108-25-01
IT LAB SAMPLE NO. Soil Mix 3

	INITIAL	FINAL
Specimen diameter, cm	5.11	
Specimen length, cm	10.29	
Wet weight of specimen, g.	378.73	387.83
Specimen cross-sect. area, cm	20.4783	
Water content, %	23.5	26.5
Wet unit weight, pcf	112.3	
Dry unit weight, pcf	90.9	
Estimated degree of saturatior	76.0	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	3.4
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	2.5
Total backpressure, psi	5.5
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 1.0E-05



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PROJECT NAME: LANL
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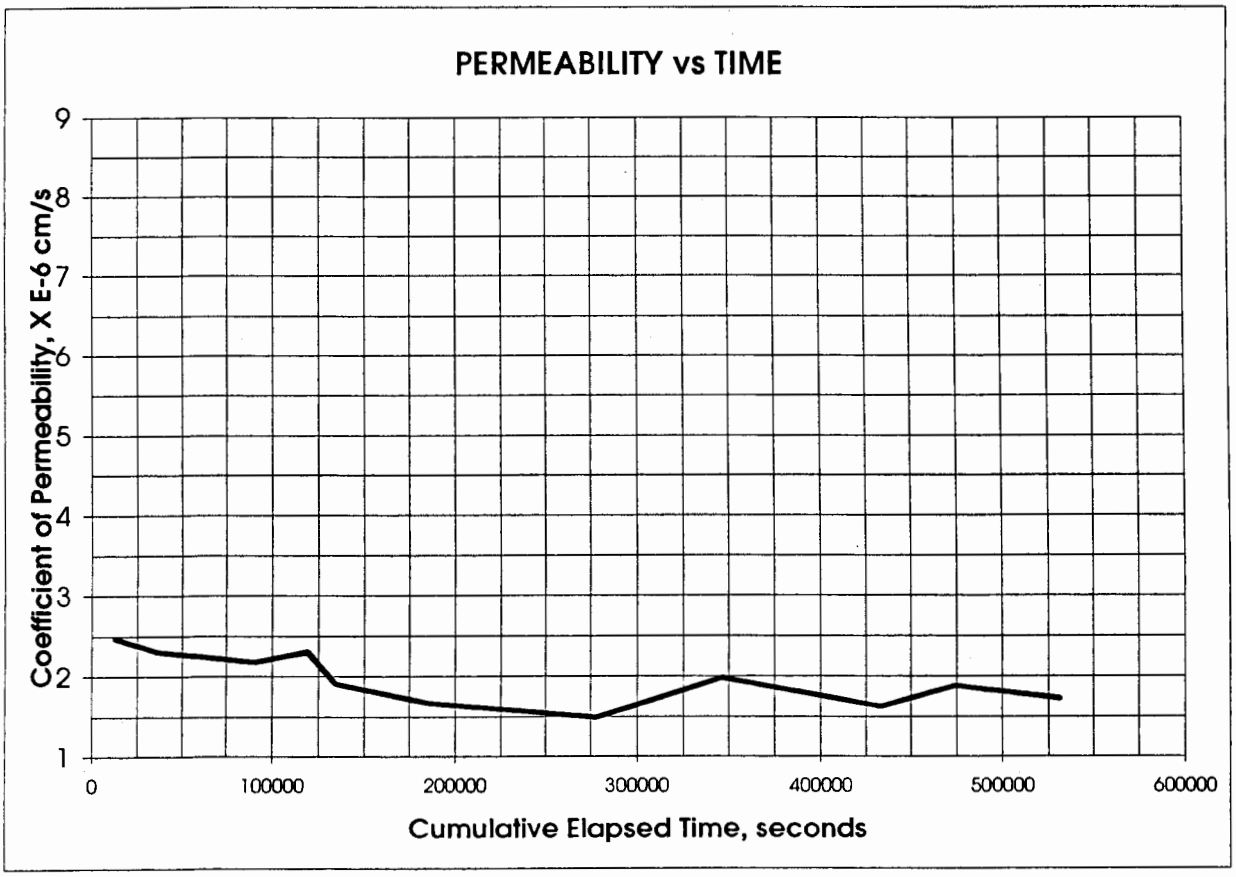
CLIENT SAMPLE NO. 1108-26-05
IT LAB SAMPLE NO. Soil Mix 4

	INITIAL	FINAL
Specimen diameter, cm	5.11	
Specimen length, cm	10.31	
Wet weight of specimen, g.	370.32	379.38
Specimen cross-sect. area, cm	20.5190	
Water content, %	26.0	29.0
Wet unit weight, pcf	109.3	
Dry unit weight, pcf	86.8	
Estimated degree of saturatior	75.9	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	6.8
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	3.0
Total backpressure, psi	5.0
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 1.8E-06



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ASTM D 5084

PROJECT NAME: LANL
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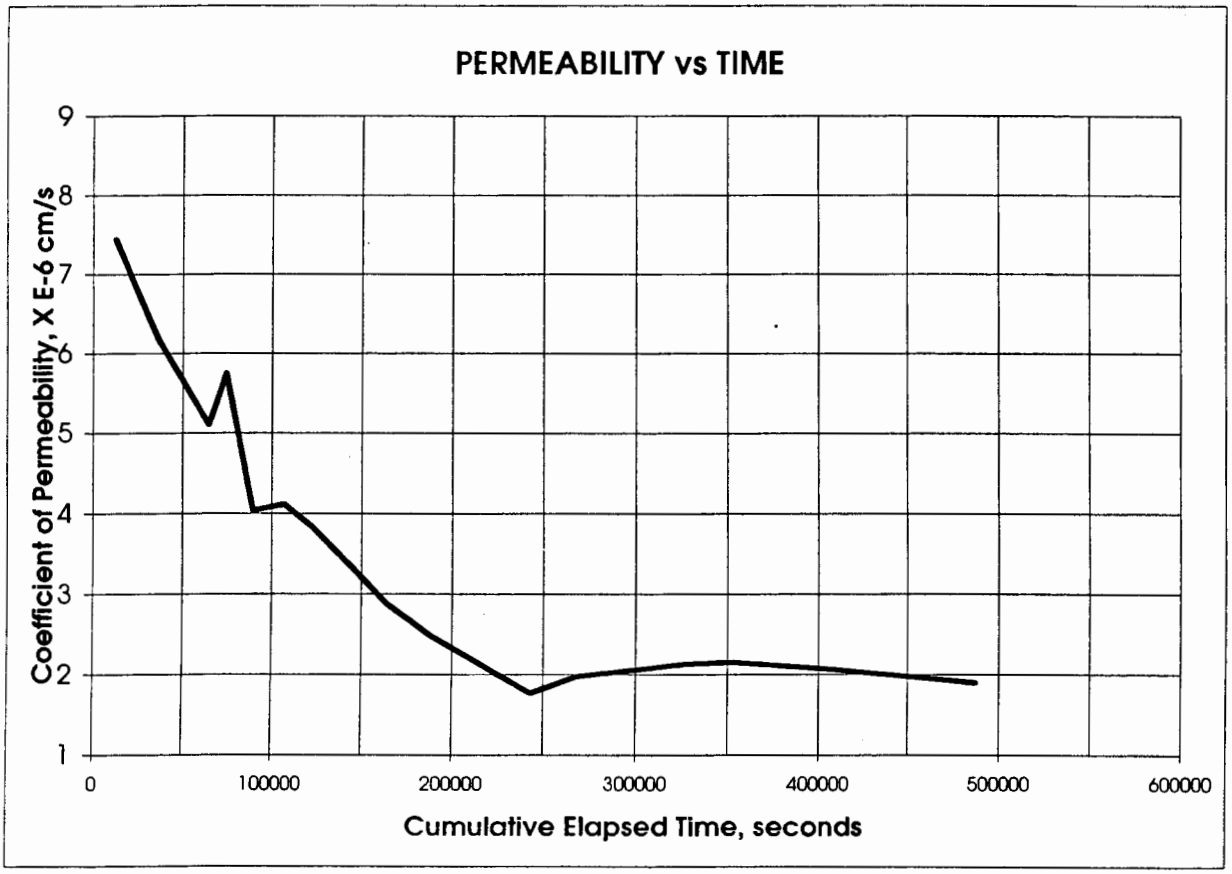
CLIENT SAMPLE NO. 1108-27-06
IT LAB SAMPLE NO. Soil Mix 5

	INITIAL	FINAL
Specimen diameter, cm	5.10	
Specimen length, cm	10.20	
Wet weight of specimen, g.	365.82	375.17
Specimen cross-sect. area, cm	20.4003	
Water content, %	29.8	33.1
Wet unit weight, pcf	109.7	
Dry unit weight, pcf	84.5	
Estimated degree of saturatior	82.5	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	6.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	3.0
Total backpressure, psi	5.0
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 2.1E-06



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ASTM D 5084

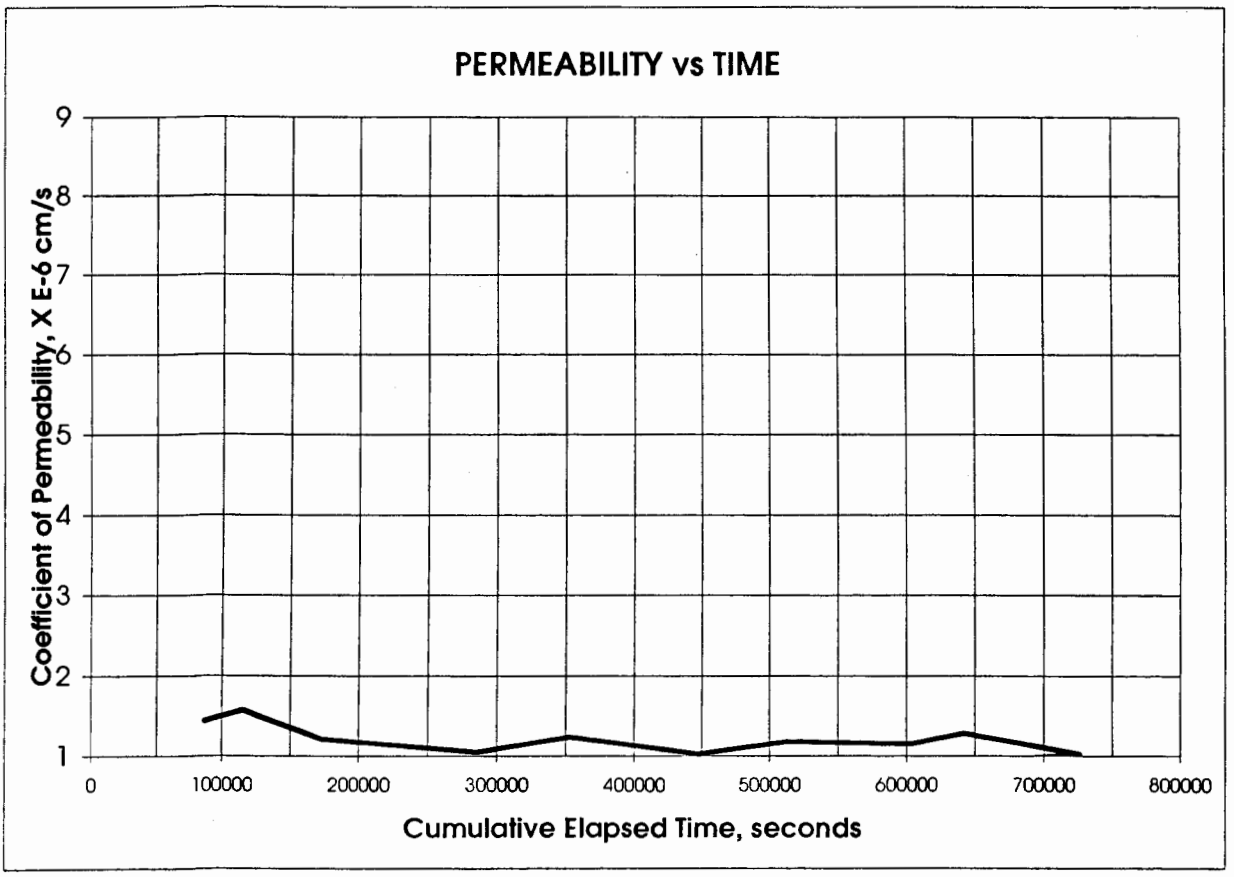
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-28-02
IT LAB SAMPLE NO. Soil Mix 6

	INITIAL	FINAL
Specimen diameter, cm	5.13	
Specimen length, cm	10.31	
Wet weight of specimen, g.	378.33	388.8
Specimen cross-sect. area, cm	20.6484	
Water content, %	22.6	25.9
Wet unit weight, pcf	111.0	
Dry unit weight, pcf	90.5	
Estimated degree of saturatior	72.2	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	6.8
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	3.0
Total backpressure, psi	5.0
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 1.2E-06



