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HYDROGEOLOGIC DATA FOR SCIENCE TRENCH BOREHOLES
AT THE AREA 5 RADIOACTIVE WASTE MANAGEMENT SITE,
NEVADA TEST SITE, NYE COUNTY, NEVADA

By

Special Projects Section

Environmental Restoration & Technology Development Department

Environmental Management Division

Reynolds Electrical & Engineering Co., Inc.

December 1993

Work performed under contract

No. DE-AC08-94-NV11432

Prepared for

Department of Energy

Nevada Operations Office

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ACRONYMS

ASTM	American Society for Testing and Materials
CFR	Code of Federal Regulations
DBS&A	Daniel B. Stephens & Associates
DOE	Department of Energy
DRI	Desert Research Institute
ERWM	Environmental Restoration and Waste Management
HGC	Hydro Geochem, Inc.
INAA	Instrumental Neutron Activation Analysis
LANL	Los Alamos National Laboratory
LDR	Land Disposal Restricted
LLNL	Lawrence Livermore National Laboratory
LLW	Low-level Waste
LLWMU	Low-level Waste Management Unit
MOSS	Mobile Open Spindle Sample
MW	Mixed Waste
MWL	Meteoric Water Line
NMIMT	New Mexico Institute of Mining and Technology
NTS	Nevada Test Site
NV	Nevada Operations Office
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
REECo	Reynolds Electrical & Engineering Co., Inc.
RSN	Raytheon Services Nevada
RWMS	Radioactive Waste Management Site
SMOW	Standard Mean Ocean Water
SNL	Sandia National Laboratories
SOP	Standard Operating Procedure
SPS	Special Projects Section
TP	Test Plan
TRU	Transuranic Waste
USCS	Unified Soil Classification System
WMD	Waste Management Division
XRF	X-Ray Fluorescence

EXECUTIVE SUMMARY

A program to conduct drilling, sampling, and laboratory testing was designed and implemented to obtain important physical, geochemical, and hydrologic property information for the near surface portion of thick unsaturated alluvial sediments at the Area 5 Radioactive Waste Management Site (RWMS). These data are required to understand and simulate infiltration and redistribution of water as well as the transport of solutes in the immediate vicinity of existing and future low-level, mixed, and high-specific-activity waste disposal cells at the site. The program was designed specifically to meet data needs associated with a Resource Conservation and Recovery Act (RCRA) Part B permit application for disposal of hazardous mixed waste, possible RCRA waivers involving mixed waste, DOE Order 5820.2A, "Radioactive Waste Management," and 40 Code of Federal Regulations (CFR) 191 requirements for land disposal of radioactive waste.

Seven boreholes up to 120 ft in depth were located on a stable pediment surface along a 200 ft long transect aligned approximately parallel to the principal direction of sediment transport from the major alluvial fan in the basin. In addition, three boreholes were located in nearby channel deposits. Drilling and geologic sampling methods were used that minimally disturbed both the hydrologic properties and conditions of the samples and the formation. Laboratory tests were conducted on both representative core and drill cuttings samples to quantify the distribution with depth of important flow and transport related parameters.

The results of laboratory testing of core and drill cuttings samples indicate that the mineralogical, material, and hydrologic properties of the alluvial deposits penetrated are very similar. That is, the portion of the subsurface penetrated by the Science Trench Boreholes can be considered a homogeneous hydrologic system. These deposits have a very similar lithologic composition, virtually free of secondary carbonate layers, primarily coarse-grained with generally less than 10 percent fines. Their porosities, saturated hydraulic conductivities, moisture retention relations, and unsaturated hydraulic conductivities were also typical of coarse-grained material.

Measurements of hydrologic conditions on the same core and drill cuttings demonstrate that the water contents of these samples are very dry near the surface, increase only slightly with depth, and are characterized by a mean value of approximately 5 percent by weight. Water potential measurements on core samples show an upward potential gradient throughout the upper 120 ft of alluvium with the largest upward gradient in the upper 30 ft.

These hydrologic condition data, when combined with hydrologic property data, indicate that very little net liquid flow (if any) is occurring in the upper vadose zone, and the direction of movement is upward. It follows that vapor movement is probably the dominant mechanism of water transport in this upper region, except immediately following precipitation events.

Environmental tracer measurements of chloride, bromide, sulfate, stable isotopes of hydrogen and oxygen, and cosmogenic chlorine-36 concentrations made on water extracted from geologic samples obtained from different depths are consistent with the above conclusions based on hydraulic data. These environmental tracer data provide strong evidence that the direction of movement for both liquid water and vapor in the upper vadose zone is upward in response to the evaporative demand of the present arid climate.

Finally, a casing and screen system was stemmed in four of the approximately 120-ft-deep boreholes to permit access to selected vadose zone depth intervals for future in situ testing and monitoring.

1.0 INTRODUCTION

The Special Projects Section (SPS) of Reynolds Electrical & Engineering Co., Inc. (REECo) is responsible for characterizing the subsurface geology and hydrology of the Area 5 Radioactive Waste Management Site (RWMS) at the Nevada Test Site (NTS), Nye County, Nevada for the U.S. Department of Energy, Nevada Operations Office (DOE/NV), Office of Environmental Restoration and Waste Management (ERWM), Waste Management Division (WMD). Geologic description and laboratory analyses of alluvium in shallow boreholes are an important subpart of the Area 5 Site Characterization Program designed to determine the suitability of the RWMS for disposal of low-level waste (LLW), mixed waste (MW), and transuranic waste (TRU).

1.1 Purpose and Justification

The primary purpose of the Science Trench Borehole Project is to characterize important properties of the near-surface alluvium thought to play an important role in the infiltration and redistribution of water and the transport of solutes through the upper vadose zone at the Area 5 RWMS. The justification for this work comes from the state of Nevada review of the original DOE/NV Resource Conservation and Recovery Act (RCRA) Part B permit application submitted in 1988 for disposal of mixed waste at the RWMS. The state of Nevada determined that the permit was deficient in characterization data concerning the hydrogeology of the vadose zone. DOE/NV agreed with the State and proposed the study of the near-surface alluvium in a series of shallow boreholes as one step toward satisfying these important site characterization data requirements. Other components of the site characterization process include the Existing Excavations and Pilot Well Projects.

A number of other federal regulations and DOE orders justify the site characterization activities incorporated in the Science Trench Borehole Project. These regulations include specific RCRA requirements for the land disposal of hazardous waste, potential RCRA

waivers for mixed waste, as well as DOE Order 5820.2A and 40 CFR 191 requirements for land disposal of radioactive waste.

1.2 Scope of Report

This report briefly describes methods and results of near-surface drilling, sample collection, field geologic descriptions, and the laboratory analyses of core and drill cuttings samples for geologic, hydrologic, physical, environmental tracer, and geochemical parameters. These data are required to calculate the average recharge rates, to determine the spatial variability of recharge. They also serve as input parameters for modeling to simulate the rates and directions which contaminants (if released from wastes) might travel downward through the vadose zone to the groundwater and/or upward to the atmosphere. This report is designed to be a repository of methods and data, which is as complete and detailed as possible. For this reason, only qualitative analyses and preliminary interpretations of the data are presented. Additional detailed analyses and interpretations of these data will be presented in separate reports being developed for submittal to peer-reviewed professional journals.

1.3 Overview of Activities

A drilling and sampling program was designed to collect representative geologic samples and to obtain information about important physical, geochemical, and hydrologic properties for the near-surface portion of the unsaturated zone at the Area 5 RWMS. The sampling and testing activities of the Science Trench Borehole Project extend the site characterization work performed in the Existing Excavation Project to greater depths (up to 120 ft), thus investigating a greater range of geologic materials than was previously possible. Seven boreholes were located on a stable pediment surface on a 200-ft-long transect, approximately aligned with the principal direction of sediment transport for the Halfpint Alluvial Fan, the principal alluvial fan at the Area 5 RWMS. Three boreholes were located between 30 and 100 ft southeast of this transect in nearby channel deposits.

Drilling and sampling methods were selected to minimize sample disturbance of hydrologic properties and to minimize the effects of drilling and sampling on the formation. Core samples were collected by drive core methods used primarily inside a hollow stem auger drill system; drill cuttings samples were collected from a casing advance underreaming drill (ODEX) system. Three boreholes were continuously cored using the drive core methods, and five boreholes were cored at selected intervals using the same methods. Drill cuttings samples were collected from two boreholes which were drilled with the ODEX system.

A casing and screen system was stemmed in four of the approximately 120-ft-deep boreholes. This allowed access to selected vadose zone depth intervals for future in situ testing and monitoring.

The lithology of the cuttings and core were described in the field. Samples were then packaged as rapidly as possible to maintain their physical integrity and to minimize water loss by evaporation. Samples were then either shipped to various testing laboratories or stored (archived) for future use. Laboratory tests were conducted on both cuttings and core samples to quantify the distribution with depth of physical, hydrologic, geochemical, environmental tracer, and mineralogic parameters. The laboratory testing data will provide the necessary estimates necessary for input parameters required to model liquid and vapor flow of water, heat flow, and solute transport in the vadose zone and upper portions of the saturated zone at the site. These calculations will be combined with environmental tracer data to estimate recharge and travel times to the water table.

Statistical analyses were conducted to determine the range of properties over the site. Also developed was a preliminary statistical model for these properties at the RWMS.

1.4 Objectives

The present study was motivated by the need to predict water flow and solute transport at the Area 5 RWMS. At this site, trenches excavated in the alluvium are currently used for the

storage of low-level radioactive waste. Unsaturated water flow occurs through thick sequences of clastic, carbonate, and volcanic sediments deposited as alluvium and colluvium. The stratigraphy of these deposits has been described in boreholes (Miller, 1966) and consists of alternating sequences of fine- and coarse-grained materials with occasional lenses of coarse, stream channel deposits. Core specimens have been analyzed to obtain generalized properties for these materials (Dixon, 1965; Snyder et al., 1993), and the recently completed Existing Excavation Project has provided a detailed description of the hydrologic properties, horizontal spatial variability, and anisotropy of these materials (REECo, 1993). In the Existing Excavation Project, the horizontal variability of individual fine- and coarse-grained layers were determined for distances up to 600 ft. In this study, the properties of these materials are further investigated in a series of vertical boreholes. Most boreholes are located on a transect aligned with the principal direction of alluvium transport, thus providing detailed information on the variation of hydrologic properties of these materials on a two-dimensional plane that extends vertically from the surface to approximately 120 ft and horizontally for almost 200 ft. This additional information is needed because previous research suggests that flow and transport processes in these types of materials are truly three-dimensional (Wierenga, 1988).

The overall objective of site characterization activities at the Area 5 RWMS is to develop a comprehensive three-dimensional model for selected physical and hydrologic properties of the alluvial deposits for use in water and gas flow and solute transport modeling at the site. The overall objective of the Science Trench Borehole Project was to extend the zone of investigation of the Existing Excavations Project to a depth of 120 ft, the portion of the unsaturated zone believed to be most important for controlling infiltration, evapotranspiration, and recharge at the site. The specific technical objectives were:

- (1) To describe the mineralogy, lithology, and stratigraphy of near-surface alluvium for use in identifying potential flow paths in the upper vadose zone.

- (2) To determine the expected range of physical, mineralogical, geochemical, and hydrological properties of near-surface alluvium needed for predictive models of flow and transport in the upper vadose zone.
- (3) To measure the near-surface vertical distribution of environmental tracer concentrations needed to estimate long-term recharge rates.
- (4) To quantify the vertical spatial variability in physical, mineralogical, geochemical, and hydrological properties in the upper vadose zone.

1.5 Site Description

The study area is located within the RWMS in northern Frenchman Flat in Area 5 of the NTS, in southern Nevada. The NTS is a DOE facility occupying approximately 1,350 mi² approximately 65 miles northwest of Las Vegas. The NTS is bordered to the north and east by the Nellis Air Force Range, a government-owned restricted access area. Activities at the NTS include a variety of nuclear and non-nuclear projects and experiments.

The Area 5 RWMS encompasses 732 acres north of Frenchman Flat. Frenchman Flat is a closed basin; the RWMS is at an elevation of 3,200 ft at the intersection of three alluvial fans on a slope of about one degree. Source rocks for the alluvium are primarily tuffs with lesser amounts of lava flows, limestone and dolomite, and quartzite (RSN, 1991). Alluvial deposits consist of combinations of fine- and coarse-grained sediments that are differentiated by the degree of sorting, grain size distribution, clast abundance, and the presence or absence of bedding.

The Area 5 RWMS is located where several alluvial fans coalesce within the Frenchman Flat drainage basin (Dozier and Rawlinson, 1991). The Low-level Waste Management Unit is a 92-acre facility located in the southeast section of the RWMS. It was established in 1978 for the purpose of disposing of low-level waste generated at the NTS and other DOE facilities.

Current waste disposal operations at the RWMS include disposal of contact-handled low-specific-activity waste in shallow trenches and pits. Waste buried at the RWMS may be containerized in metal drums, plywood boxes, cardboard boxes, metal boxes, and nonstandard containers.

DOE/NV has in the recent past accepted low-level mixed waste containing hazardous constituents that are not land disposal restricted (LDR), and plans are being made to resume accepting this type of mixed waste in the near future. Moreover, high-specific-activity waste was buried at the RWMS in boreholes measuring approximately 10 ft in diameter and 120 ft in depth. Long-term DOE/NV waste management goals include obtaining regulatory approval to resume disposing high-specific-activity waste, as well as developing the capability to dispose of low-level mixed LDR waste, that does not meet treatment standards.