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ASTM D 5084

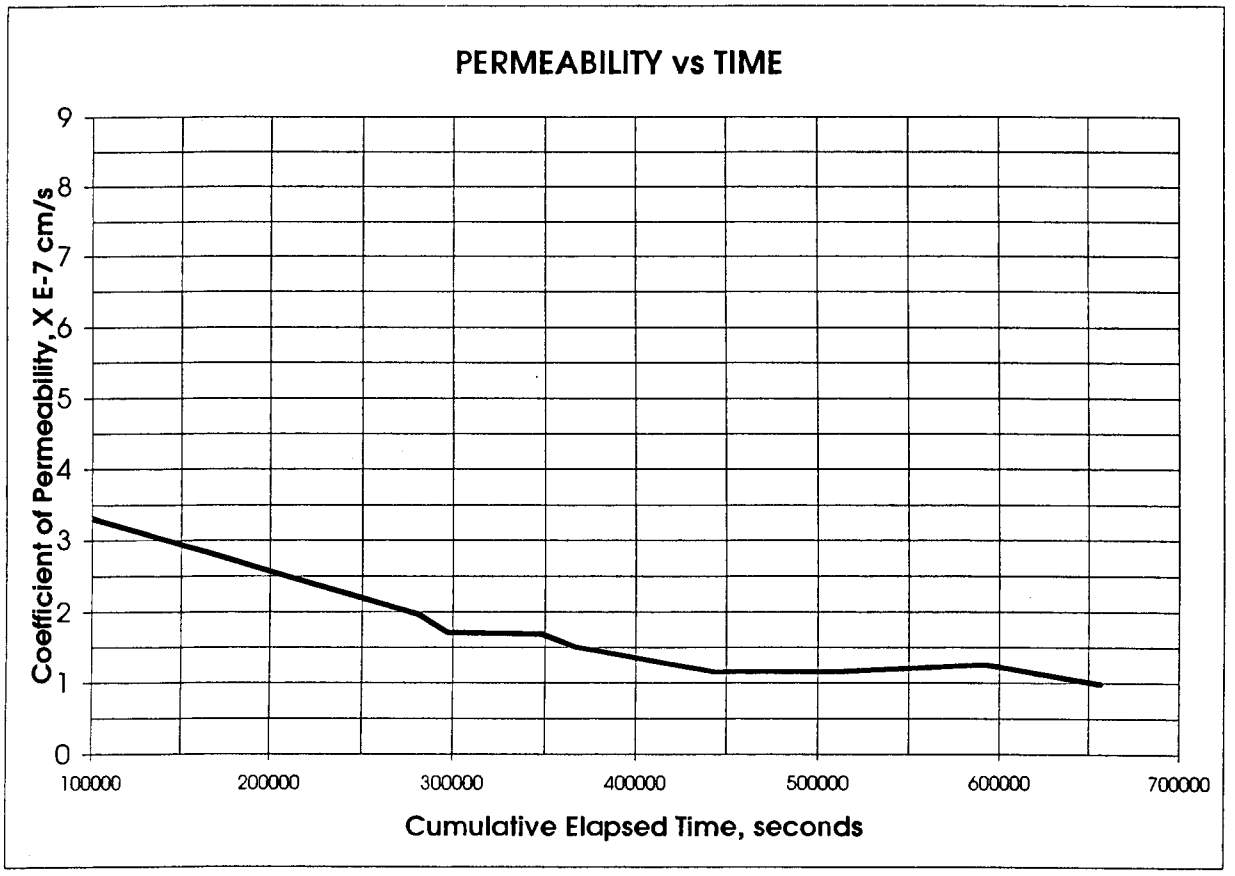
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-29-02
IT LAB SAMPLE NO. Soil Mix 7

	INITIAL	FINAL
Specimen diameter, cm	5.11	
Specimen length, cm	10.27	
Wet weight of specimen, g.	371.6	368.84
Specimen cross-sect. area, cm	20.4919	
Water content, %	25.2	24.3
Wet unit weight, pcf	110.3	
Dry unit weight, pcf	88.0	
Estimated degree of saturatior	76.1	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	6.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	5.0
Total backpressure, psi	5.0
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 1.1E-07



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PROJECT NAME: LANL
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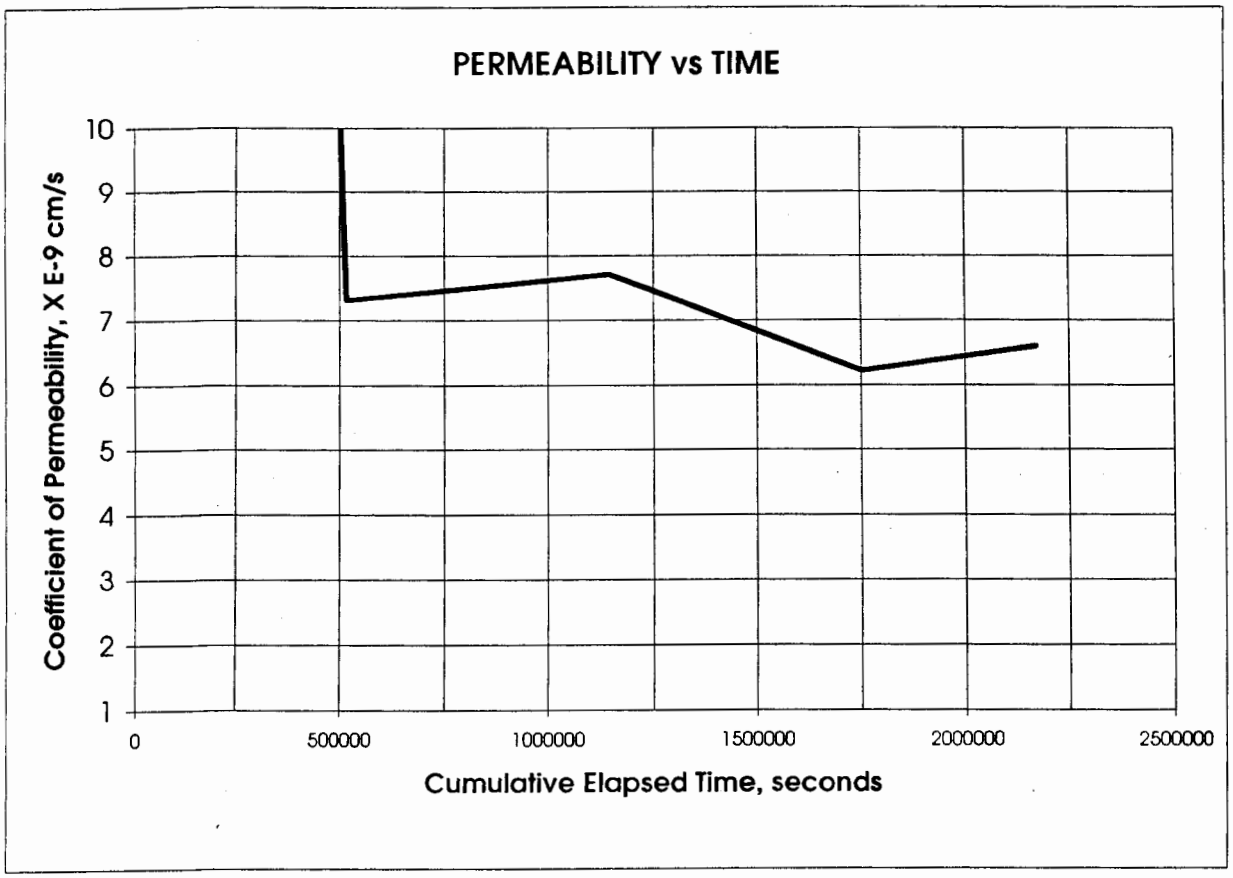
CLIENT SAMPLE NO. 1108-30-06
IT LAB SAMPLE NO. Soil Mix 8

	INITIAL	FINAL
Specimen diameter, cm	5.11	
Specimen length, cm	10.35	
Wet weight of specimen, g.	369.23	379.74
Specimen cross-sect. area, cm	20.4715	
Water content, %	25.5	29.1
Wet unit weight, pcf	108.8	
Dry unit weight, pcf	86.7	
Estimated degree of saturatior	74.5	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	13.6
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	6.0
Total backpressure, psi	5.0
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 7.0E-09



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ASTM D 5084

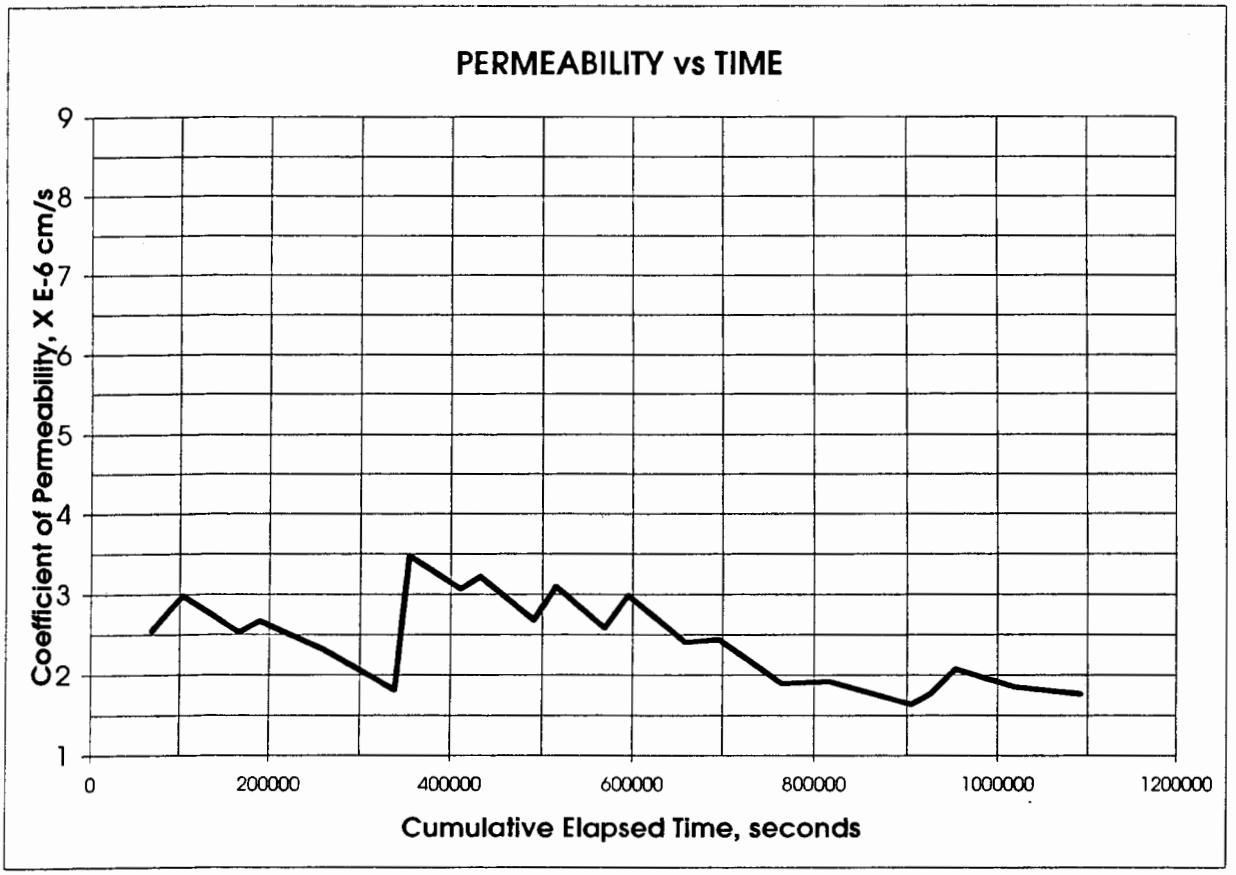
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-14-08
IT LAB SAMPLE NO. Tuff Mix 1

	INITIAL	FINAL
Specimen diameter, cm	5.10	
Specimen length, cm	10.16	
Wet weight of specimen, g.	384.78	394.17
Specimen cross-sect. area, cm	20.4647	
Water content, %	22.0	25.0
Wet unit weight, pcf	115.5	
Dry unit weight, pcf	94.7	
Estimated degree of saturatior	78.1	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	6.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	3.0
Total backpressure, psi	6.0
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 1.9E-06



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ASTM D 5084

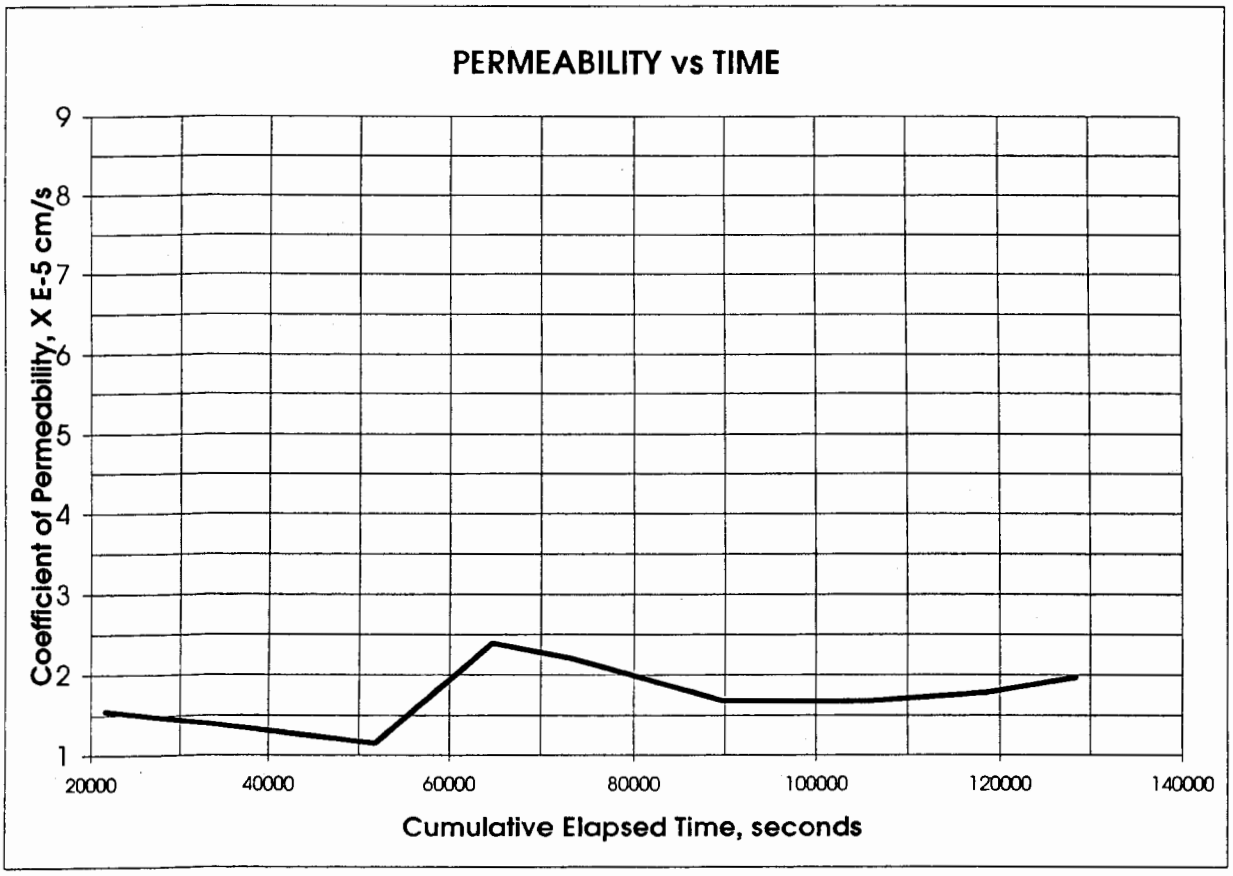
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-15-08
IT LAB SAMPLE NO. Tuff Mix 2

	INITIAL	FINAL
Specimen diameter, cm	5.09	
Specimen length, cm	10.18	
Wet weight of specimen, g.	378.92	389.61
Specimen cross-sect. area, cm	20.3495	
Water content, %	21.3	24.7
Wet unit weight, pcf	114.2	
Dry unit weight, pcf	94.2	
Estimated degree of saturatior	74.5	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	3.5
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	2.5
Total backpressure, psi	6.5
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 1.8E-05



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ASTM D 5084

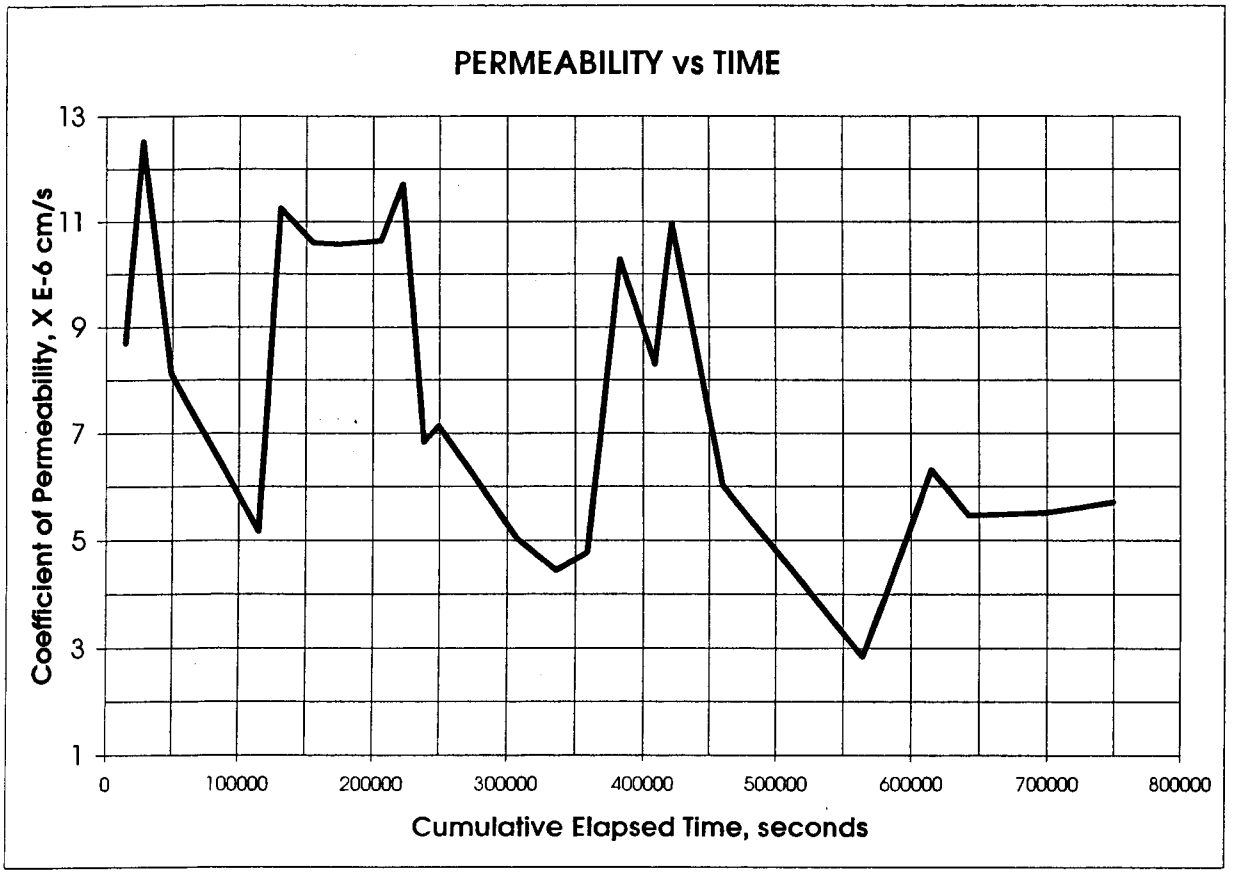
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-16-08
IT LAB SAMPLE NO. Tuff Mix 3

	INITIAL	FINAL
Specimen diameter, cm	5.10	
Specimen length, cm	10.20	
Wet weight of specimen, g.	381	392.38
Specimen cross-sect. area, cm	20.4003	
Water content, %	22.6	26.3
Wet unit weight, pcf	114.3	
Dry unit weight, pcf	93.3	
Estimated degree of saturatior	77.4	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	6.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	2.5
Total backpressure, psi	6.5
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 5.8E-06



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ASTM D 5084

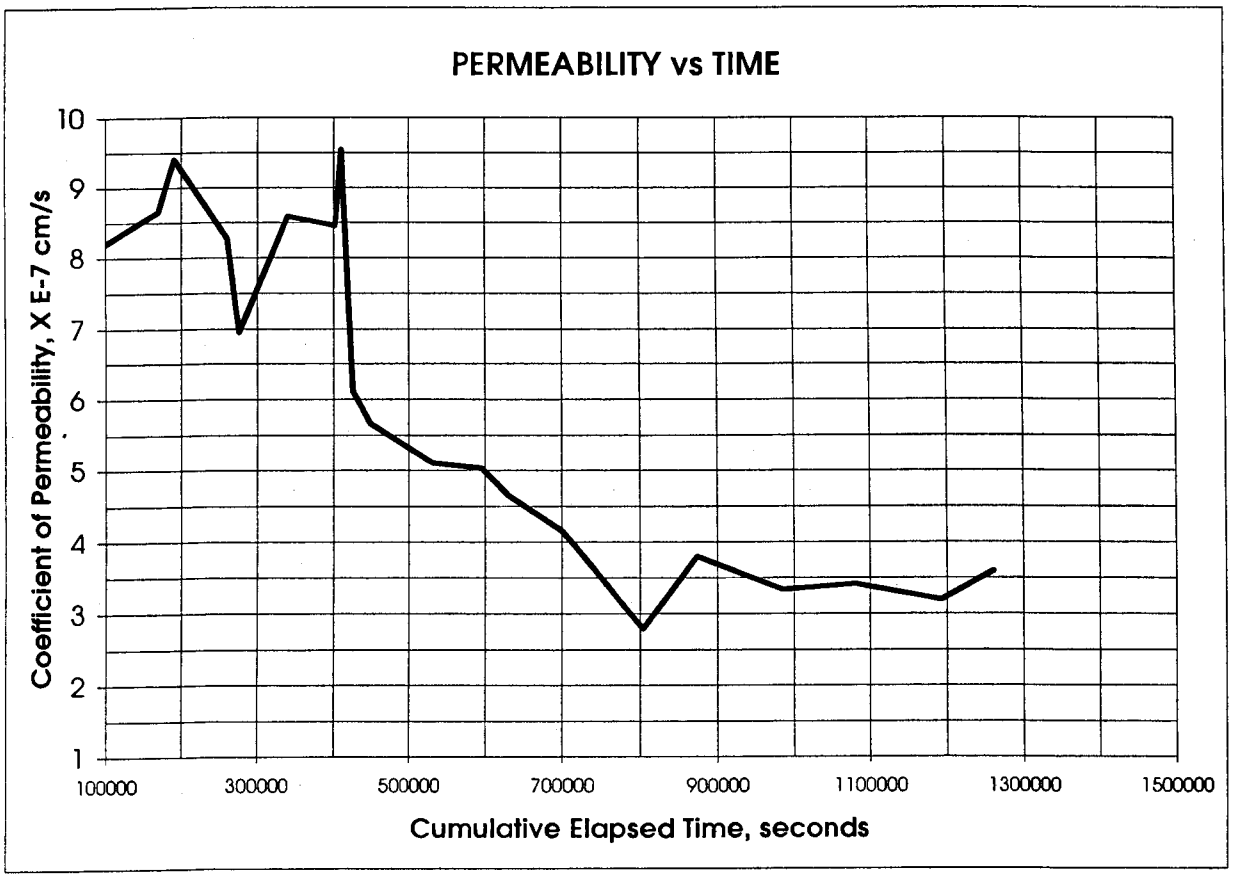
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-17-08
IT LAB SAMPLE NO. Tuff Mix 4

	INITIAL	FINAL
Specimen diameter, cm	5.10	
Specimen length, cm	10.20	
Wet weight of specimen, g.	375.86	385.88
Specimen cross-sect. area, cm	20.4342	
Water content, %	23.8	27.1
Wet unit weight, pcf	112.6	
Dry unit weight, pcf	90.9	
Estimated degree of saturatior	76.9	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	6.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	5.0
Total backpressure, psi	6.0
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 3.4E-07



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IT Project No.: 831775.00000000

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HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

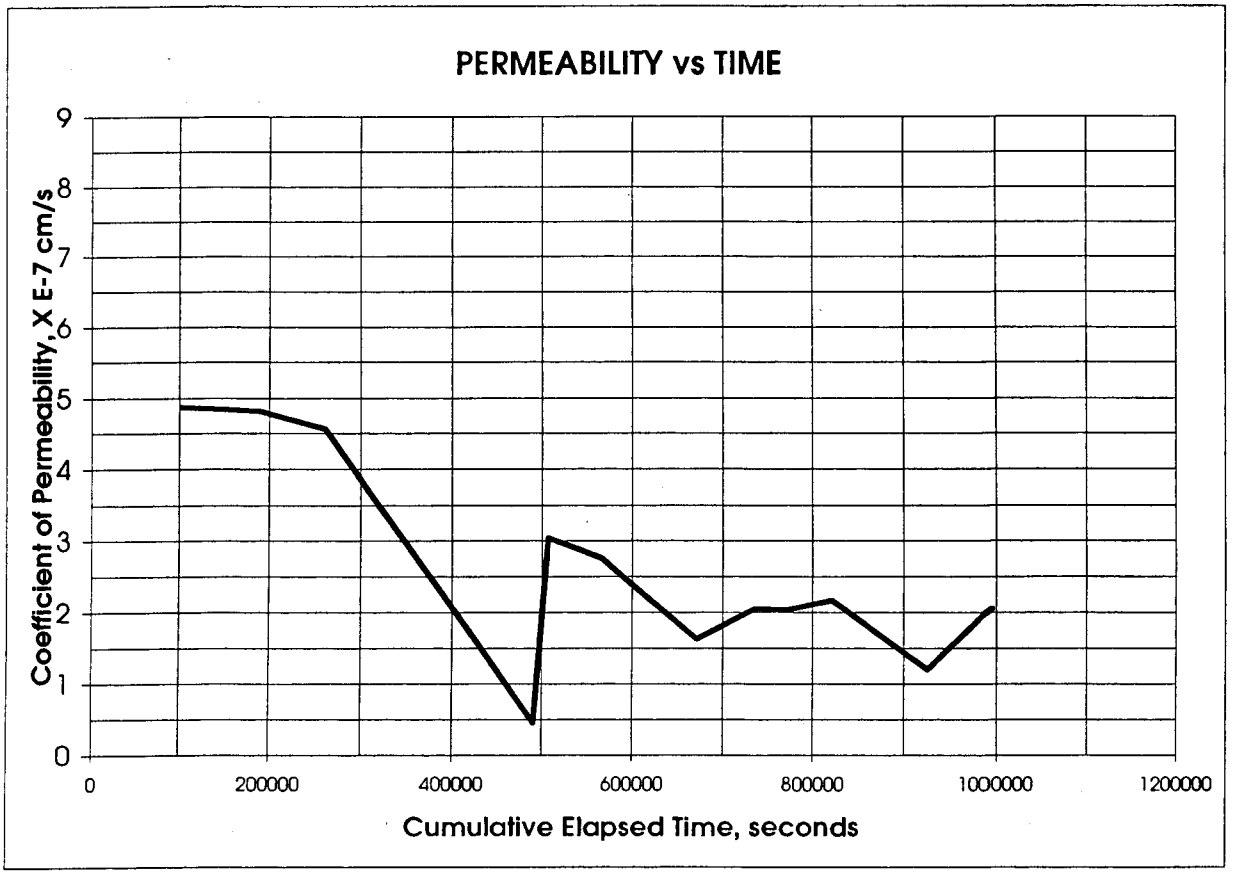
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-18-08
IT LAB SAMPLE NO. Tuff Mix 5

	INITIAL	FINAL
Specimen diameter, cm	5.11	
Specimen length, cm	10.23	
Wet weight of specimen, g.	387.77	396.9
Specimen cross-sect. area, cm	20.5326	
Water content, %	23.0	25.9
Wet unit weight, pcf	115.3	
Dry unit weight, pcf	93.7	
Estimated degree of saturatior	79.7	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	6.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	5.0
Total backpressure, psi	6.0
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 1.9E-07