1.6 Site Climate and Meteorology

The climate and meteorology of the region are typical of the upper Mojave Desert province. Two major air movement patterns affect this area. Pacific air flowing over the Sierra Nevada exerts its influence from fall through spring. As the Pacific high-pressure area dissipates in summer, the warm moist air mass in the Gulf of Mexico exerts its influence. Average daily temperatures range from 2°C in January to 24°C in August. Precipitation is highly variable in the desert. The summer months are typified by intense, isolated thunderstorms, and the winter storms are of long duration and low intensity. The average precipitation is approximately 10 cm per year. The estimated evapotranspiration rate is 220 cm per year (EG&G/SAIC, 1991).

2.0 BOREHOLE DRILLING, CORING, AND COMPLETION METHODS

This section describes the drilling, sampling, and completion methods used in the Science Trench Borehole Project during the period from January 1992 to March 1992. Detailed descriptions of the procedures used are in REECO Quality Assurance Standard Operating

Procedures (SOPs) and Test Plans (TPs) listed in Table 1. In addition to following these formal procedures and recording field data on specific standard forms, daily information on drilling, sampling, and completion activities were recorded in the project logbooks.

2.1 Description of Sampling Scheme

The sampling scheme was designed to obtain information about important physical and hydrologic properties for alluvium to a depth of 120 ft, the portion of the unsaturated zone thought to control the important hydrologic processes of infiltration, evapotranspiration, and recharge. Sample size calculations performed for the Existing Excavations Project were used to determine the number of core specimens needed to estimate the mean values of hydrologic properties. These cores were supplemented by an additional set of cores to obtain a sufficient number of data locations to calculate informative vertical sample variograms. The completed design is shown in Figure 1; a summary of borehole depths, elevations, drilling methods, and completion methods are in Table 2. It was initially expected that mean particle sizes would decrease in the direction of alluvium transport. To test this hypothesis, seven of the ten boreholes were located on a 200-ft-long sampling transect that was approximately aligned with the principal sediment transport direction of the alluvial fan (Figure 1). The remaining boreholes were located between 30 and 100 ft southeast of this transect in the nearby channel deposits.

2.2 Drilling and Casing

The Science Trench Boreholes were drilled and completed by Boyles Brothers Drilling Company using hollow stem auger and percussion-hammer, casing-advance underreamer (ODEX) drilling systems (Appendix A).

Table 1. Standing Operating Procedures and Test Plans applicable to Science Trench Borehole drilling and completion.

Test Plans and Procedures	Title	Date	Revision
AADzD.T.04.00	Surface resistivity survey site characterization borehole	10/17/91	0
AADzD.T.06.00	Geologic logging of core and drill cuttings	2/13/92	0
AADzD.T.13.00	Determination of mineralogic and geologic characteristics of alluvial samples	1/13/91	0
WMD-T16	Science Trench sampling for determining characteristics of geologic samples	2/20/92	0
AADzD.D.04.00	Handling, division, preparation, control, and transport of characterization samples	2/13/92	0
WMD-D11	Handling in-progress data records for Special Projects Section activities	2/20/92	0
WMD-D12	Calculation check sheet	5/7/92	0
AADzD.03.00	Neutron logging, the vadose zone monitoring system	1/31/90	0
WMD-D17	Pilot Well abandonment	5/18/92	0

Figure 1. Cross-section along main sampling transect showing Science Trench Borehole locations and depths. Note boreholes ST-6, 6A, and 7 are projected into cross-section.

Table 2. Summary of basic Science Trench Borehole information.

Borehole	Drilling Method	Elevation (ft)	Total Depth (ft)	Completion Method
ST-1	ODEX¹	3,176.82	117.50	SS³
ST-2	HSA²	3,176.46	123.75	BF⁴
ST-2A	ODEX	3,177.76	120.00	SS
ST-3	HSA	3,177.93	14.25	BF
ST-4	HSA	3,178.74	113.75	BF
ST-4A	ODEX	3,179.06	120.00	SS
ST-5	HSA	3,179.27	37.50	BF
ST-6	HSA	3,176.31	116.17	BF
ST-6A	ODEX	3,176.67	120.00	SS
ST-7	HSA	3,178.91	35.00	BF

¹ODEX System 140

²Hollow stem auger

³Screened and stemmed

⁴Backfilled

2.2.1 Hollow Stem Auger Boreholes

Boreholes ST-1 through ST-7 were drilled using a Mobile Drill Model B-61 HDX auger rig. Hollow stem auger flights were used to advance the borehole and to provide access for coring by the drive or push core methods. Coring methods are described in detail in Section 2.3.1. The general drilling/coring operation first involved taking a core sample, then augering down to the bottom of the cored interval or onto the next core sample depth. This sequence of coring/drilling steps was repeated until total depth of the borehole was reached.

Surface casing was set in the first five boreholes (ST-1 through ST-5). The upper 10 ft of these boreholes were drilled using approximately 12.75-in outside diameter by 8.25-in inside diameter hollow stem auger flights. After reaching the 10-ft depth, the auger flights were removed and a 10-ft section of 10.75-in outside diameter carbon steel pipe was installed as a surface casing. Some water (approximately 5 gal) was added to each borehole prior to removing the augers in an attempt to stabilize the hole and reduce caving. Materials added to stabilize borehole walls near the ground surface are summarized in Appendix A.8.

Even after the addition of water, the boreholes still caved while the auger flights were being removed. After setting the 10.75-in casing on the fill material in each borehole, cement was poured into the annular space between the formation and the casing. The remainder of the casing sticking up was then cut off at ground level to permit drilling to continue. The shallow surface casing did not stay in place during the drilling of ST-1 and ST-2, and caving problems required setting surface casing to deeper depths. Attempts were then made to set surface casing at 25 and 30 ft in ST-1 and ST-2, respectively. Caving still occurred in both boreholes, and the actual depths of surface casing set in ST-1 and ST-2 were approximately 19.3 and 18.5 ft, respectively.

Extensive use of bentonite and water would probably have better stabilized the borehole walls and reduced caving, but this combination of materials would have significantly changed the permeability, thus possibly affecting subsequent data collection efforts. It should be noted

that ST-1 was completely redrilled with the ODEX system (Section 2.2.2) prior to installing the casing-screen access system (Section 2.5) in an effort to remove caved material as well as the previously added bentonite and water. Moreover, ST-2 was closed (abandoned) by backfilling with a low permeability mixture of bentonite and silica sand after the completion of drilling and coring. Borehole ST-2 was not used for any in situ tests.

After cementing the surface casing in place, augering and sampling activities were continued with a 4.25-in inside diameter by 7-in outside diameter auger. Occasionally, various size cobbles and boulders were encountered. In most cases these could be moved aside by working the auger bit up and down. However, in several instances, it was necessary to use an air percussion hammer with a chisel bit inside the hollow stem auger to break up the large rocks which were impeding the advancement of the auger.

The target borehole depth of approximately 120 ft was reached in boreholes ST-1, ST-2, ST-4, and ST-6. Borehole ST-3 was stopped at a depth of approximately 14 ft when a broken chisel bit could not be removed from the bottom of the borehole. Boreholes ST-5 and ST-7 were stopped at approximately 35 ft due to program constraints.

After reaching total depth in each borehole, the auger flights were removed. Original plans called for leaving the uncased boreholes open until time and funds were available to install vadose zone instruments. However, severe caving occurred in all boreholes as the auger flights were removed. In some cases all but 10 ft of the hole caved after removing the augers.

When it became apparent that the 4.25-in inside diameter hollow stem auger was not large enough to permit completion of the boreholes in the manner required (Section 2.5), a decision was made to use ODEX drilling and casing methods to facilitate completion of the four 120-ft boreholes. ODEX drilling activities are described in the following section.

2.2.2 ODEX Boreholes

The ODEX drilling system was used with a Schram Model T685 rotary rig. The ODEX 140 system drills used was approximately a 7.375-in borehole drill with a 6.625-in outside diameter steel casing and a dual wall drill pipe. Air was the only drilling fluid used. This drilling method has been described in detail by Hammermeister et al. (1986), therefore, only a brief description is included here.

This method uses a down hole percussion hammer to drill and ream at the bottom joint of the casing. A pilot bit, in conjunction with an eccentric reamer is used to drill a hole slightly larger than the outside diameter of the casing. The percussion hammer forces the casing down the borehole by impacting on a shoe attached to the bottom joint of the casing. Thus, the casing is advanced downward as the borehole is drilled deeper. Air (as drilling fluid) is introduced into the hole through the annulus between the inner and outer strings of the dual wall drill pipe. Cuttings are brought to the surface through the inner string of drill pipe, thereby minimizing the disturbance to the formation. The casing is advanced downward until the desired depth for coring is reached. After tripping out the drill rod, the interval is cored. After tripping the drill rod back in, the interval is enlarged (reamed) by advancing the casing to the bottom of the cored interval. This drilling, coring, reaming, and casing sequence is repeated until the total depth of the borehole is reached. After the total depth of the borehole is reached, the outer ODEX casing can be used to hold back the formation during the installation and stemming of an inner casing/screen assembly and/or vadose zone instrument packages.

This casing advance underreaming system is ideally suited for vadose zone characterization studies because it minimizes the disturbance of the in situ water content related properties in the cuttings, core, and formation. This method works well with air as a drilling fluid. It cases (seals off) the formation from the drying effects of air immediately above the drill bit, and minimizes the exposure of drill cuttings to the air by moving them rapidly and efficiently to the ground surface.

Borehole ST-1 was originally drilled by hollow stem auger methods and was redrilled and completed using the ODEX system. Significant deviation of the original auger borehole from the vertical resulted in a large amount of frictional resistance between the formation and the relatively rigid ODEX casing. To avoid this problem, ST-2A, ST-4A, and ST-6A were drilled as new boreholes located approximately 5 ft away from ST-2, ST-4, and ST-6 auger boreholes, respectively. Core samples were not collected from ST-4A, only cuttings samples. No geologic samples of any type were collected from ST-6A.

2.3 Geologic Sample Collection

The following sections describe methods used to obtain geologic samples for measurement of important physical, hydrologic, and geochemical parameters. These measurements are necessary to characterize the present day movement of fluids and solutes in the vadose zone and to model future movement of fluids and solutes. These methods were selected to ensure that geologic samples would be as representative as possible of in situ conditions.

2.3.1 Cores

Many of the laboratory tests described in Section 3 require samples with pore size distributions and water contents which are unaltered. The alluvial coring methods described below are the only known methods capable of producing this type of core sample from unconsolidated, relatively dry, coarse-grained alluvial deposits.

Three core sample collection systems were used in the Science Trench Boreholes: the standard 140-lb drop hammer core system, (used in geotechnical investigations), the Mobile Open Spindle Sample (MOSS) wire line core system, and the drive core-air percussion hammer system. All three coring systems were used with the auger rig. Only the drive core-air percussion hammer system was used with the ODEX drilling system. These systems and their relative success in obtaining core are described below.

The drop hammer core system utilizes a 140-lb weight which is dropped repeatedly over a 30-in stroke to drive a split- or solid-tube core barrel. The number of strokes and total penetration were recorded in the field logbook and the Borehole Log Sheets (Appendix B). Coring with this system started from the ground surface to a depth of 10 ft in ST-1. Full 30-in cores were obtained from these shallow depths, but this process was slow due to the extensive number of impacts needed (typically 80 to 150 or more). In some cases, even small rocks would completely stop the penetration of the system. At depths greater than 10 ft, the drop hammer core system was simply unable to penetrate the more consolidated formation, and its use was discontinued.

The MOSS system was developed by Mobile Drill Company as a means to rapidly obtain cores in hollow stem augers by using a wireline. The MOSS unit, attached to a solid-tube core barrel, was lowered inside the hollow stem auger via a wireline to the bottom auger flight where it locked into a special latching system which positions the cutting shoe on the core barrel slightly beyond the bottom most auger flight. The core barrel (which does not rotate) is pushed into the formation as the auger system is rotated and advanced downward. Several attempts were made at different depths to vary the distance the shoe on the core barrel extended past the auger bit from 0- (no recovery) to 6-in (unable to advance auger bit). Generally, core recovery was poor, and it was determined that the MOSS system was not suited for sampling alluvial materials at the Area 5 RWMS.

The drive core-air percussion hammer system proved to be very successful in obtaining intact and minimally disturbed core samples. A 3-in diameter Ingersoll-Rand air percussion hammer was used to drive either a heavy-walled 4.0-in outside diameter split-tube sampler or a heavy-walled solid-tube sampler. Both types of samplers were initially 2.5-ft-long by 3.5-in-inside diameter and contained 3-in-long by 3.5-in outside diameter Lexan (polycarbonate) core liners. The uphole threads on the split-tube samplers were damaged during coring and replaced on numerous occasions. The solid-tube samplers proved to be less susceptible to being damaged by the coring process.

The drive core-air percussion hammer system was run into the borehole on drill rods inside the hollow stem augers and ODEX casing to the sample point. The air percussion hammer was used to drive the samplers approximately 2.5 ft which typically required two to five minutes, depending on formation conditions. The air percussion hammer was periodically oiled with a small amount of Wesson vegetable oil. Core recovery was affected by large rocks occasionally blocking the sampler opening or core falling out of the sampler while "tripping out" to the ground surface.