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ASTM D 5084

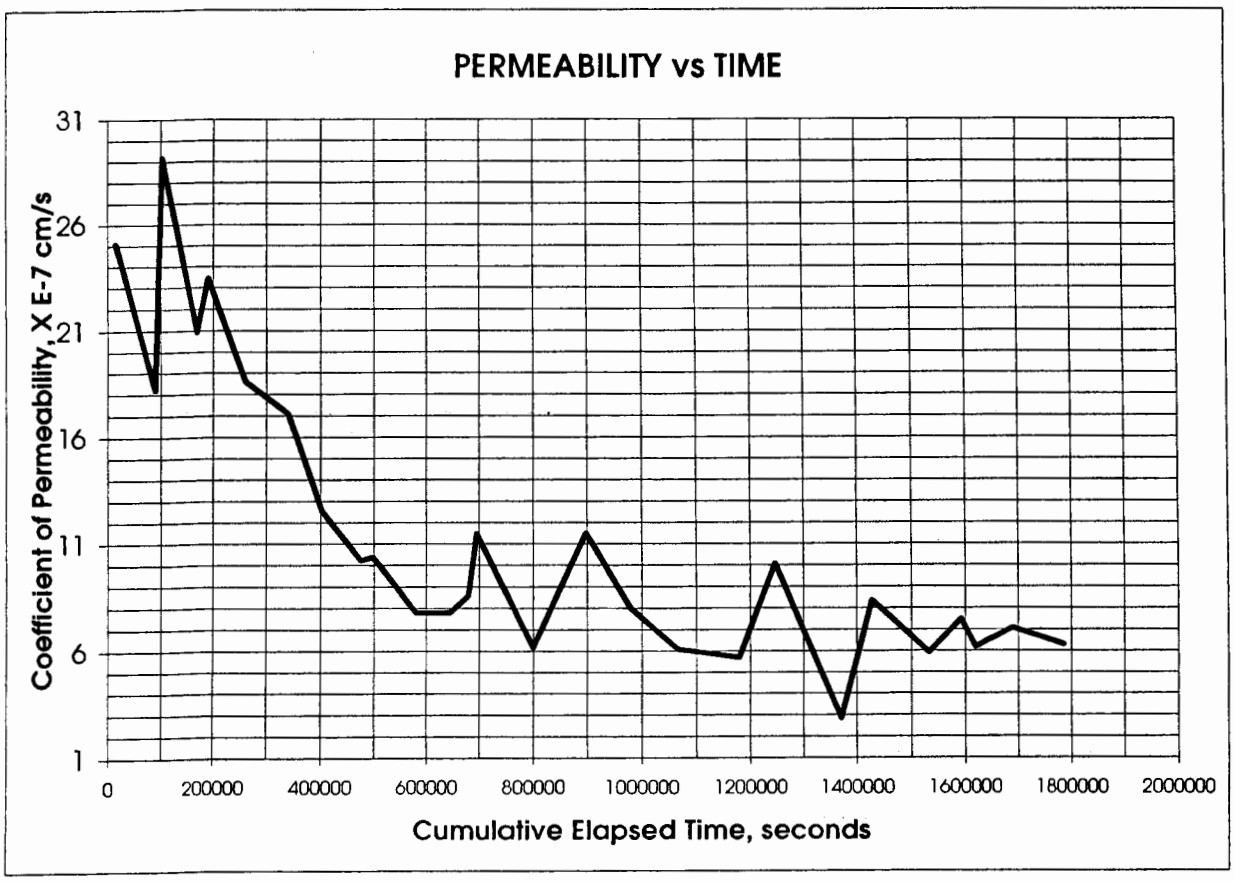
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-19-10
IT LAB SAMPLE NO. Tuff Mix 6

	INITIAL	FINAL
Specimen diameter, cm	5.09	
Specimen length, cm	10.25	
Wet weight of specimen, g.	381.75	392.34
Specimen cross-sect. area, cm	20.3698	
Water content, %	21.5	24.9
Wet unit weight, pcf	114.1	
Dry unit weight, pcf	93.9	
Estimated degree of saturatior	74.9	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	6.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	4.0
Total backpressure, psi	6.0
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 6.8E-07



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ASTM D 5084

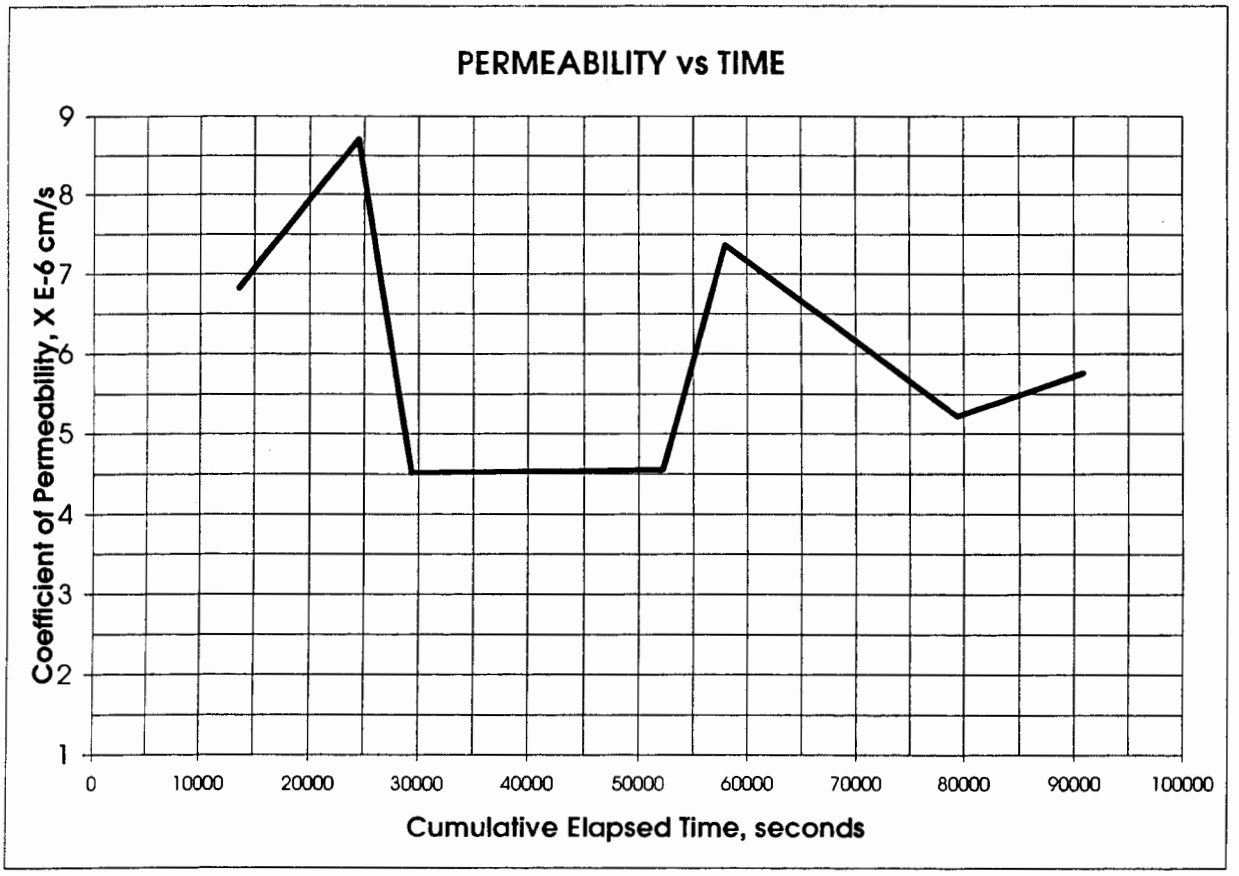
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-20-10
IT LAB SAMPLE NO. Tuff Mix 7

	INITIAL	FINAL
Specimen diameter, cm	5.11	
Specimen length, cm	10.31	
Wet weight of specimen, g.	386.55	386.55
Specimen cross-sect. area, cm	20.5258	
Water content, %		28.7
Wet unit weight, pcf	114.0	
Dry unit weight, pcf		
Estimated degree of saturatior		
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	6.8
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	3.0
Total backpressure, psi	6.0
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 5.7E-06



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ASTM D 5084

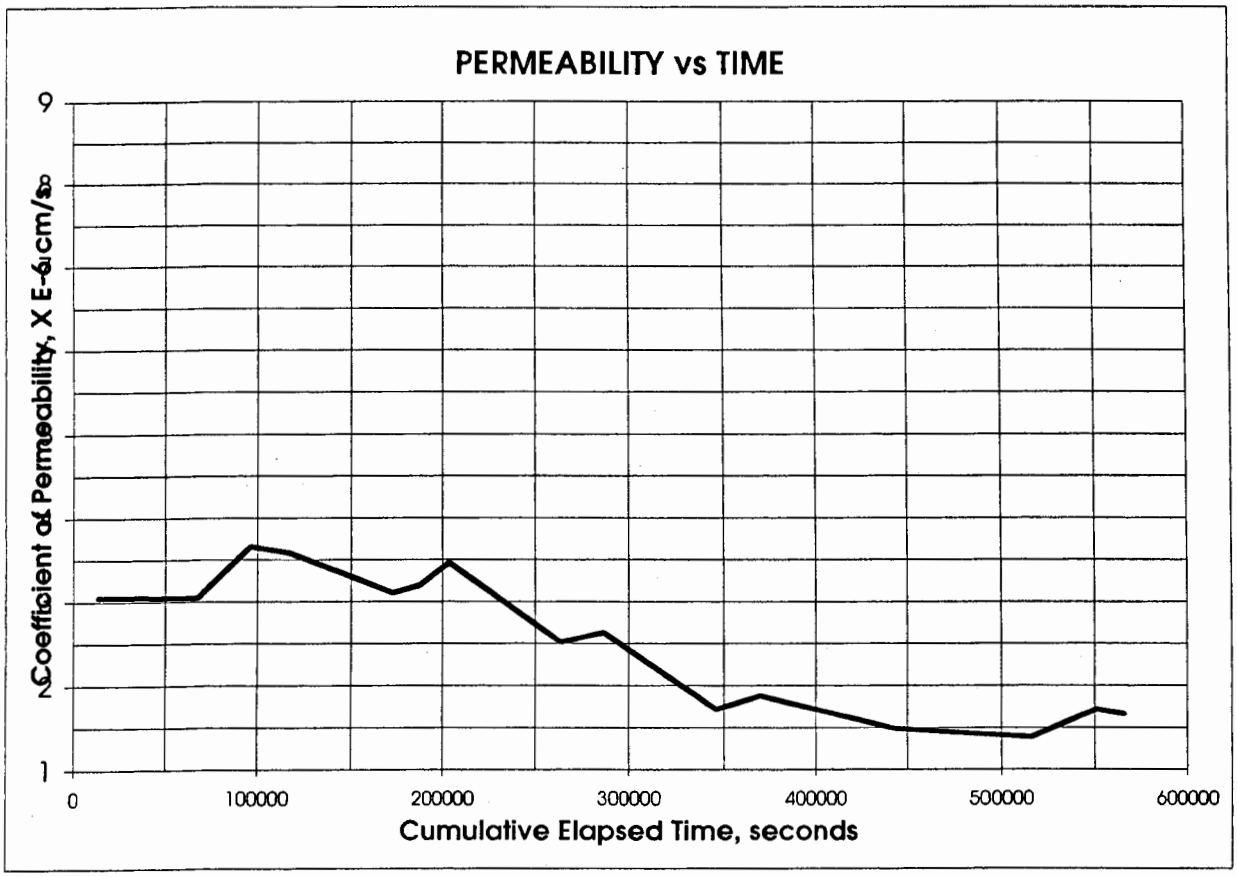
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-21-10
IT LAB SAMPLE NO. Tuff Mix 8

	INITIAL	FINAL
Specimen diameter, cm	5.10	
Specimen length, cm	10.23	
Wet weight of specimen, g.	367.83	379.1
Specimen cross-sect. area, cm	20.3901	
Water content, %	25.9	29.7
Wet unit weight, pcf	110.1	
Dry unit weight, pcf	87.4	
Estimated degree of saturatior	76.8	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	6.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	3.5
Total backpressure, psi	6.0
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 1.6E-06



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HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

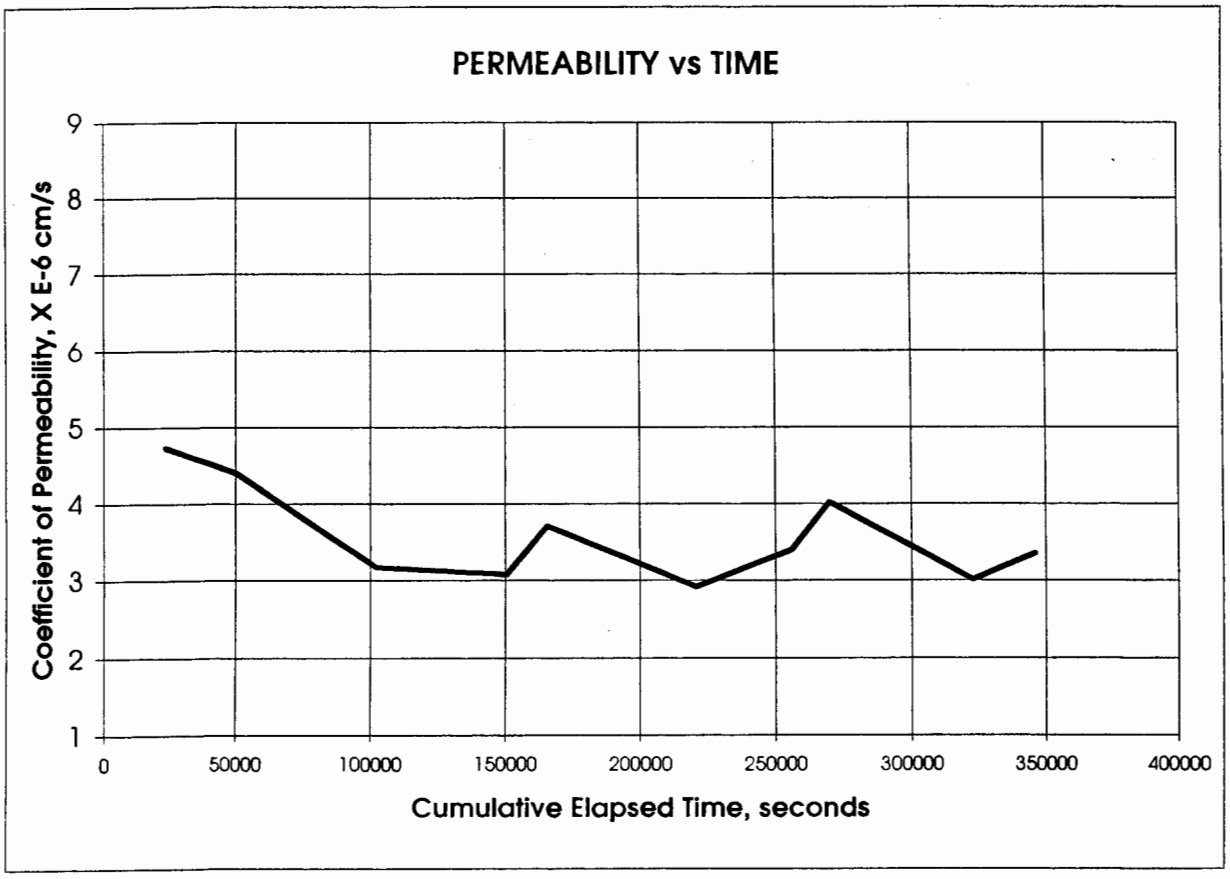
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-32-03
IT LAB SAMPLE NO. Tuff/Soil Mix 1

	INITIAL	FINAL
Specimen diameter, cm	5.08	
Specimen length, cm	10.16	
Wet weight of specimen, g.	391.97	394.35
Specimen cross-sect. area, cm	20.2683	
Water content, %	25.1	25.8
Wet unit weight, pcf	118.8	
Dry unit weight, pcf	95.0	
Estimated degree of saturatior	89.6	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	6.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	3.0
Total backpressure, psi	6.5
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 3.4E-06



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ASTM D 5084

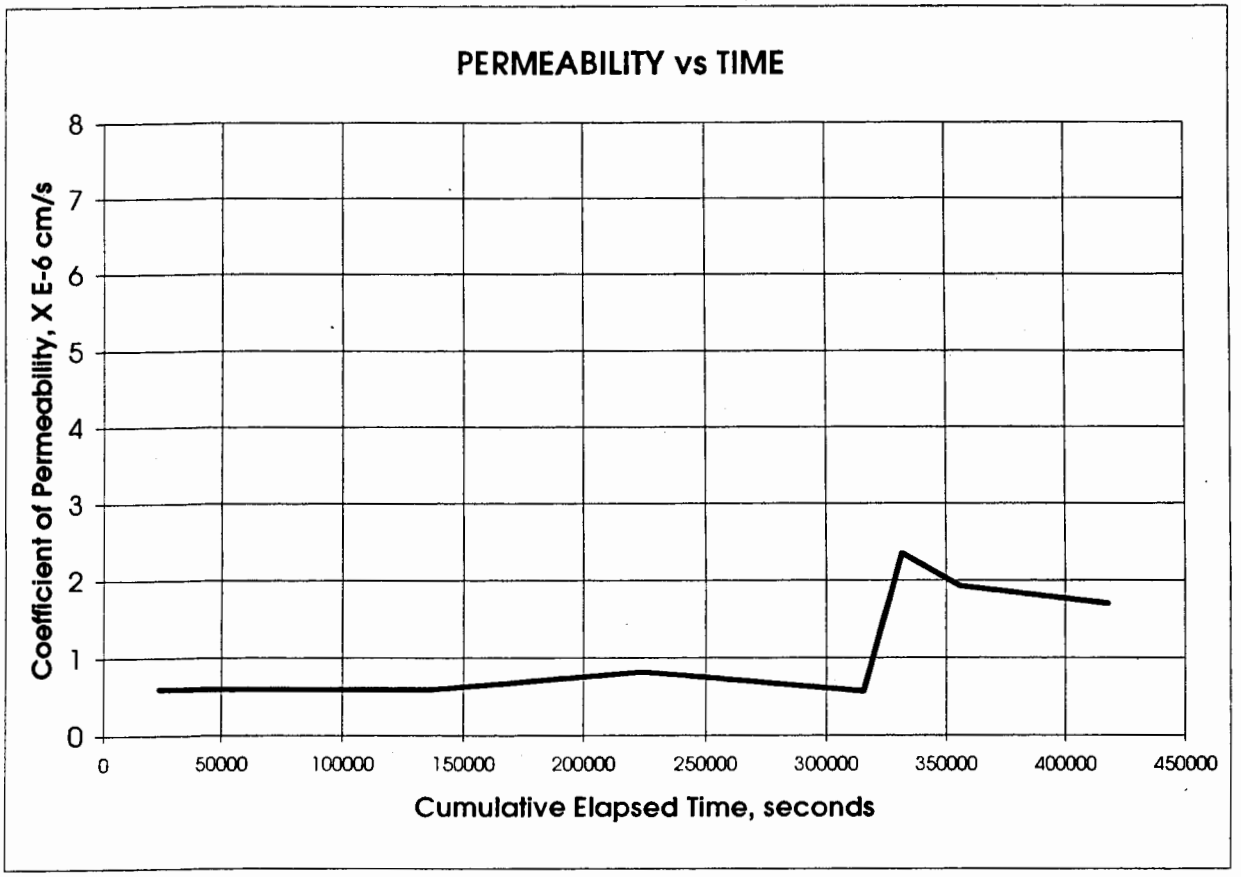
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-33-01
IT LAB SAMPLE NO. Tuff/Soil Mix 2

	INITIAL	FINAL
Specimen diameter, cm	5.11	
Specimen length, cm	10.21	
Wet weight of specimen, g.	382.5	
Specimen cross-sect. area, cm	20.5224	
Water content, %		
Wet unit weight, pcf	114.0	
Dry unit weight, pcf		
Estimated degree of saturatior		
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	10.3
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	3.5
Total backpressure, psi	5.5
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 2.0E-06



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ASTM D 5084

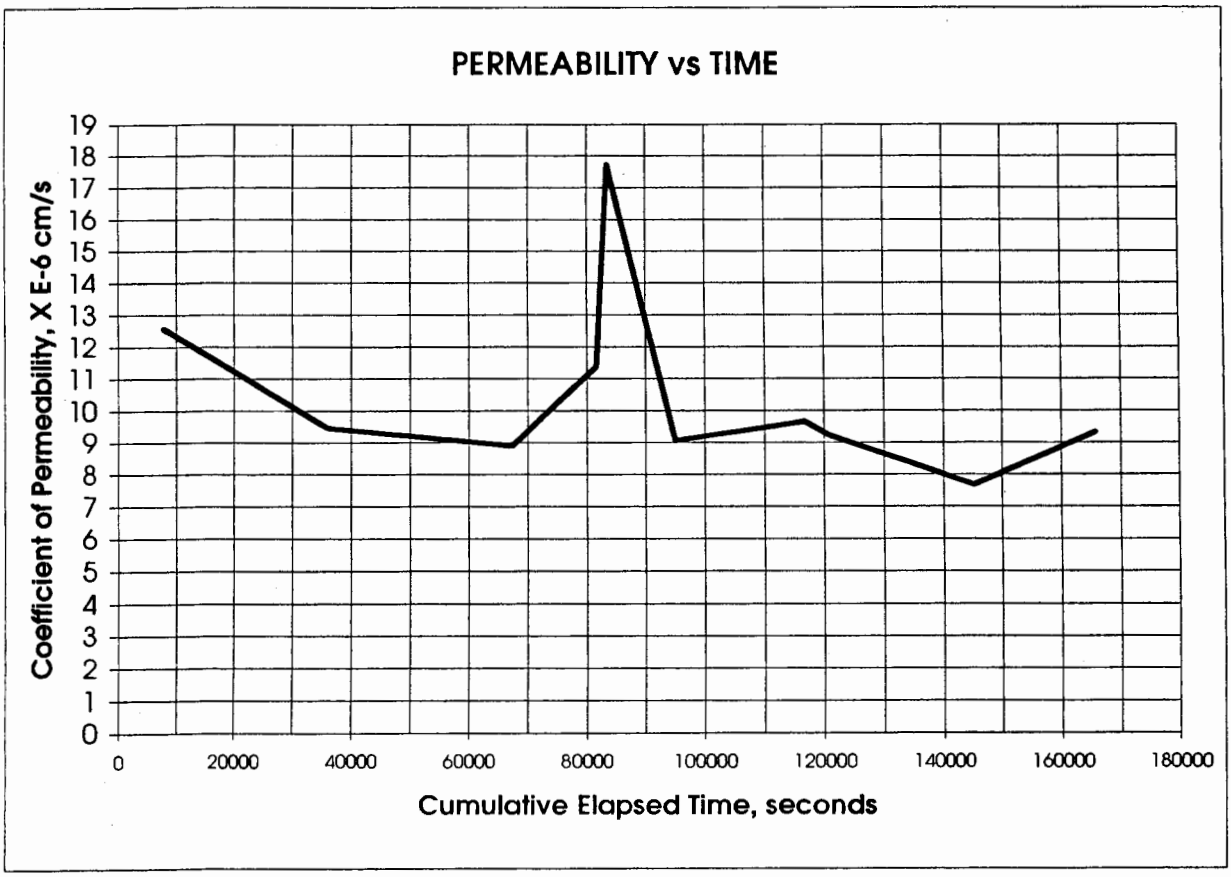
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-34-01
IT LAB SAMPLE NO. Tuff/Soil Mix 3

	INITIAL	FINAL
Specimen diameter, cm	5.09	
Specimen length, cm	10.24	
Wet weight of specimen, g.	393.43	388.18
Specimen cross-sect. area, cm	20.3732	
Water content, %	30.1	28.3
Wet unit weight, pcf	117.8	
Dry unit weight, pcf	90.6	
Estimated degree of saturation	96.3	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	6.9
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	2.5
Total backpressure, psi	6.5
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 9.0E-06



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ASTM D 5084

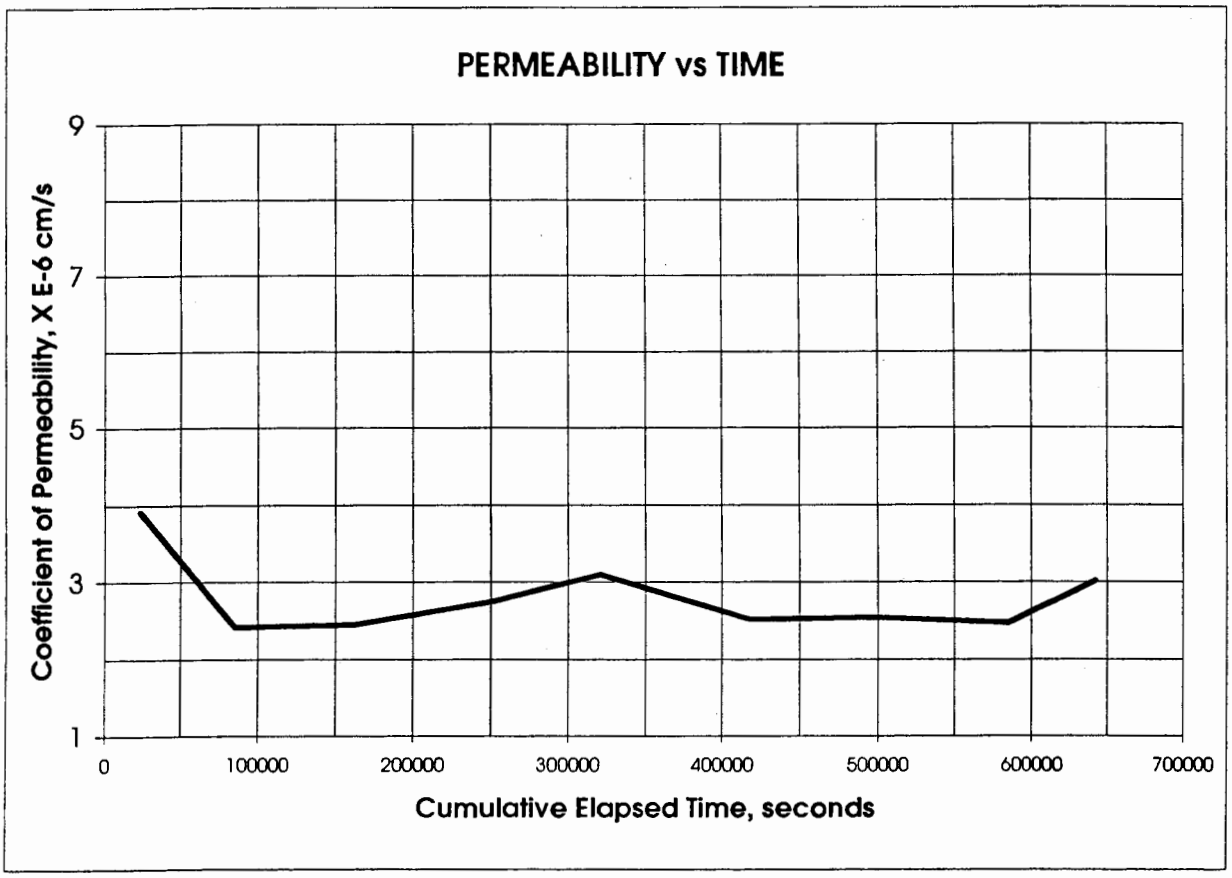
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-37-01
IT LAB SAMPLE NO. Tuff/Soil Mix 6