Appendix C contains the details of all core runs in the Science Trench Borehole Project, including cored intervals, footage and percent recovery, penetration rate, and sample disposition.

2.3.2 Drill Cuttings

Drill cuttings samples from the ODEX-drilled boreholes, were collected at 2.5-ft depth intervals from a cyclone separator on the Schram T685 rotary rig. Cuttings samples were removed from the cyclone separator immediately after drilling each depth interval to minimize the potential for any further water content loss due to long residence times in the separator. These samples were then placed into jars, capped, labeled with appropriate sample identification information, and moved to a temperature-controlled field laboratory for geologic description and disposition. Drill cuttings samples were not collected during borehole cleaning activities, again to ensure that samples were as representative as possible.

2.4 Handling, Geologic Description, and Disposition of Samples

Lithologies were determined from core samples. Both drill cuttings and core samples were handled (in the field laboratory and during subsequent storage and transport) in a manner to minimize the evaporative loss of water from the samples, which, helped to ensure the water contents of the samples were as close to in situ conditions as possible. The reader is referred to appropriate SOPs (Table 1) for details of the procedures.

2.4.1 Core Samples

Core samples in liner segments were removed from the split-tube sampler by disassembling the sampler and simply lifting each Lexan segment out of the split-tube sampler. Core samples were removed from the solid-tube sampler by a pneumatic core extruder. A geologic description was made on the core by examining the open ends of each 3-in-long liner segment. This geologic description was recorded on the Borehole Log Sheets (Appendix B).

Following the geologic description, each 3-in-long core segment was capped, taped, and labeled with the appropriate sample identification information as well as the intended laboratory test for the sample. Core segments were further sealed in Protect-A-Core and labelled once again with the same information.

Most of the core segments were specified for different types of laboratory testing and the remainder stored for future use. Appendix C summarizes the different tests specified for each core run. The specific test of each 3-in-long core segment is indicated on the detailed Borehole Log Sheets (Appendix B). Because core recovery was not always 100 percent, and further, because some core segments were more disturbed than others (e.g., disturbance of water content, porosity, and aggregation from in situ conditions), the assignment of core segments for selected tests were based on a priority system. This system took into account the relative importance of different laboratory tests, as well as the degree of disturbance that was acceptable for each type of test; and is described in detail in the applicable TP (WMD-T16) listed in Table 1. The core assignment procedure was altered when a core run contained a stratigraphic contact. In this case, cores on both sides of the stratigraphic contact were assigned to the same high-priority hydrologic parameter tests.

2.4.2 Drill Cuttings Samples

A geologic description of drill cuttings samples from the ODEX drilling method was made once samples were transported to the temperature-controlled field laboratory. Sample jars

containing drill cuttings were briefly opened and the same geologic description and procedures referred to above for core samples were followed for drill cuttings samples. This descriptive information was recorded in a field logbook. Sample jar lids were then taped, sealed in Protect-A-Core, and labelled once again with appropriate sample identification information and intended test. Because these samples were more disturbed than core samples, fewer laboratory tests were specified.

Drill cuttings were not collected from hollow stem auger drilling because of the poor cuttings return and the caving problems which continually mixed cuttings from different levels in the auger boreholes.

2.4.3 Radiological Surveys of Geologic Samples

Radiation protection workers analyzed cuttings and core samples with a gamma spectrometer and collected swipe samples for alpha, beta, and tritium levels on a daily basis. Swipe samples were also collected from core barrels after each core run. All radiological monitoring results were consistent with natural levels of background radiation.

2.5 Borehole Completion and Closure

As mentioned above (Section 2.1), it was discovered during drilling that uncased boreholes would not stay open for future instrumentation and testing activities. To ensure that some of these boreholes could be used for future testing, a completion program was designed which involved stemming with an access casing of multiple well screen intervals in ST-1, ST-2A, ST-4A, and ST-6A. To provide flexibility for future testing, it was determined that this casing-screen access system should be a 4-in nominal diameter PVC flush-joint monitor well casing with 5-ft-long sections of 0.02-in slot well screen spaced at 15-ft intervals. Diagrams of this access casing and stemming material designed to isolate the screened intervals in this casing for each borehole are in Appendix I.

The completion program first involved running the casing-screen access system inside the ODEX 140 casing. As the ODEX casing was pulled out of the borehole, stemming materials were added to fill the annular space between the formation and the casing-screen access system. Stemming materials were poured from the ground surface and were allowed to free-fall to the bottom of the borehole. The screened sections were stemmed with 10/20 mesh (0.0331-0.0787-in grain size) "Colorado Silica Sand" to insure a high permeability pneumatic link between the formation and the well screen. The cased sections (regular blank casing) were stemmed with a 50/50 mixture of 10/20 mesh sand (as above) and Baroid "Aqua-Gel" powdered 200 mesh (0.0029 in) bentonite (sodium montmorillonite clay). The sand/bentonite mix was selected to provide a low-permeability annular seal to prevent preferential flow of fluids between well screens and from the ground surface in the vicinity of the boreholes. The air permeability of the dry soil/bentonite mix was found to be approximately $1.25 \times 10^{-11} \text{ cm}^2$ in laboratory tests. This value is at least three orders of magnitude less than the air permeability of the alluvial formation.

The depths to the top of each interval of different material were measured during the stemming operation. These stemming material depths, together with the screened depths, are presented in the completion diagrams in Appendix I. The contacts between material types were also determined indirectly by neutron-moisture logs (Appendix I) conducted several months after the completion of the boreholes. These logs suggest that the stemming materials had settled up to several feet since the original completion depths were measured. Sand intervals attenuate neutrons less than bentonite intervals, and the former are clearly shown as decreases in counts in these neutron logs. This settling of stemming materials is not surprising, considering the gravity free-fall methods of delivering stemming materials down the borehole, the small annular space between the 4-in PVC casing-screen system and ODEX casing, and the high humidity conditions (rainfall) during stemming activities.

All of the other auger boreholes were closed (abandoned) by first pulling the surface casing (if applicable) and then backfilling with the dry bentonite powder-sand mixture. This mixture has air and water permeabilities much lower than that of the surrounding formation. These

permeabilities are expected to decrease even further when the bentonite adsorbs water (hydrates) from the formation.

3.0 LABORATORY TESTING METHODS

This section presents a brief description of the laboratory testing methods used to obtain the data contained in this report. A summary of the tests and testing methods is in Table 3; additional details are contained in the cited references. REECo approved the Quality Assurance (QA) programs of the following laboratories: Daniel B. Stephens & Associates, Inc. (DBS&A), Albuquerque, New Mexico; Dr. B. Branvold, New Mexico Institute of Mining and Technology (NMIMT), Socorro, New Mexico; Dr. P. Kyle, NMIMT; and Hydro Geochem, Inc., (HGC), Tucson, Arizona, Sandia National Laboratories, Albuquerque, New Mexico was responsible for reviewing the QA programs for the laboratories of Dr. S. Tyler, Desert Research Institute (DRI), Reno, Nevada; and Dr. M. Caffee, Lawrence Livermore National Laboratory (LLNL), Livermore, California.

3.1 Stratigraphy, Lithology, Mineralogy, and Carbon

3.1.1 Stratigraphy and Lithology

Visual geologic descriptions were made on both core and cuttings samples and recorded on the Borehole Log Sheets (Appendix B). Procedures for the description and identification of core and drill cuttings samples are given in the REECo TP "Geologic Logging of Core and Drill Cuttings" (Table 1). This TP is based on the standard ASTM D 2488-90 procedure for describing unconsolidated soils which in turn incorporates the Unified Soil Classification System (USCS) for delineating major textural (particle size distribution) groups. The descriptive information collected on core and drill cuttings samples included USCS classification, shape and sorting of sands and gravels, color, major rock types and accessory minerals, moisture content, odor, cementation, stratification, reaction to dilute hydrochloric

Table 3. Summary of laboratory tests and testing methods.

Test	Method(s)	Reference(s)
Stratigraphy and Lithology	Geologic description	ASTM D2488-90
Mineralogy	X-ray fluorescence	Govindaraju (1989) Norrish and Hutton (1969) Jacobs et al. (1977)
	Instrumental neutron activation analysis	Lindstrom and Korotev (1982)
Inorganic Carbon	Pressure calcimetry	Nelson (1982)
Total Organic Carbon	Combustion	ASTM D 2579-85
Particle Size Distribution	Dry sieve/hydrometer	ASTM D 422-63
Bulk Density	Ring method	Blake and Hartge (1986)
Computed Porosity	Ring method	Danielson and Sutherland (1986)
Saturated Porosity	Pressure plate	Leamer and Shaw (1941)
Saturated Hydraulic Conductivity	Constant head Falling head	ASTM D 2434-68 Klute and Dirksen (1986)
Water Characteristic Curves	Hanging water column Pressure plate extractor Thermocouple psychrometer	Klute (1986) ASTM D 2325-68 Rawlins and Campbell (1986)
Unsaturated Hydraulic Conductivity	Computation	Mualem (1976)
Gravimetric and Volumetric Water Contents	Oven drying	ASTM D 2216-80
Matric Potential	Filter paper method	Campbell and Gee (1986)
Water Potential	Chilled mirror water activity meter	Gee et al. (1992)
Chloride and Bromide	Ion chromatography	LANL (1991), LANL (1992)
Stable Isotopes	Mass spectroscopy	
Chlorine-36	Toluene extraction Accelerator mass spectroscopy	Ingraham and Shadel (1992) Davis et al. (1990)
Soluble and Adsorbed Sulfate	Ion chromatography	Tabatabai (1982)

acid, plasticity, and the presence of roots. Field descriptions of texture were supplemented with textural classifications based on laboratory particle size analysis data on the final versions of the Borehole Log Sheets in Appendix B.

3.1.2 Mineralogy

Core samples were pulverized and subsampled for major elements (SiO, TiO₂, Al₂O₃, Fe₂O₃, MnO, MgO, CaO, Na₂O, K₂O, and P₂O₅) and trace elements (Rb, Sr, Zr, Y, Nb, Pb, Th) analyzed by X-ray fluorescence (XRF). The weight loss on ignition (LOI) was also determined for each sample as a check on the quality of the analyses.

XRF analyses were made on fused disks (major elements) and pellets (minor elements) prepared using the methods of Norrish and Hutton (1969). Fused disks were prepared by oxidizing approximately 0.5 g of finely powdered soil in a crucible at high temperature; pellets were prepared by compressing approximately 7 g of soil into a mold at high pressure. The fused disks were then analyzed in a Rigaku Model 3064 X-ray fluorometer. The instrument was calibrated using suites of well characterized international rock standards listed by the International Working Group on Analytical Standards of Minerals, Ores and Rocks (Govindaraju, 1989). Additional rock standards were run as unknowns to determine accuracy and precision.

Selected core samples were also analyzed for the following elements by instrumental neutron activation analysis (INAA): FeO, Na₂O, Sc, Cr, Zn, As, Br, Sb, Cs, Ba, La, Ce, Nd, Sm, Eu, Tb, Yb, Lu, Hf, Ta, Th, and U.

INAA analyses were made using packed sample vials prepared using the method of Jacobs et al. (1977). Approximately 100 mg of finely ground soil were packed and sealed in polyethylene or silica vials. Packed samples and standards were irradiated at either the University of Missouri Research Reactor or Texas A & M University Nuclear Science Center. Results were interpreted using software developed by Lindstrom and Korotev (1982).

National Institute of Standards and Technology standard reference material 1633a (coal fly ash) was used to calibrate all elements measured by INAA except Na_2O . The Na_2O calibration standard and the standard used for the QA/QC measurements were the U.S. Geological Survey basalt (BCR-1) and granite (G-2) respectively. Both XRF and INAA analyses were conducted by Dr. P. Kyle, NMIMT.

3.1.3 Carbon

Selected soil samples were prepared for carbon analyses using U.S. Environmental Protection Agency Standard Method No. 9060 (U.S. EPA, 1986).

Total organic carbon content of soil samples was determined using ASTM (D 2579-85), a dry combustion method, and an Oceanographic Instruments Model 524D Total Carbon System instrument. Inorganic carbon content of soil samples was determined using the pressure-calculator method (Nelson, 1982). Carbonates present in soil samples were oxidized by hydrochloric acid, liberating carbon dioxide gas which was quantified using the Model 524D instrument. Carbon measurements were performed by Dr. D. Branvold, NMIMT.

3.2 Physical Properties

Several physical properties are relatively easy and inexpensive to measure and provide valuable insight into understanding the hydrogeologic system beneath the Area 5 RWMS. These properties include particle size distributions, bulk density, and porosity. Particle size distributions of alluvial samples are not sensitive to sample disturbance (as long as all size fractions are represented in the sample) and were determined on both intact core and drill cuttings samples. Bulk density and porosity, however, are dependent on the preservation of particle packing and structure, which can be altered by sample collection. For this reason, bulk density and porosity were only measured on intact core samples.

3.2.1 Particle Size Distributions

Particle size distributions were determined for drill cuttings and core samples by dry sieving and hydrometer (ASTM D 422-63). The dry sieve method was selected because analyses conducted in the Existing Excavations Project (REECo, 1993) indicated only small differences existed between particle size distributions obtained in these materials by the dry sieving versus the more expensive wet sieving method. Because sieving destroys the physical integrity of core samples, this test was always performed after tests to determine bulk density, porosity, saturated hydraulic conductivity, and water characteristic curve data were completed. Grain size diameter parameters d_{10} , d_{50} , and d_{60} were computed from the particle size distributions using linear interpolation; for example, 10 percent of a sample's weight has a particle size smaller than d_{10} .