	INITIAL	FINAL
Specimen diameter, cm	5.10	
Specimen length, cm	10.30	
Wet weight of specimen, g.	372.51	383.46
Specimen cross-sect. area, cm	20.4681	
Water content, %	25.7	29.4
Wet unit weight, pcf	110.3	
Dry unit weight, pcf	87.8	
Estimated degree of saturatior	76.9	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	3.4
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	2.5
Total backpressure, psi	5.5
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 2.6E-06



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ASTM D 5084

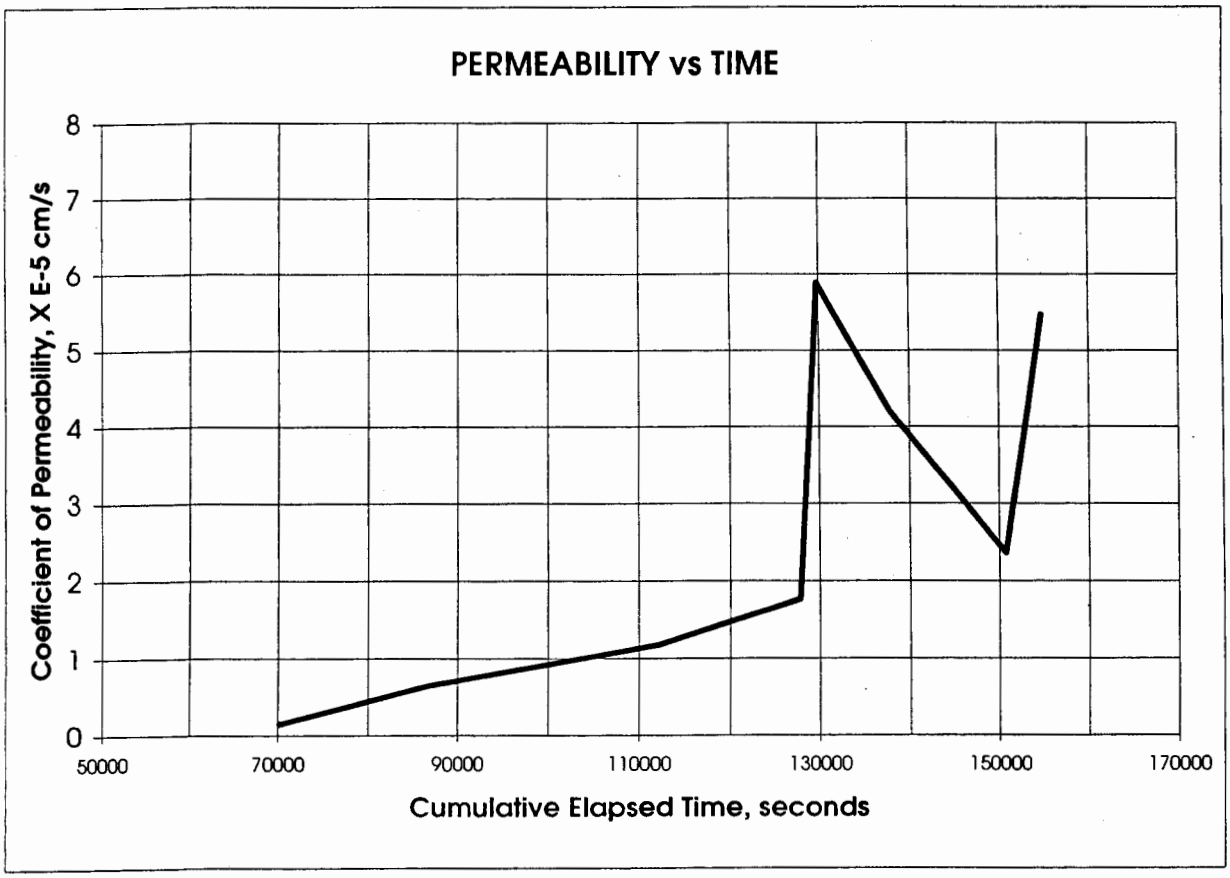
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-38-01
IT LAB SAMPLE NO. Tuff/Soil Mix 7

	INITIAL	FINAL
Specimen diameter, cm	5.11	
Specimen length, cm	10.29	
Wet weight of specimen, g.	366.99	
Specimen cross-sect. area, cm	20.5483	
Water content, %		
Wet unit weight, pcf	108.4	
Dry unit weight, pcf		
Estimated degree of saturatior		
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	10.3
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	2.5
Total backpressure, psi	7.5
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 4.5E-05



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HYDRAULIC CONDUCTIVITY / PERMEABILITY
ASTM D 5084

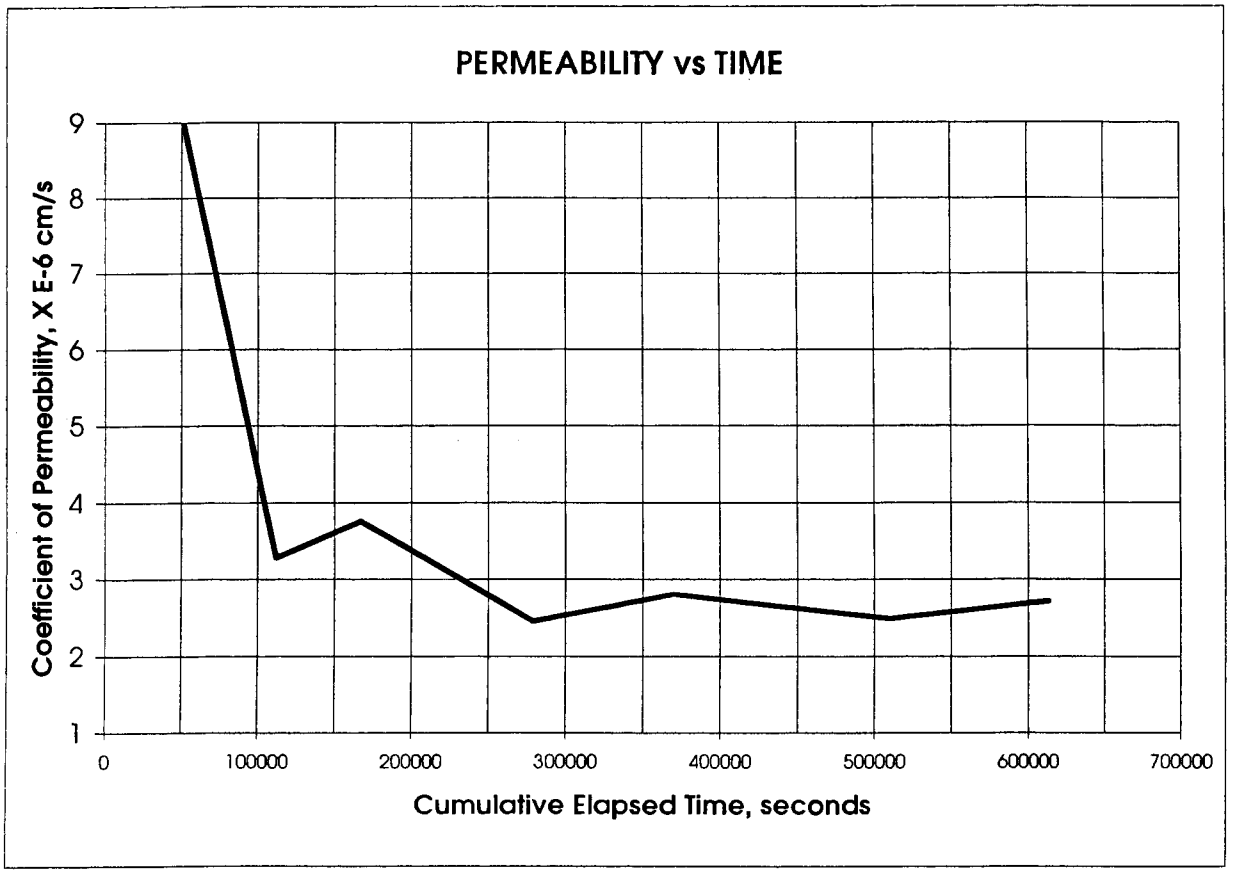
PROJECT NAME: LANL
PROJECT NO. 831775

CLIENT SAMPLE NO. 1108-39-01
IT LAB SAMPLE NO. Tuff/Soil Mix 8

	INITIAL	FINAL
Specimen diameter, cm	5.11	
Specimen length, cm	10.30	
Wet weight of specimen, g.	354.67	366.21
Specimen cross-sect. area, cm	20.4715	
Water content, %	29.3	33.6
Wet unit weight, pcf	105.0	
Dry unit weight, pcf	81.2	
Estimated degree of saturatior	75.0	
Estimated spec. gravity of solid	2.65	

Hydraulic gradient	3.4
Min. consolidation stress, psi	2.0
Max. consolidation stress, psi	2.5
Total backpressure, psi	6.5
Permeant Fluid	Deaired DI Water

Coefficient of Permeability, cm/s 2.6E-06



Freeze / Thaw Tests

IT GEOTECHNICAL
LABORATORY
OAK RIDGE, TN
(865) 482-6497

FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Sediment mix 1

CLIENT SAMPLE NUMBER:
1108-06-04

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.1339	0.1244	0.0095	0.01
2	0.1905	0.1623	0.0282	0.04
3	2.6555	0.0465	2.6090	2.65
4	5.3277	0.0790	5.2487	7.90
5	1.6407	0.0216	1.6190	9.51
6	3.9030	0.0173	3.8857	13.40
7	1.7299	0.0032	1.7267	15.13
8	1.4276	0.0000	1.4276	16.55
9	1.0762	0.0022	1.0740	17.63
10	1.2407	0.0217	1.2190	18.85
11	1.3492	0.0260	1.3231	20.17
12	5.4480	0.0022	5.4458	25.62

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IT Project ID: LANL
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FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Sediment mix 2

CLIENT SAMPLE NUMBER:
1108-07-04

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.4329	0.2873	0.1456	0.15
2	0.9370	0.2309	0.7062	0.85
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				

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FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Sediment mix 3

CLIENT SAMPLE NUMBER:
1108-08-04

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	3.2139	0.3964	2.8175	2.82
2	3.1103	0.2981	2.8122	5.63
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				

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FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Sediment mix 4

CLIENT SAMPLE NUMBER:
1108-09-04

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	34.5829	0.7782	33.8047	33.80
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				

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FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Sediment mix 5

CLIENT SAMPLE NUMBER:
1108-10-04

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.1854	0.1985	-0.0131	-0.01
2	0.2465	0.2012	0.0453	0.03
3	0.5038	0.0642	0.4396	0.47
4	3.1194	0.2097	2.9098	3.38
5	0.7857	0.0340	0.7517	4.13
6	0.7386	0.0219	0.7167	4.85
7	1.4271	0.0071	1.4200	6.27
8	0.8631	0.0000	0.8631	7.13
9	0.3737	0.0000	0.3737	7.51
10	0.3675	0.0099	0.3576	7.86
11	1.2101	0.0000	1.2101	9.07
12	0.5534	0.0000	0.5534	9.63

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FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Sediment mix 6

CLIENT SAMPLE NUMBER:
1108-11-04

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.2530	0.2891	-0.0361	-0.04
2	0.2497	0.2979	-0.0482	-0.08
3	0.1538	0.0197	0.1340	0.05
4	1.0006	0.1291	0.8715	0.92
5	0.5254	0.0329	0.4925	1.41
6	1.0816	0.0513	1.0302	2.44
7	0.4837	0.0088	0.4749	2.92
8	0.7336	0.0871	0.6465	3.57
9	0.5409	0.0360	0.5049	4.07
10	0.3602	0.0448	0.3153	4.39
11	11.4288	0.0033	11.4255	15.81
12	10.9319	0.0022	10.9297	26.74

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FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Sediment mix 7

CLIENT SAMPLE NUMBER:
1108-12-04

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.2413	0.2424	-0.0011	0.00
2	0.2470	0.2447	0.0023	0.00
3	2.5497	0.0476	2.5021	2.50
4	3.2206	0.1392	3.0814	5.58
5	1.6332	0.0238	1.6094	7.19
6	8.4844	0.0238	8.4606	15.65
7	0.7831	0.0000	0.7831	16.44
8	0.5489	0.0000	0.5489	16.99
9	0.3393	0.0079	0.3314	17.32
10	0.3136	0.0340	0.2796	17.60
11				
12				

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March 22, 2002
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IT Project No.: 831775.00000000

IT GEOTECHNICAL LABORATORY
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FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name: **LANL**

Project No.: **831775.00000000**

LAB SAMPLE NUMBER: Sediment mix 8

CLIENT SAMPLE NUMBER: 1108-13-04

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.3049	0.3911	-0.0861	-0.09
2	0.3141	0.3397	-0.0257	-0.11
3	1.0957	0.0267	1.0690	0.96
4	2.3071	0.1373	2.1698	3.13
5	5.6122	0.0109	5.6014	8.73
6	21.7062	0.0827	21.6235	30.35
7	1.2916	0.0037	1.2879	31.64
8	0.6493	0.0024	0.6468	32.29
9				
10				
11				
12				

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FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Tuff mix 1

CLIENT SAMPLE NUMBER:
1108-14-02

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.238	0.164	0.074	0.07
2	0.088	0.119	-0.032	0.04
3	0.024	0.010	0.014	0.06
4	0.619	0.036	0.583	0.64
5	3.233	0.014	3.219	3.86
6	1.717	0.046	1.671	5.53
7	0.215	0.023	0.192	5.72
8	0.462	0.000	0.462	6.18
9	0.206	1.294	-1.088	5.09
10	0.429	0.126	0.303	5.40
11	0.176	0.117	0.059	5.46
12	0.132	0.079	0.053	5.51

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FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Tuff mix 2

CLIENT SAMPLE NUMBER:
1108-15-02

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.330	0.278	0.052	0.05
2	0.090	0.410	-0.320	-0.27
3	0.050	0.002	0.048	-0.22
4	0.984	0.041	0.943	0.72
5	2.534	0.000	2.534	3.26
6	1.994	0.098	1.896	5.15
7	0.376	0.000	0.376	5.53
8	0.238	0.001	0.237	5.77
9	0.321	0.091	0.230	6.00
10	0.225	0.026	0.199	6.20
11	0.345	0.053	0.293	6.49
12	0.334	0.011	0.323	6.81

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ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Tuff mix 3

CLIENT SAMPLE NUMBER:
1108-16-02

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.288	0.257	0.031	0.03
2	0.067	0.130	-0.063	-0.03
3	2.133	0.000	2.133	2.10
4	2.246	0.035	2.210	4.31
5	1.064	0.000	1.064	5.38
6	1.209	0.051	1.159	6.53
7	0.676	0.000	0.676	7.21
8	0.572	0.000	0.572	7.78
9	0.169	0.184	-0.016	7.77
10	0.212	0.130	0.082	7.85
11	0.204	0.085	0.119	7.97
12	0.083	0.084	-0.001	7.97

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FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Tuff mix 4

CLIENT SAMPLE NUMBER:
1108-17-02

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.188	0.168	0.019	0.02
2	0.077	0.081	-0.004	0.02
3	0.393	0.000	0.393	0.41
4	0.796	0.015	0.781	1.19
5	0.975	0.000	0.976	2.17
6	1.473	0.036	1.437	3.60
7	0.798	0.000	0.798	4.40
8	0.579	0.000	0.579	4.98
9	0.905	0.105	0.800	5.78
10	0.412	0.016	0.396	6.17
11	0.941	0.028	0.914	7.09
12	0.494	0.051	0.443	7.53

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ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Tuff mix 5

CLIENT SAMPLE NUMBER:
1108-18-02

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.243	0.224	0.019	0.02
2	0.092	0.130	-0.038	-0.02
3	0.231	0.000	0.231	0.21
4	1.055	0.062	0.993	1.20
5	0.795	0.034	0.761	1.96
6	0.515	0.093	0.423	2.39
7	0.321	0.028	0.294	2.68
8	0.152	0.003	0.149	2.83
9	1.528	0.060	1.469	4.30
10	0.138	0.023	0.115	4.41
11	0.249	0.189	0.060	4.47
12	0.129	0.001	0.128	4.60

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ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Tuff mix 6

CLIENT SAMPLE NUMBER:
1108-19-02

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.533	0.355	0.177	0.18
2	0.092	0.153	-0.061	0.12
3	0.000	0.000	0.000	0.12
4	0.836	0.061	0.775	0.89
5	1.418	0.002	1.416	2.31
6	1.199	0.075	1.124	3.43
7	0.348	0.003	0.345	3.78
8	0.609	0.009	0.600	4.38
9	0.848	0.027	0.821	5.20
10	0.244	0.023	0.220	5.42
11	0.202	0.190	0.012	5.43
12	0.271	0.014	0.256	5.69

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FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Tuff mix 7

CLIENT SAMPLE NUMBER:
1108-20-02

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.412	0.341	0.072	0.07
2	0.119	0.163	-0.044	0.03
3	1.246	0.000	1.246	1.27
4	1.771	0.061	1.710	2.98
5	1.572	0.000	1.572	4.56
6	0.976	0.055	0.921	5.48
7	0.467	0.000	0.467	5.94
8	0.656	0.000	0.656	6.60
9	0.566	0.273	0.292	6.89
10	0.751	0.055	0.696	7.59
11	0.433	0.116	0.317	7.91
12	0.147	0.034	0.112	8.02

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FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Tuff mix 8

CLIENT SAMPLE NUMBER:
1108-21-02

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.528	0.339	0.189	0.19
2	0.171	0.192	-0.022	0.17
3	1.203	0.041	1.162	1.33
4	0.812	0.055	0.757	2.09
5	1.354	0.000	1.354	3.44
6	2.856	0.238	2.618	6.06
7	0.725	0.124	0.601	6.66
8	1.649	0.000	1.649	8.31
9	2.338	0.059	2.279	10.59
10	1.615	0.012	1.604	12.19
11	0.495	0.225	0.270	12.46
12	0.647	0.004	0.644	13.11

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ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Soil mix 1

CLIENT SAMPLE NUMBER:
1108-23-01

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.135	0.094	0.041	0.04
2	0.076	0.192	-0.116	-0.07
3	0.480	0.038	0.442	0.37
4	1.524	0.030	1.494	1.86
5	1.260	0.017	1.243	3.10
6	0.648	0.022	0.626	3.73
7	0.596	0.015	0.580	4.31
8	0.351	0.000	0.351	4.66
9	0.194	0.000	0.194	4.86
10	0.674	0.000	0.674	5.53
11	0.351	0.000	0.351	5.88
12	0.443	0.000	0.443	6.32

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FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Soil mix 4

CLIENT SAMPLE NUMBER:
1108-26-01

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.217	0.125	0.092	0.09
2	0.137	0.101	0.036	0.13
3	0.756	0.036	0.721	0.85
4	1.425	0.027	1.398	2.25
5	3.318	0.010	3.308	5.55
6	2.609	0.039	2.570	8.12
7	2.264	0.029	2.235	10.36
8	1.719	0.001	1.717	12.08
9	1.096	0.000	1.096	13.17
10	1.718	0.013	1.705	14.88
11	2.099	0.059	2.039	16.92
12	2.787	0.002	2.785	19.70

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FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Soil mix 5

CLIENT SAMPLE NUMBER:
1108-27-01

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.198	0.128	0.070	0.07
2	0.128	0.114	0.014	0.08
3	0.143	0.064	0.079	0.16
4	1.415	0.047	1.367	1.53
5	1.079	0.027	1.052	2.58
6	0.819	0.039	0.781	3.36
7	0.707	0.021	0.687	4.05
8	0.663	0.000	0.663	4.71
9	0.847	0.000	0.847	5.56
10	0.701	0.000	0.701	6.26
11	1.426	0.026	1.401	7.66
12	0.294	0.000	0.294	7.96

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FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Soil mix 8

CLIENT SAMPLE NUMBER:
1108-30-03

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.248	0.182	0.066	0.07
2	0.194	0.144	0.050	0.12
3	0.116	0.045	0.072	0.19
4	0.237	0.049	0.189	0.38
5	0.528	0.007	0.520	0.90
6	2.065	0.046	2.019	2.92
7	1.374	0.056	1.318	4.23
8	1.117	0.046	1.071	5.31
9	0.663	0.000	0.663	5.97
10	22.109	0.018	22.091	28.06
11	0.511	0.012	0.499	28.56
12				

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FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Tuff mix 1

CLIENT SAMPLE NUMBER:
1108-14-02

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.238	0.164	0.074	0.07
2	0.088	0.119	-0.032	0.04
3	0.024	0.010	0.014	0.06
4	0.619	0.036	0.583	0.64
5	3.233	0.014	3.219	3.86
6	1.717	0.046	1.671	5.53
7	0.215	0.023	0.192	5.72
8	0.462	0.000	0.462	6.18
9	0.206	1.294	-1.088	5.09
10	0.429	0.126	0.303	5.40
11	0.176	0.117	0.059	5.46
12	0.132	0.079	0.053	5.51

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FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Tuff/Sed mix 1

CLIENT SAMPLE NUMBER:
1108-32-03

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.199	0.162	0.037	0.04
2	0.092	0.068	0.024	0.06
3	0.958	0.011	0.946	1.01
4	5.374	0.068	5.306	6.31
5	1.381	0.039	1.342	7.66
6	0.246	0.036	0.210	7.87
7	0.975	0.003	0.972	8.84
8	0.377	0.019	0.358	9.19
9	0.196	0.002	0.193	9.39
10	0.106	-0.003	0.110	9.50
11				
12				

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FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Tuff/Sed mix 2

CLIENT SAMPLE NUMBER:
11108-33.03

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.331	0.364	-0.033	-0.03
2	0.137	0.110	0.028	-0.01
3	4.216	0.000	4.216	4.21
4	4.501	0.054	4.447	8.66
5	0.669	0.000	0.669	9.33
6	0.720	0.023	0.697	10.02
7	0.550	0.000	0.550	10.57
8	0.721	0.032	0.689	11.26
9	0.407	0.000	0.407	11.67
10	0.264	0.000	0.264	11.93
11				
12				

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FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Tuff/Sed mix 3

CLIENT SAMPLE NUMBER:
1108-34-03

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.292	0.291	0.000	0.00
2	0.122	0.094	0.028	0.03
3	3.705	0.000	3.705	3.73
4	4.454	0.041	4.413	8.15
5	0.912	0.000	0.912	9.06
6	0.571	0.022	0.549	9.61
7	0.835	0.000	0.835	10.44
8	0.516	0.006	0.510	10.95
9	0.574	0.000	0.574	11.53
10	0.452	0.005	0.448	11.97
11				
12				

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FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Tuff/Sed mix 4

CLIENT SAMPLE NUMBER:
1108-35-02

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.410	0.241	0.168	0.17
2	0.158	0.095	0.063	0.23
3	2.588	0.068	2.520	2.75
4	6.593	0.039	6.555	9.31
5	1.626	0.000	1.626	10.93
6	1.888	0.020	1.869	12.80
7	2.064	0.000	2.064	14.86
8	1.195	0.021	1.174	16.04
9	1.007	0.006	1.001	17.04
10	0.975	0.012	0.963	18.00
11				
12				

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IT Project No.: 831775.00000000

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ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Tuff/Sed mix 5

CLIENT SAMPLE NUMBER:
1108-36-03

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.239	0.225	0.014	0.01
2	0.101	0.126	-0.025	-0.01
3	1.279	0.024	1.255	1.24
4	5.053	0.069	4.983	6.23
5	0.540	0.064	0.477	6.70
6	0.118	0.065	0.053	6.76
7	0.190	0.016	0.173	6.93
8	0.194	0.046	0.148	7.08
9	0.175	0.034	0.140	7.22
10	0.124	0.006	0.118	7.34
11				
12				

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FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
LANL

Project No.:
831775.00000000

LAB SAMPLE NUMBER:
Tuff/Sed mix 6

CLIENT SAMPLE NUMBER:
1108-37-03

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.542	0.565	-0.023	-0.02
2	0.169	0.163	0.007	-0.02
3	0.000	0.000	0.000	-0.02
4	4.008	0.080	3.928	3.91
5	2.623	0.000	2.623	6.54
6	1.154	0.029	1.125	7.66
7	3.468	0.000	3.468	11.13
8	1.107	0.037	1.070	12.20
9	1.202	0.000	1.202	13.40
10	1.524	0.030	1.494	14.89
11				
12				

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ASTM D 4842

Project Name:
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Project No.:
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LAB SAMPLE NUMBER:
Tuff/Sed mix 7

CLIENT SAMPLE NUMBER:
1108-38-03

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.497	0.391	0.106	0.11
2	0.146	0.140	0.005	0.11
3	2.310	0.000	2.310	2.42
4	3.431	0.079	3.353	5.77
5	1.293	0.000	1.293	7.07
6	0.757	0.035	0.722	7.79
7	1.778	0.000	1.778	9.57
8	0.316	0.027	0.289	9.86
9	0.175	0.000	0.175	10.03
10	0.393	0.007	0.386	10.42
11				
12				

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FREEZE/THAW of SOLID WASTES
ASTM D 4842

Project Name:
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Project No.:
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LAB SAMPLE NUMBER:
Tuff/Sed mix 8

CLIENT SAMPLE NUMBER:
1108-39-03

CYCLE NUMBER	AVR RELATIVE MASS LOSS SAMPLE, %	AVR RELATIVE MASS LOSS CONTROL, %	AVR CORRECTED RELATIVE MASS LOSS, %	AVR CUMULATIVE CORR. RELALTIVE MASS LOSS, %
1	0.456	0.511	-0.055	-0.06
2	0.152	0.179	-0.026	-0.08
3	1.016	0.126	0.889	0.81
4	4.260	0.086	4.174	4.98
5	3.156	0.052	3.104	8.09
6	16.500	0.043	16.457	24.54
7	2.808	0.000	2.808	27.35
8				
9				
10				
11				
12				

Appendix C
Nonconformance / Variance Reports

NONCONFORMANCE/VARIANCE REPORT

NONCONFORMANCE or VARIANCE (circle one)	Project Name: LANL	Date: 1/3/02	Page 1 of 1
	Project No. 1-3-02 ~~817~~ 831775		Report No. ETDC-115-02-N

Nonconformance/Variance Description (include requirement violated

SAMPLE SHIPMENTS of RAW SOIL AND TUFF RECEIVED WITHOUT CHAIN-of-CUSTODY DOCUMENTS.

SHIPMENTS RECEIVED 12-17-01, 12-20,01

TEN SAMPLES TOTAL: MD21-01-0595, MD21-01-054401, MD21-01-0546, MD21-01-054901, MD21-01-054701, TUFF 595, TUFF 583, TUFF 564, MD21-01-0548, 564 SOIL

Identified by [signature]

Root Cause

N/A

Corrective Action (include expected completion date)

NOTIFY CLIENT

To be completed by — Expected Completion Date

Action taken to preclude recurrence

N/A

To be performed by — Expected Completion Date

Client notified (include client name, how notified, and response)

PAUL LOAR NOTIFIED VERBALLY

Notified by [signature] — Date 1/3/02

Corrective action completed by — Date

Corrective action approved by

Laboratory Supervisor _____ Date _____

Project Manager [signature] Date 1/3/02

QA Comments

QAO Approval — Date

Use back of page for additional space. Attach additional pages if necessary.