Particle size analyses were conducted on all cuttings samples (collected at 2.5-ft depth intervals) and on two 3-in. core segments from each core run. The particle size measurements were performed by DBS&A.

3.2.2 Bulk Density and Porosity

Dry bulk densities, ρ_b (g/cm³), were determined on two 3-in-long core segments from each core run using the method in Blake and Hartge (1986). Saturated porosity, Φ (%), was measured directly using the method in Leamer and Shaw (1941). Computed porosity was estimated using the formula: $\Phi = 100(1 - \rho_b/\rho_g)$, where ρ_g is the grain (particle) density. A grain density value of 2.65 g/cm³ was assumed for these calculations. Dry bulk densities and porosity measurements were performed by DBS&A and Dr. S. Tyler, DRI, Reno, NV.

3.3 Hydrologic Properties

3.3.1 Saturated Hydraulic Conductivity

Saturated hydraulic conductivity, K_s (cm/s), was determined on one 3-in-long core segment from each core run using the constant head (ASTM D 2434-68) and falling head (Klute and Dirksen, 1986) methods. Saturated hydraulic conductivity measurements were performed by DBS&A.

3.3.2 Water Characteristic Curves

Water characteristic curve data, $h(\Theta)$, where h is matric potential in cm of water and Θ is volumetric water content (cm^3/cm^3), were determined for selected core using the methods in Klute (1986), ASTM D 2325-68, and Rawlins and Campbell (1986). Preliminary examination of water characteristic curves indicated that they could be described well by the van Genuchten equation (van Genuchten, 1980). The equation was fit to each water characteristic curve to obtain values for residual water content and the shape parameters α and n using the program RETC (van Genuchten, 1980). The van Genuchten equation is:

$$\Theta = \Theta_r + (\Theta_s - \Theta_r) \left[\frac{1}{1 + (\alpha h)^n} \right]^m \quad (1)$$

where Θ is volumetric water content, Θ_r is the residual volumetric water content, Θ_s is the saturated volumetric water content, h is matric potential expressed as a pressure head (cm), and $m = 1 - 1/n$. For the purpose of fitting Equation 1, the value of Θ at $h = -0.1$ cm was used for Θ_r . Water characteristic curves measurements were performed by DBS&A.

3.3.3 Unsaturated Hydraulic Conductivity

Unsaturated hydraulic conductivity, $K(S)$, for core samples is generally calculated from water characteristic curve and saturated hydraulic conductivity data because direct measurement is

extremely difficult, especially at low water contents. In this report, $K(S)$ was computed using the fitted values of n and m from Equation 1 and the Mualem (1976) model of unsaturated hydraulic conductivity expressed as:

$$K(S) = K_s S^{1/2} \left[1 - (1 - S^{1/m})^m \right]^2 \quad (2)$$

where S is the effective saturation defined as:

$$S = \frac{(\Theta - \Theta_r)}{(\Theta_s - \Theta_r)} \quad (3)$$

In this report, unsaturated hydraulic conductivity data are presented in the form $K(\Theta)$, which can be obtained by solving Equation 3 for Θ as a function of S and substituting this function into Equation 2.

3.4 Hydrologic Conditions

3.4.1 Water Content

Gravimetric water content, w (%), was determined for drill cuttings and cores samples using ASTM D 2216-80. Volumetric water content, Θ (cm^3/cm^3), was determined for core samples using ASTM D 2216-80. Measurements were performed by DBS&A and Dr. S. Tyler, DRI, Reno, NV.

3.4.2 Water Potential and Matric Potential

Water potential, defined as the sum of matric and osmotic potentials, was measured on soil samples using two methods. The chilled mirror method (Gee et al., 1992) was used on all soil samples designated for water potential measurement. The filter paper method (Campbell and Gee, 1986) was used on selected duplicate samples to permit comparison of methods. In the chilled mirror method, a small quantity of soil is brought into vapor equilibrium with a mirror in a closed chamber. The temperature of the mirror is slowly decreased until the dew point is reached. Equilibrium relative humidities in the atmosphere above the soil sample

(and a series of salt solutions used for instrument calibration) were determined from measured dew point temperatures. These values were converted to equivalent water potentials using thermodynamic relations (the Kelvin Equation).

The filter paper method first involves developing standard curves that relate the matric potential and water content for selected filter paper. A sample of soil is then brought into vapor equilibrium with a piece of preweighed, initially-dry filter paper by sealing the soil and paper in a closed chamber for seven days. The filter paper is then removed from the chamber and weighed to determine its water content. The water potential and/or matric potential of the soil sample is then determined from the standard curve. If water is transferred via liquid flow from the soil to the filter paper, values from the standard curve are considered matric potentials. If water is transferred primarily via vapor diffusion, the resulting values are considered water potentials. Because of the unknown relative amounts of liquid flow and vapor diffusion, the resulting values in this study will be arbitrarily assumed as water potentials. Water potential and matric potential measurements were conducted by Dr. S.Tyler, DRI, Reno, NV.

3.5 Environmental Tracers

3.5.1 Chloride and Bromide

Chloride and bromide concentrations were determined using methods developed by Los Alamos National Laboratory (LANL, 1991; LANL, 1992). A 50 g subsample was extracted by reacting with distilled water. Chloride and bromide concentrations were then measured on aliquots of the extraction fluid using an Dionex Model 4000i ion chromatograph. Standard curves were prepared using sodium bromide and sodium chloride standard solutions. Precision for this method was determined to be approximately 5 percent. Detection limits were 0.05 ppm for chloride and 0.02 ppm for bromide. Chloride and bromide measurements were conducted by Dr. D. Bravold, NMIMT.

3.5.2 Stable Isotopes

Stable isotope concentrations were determined by first extracting soil samples using a toluene distillation procedure (Ingraham and Shadel, 1992). Aliquots of the extracted fluid were then vaporized and stable isotope concentrations were measured using a mass spectrometer.

Precision for this method was determined to be approximately 1 percent for δD and approximately 0.2 percent for $\delta^{18}O$. All values are reported using the standard notation as percent variation of Standard Mean Ocean Water (SMOW) (Ferronsky and Polyakov, 1982). Stable isotope concentrations were measured at DRI, Las Vegas, NV, under the direction of Dr. S. Tyler.

3.5.3 Chlorine-36

Chlorine-36 was extracted from soil by reacting soil samples (approximate mass of 1 kg) with reagent-grade water in proportions ranging from 1:1 to 1:3 (volume of soil:volume of water) for 48 hours. Aliquots of the extracted fluid were then analyzed for chlorine isotopes using a tandem accelerator mass spectrometer. Extractions were performed by Hydro Geochem, Inc., Tucson, Arizona; spectrometer measurements were performed by Dr. M. Caffee, LLNL.

3.5.4 Soluble and Adsorbed Sulfate

Soluble sulfate concentrations were determined by extracting approximately 5 g of soil with 0.1M lithium chloride solution in a batch reactor for one hour (Tabatabai, 1982). Sulfate concentrations were then measured on aliquots of the extracted fluid using an Dionex Model 4000i ion chromatograph. The detection limit was 0.05 ppm.

Adsorbed sulfate concentrations were determined using the soil from the batch reactors used in the soluble sulfate analyses. Soil was separated from the extraction fluid by centrifugation and repeatedly washed with distilled water to ensure complete removal of any remaining soluble sulfate. The washed soil was centrifuged and adsorbed sulfate was removed by

extracting the washed soil with distilled water containing 500 ppm calcium phosphate and 0.1M lithium chloride in a batch reactor for one hour. Adsorbed sulfate concentrations were then measured on aliquots of the extraction fluid using an Dionex Model 4000i ion chromatograph. The detection limit was 0.05 ppm. Soluble and adsorbed sulfate measurements were conducted by Dr. D. Branvold, NMIMT.

4.0 RESULTS

As described in Section 3, core and drill cuttings samples were sent to a number of different testing laboratories to measure a range of properties. In most cases, a testing laboratory conducted several related tests on the same sample. For example, gravimetric water content, bulk density, porosity, saturated hydraulic conductivity, water characteristic curves, and particle size distributions were conducted on the same core sample. A number of samples were placed in storage (archived) for additional testing as required.

A summary of the numbers and types of tests performed on core and drill cuttings samples is given in Table 4; a complete listing of all laboratory data is given in the appendices.

Several of the physical and hydrologic properties determined by laboratory testing (porosity, saturated hydraulic conductivity, water characteristic curve, and matric potential) are influenced by the pore size distribution of the soil. Therefore, any disturbance of the in situ pore size distribution resulting from the sampling process can affect the validity of laboratory measurements. For example, drive coring may compact core samples, increasing bulk density, decreasing porosity and saturated hydraulic conductivity, and altering water characteristic curve data obtained for the core compared to in situ soil conditions. Also, the pore size distribution of a core sample may be altered by handling and laboratory testing, for example, by a loss of fines or by loosening of soil cores in the sample holders. Although the magnitudes of these effects caused by the sampling and testing procedures used in this study are unknown, measured values of parameters reported here are generally within the range of values for similar coarse-grained materials previously reported in the literature.

Table 4. Summary of numbers of tests performed on core and drill cuttings samples from Science Trench Boreholes.

Core

<u>Borehole</u>	<u>Particle size distribution</u>	<u>Gravimetric water content</u>	<u>Volumetric water content</u>	<u>Bulk density</u>	<u>Saturated porosity</u>	<u>Water potential</u>
ST-1	32	155	82	82	40	41
ST-2	36	193	100	100	43	55
ST-2A	4	14	4	8	4	47
ST-3	4	4	-	-	-	4
ST-4	40	174	93	93	39	30
ST-5	9	45	23	23	10	14
ST-6	18	80	42	42	19	23
ST-7	13	47	21	21	11	10

<u>Borehole</u>	<u>Saturated hydraulic conductivity</u>	<u>Water characteristic curves</u>	<u>Carbon</u>	<u>Chloride</u>	<u>Bromide</u>	<u>Sulfate</u>	<u>XRF¹, INAA</u>	<u>Stable isotopes</u>	<u>³⁶Cl</u>
ST-1	41	5	34	41	41	36	32	12	6
ST-2	46	-	37	57	57	37	36	7	-
ST-2A	4	-	7	3	3	4	-	3	-
ST-3	-	-	4	3	3	4	4	-	-
ST-4	53	15	43	29	29	43	3	7	-
ST-5	10	-	9	14	14	9	4	-	-
ST-6	19	-	18	18	18	18	-	-	-
ST-7	11	-	13	13	13	4	-	-	-

Drill cuttings

<u>Borehole</u>	<u>Particle size distribution</u>	<u>Gravimetric water content</u>	<u>Water potential</u>	<u>Carbon</u>	<u>Chloride</u>	<u>Bromide</u>	<u>Sulfate</u>	<u>Stable isotopes</u>
ST-2A	42	85	43	38	41	41	41	4
ST-4A	-	12	12	12	11	11	12	-

¹XRF and INAA are methods used to measure element and oxide composition (see Section 3.1.2).

4.1 Stratigraphy, Lithology, Mineralogy, and Carbon

4.1.1 Lithology and Stratigraphy

Information on lithology and stratigraphy are needed to define the geometry of the flow system, identify layers with distinctive physical and hydrologic properties, and identify important flow paths or processes important for modeling water, heat, and solute flow at the site. Descriptions of the lithology and stratigraphy are contained on the Borehole Log Sheets (Appendix B).

Geologic descriptions of core and drill cuttings samples indicated that soil materials were composed primarily of tuff clasts with occasional clasts of quartzite and limestone. Basalt clasts were even rarer and only identified in a few samples. The degree of welding in tuff clasts (observable only in large clasts) ranged from welded to non-welded. Soils were generally weakly cemented to uncemented and exhibited a weak to moderate reaction to dilute hydrochloric acid. Typically, well sorted gravels are less angular than poorly sorted fractions of similar particle size. Cobbles were generally subrounded. The general color of the alluvial samples was predominantly very pale brown to light yellowish brown. Gravels, when separated from other size fractions, were pink and gray in color.

A summary of the USCS classification data for all samples is in Table 5 (the justification for combining core and cuttings samples was given in Section 3.2). Approximately two-thirds of the samples were classified as either poorly-graded sand with silt, SP-SM (29 percent), or well-graded sand with silt, SW-SM (36 percent). Only a small portion of the samples contained significant amounts of gravel or clay. There were no apparent differences in numbers of specific USCS classifications among the boreholes, and core and cuttings samples appeared to give generally similar results.

The Science Trench Boreholes were drilled along the western margin of the lower-to-middle part of the Halfpint Alluvial Fan, below its apex where flow paths are unpredictable

Table 5. Summary of USCS group names for core and drill cuttings samples from Science Trench Boreholes.