Appendix B – Performance Testing Reports

Appendix C – SEP Testing Reports

LANL (WASHINGTON GROUP) SEP Metals Analytical Data Summary
Date:3/25/02
PROJECT#831775

SEP FRACTION CONCENTRATIONS AS EXTRACTED

		SED	TUFF	SED/TUFF	110812	110920	110836	110838
Air Dried Sample Wt. (g):		45.04	45.01	45.00	44.99	45.01	45.00	44.99
Percent Solids (fraction)		1.000	1.000	1.000	1.000	1.000	1.000	1.000
Sample Dry Solids Weight (g):		45.040	45.010	45.000	44.990	45.010	45.000	44.990
Sample Water Weight (g):		0.000	0.000	0.000	0.000	0.000	0.000	0.000
Tare Wt (g)		36.54	38.71	38.14	38.43	38.18	38.13	38.62
Volume Extractant (mLs):		225	225	225	225	225	225	225
Ion Exchangeable	1		225 mLs 1M $MgCl_2$					
Density Extractant (g/mL):		1.0712						
Vol Extract Recovered (mL)		208.0	215.0	210.0	220.0	215.0	215.0	210.0
Gross wt Tare+residue (g)		97.24	105.91	201.85	97.33	97.58	96.80	98.84
Residue wt (g)		60.70	67.20	163.71	58.90	59.40	58.67	60.22
Weight Air Dry Solids (g):		45.04	45.01	45.00	44.99	45.01	45.00	44.99
Wt. Residual Liquid (g):		15.66	22.19	118.71	13.91	14.39	13.67	15.23
Density of Residual Liquid (g/mL):		1.071	1.071	1.071	1.071	1.071	1.071	1.071
Strontium -90	pCi/L	946.200	5006.900	2696.800	423.400	942.800	732.600	823.800
Cesium -137	pCi/L	0.074	76.146	16.382	0.011	174.750	38.025	35.079
Strontium -90	pCi/L	946.200	5006.900	2696.800	423.400	942.800	732.600	823.800
Cesium -137	pCi/L	0.074	76.146	16.382	0.011	174.750	38.025	35.079
Carbonate Fraction	2		225 mLs 1M NaOAC/25%HOAC pH 5.0					
Density Extractant (g/mL):		1.047						
Vol Extract Recovered (mL)		215.0	210.0	210.0	225.0	220.0	215.0	220.0
Gross wt Tare+residue (g)		96.51	110.77	103.80	94.88	97.78	95.32	95.08
Residue wt (g)		59.97	72.06	65.66	56.45	59.60	57.19	56.46
Weight Air Dry Solids (g):		45.04	45.01	45.00	44.99	45.01	45.00	44.99
Wt. Residual Liquid (g):		14.93	27.05	20.66	11.46	14.59	12.19	11.47
Density of Residual Liquid (g/mL):		1.048	1.049	1.055	1.048	1.048	1.048	1.048
Strontium -90	pCi/L	78.600	717.100	312.200	233.400	703.400	339.900	458.600
Cesium -137	pCi/L	0.0	237.4	67.9	43.7	406.70	82.07	94.88
corrected for liquid contribution								
Strontium -90	pCi/L	20.873	294.992	-577.737	210.298	650.282	300.579	409.638
Cesium -137	pCi/L	0.0	231.0	62.4	43.7	396.85	80.03	92.80

LANL (WASHINGTON GROUP) SEP Metals Analytical Data Summary
Date:3/25/02
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Weight Air Dry Solids (g):		45.04	45.01	45.00	44.99	45.01	45.00	44.99			
Wt. Residual Liquid (g):		15.66	22.19	118.71	13.91	14.39	13.67	15.23			
Oxyhydroxide Fraction 3		225 mLs 0.1M Hydroxylamine Hydrochloride pH 2									
Density Extractant (g/mL):		0.9881									
Vol Extract Recovered (mL)		215.0	220.0	215.0	220.0	220.0	215.0	220.0			
Gross wt Tare+residue (g)		96.66	104.01	102.38	94.32	92.95	94.10	91.86			
Residue wt (g)		60.12	65.30	64.24	55.89	54.77	55.97	53.24			
Weight Air Dry Solids (g):		45.04	45.01	45.00	44.99	45.01	45.00	44.99			
Wt. Residual Liquid (g):		15.08	20.29	19.24	10.90	9.76	10.97	8.25			
Density of Residual Liquid (g/mL):		0.992	0.994	0.993	0.991	0.992	0.991	0.991			
Strontium-90	pCi/L	26.400	307.800	106.400	152.000	404.500	168.700	209.900			
Cesium-137	pCi/L	29.78	162.26	23.09	25.68	126.990	22.31	40.03			
corrected for liquid contribution											
Strontium-90	pCi/L	21.722	234.069	81.403	141.186	363.527	151.997	188.636			
Cesium-137	pCi/L	29.775	137.847	.000	.000	103.300	18.275	35.627			
Organic Fraction	4		50 mLs 5% NaOCL(pH 8.5)								
Density Extractant (g/mL):		1.0798									
Vol Extract Recovered (mL)		220.00	215.00	220.00	230.00	220.00	230.00	220.00			
Gross wt Tare+residue (g)											
Residue wt (g)		-38.54	-38.71	-38.14	-38.43	-38.18	-38.13	-38.62			
Weight Air Dry Solids (g):		45.04	45.01	45.00	44.99	45.01	45.00	44.99			
Wt. Residual Liquid (g):		-81.58	-83.72	-83.14	-83.42	-83.19	-83.13	-83.61			
Density of Residual Liquid (g/mL):		1.074	1.073	1.073	1.076	1.076	1.076	1.077			
Strontium-90	pCi/L	21.900	60.800	43.000	44.200	124.200	51.900	58.600			
Cesium-137	pCi/L	84.	549.	146.	68.8.	542.77	167.5	157.5			
corrected for liquid contribution											
Strontium-90	pCi/L	20.229	35.207	34.568	37.115	107.247	43.990	51.110			
Cesium-137	pCi/L	82.135	535.848	143.990	67.605	537.448	166.444	156.072			

LANL (WASHINGTON GROUP) SEP Metals Analytical Data Summary
Date:3/25/02
PROJECT#831775

Weight Air Dry Solids (g):		45.04	45.01	45.00	44.99	45.01	45.00	44.99
Wt. Residual Liquid (g):		15.66	22.19	118.71	13.91	14.39	13.67	15.23
Sulfide Fraction	5	50 mLs 4M HNO_3						
Density Extractant (g/mL):		1.111						
Vol Extract Recovered (mL)		220.0	220.0	215.0	220.0	225.0	225.0	225.0
Gross wt Tare+residue (g)		97.65	107.47	103.17	91.33	91.65	92.24	93.16
Residue wt (g)		61.11	68.76	65.03	52.90	53.47	54.11	54.54
Weight Air Dry Solids (g):		45.04	45.01	45.00	44.99	45.01	45.00	44.99
Wt. Residual Liquid (g):		16.07	23.75	20.03	7.91	8.46	9.11	9.55
Density of Residual Liquid (g/mL):		1.130	1.131	1.131	1.130	1.129	1.130	1.129
Strontium -90	pCi/L	23.600	64.000	45.500	46.700	129.800	109.500	61.700
Cesium -137	pCi/L	2.321	8077.	3523.	1869.	54.1	2819.	2999.
corrected for liquid contribution								
Strontium -90	pCi/L	34.756	96.291	68.087	69.948	194.810	136.654	92.586
Cesium -137	pCi/L	2363.706	8368.552	3599.997	1904.988	338.230	2906.930	3082.014
Residual Fraction	6	Total HNO3/HF/HCL 3052						
Density Extractant (g/mL):		NA						
Fr 5 - Residue wt (g)		61.11	68.76	65.03	52.90	53.47	54.11	54.54
Fr 5 - Weight Air Dry Solids (g):		45.04	45.01	45.00	44.99	45.01	45.00	44.99
Fr 5 - Wt. Residual Liquid (g):		16.07	23.75	20.03	7.91	8.46	9.11	9.55
Fr 5 - Density of Res. Liq. (g/mL):		1.130	1.131	1.131	1.130	1.129	1.130	1.129
Fr 5 - Fr Air Dry Solids in Residue:		0.737	0.655	0.692	0.850	0.842	0.832	0.825
Fr 6 - Analysis aliquot (g)		2.85	2.92	2.87	3.33	3.36	3.43	3.52
Strontium -90	pCi/kg	2480.213	4362.676	4756.834	4203.788	7727.508	3192.248	3504.379
Cesium -137	pCi/kg	7.374	24.401	8.735	3.676	13.642	6.409	5.890
corrected for liquid contribution/aliquot/solids content								
Strontium -90	mg/Kg	3357.685	6665.391	6856.247	4935.616	9156.352	3618.875	4236.651
Cesium -137	mg/Kg	9272.059	33506.928	11236.649	4031.331	16196.721	7200.848	6576.191

LANL (WASHINGTON GROUP) SEP Metals Analytical Data Summary
Date:3/25/02
PROJECT#831775

Weight Air Dry Solids (g):		45.04	45.01	45.00	44.99	45.01	45.00	44.99			
Wt. Residual Liquid (g):		15.66	22.19	118.71	13.91	14.39	13.67	15.23			
SEP TOTAL SUMMED CORRECTED FOR SOLIDS CONTENT											
Strontium -90	mg/Kg	6458.27	36065.21	21852.12	9378.16	20354.56	10581.45	11957.58			
Cesium-137	mg/Kg	21895	61642	30674	14156	22573	23339	23732			

Sample SEP Fractional Metal Concentration

Field SAMPLE ID
TDL SAMPLE ID SED

SEP FRACTION CONCENTRATION, pCi/Kg, Dry Weight

	Ion Exchangeable		Carbonate		Oxyhydroxide		Organic		Sulfide		Residual		Total
	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg
Strontium -90	4726.798	55.4%	111.04	1.3%	115.379	1.4%	107.9	1.3%	115.03	1.3%	3357.68	39.3%	8533.8
Cesium-137	0.370	0.0%	0	0.0%	158.2	0.9%	438	2.5%	7823	44.2%	9272	52.4%	17691

Sample SEP Fractional Metal Concentration

Field SAMPLE ID
TDL SAMPLE ID TUFF

SEP FRACTION CONCENTRATION, pCi/Kg, Dry Weight

	Ion Exchangeable		Carbonate		Oxyhydroxide		Organic		Sulfide		Residual		Total
	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg
Strontium -90	25028.938	71.3%	1610.396	4.6%	1304.177	3.7%	192.0	0.5%	314.38	0.9%	6665.391	19.0%	35115.2
Cesium-137	380.645	0.6%	1261	1.9%	768.05	1.2%	2922	4.4%	27323	41.3%	33509	50.6%	66163

IT Corporation
3/25/02

BNL Sediments
Project No.: 829073.05000000

Sample SEP Fractional Metal Concentration

Field SAMPLE ID
TDL SAMPLE ID **SED/TUFF**

SEP FRACTION CONCENTRATION, pCi/Kg, Dry Weight

	Ion Exchangeable		Carbonate		Oxyhydroxide		Organic		Sulfide		Residual		Total
	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg
Strontium -90	13484.000	63.6%	**0.00**	0.0%	442.440	2.1%	187.7	0.9%	223.20	1.1%	6856.25	32.4%	21193.6
Cesium-137	81.9	0.3%	466	1.9%	0.0	0.0%	782	3.2%	11801	48.4%	11237	46.1%	24368

Sample SEP Fractional Metal Concentration

Field SAMPLE ID
TDL SAMPLE ID **110812**

SEP FRACTION CONCENTRATION, pCi/Kg, Dry Weight

	Ion Exchangeable		Carbonate		Oxyhydroxide		Organic		Sulfide		Residual		Total
	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg
Strontium -90	2117.471	22.7%	1112.42	11.9%	740.390	7.9%	194.7	2.1%	229.24	2.5%	4935.6	52.9%	9329.8
Cesium-137	0.05	0.0%	231	2.1%	0.0	0.0%	355	3.3%	6243	57.5%	4031	37.1%	10860

Sample SEP Fractional Metal Concentration

Field SAMPLE ID
TDL SAMPLE ID **110820**

SEP FRACTION CONCENTRATION, pCi/Kg, Dry Weight

	Ion Exchangeable		Carbonate		Oxyhydroxide		Organic		Sulfide		Residual		Total
	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg
Strontium -90	4712.953	23.1%	3444.77	16.8%	1929.632	9.4%	559.6	2.7%	639.24	3.1%	9158	44.8%	20444.5
Cesium-137	873.56	3.7%	2102	8.9%	548.3	2.3%	2804	11.9%	1110	4.7%	16197	68.5%	23635

Sample SEP Fractional Metal Concentration

Field SAMPLE ID
TDL SAMPLE ID **110836**

SEP FRACTION CONCENTRATION, pCi/Kg, Dry Weight

	Ion Exchangeable		Carbonate		Oxyhydroxide		Organic		Sulfide		Residual		Total
	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg
Strontium -90	3663.000	34.7%	1588.136	15.1%	799.261	7.6%	230.770	2.2%	448.576	4.3%	3818.875	36.2%	10548.6
Cesium-137	190.125	1.0%	423	2.3%	96.10	0.5%	873	4.8%	9542	52.1%	7201	39.3%	18325

Sample SEP Fractional Metal Concentration

Field SAMPLE ID
TDL SAMPLE ID **110838**

SEP FRACTION CONCENTRATION, pCi/Kg, Dry Weight

	Ion Exchangeable		Carbonate		Oxyhydroxide		Organic		Sulfide		Residual		Total
	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg	%	pCi/kg
Strontium -90	4119.916	34.1%	2178.099	18.0%	989.258	8.2%	265.1	2.2%	303.22	2.5%	4236.65	35.0%	12092.2
Cesium-137	175.434	1.0%	493	2.7%	186.836	1.0%	809	4.4%	10093	55.1%	6576	35.9%	18335