Borehole	Sample Type	Number and percent of samples with given USCS group names ¹										TOTAL
		SM-SC	SM	SP-SM	SW-SM	SP-1	SW-1	GM	GP	GW-1	GW-GM	
ST-1	Core	4 (12%)	2 (6%)	8 (24%)	14 (42%)		3 (9%)		1 (3%)	1 (3%)		33
ST-2A	Core and drill cuttings		8 (18%)	14 (31%)	16 (36%)		7 (16%)					45
ST-2	Core	1 (3%)	4 (10%)	12 (31%)	17 (44%)	1 (3%)	4 (10%)					39
ST-3	Core		3 (75%)		1 (25%)							4
ST-4A	Drill cuttings		2 (12%)	4 (33%)	6 (50%)							12
ST-4	Core	2 (4%)	9 (17%)	15 (29%)	20 (38%)	3 (6)	1 (2%)	1 (2%)			1 (2%)	52
ST-5	Core		3 (33%)	3 (33%)	1 (11%)	1 (11%)	1 (11%)					9
ST-6	Core		2 (11%)	6 (34%)	4 (22%)	3 (17%)	3 (17%)					18
ST-7	Core			4 (31%)	3 (23%)	2 (15%)	3 (23%)			1 (8%)		13
TOTAL		7 (3%)	33 (15%)	66 (29%)	81 (36%)	10 (4%)	22 (10%)	1 (0.4%)	1 (0.4%)	2 (0.9%)	1 (0.4%)	224

Group Names:

SM-SC: Silty sand with clay (greater than 12% silt)

SM: Silty sand (greater than 12% silt)

SP-SM: Poorly-graded sand with silt (from 5 to 12% silt)

SW-SM: Well-graded sand with silt (5 to 12% silt)

SP: Poorly-graded sand (less than 5% silt)

SW: Well-graded sand (less than 5% silt)

GM: Silty gravel (greater than 12% silt)

GP: Poorly-graded gravel

GW: Well-graded gravel

GW-GM: Well-graded gravel with silt (5 to 12% silt)

(Schmeltzer et al., 1993). Alluvial fans are formed as detrital material is eroded, carried by water and gravity down-slope, and redeposited. A previous study (Dozier and Rawlinson, 1991), of surface exposures of alluvial fan deposits in the general vicinity of the Area 5 RWMS and of subsurface exposures in shallow (approximately 30 ft deep) waste disposal excavations within the Area 5 RWMS, suggested that the primary depositional processes involved in forming these alluvial fans were sheet floods debris and channel flows. These types of processes often combine to produce deposits with a highly variable and discontinuous stratigraphy, both in the lateral and vertical directions (Snyder et al., 1993).

Preliminary stratigraphic columns were prepared for the Science Trench Boreholes using the USCS group names and particle size distribution data (Appendix B). The columns show the vertical distribution of USCS group names and the percentages of gravel (percent passing the No. 4 sieve) and fines (percent passing the No. 200 sieve). These data indicate that individual soil horizons are generally less than 5 ft thick and that the thickest layers consist primarily of well-graded, fine-grained materials. These layers alternate with thin layers consisting of poorly-graded, coarse-grained materials. The discontinuous nature of soil layers makes it difficult to correlate individual textural units between boreholes located approximately 50 ft apart. In some cases it is even difficult to correlate textural units between boreholes, (drilled with different methods) separated by only 5 ft.

Although it was not possible to correlate textural units between boreholes, this does not pose a significant problem for understanding hydrologic processes in the near-surface unsaturated zone. It is shown qualitatively in Sections 4.2 and 4.3, and quantitatively in a report prepared for submittal to a peer-reviewed professional journal (Sully et al., 1993), that the physical and hydrologic properties of these textural units required to simulate fluid flow are very similar, and that the portion of the subsurface penetrated by the Science Trench Boreholes can be considered an approximately homogeneous hydrogeologic system. Istok et al. (1993) reached similar conclusions based on an analysis of hydrogeologic data for individual fine- and coarse-grained alluvial layers exposed in 600-ft-long lateral transects in two existing excavations within the Area 5 RWMS.

4.1.2 Mineralogy

Information on the mineralogy of soil materials is useful for identifying soil horizons with chemical properties that have the potential to affect the transport of contaminants. For example, certain waste components may adsorb strongly to certain mineral surfaces. Clay minerals, because of their large specific surface area and charge, may be particularly important for attenuating the transport of some solutes. For this reason, selected core samples were sent to Sandia National Laboratories for identification of individual clay minerals by x-ray diffraction. However, these analyses had not been completed at the date of publication of this report.

The mineralogy of soil materials was assessed using whole-sample analyses for element and oxide composition. A complete listing of composition data is in Appendix H; Tables 6 and 7 and Figures 2 and 3 illustrate some of the major trends. Overall, the elemental composition of minerals remained fairly constant with depth. It should be noted that full depth profiles of the data were limited to ST-1 and ST-2, with selected core samples analyzed from ST-4 and ST-5. These analyses further indicate that the Science Trench Borehole samples have the same general composition as the source rock for the alluvium at the Area 5 RWMS, that is, primarily Tertiary volcanics from the Massachusetts Mountains (Timber Mountain Tuff). These results are consistent with visual lithologic descriptions described in Section 4.1.1. The Tertiary volcanics, and subsequently the alluvium, have a basic rhyolitic composition of approximately 65 percent SiO_2 and 13 percent Al_2O_3 ; all other major elements total less than 5 percent.

4.1.3 Carbon

Information on inorganic and organic carbon are useful for identifying soil layers that have the potential for retarding the movement or altering the chemical behavior of contaminants (Domenico and Schwartz, 1990). For example, many organic contaminants are strongly sorbed to organic carbon. Inorganic carbon measurements can help to identify caliche

Table 6. Descriptive statistics for element and oxide composition data for core samples from borehole ST-1; "min" and "max" are minimum and maximum, "mean" and "s" are the sample mean and standard deviation, "CV" is coefficient of variation and "n" is sample size.

	% Composition by weight														
	SiO ¹	TiO ₂ ¹	Al ₂ O ₃ ¹	Fe ₂ O ₃ ¹	MnO ¹	MgO ¹	CaO ¹	Na ₂ O ¹	K ₂ O ¹	P ₂ O ₅ ¹	LOI ²	H ₂ O ¹	FeO ³	Na ₂ O ³	
min	58.99	0.17	7.15	1.22	0.04	0.55	2.51	1.68	1.86	0.03	4.08	0.63	1.15	1.76	
max	78.63	0.38	132.30	2.68	0.08	1.96	9.51	3.19	4.14	0.12	12.30	5.55	2.44	3.15	
mean	64.94	0.26	15.87	1.88	0.06	1.27	5.00	2.77	3.53	0.06	7.65	2.48	1.62	2.71	
s	3.54	0.05	21.28	0.30	0.01	0.33	1.56	0.28	0.40	0.02	1.83	1.07	0.25	0.30	
CV (%)	5.50	18.50	134.10	16.20	17.80	25.70	31.30	10.00	11.30	26.70	23.90	43.10	15.30	11.00	
n	32	32	32	32	32	32	32	32	32	32	32	32	21	21	

	Composition (ppm)												
	Sc ³	Cr ³	Zn ³	As ³	Br ³	Rb ⁴	Rb ³	Sr ⁴	Y ⁴	Zr ⁴	Nb ⁴	Sb ³	Cs ³
min	2.38	7.0	25.0	2.9	1.5	70.0	58.0	162.0	18.0	114.0	12.0	0.0	1.6
max	6.11	25.0	81.0	7.1	5.2	170.0	1115.0	386.0	30.0	250.0	24.0	0.7	5.4
mean	4.00	12.0	44.5	5.0	2.3	117.3	149.6	328.9	24.6	173.3	18.4	0.5	3.4
s	0.77	3.5	11.1	0.9	0.9	18.2	177.4	46.8	2.3	28.8	2.3	0.1	0.8
CV (%)	19.20	29.4	25.0	18.1	39.8	15.5	118.6	14.2	9.4	16.6	12.5	27.7	22.7
n	32	32	32	32	32	32	32	32	32	32	32	32	32

	Composition (ppm)														
	Ba ³	La ¹	Ce ³	Nd ³	Sm ³	Eu ³	Tb ³	Yb ³	Lu ³	Hf ³	Ta ³	Pb ⁴	Th ⁴	Th ³	U ³
min	197.0	29.7	60.0	16.0	3.46		0.40	1.30	0.21	3.23	1.01	14.0	8.0	8.0	1.7
max	737.0	71.6	130.3	46.2	7.00		0.92	2.90	0.42	8.46	1.75	25.0	19.0	17.3	5.7
mean	570.5	42.9	81.2	28.4	5.30		0.66	2.29	0.33	5.42	1.36	21.8	15.5	14.5	3.5
s	112.5	8.5	14.8	6.2	0.64		0.08	0.28	0.04	0.99	0.18	2.2	2.0	1.8	0.6
CV (%)	19.7	19.8	18.2	21.9	12.10		12.60	12.3	12.70	18.20	13.20	10.2	13.0	12.5	18.6
n	32	32	32	32	32		32	32	32	32	32	32	32	32	32

¹Analyzed by major element XRF methods

²LOI means "loss on ignition"

³Analyzed by INAA methods

⁴Analyzed by trace element XRF methods

Table 7. Descriptive statistics for element and oxide composition data for core samples from borehole ST-2; "min" and "max" are minimum and maximum, "mean" and "s" are the sample mean and standard deviation, "CV" is coefficient of variation and "n" is sample size.

% Composition by weight														
	SiO ¹	TiO ₂ ¹	Al ₂ O ₃ ¹	Fe ₂ O ₃ ¹	MnO ¹	MgO ¹	CaO ¹	Na ₂ O ¹	K ₂ O ¹	P ₂ O ₅ ¹	LOI ²	H ₂ O ¹	FeO ³	Na ₂ O ³
min	55.62	0.20	10.60	1.52	0.04	0.68	1.42	2.11	2.84	0.04	4.42	0.96	1.38	2.17
max	70.62	0.36	13.74	2.58	0.07	2.58	8.87	3.46	4.33	0.11	16.50	4.55	2.36	3.38
mean	64.27	0.27	12.40	2.01	0.06	1.17	4.80	2.78	3.58	0.06	7.92	2.30	1.76	2.83
s	2.65	0.04	0.63	0.28	0.01	0.35	1.55	0.27	0.28	0.02	2.14	0.92	0.25	0.26
CV (%)	4.10	14.30	5.10	13.80	13.20	29.50	32.30	9.60	7.80	30.70	27.00	40.10	14.30	9.10
n	36	36	36	36	36	36	36	36	36	36	36	26	37	37

Composition (ppm)														
	Sc ³	Cr ³	Zn ³	As ³	Br ³	Rb ⁴	Rb ³	Sr ⁴	Y ⁴	Zr ⁴	Nb ⁴	Sb ³	Cs ³	
min	3.09	6.70	37.00	3.40	0.50	82.00	85.00	196.00	21.00	150.00	14.00	0.30	2.32	
max	5.58	22.90	105.00	8.30	4.00	172.00	175.00	405.00	34.00	256.00	25.00	3.80	5.50	
mean	4.15	12.55	48.38	5.29	2.24	118.00	116.00	335.90	25.11	178.70	18.73	0.61	3.50	
s	0.63	4.07	11.52	1.12	0.78	18.14	18.72	43.16	2.59	23.39	2.10	0.55	0.73	
CV (%)	15.3	32.40	23.80	21.30	35.00	15.40	16.10	12.90	10.30	13.10	11.20	89.60	20.80	
n	37	37	37	37	37	37	37	37	37	37	37	37	37	

Composition (ppm)															
	Ba ³	La ³	Ce ³	Nd ³	Sm ³	Eu ³	Tb ³	Yb ³	Lu ³	Hf ³	Ta ³	Pb ⁴	Th ⁴	Th ³	U ³
min	411.00	34.40	65.60	22.00	4.72	0.64	0.58	1.84	0.27	4.24	1.10	14.00	9.00	11.40	2.50
max	840.00	66.40	122.20	41.00	7.30	0.99	0.89	3.25	0.43	7.84	1.86	26.00	22.00	20.20	4.60
mean	619.60	47.59	88.90	30.82	5.73	0.83	0.69	2.33	0.33	5.73	1.38	21.92	15.24	15.18	3.40
s	92.37	8.24	14.93	4.23	0.63	0.09	0.08	0.29	0.04	0.73	0.17	2.23	2.61	1.87	0.42
CV (%)	14.90	17.30	16.80	13.70	11.10	10.80	11.20	12.70	10.60	12.70	12.30	10.20	17.10	12.40	12.40
n	37	37	37	37	37	34	37	37	37	37	37	37	37	37	37

¹Analyzed by major element XRF methods

²LOI means "loss on ignition"

³Analyzed by INAA methods

⁴Analyzed by trace element XRF methods

Figure 2. Depth profiles of element and oxide composition data by XRF for core samples from borehole UE5ST-2.

Figure 2. (Continued)

Figure 2. (Continued)

Figure 3. Depth profiles of element and oxide composition data by INAA for core samples from borehole UE5ST-2.

Figure 3. (Continued)

Figure 3. (Continued)

(carbonate cemented) layers. Caliche layers have extremely low porosities and hydraulic conductivities and thus can greatly influence hydrologic processes of infiltration, redistribution, and recharge.

Appendix F contains a complete listing of inorganic and organic carbon data for all core and drill cuttings samples. The data show that inorganic carbon concentrations are very low (mean values are less than 1 percent by weight [Table 8]). Depth profiles of inorganic carbon show that inorganic carbon concentrations are relatively constant throughout the thickness of alluvium penetrated by the Science Trench Boreholes (Figure 4). This implies that the source rock for the entire thickness of alluvium penetrated contained approximately the same percentage of carbonates and that significant deposits of caliche were absent.

Organic carbon concentrations, although generally an order of magnitude lower than inorganic carbon concentrations, were also uniform, indicating the absence of significant humus accumulation by soil-forming processes. The absence of caliche and humus layers also supports the hypothesis (discussed in the following sections) that the hydrogeologic system at the Area 5 RWMS can be considered to be a homogeneous hydrogeologic system.

4.2 Physical Properties

4.2.1 Particle Size Distributions

Information on particle size distributions is useful because many hydrologic properties are at least partially correlated with the proportion of fine and coarse particles in a sample. Particle size distribution data, therefore, may provide a relatively inexpensive way for identifying soil layers with distinctive hydraulic properties.

Table 8. Descriptive statistics for carbon data for core samples from Science Trench Boreholes; "min" and "max" are minimum and maximum, "mean" and "s" are the sample mean and standard deviation, "CV" is coefficient of variation and "n" is sample size.

<u>ST-1</u>				<u>ST-2A</u>			
	Organic carbon (%)	Inorganic carbon (%)	Total carbon (%)	Organic carbon (%)	Inorganic carbon (%)	Total carbon (%)	
min	0.030	0.220	0.270	0.020	0.320	0.350	
max	0.120	2.000	2.090	0.090	1.130	1.180	
mean	0.062	0.676	0.738	0.048	0.695	0.743	
s	0.021	0.311	0.323	0.014	0.171	0.176	
CV (%)	34.9	46.1	43.8	28.8	24.6	23.7	
n	34	34	34	45	45	45	

<u>ST-2</u>				<u>ST-3</u>			
	Organic carbon (%)	Inorganic carbon (%)	Total carbon (%)	Organic carbon (%)	Inorganic carbon (%)	Total carbon (%)	
min	0.02	0.130	0.150	0.100	0.700	0.800	
max	0.11	1.300	1.350	0.140	1.200	1.310	
mean	0.061	0.657	0.718	0.118	0.900	1.018	
s	0.021	0.250	0.257	0.014	0.187	0.185	
CV (%)	35.2	38.1	35.9	11.7	20.8	18.1	
n	37	37	37	4	4	4	

<u>ST-4A</u>				<u>ST-4</u>			
	Organic carbon (%)	Inorganic carbon (%)	Total carbon (%)	Organic carbon (%)	Inorganic carbon (%)	Total carbon (%)	
min	0.410	0.610	1.090	0.020	0.300	0.320	
max	0.860	0.970	1.630	0.130	1.870	1.940	
mean	0.594	0.786	1.380	0.063	0.796	0.858	
s	0.115	0.105	0.182	0.025	0.305	0.315	
CV (%)	19.4	13.4	13.2	40.2	38.4	36.7	
n	12	12	12	43	43	43	

<u>ST-5</u>				<u>ST-6</u>			
	Organic carbon (%)	Inorganic carbon (%)	Total carbon (%)	Organic carbon (%)	Inorganic carbon (%)	Total carbon (%)	
min	0.04	0.400	0.550	0.030	0.260	0.290	
max	0.15	0.970	1.030	0.120	1.260	1.320	
mean	0.079	0.652	0.731	0.065	0.799	0.863	
s	0.033	0.174	0.161	0.024	0.232	0.236	
CV (%)	41.4	26.6	22.0	37.4	29.1	27.3	
n	9	9	9	18	18	18	

<u>ST-7</u>							
	Organic carbon (%)	Inorganic carbon (%)	Total carbon (%)				
min	0.040	0.290	0.370				
max	0.100	1.010	1.110				
mean	0.071	0.689	0.761				
s	0.018	0.158	0.162				
CV (%)	25.0	23.0	21.3				
n	13	13	13

Figure 4. Depth profiles of inorganic carbon data for core samples from Science Trench Boreholes.

Appendix D contains a complete listing of particle size distribution data for core and drill cuttings samples. The overall character of the materials is that of a well-graded, medium sand with considerable amounts of gravel and less than 10 percent fines (Table 9). Soils were classified in the field using the USCS as SW, SP, and SM with lesser amounts of SW, SC, GM, GW, and GP (Table 5). Appendix B, "Borehole Log Sheets" lists the USCS classification for each core run.

Plots of the percent passing the No. 4 and No. 200 sieves vs. depth illustrate the extreme uniformity of particle sizes in the alluvium at this site (Figures 5 and 6). Particles larger than the No. 4 sieve (4.75 mm) are classified as gravel and particles smaller than the No. 200 sieve (0.075 mm) are classified as fines (silt and clay). These plots show the vertical distribution of percent gravel, sand, and fines (combined silt and clay).

Figure 6 compares the vertical distributions of percent gravel, sand, and fines for core samples from borehole ST-2 and for drill cuttings samples from borehole ST-2A. These boreholes were located less than 5 ft apart. The amount of fines (percent passing No. 200 sieve) are remarkably constant between boreholes and sample type. Variability in the amount of gravel (percent passing No. 4 sieve) was slightly larger and this may be due to a number of geologic, drilling, and sampling related factors. Clearly, differences in sample sizes can complicate the interpretation of the amount of coarse fragments in these materials.

Based on the extreme uniformity of distribution of particle sizes with depth, it is expected that hydraulic properties (saturated hydraulic conductivity, water characteristic curve data, and unsaturated hydraulic conductivity) will also be uniform with depth.

4.2.2 Bulk Density and Porosity

Information on bulk density and porosity is required because these properties are input parameters for numerical simulations of fluid, heat, and solute transport. Porosity (saturated volumetric water content) is also used to fit water characteristic curve data with functional

Table 9. Descriptive statistics for particle size distribution data for core and drill cuttings samples in Science Trench Boreholes; "min" and "max" are minimum and maximum, "mean" and "s" are the sample mean and standard deviation, "CV" is coefficient of variation and "n" is sample size.

ST-1 (core)

	percent passing indicated sieve size -----									
	3/4	3/8	4	6	10	16	40	70	140	200
min	61.60	56.40	52.70	50.70	47.90	44.60	29.60	14.80	4.60	2.50
max	100.00	98.50	94.70	90.10	86.70	82.40	69.40	49.20	23.50	16.30
mean	95.75	91.02	85.42	80.17	73.84	67.49	50.71	30.25	12.22	7.77
s	12.05	12.36	11.31	11.88	13.49	14.85	14.88	11.29	5.31	3.80
CV(%)	12.60	13.60	13.20	14.80	18.30	22.00	29.30	37.30	43.40	48.90
n	32	32	32	32	32	32	32	32	32	32

ST-2A (core and drill cuttings)

	percent passing indicated sieve size -----									
	3/4	3/8	4	6	10	16	40	70	140	200
min	66.40	59.80	53.20	50.70	47.60	40.30	26.10	14.8	4.80	2.90
max	100.00	99.50	97.40	96.00	94.70	92.70	84.20	62.1	25.90	15.70
mean	98.57	94.34	86.81	81.93	75.54	68.41	51.68	32.82	13.37	8.55
s	6.34	7.78	10.25	10.88	12.35	13.23	13.18	10.13	4.67	3.15
CV(%)	6.40	8.20	11.80	13.30	16.30	19.30	25.50	30.9	34.90	36.80
n	45	45	45	45	45	45	45	45	45	45

ST-2 (core)

	percent passing indicated sieve size -----									
	3/4	3/8	4	6	10	16	40	70	140	200
min	73.40	69.10	65.80	58.80	44.20	30.40	16.60	10.90	5.40	3.50
max	100.00	100.00	99.60	99.60	99.40	97.80	77.20	55.90	24.60	20.40
mean	95.96	91.10	84.44	79.17	72.83	66.54	51.13	32.43	13.26	8.50
s	6.66	7.55	8.77	10.19	12.71	14.66	15.12	11.60	4.82	3.38
CV(%)	6.90	8.30	10.40	12.90	17.50	12.00	29.60	35.80	36.30	39.80
n	36	36	38	38	38	38	38	38	38	38

ST-4 (core)

	percent passing indicated sieve size -----									
	3/4	3/8	4	6	10	16	40	70	140	200
min	57.10	47.20	42.10	39.60	36.60	33.90	28.80	16.70	6.70	4.50
max	100.00	100.00	100.00	100.00	99.70	98.20	78.50	55.10	29.30	22.60
mean	94.10	89.56	84.47	80.16	74.85	69.19	54.28	35.18	15.07	9.63
s	9.59	11.11	11.39	11.80	12.12	12.09	11.05	9.04	5.20	3.99
CV(%)	10.20	12.50	13.50	14.70	16.20	17.50	20.30	25.70	34.50	41.40
n	52	52	55	55	55	55	55	55	55	55

Table 9. (Continued).

ST-5 (core)

	percent passing indicated sieve size									
	3/4	3/8	4	6	10	16	40	70	140	200
min	90.20	83.00	80.04	74.40	69.60	63.80	30.90	7.20	1.70	1.20
max	100.00	100.00	99.50	99.00	96.00	83.80	71.10	53.00	29.50	21.40
mean	98.51	95.97	88.71	84.78	80.48	74.31	53.68	32.11	14.19	10.20
s	3.11	5.79	6.51	7.96	8.29	7.11	10.80	11.93	7.39	5.98
CV(%)	3.10	6.00	7.30	9.40	10.30	9.60	20.10	37.20	52.10	58.40
n	9	9	9	9	9	9	9	9	9	9

ST-6 (core)

	percent passing indicated sieve size									
	3/4	3/8	4	6	10	16	40	70	140	200
min	75.70	65.00	51.20	46.40	41.40	36.30	23.20	12.60	3.70	2.50
max	100.00	99.50	98.80	95.80	92.20	87.80	76.60	56.80	25.00	16.20
mean	94.58	88.24	82.41	78.03	73.15	67.33	50.14	29.92	12.54	8.05
s	7.13	10.25	13.05	13.46	14.03	14.28	14.53	12.94	6.01	3.67
CV(%)	7.50	11.60	15.80	17.20	19.20	21.20	29.00	43.20	47.90	45.60
n	18	18	18	18	18	18	18	18	18	18

ST-7 (core)

	percent passing indicated sieve size									
	3/4	3/8	4	6	10	16	40	70	140	200
min	56.10	53.20	50.90	49.60	47.50	43.30	27.90	13.20	5.40	3.90
max	100.00	97.70	95.20	92.10	89.30	86.00	73.20	45.30	16.10	9.20
mean	94.46	89.14	83.31	78.03	72.36	66.07	47.79	26.92	9.95	5.95
s	11.96	12.41	12.66	12.54	12.79	13.15	13.58	10.41	3.50	1.82
CV(%)	12.60	13.90	15.20	16.10	17.70	19.90	28.40	38.70	35.20	30.60
n	13	13	13	13	13	13	13	13	13	13

Figure 5. Depth profiles of selected particle size distribution data (percent passing No. 4 and No. 200 sieves) for core samples from Science Trench Boreholes.

Figure 6. Depth profiles of selected particle size distribution data (percent passing No. 4 and No. 200 sieves) for core and drill cuttings samples from Science Trench Boreholes.

relationships needed for unsaturated fluid flow modeling. Appendix D contains a complete listing of all bulk density and porosity data.

Plots of both bulk density and computed porosity vs. depth for boreholes ST-1, ST-2, ST-4, and ST-6 show no consistent trends within or between boreholes except for a slight increase in bulk density and decrease in porosity with depth in the upper 20 ft of each borehole (Figures 7 and 8). Mean values and coefficients of variation for all boreholes are nearly identical (Table 10). This uniformity in bulk density may be due to a number of factors including uniformity in particle size distributions, mineralogy, lithology, and the near absence of secondary mineral cementing agents. The low values measured in ST-2 near the 85-ft depth (Figure 7) are most likely an artifact of sampling. Finally, it is not known if the slightly higher bulk densities of a number of core samples from ST-1 are indicative of in situ material properties or merely an artifact of sampling.

4.3 Hydrologic Properties

Hydrologic properties are required, together with hydrologic conditions, to simulate water movement and to estimate travel times in the unsaturated zone. The most important hydrologic properties for water flow modeling are the unsaturated hydraulic conductivity and water characteristic functions. Unsaturated hydraulic conductivity functions are very difficult, if not impossible, to measure in the laboratory on the very dry in situ water contents (Section 4.4) found in the vadose zone beneath the Area 5 RWMS. In this study, parameters defining the unsaturated hydraulic conductivity functions in Equation 3 (Section 3.3.3) were estimated using measured values of saturated hydraulic conductivity and the fitted van Genuchten parameters. Water characteristic functions were obtained by fitting measured water characteristic curve data.

Figure 7. Depth profiles of bulk density for core samples from Science Trench Boreholes.

Figure 8. Depth profiles of computed porosity for core samples from Science Trench Boreholes.

Table 10. Descriptive statistics for bulk density and porosity for core samples from Science Trench Boreholes; "min" and "max" are minimum and maximum, "mean" and "s" are the sample mean and standard deviation, "CV" is coefficient of variation and "n" is sample size.

	<u>ST-1</u>			<u>ST-2A</u>		
	Bulk density (g/cm ³)	Computed porosity (%)	Saturated porosity (%)	Bulk density (g/cm ³)	Computed porosity (%)	Saturated porosity (%)
min	1.35	26.30	26.30	1.460	31.30	27.10
max	1.95	48.90	43.70	1.820	44.50	38.30
mean	1.56	40.68	34.78	1.621	38.75	32.38
s	0.11	4.84	3.18	0.105	3.87	4.56
CV (%)	7.3	11.9	9.1	6.5	10.0	14.1
n	82	41	40	10	10	6

	<u>ST-2</u>			<u>ST-4</u>		
	Bulk density (g/cm ³)	Computed porosity (%)	Saturated porosity (%)	Bulk density (g/cm ³)	Computed porosity (%)	Saturated porosity (%)
min	1.030	33.60	28.90	1.370	31.40	7.20
max	1.840	52.70	44.50	1.710	48.20	40.10
mean	1.554	42.18	37.35	1.527	42.45	35.30
s	0.113	3.67	3.78	0.073	2.63	5.12
CV (%)	7.3	8.7	10.1	4.8	6.2	14.5
n	100	45	43	93	53	39

	<u>ST-5</u>			<u>ST-6</u>		
	Bulk density (g/cm ³)	Computed porosity (%)	Saturated porosity (%)	Bulk density (g/cm ³)	Computed porosity (%)	Saturated porosity (%)
min	1.440	32.70	27.40	1.470	33.90	28.40
max	1.870	43.70	34.60	1.800	44.60	39.40
mean	1.622	38.11	31.69	1.604	40.44	34.41
s	0.112	4.08	2.80	0.091	2.82	2.92
CV (%)	6.9	6.9	8.8	5.7	7.0	7.0
n	23	23	10	42	19	19

	<u>ST-7</u>		
	Bulk density (g/cm ³)	Computed porosity (%)	Saturated porosity (%)
min	1.410	32.60	27.20
max	1.830	46.80	39.90
mean	1.623	39.69	32.35
s	0.115	4.38	3.70
CV (%)	7.1	11.0	11.4
n	21	11	11

4.3.1 Saturated Hydraulic Conductivity

A complete listing of saturated hydraulic conductivity data for core samples from the Science Trench Boreholes is in Appendix D. Measured values ranged from 1×10^{-5} to 4.9×10^{-3} cm/s and mean values from all boreholes were all on the order of 10^{-4} cm/s (Table 11). Also, although the coefficient of variations of the measured values were fairly large (between 50 and 150 percent), as is expected for this property, there were no apparent trends with depth (Figure 9). These values are typical of values for silty sand alluvial deposits reported in the literature (Freeze and Cherry, 1979). Previous statistical analyses of saturated hydraulic conductivity have indicated that this parameter is lognormally distributed; however, the descriptive statistics in Table 13 were not computed on the logarithms of the data to permit easier comparison with data for other soil properties presented in this report. More detailed interpretations of the data will be presented elsewhere in a peer-reviewed journal format.

4.3.2 Water Characteristic Curves

A complete listing of water characteristic curve data for cores from the Science Trench Boreholes is in Appendix E. Composite water characteristic curves (all cores from ST-1 and ST-4) are plotted in Figure 10. The data were very similar for all cores tested; the range in observed volumetric water content for each value of pressure head was between 5 and 8 percent. Saturated water contents, Θ_s , ranged from 33 to 40 percent and residual water contents, Θ_r , ranged from 0 to 10 percent. Descriptive statistics for fitted van Genuchten (equation 2, Section 3.3.3) parameters are in Table 12. The range in fitted parameters was generally small with coefficients of variation less than 32 percent. These parameter values are similar to those reported for individual fine and coarse layers in the Existing Excavations Project Data Report (REECO, 1993).

Table 11. Descriptive statistics for saturated hydraulic conductivity for core samples from Science Trench Boreholes; "min" and "max" are minimum and maximum, "mean" and "s" are the sample mean and standard deviation, "CV" is coefficient of variation and "n" is sample size.

	<u>ST-1</u> Saturated hydraulic conductivity (cm/s)	<u>ST-2A</u> Saturated hydraulic conductivity (cm/s)	<u>ST-2</u> Saturated hydraulic conductivity (cm/s)
min	3.3×10^{-5}	2.1×10^{-5}	4.1×10^{-5}
max	4.9×10^{-3}	9.0×10^{-4}	4.1×10^{-3}
mean	7.25×10^{-4}	2.99×10^{-4}	6.49×10^{-4}
s	9.20×10^{-4}	3.38×10^{-4}	8.86×10^{-4}
CV (%)	126.9	113.0	136.4
n	41	6	46
	<u>ST-4</u> Saturated hydraulic conductivity (cm/s)	<u>ST-5</u> Saturated hydraulic conductivity (cm/s)	<u>ST-6</u> Saturated hydraulic conductivity (cm/s)
min	1.9×10^{-5}	2.3×10^{-4}	1.0×10^{-5}
max	4.3×10^{-3}	1.5×10^{-3}	3.7×10^{-3}
mean	2.91×10^{-4}	8.37×10^{-4}	7.77×10^{-4}
s	9.04×10^{-4}	4.89×10^{-4}	9.89×10^{-4}
CV (%)	114.2	58.4	127.4
n	53	10	19
	<u>ST-7</u> Saturated hydraulic conductivity (cm/s)		
min	1.2×10^{-4}		
max	2.1×10^{-3}		
mean	9.65×10^{-4}		
s	6.73×10^{-4}		
CV (%)	69.8		
n	11

Figure 9. Depth profiles of saturated hydraulic conductivity for core samples from Science Trench Boreholes.

Figure 10. Composite water characteristic curve data for core samples from ST-1 and ST-4.

Table 12.

Descriptive statistics for fitted van Genuchten parameters for water characteristic curve data from all core samples and all Science Trench Boreholes combined; "min" and "max" are minimum and maximum, "mean" and "s" are the sample mean and standard deviation, "CV" is coefficient of variation and "n" is sample size.

Statistic	Θ_r (cm ³ /cm ³)	Θ_s (cm ³ /cm ³)	α (cm ⁻¹)	n
min	0.00	0.33	0.008	1.18
max	0.10	0.40	0.189	3.16
mean	0.511	0.363	0.034	1.604
s	4.034	2.00	0.041	0.456
CV (%)	79.0	5.5	121.0	28.4
n	20	20	20	20

Figure 11. Fitted unsaturated hydraulic conductivity functions for core samples from ST-1 and ST-4.

4.3.3 Unsaturated Hydraulic Conductivity

Computed unsaturated hydraulic conductivity functions for selected cores from boreholes ST-1 and ST-4 illustrate the range of fitted values obtained (Figure 11). These plots illustrate that unsaturated hydraulic conductivities decrease sharply with decreasing water contents. At the low measured in situ formation water contents (Section 4.4.1), the unsaturated hydraulic conductivities are 5 to more than 20 orders of magnitude less than saturated hydraulic conductivities reported in the previous section.

4.4 Hydrologic Conditions

Hydrologic conditions are parameters that vary over time. These include gravimetric and volumetric water contents and water potential. The gradient of water potential values (i.e., the difference in water potential between two points divided by the distance separating the points) is one of the primary forces which drive the movement of liquid. Information on hydrologic conditions is needed to determine if the profile is in hydrologic equilibrium at the time of sampling, to predict directions and rates of insitu water flow, and serve as initial conditions for numerical water flow modeling. At equilibrium, the relationship between the water content and water potential is determined by the water characteristic function.

4.4.1 Water Content

A complete listing of water content data obtained for core and drill cuttings samples are in Appendices D and F. Descriptive statistics (Table 13) and plotted vertical profiles (Figures 12 and 13) indicate that water content values are remarkably low and constant throughout the approximately 120 ft of alluvium penetrated by the Science Trench Boreholes. The only noticeable trend is possibly a slight increase in water content with depth (Figures 12 and 13). The mean values of volumetric water contents of core samples from ST-1 and ST-4 (Table 13) correspond to the high potential portion of the water characteristic curves measured on core samples from these same boreholes shown in Figure 10. This indicates that in situ

Table 13. Descriptive statistics for water content and water potential data for core samples from Science Trench Boreholes; "min" and "max" are minimum and maximum, "mean" and "s" are the sample mean and standard deviation, "CV" is coefficient of variation and "n" is sample size.

	<u>ST-1</u>			<u>ST-2A</u>		
	Gravimetric water content (%)	Volumetric water content (%)	Water potential (bars)	Gravimetric water content (%)	Volumetric water content (%)	Water potential (bars)
min	1.90	3.80	-83.8	2.90	5.80	-69.40
max	9.20	13.30	-15.0	7.40	10.00	-19.10
mean	5.19	8.34	-28.9	4.78	7.40	-34.44
s	1.39	1.95	17.5	0.86	1.23	11.73
CV (%)	26.8	23.4	60.6	18.1	16.6	34.1
n	155	82	41	99	10	47

	<u>ST-2</u>			<u>ST-4A</u>		
	Gravimetric water content (%)	Volumetric water content (%)	Water potential (bars)	Gravimetric water content (%)	Volumetric water content (%)	Water potential (bars)
min	2.40	4.70	-70.10	3.30	-	-59.50
max	21.40	31.60	-14.30	7.30	-	-12.90
mean	5.68	9.49	-29.59	5.35	-	-25.03
s	2.09	3.40	13.49	1.14	-	14.28
CV (%)	36.7	35.8	45.6	21.3	-	57.0
n	193	100	55	12	0	12

	<u>ST-4</u>			<u>ST-5</u>		
	Gravimetric water content (%)	Volumetric water content (%)	Water potential (bars)	Gravimetric water content (%)	Volumetric water content (%)	Water potential (bars)
min	1.20	4.10	-164.50	2.10	3.60	-90.90
max	12.10	17.90	-25.90	7.40	8.00	-30.80
mean	5.44	8.03	-59.46	3.74	5.63	-54.66
s	1.46	2.10	36.51	0.86	1.08	17.69
CV (%)	26.9	26.2	61.4	23.0	19.2	32.4
n	174	93	16	46	23	14

	<u>ST-6</u>			<u>ST-7</u>		
	Gravimetric water content (%)	Volumetric water content (%)	Water potential (bars)	Gravimetric water content (%)	Volumetric water content (%)	Water potential (bars)
min	1.30	2.00	-150.80	1.90	3.80	-101.1
max	11.60	12.40	-13.60	10.80	13.70	-44.0
mean	4.95	7.46	-44.60	3.70	5.61	-60.8
s	1.74	2.20	31.06	1.77	2.01	21.3
CV (%)	35.1	29.5	69.6	47.7	35.8	35.2
n	80	42	23	47	21	10

Figure 12. Depth profiles of volumetric water content for core samples from Science Trench Boreholes.

Figure 13. Depth profiles of gravimetric water content for core and drill cuttings samples from Science Trench Boreholes.

alluvial materials exist in a highly drained and quasi-steady state (equilibrium) condition. In fact, mean volumetric water contents of profiles were less than 10 percent and were within approximately 5 percent of fitted residual water contents (compare volumetric water contents in Table 13 with values of Θ_r in Table 12). Clearly, little if any liquid water is presently draining downward through the system. The extremely low values of unsaturated hydraulic conductivity predicted for these water contents (Section 4.3.3) further support this hypothesis. Water potential data (discussed in Section 4.4.2) will in fact show that water is moving upward (very slowly) in the upper 120 ft.

Gravimetric water content profiles of core and cuttings samples from ST-2 and ST-2A are illustrated in Figure 13. As mentioned previously, these boreholes are located less than 5 ft apart. Water contents in cuttings samples appear to be just slightly lower than core samples in these profiles, and mean values (Table 13) are consistent with this observation. Although these differences in water content are noticeable, they are not statistically significant at the 95 percent confidence level. These slight differences are most likely due to the drying effects of the air drilling fluid on the cuttings as they are transported to the ground surface.

4.4.2 Water Potential

A complete listing of water potential data for core and drill cuttings samples from the Science Trench Boreholes is in Appendix F; descriptive statistics are in Table 13. A comparison of water potentials measured by both the chilled mirror and filter paper methods (Section 3.4.2) on selected core samples indicates relatively good agreement between methods at higher (less negative) water potentials. However, at lower water potentials (and water contents) filter paper values are significantly less than chilled mirror values. These results were not surprising because the filter paper method relies primarily on vapor diffusion (a very slow process) to transfer water from the soil to the filter paper at low water contents. The 7-day equilibration time used in the filter paper method apparently was not long enough to obtain representative water potentials by this method.

Water potential data from ST-1, ST-2, ST-4, and ST-6 (Figure 14) show an upward gradient throughout the upper 120 ft of alluvium with the largest gradient in the upper 30 ft. These data suggest that liquid water is probably moving very slowly upward in the near surface. The hydraulic gradient, which is the total driving force, can be defined as the gravitational potential gradient plus the water potential gradient minus the osmotic potential gradient. The data indicate that, at this site, the water potential gradient is the principal driving force to move liquid water because other potential gradients affecting water movement are small compared to the water potential gradient. For example, the water potential gradient near the ground surface is very large, the osmotic component of this potential has a value near zero based on dissolved salt data, and the gravitational gradient is equal to unity (1.0) by definition.

Environmental tracer data from the Science Trench Boreholes (Section 4.5) support the hypothesis that liquid water is moving upward in the upper vadose zone.

4.5 Environmental Tracers

The hydraulic property and hydrologic condition data presented in previous sections can be used to estimate rates of vadose zone water movement, travel times, and recharge.

Environmental tracer data provide an alternative and independent method for estimating these quantities. The basic principal used in this approach is that infiltrating water (from precipitation and run-off) contains dissolved natural and man-made materials that can serve as conservative (nonsorbing) tracers for water as it moves into and through the vadose zone.

The concentrations of these tracers are measured with depth, and the analysis of these data yields information concerning the history of the movement of water through the unsaturated zone. Furthermore, it is assumed that formation materials do not contribute to the concentrations of these tracers as soil water moves through the vadose zone. In the following, only general observations will be made concerning the tracer profile data. Detailed analyses of these data will be presented in reports which will be submitted to peer-reviewed journals.

Figure 14. Depth profiles of water potential for core samples from Science Trench Boreholes.

4.5.1 Chloride and Bromide

Chloride and bromide ions can serve as tracers because their negative charge discourages sorption with negatively-charged soil mineral surfaces at soil solution pH values commonly found in soils and alluvium. The chloride/bromide mass balance method for estimating recharge (Allison and Hughes, 1983) is based on the assumption that concentrations of these ions are relatively constant in precipitation. As water evaporates from the soil surface, dissolved ions are left in the soil, increasing their concentrations in the soil solution.

A complete listing of measured chloride and bromide concentrations for core and drill cuttings samples from the Science Trench Boreholes is in Appendix F. Only qualitative descriptions of the data are presented here; the chloride and bromide concentration data in Appendix F will be converted to a per unit volume basis when conducting quantitative analysis of the data.

The relatively high concentrations of chloride in the upper 120 ft of alluvium (Figure 15), suggest that evaporation rates are high compared to the downward rate of water movement under the present climate (Conrad, 1993). This hypothesis is consistent with the water potential gradient data (Section 4.4.2) which suggests that water in the upper vadose zone is moving slowly. Bromide profiles (Figure 16) are similar in shape to chloride profiles. Dry soil chloride to bromide ratios are uniform with depth (Figure 17).

4.5.2 Stable Isotopes

The stable isotopes of hydrogen and oxygen are excellent tracers of water movement because they are a part of the water molecule itself. After precipitation enters the soil at a particular site, the relatively constant isotopic composition of precipitation water (for that site) changes due to processes such as evaporation and condensation. Evaporation, for example, will result in an enrichment of heavy isotopes of oxygen and hydrogen (^{18}O and ^2H) and a decrease in the lighter more prevalent isotopes of oxygen and hydrogen (^{16}O and ^1H) [Drever, 1988].

Figure 15. Depth profiles of dry soil chloride concentrations for core samples from Science Trench Boreholes.

Figure 16. Depth profiles of dry soil bromide concentrations for core samples from Science Trench Boreholes.

Figure 17. Depth profiles of dry soil chloride/bromide ratios for core samples from Science Trench Boreholes.

Thus, concentrations of these isotopes and their distribution with depth provide insight into the magnitude of enrichment processes such as evaporation.

A complete listing of the stable isotope data for samples from the Science Trench Boreholes is in Appendix G. Depth profiles of standardized ratios of oxygen isotopes ($^{18}\text{O}/^{16}\text{O}$) and hydrogen isotopes ($^2\text{H}/^1\text{H}$) measured on core samples from ST-1, ST-2, and ST-4 are presented in Figure 18. The profile plots generally show enrichment of heavy isotopes near the surface, suggesting that the shallow water has been subjected to more evaporation/condensation cycles than the deeper water. A plot of these standardized ratios measured on both core and drill cuttings samples from closely spaced ST-2 and ST-2A (Figure 19) indicates drill cuttings samples, at least above 100 ft, provide data that are consistent with core samples.

A plot of the standardized ratio of oxygen isotopes ($^{18}\text{O}/^{16}\text{O}$) vs. hydrogen isotopes ($^2\text{H}/^1\text{H}$) in precipitation over the world falls roughly along a straight line called the meteoric water line (MWL). The MWL together with standardized stable isotope ratios found in water extracted from selected ST-1, ST-2, and ST-4 core samples are shown in Figure 20. The relatively straight line formed from plotting stable isotope ratios in water obtained from core samples deviates from the meteoric water line in a manner similar to stable isotope ratios measured in open bodies of water which have been subjected to evaporation over time (Domenico and Schwartz, 1990). This plot further supports the hypothesis (Section 4.5.4) that evaporation rates are high compared to the downward rate of water movement in the near surface under the present climate (Chapman, 1993).

4.5.3 Chlorine-36

The radioisotope ^{36}Cl , is continually produced in the upper atmosphere. This isotope, together with the stable isotope ^{35}Cl (Section 4.5.1), are dissolved in ionic form in precipitation and enter the ground via infiltration. During periods of geomagnetic field reversals, increased production of ^{36}Cl is thought to occur (Blinov, 1988). Furthermore, these field reversals and

Figure 18. Depth profiles of stable isotope data for core samples from Science Trench Boreholes.

Figure 19. Depth profiles of stable isotope data for core and drill cuttings samples from Science Trench Boreholes.

Figure 20. Comparison of measured stable isotope data for core samples from Science Trench Boreholes with stable isotope data for the global Meteoric Water Line.

associated changes in ^{36}Cl production rates can possibly be dated. The relative magnitude of the ratios of these isotopes in soil profiles provides information about the age of the soil water.

A complete listing of all ^{36}Cl data is in Appendix G. The depth profile of $^{36}\text{Cl}/^{35}\text{Cl}$ ratios from selected ST-1 core samples is plotted in Figure 21. The modern-day range of the ratios found in present day precipitation is 450 to 550. The ratios above a depth of approximately 100 ft are elevated above present day conditions, suggesting that they were produced during the time period of the last geomagnetic field reversal (Conrad, 1993). Since this last field reversal occurred approximately 15,000 years ago, it has taken at least this amount of time for water to reach a depth of approximately 100 ft. These elevated ratios have also been found in pack rat middens that have been tentatively dated to be approximately 21,000 years old by ^{14}C dating methods (Phillips et al., 1988). These data are consistent with both hydraulic parameter data and previously discussed environmental tracer data which indicate that the downward rate of liquid water movement is extremely slow, if not zero.

4.5.4 Soluble and Adsorbed Sulfate

Inorganic sulfate may occur in soils as water soluble and insoluble compounds and as adsorbed sulfate on soil colloids; the amounts of each form depend on a number of soil properties and conditions (Tabatabai, 1982). Large quantities of water soluble sulfate can accumulate in arid region soils and their concentration profiles described below provide supporting evidence for the hypothesis that evaporation is the dominant mechanism of fluid movement in the upper vadose zone.

Soluble and adsorbed sulfate measurements were made on all core and drill cuttings samples from the Science Trench Boreholes. The latter measurements were not requested by REECo, but were provided by the testing laboratory at no charge. Tabular soluble and adsorbed sulfate concentration data are provided in Appendix F. Examination of this tabular data indicates that the amounts of adsorbed sulfate on soil colloids (e.g., anion exchange sites) are

Figure 21. Depth profile of $^{36}\text{Cl}/^{35}\text{Cl}$ ratios for core samples from borehole ST-1.

small compared to soluble sulfate. This is consistent with the relatively small amounts of colloidal (clay size fraction) material found in the Science Trench Boreholes.

Depth profiles of soluble sulfate concentrations from core samples collected from ST-1, ST-2, ST-4, and ST-6 are presented in Figure 22. These data show relatively high and variable concentrations of sulfate in the upper 30 ft of the profiles for each of these boreholes and slowly decreasing concentrations between approximately 30 and 120 ft for each borehole except ST-4. Concentrations in ST-4 remain fairly constant between approximately 30 and 120 ft.

These profiles are somewhat similar in shape to chloride and bromide profiles (Section 4.5.1); that is, sulfate concentrations are enriched near the ground surface. However, the depth at which concentrations decrease to lower values are noticeably shallower for sulfate than for chloride and bromide, and there is more variability in sulfate concentrations near the ground surface. These differences may be due in part to the factors discussed above. That is, elevated levels of sulfate do not penetrate as deep as chloride and bromide because of the lower solubility of sulfate salts. The large variability in sulfate concentrations in the upper 30 ft is probably due to the presence of layered deposits of sulfate minerals (e.g., gypsum).

5.0 SUMMARY

This report has briefly described the methods and results of near-surface Science Trench Borehole drilling, sample collection, field geologic descriptions, and the laboratory analyses of samples for mineralogic, material, hydrologic, and environmental tracer parameters. These data are required to understand and model the flow and transport processes in the upper vadose zone. This report has provided only qualitative analyses and preliminary interpretations of the data. Detailed quantitative analyses and final interpretations will be presented elsewhere in reports which will be written for submittal to peer-reviewed journal publications.

Figure 22. Depth profiles of soluble sulfate data for core samples from Science Trench Boreholes.

Some of the important findings of this study are:

- (1) The alluvial deposits penetrated (approximately 120-ft-deep by 200-ft-long transect) are lithologically homogeneous and do not contain layers of secondary carbonate.
- (2) The alluvial deposits are virtually homogeneous with respect to particle size distributions and are composed of primarily sands with some gravel and generally less than 10 percent fines.
- (3) Hydrologic properties including porosities, saturated hydraulic conductivities, moisture retention relations, and unsaturated hydraulic conductivities are typical of coarse-grained materials.
- (4) Water contents of these alluvial deposits are very dry near the surface, increase only slightly with depth, and are characterized by a mean value of approximately 5 percent by weight.
- (5) Water potential depth profile measurements show an upward potential gradient throughout the upper 120 ft of alluvium with the largest upward gradients in the upper 30 ft.
- (6) Unsaturated hydraulic conductivity data together with water potential data indicate that very little liquid flow is occurring (if any) in the upper vadose zone and the direction of movement is upward.
- (7) Liquid water movement is virtually negligible, vapor movement is probably the dominant mechanism of water movement in the upper region.
- (8) Environmental tracer measurements of chloride, bromide, sulfate, hydrogen and oxygen stable isotopes, and cosmogenic chlorine-36 concentrations in soil water vs. depth

provide strong evidence that the direction of movement for both liquid water and vapor in the upper vadose zone is upward in response to the evaporative demand of the present arid climate.

In conclusion, the results of laboratory testing of core and drill cuttings samples indicate that the mineralogical, material, and hydrologic properties of the alluvial deposits penetrated are very similar. That is, the portion of the subsurface penetrated by the Science Trench Boreholes can be considered to be a homogeneous hydrologic system when simulating flow and transport processes. Furthermore, both water content and water potential depth profile data qualitatively demonstrate that the system is in a highly drained condition where the magnitude of liquid flow is extremely low and the direction is upward. Finally, environmental tracer data have consistently shown that evaporative conditions have predominated in the near surface under the present arid climate.

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7.0 APPENDICES

APPENDIX A

Table A.1. Chronological drilling and completion summary for borehole ST-1.

Date	Auger depth (ft)	Auger inside diameter (in)	Casing depth (ft)	Casing size (in)	Core run numbers	Activities
1/14/92	10	6.625			1 - 5	Safety meeting. Boyles Brothers Mobile B61 HDX rig #5808 on site. Added water to cuttings.
1/16/92						Poured cement.
1/17/92	25	4.25			6 - 12	Hole caving. Pulled casing out.
1/20/92	45	4.25			3 - 19	Broke off sampler in hole and fished out. Pulled out augers.
1/21/92	65	4.25			20 - 27	Had to thaw out steam cleaner.
1/22/92	78.5	4.25			28 - 32	Repaired center bit ears.
1/23/92	97.9	4.25			33 - 39	
16 1/24/92	116.5	4.25			40 - 47	Drove to airport for parts.
1/27/92						Pulled auger out of hole.
1/30/92			25	10.75		Moved rig on hole. Hole caved to 17 ft. Installed 20 ft of casing.
2/11/92			120			Moved ODEX rig # 5607 on hole.
2/12/92						Installed 4 in. PVC to depth of 120.25 ft. Stemmed with 10-20 sand to 114.25 ft. Stemmed with bentonite and sand mix to 101.58 ft. Stemmed with 10-20 sand to 94.58 ft. Shut down due to rain.
2/13/92						Stemmed with bentonite and sand mix to 96.17 ft. Stemmed with 10-20 sand to 93.5 ft. Stemmed hole with bentonite and sand mix to 78.17 ft. Stemmed with 10-20 sand to 69 ft. Stemmed with bentonite and sand mix to 68.75 ft. Shut down due to rain.

Table A.1. (Continued).

Date	Auger depth (ft)	Auger inside diameter (in)	Casing depth (ft)	Casing size (in)	Core run numbers	Activities
2/14/92						Stemmed with bentonite and sand mix to 61.42 ft. Stemmed with 10-20 sand to 53.67 ft. Stemmed with bentonite and sand to 41.08 ft. Stemmed with 10-20 sand to 34.08 ft. Stemmed with bentonite and sand to 27.75 ft. Stemmed with 10-20 sand to 17.33 ft. Stemmed with bentonite and sand to 3 ft. Moved rig off hole.

Table A.2. Chronological drilling summary for boreholes ST-2 and ST-2A and completion summary for borehole ST-2A.

Date	Auger depth (ft)	Auger inside diameter (in)	Casing depth (ft)	Casing size (in)	Core run numbers	Activities
1/15/92	7.5	4.25			1 - 3	Moved rig #5808 on and off hole.
1/16/92						Poured cement.
1/27/92	17.5	4.25			4 - 6	Moved rig on hole. Steam cleaned augers. Problems removing sampler shoes.
1/28/92	30	4.25			7 - 11	
1/30/92			30	10.75		Moved rig on hole. Pulled casing. Hole caved to 17 ft. Installed 20 ft of casing and grouted.
1/31/92	45	4.25			12 - 16	
2/3/92	62.5	4.25			17 - 23	Cleaned out air hammer. Re-packed right angle gear box bearing.
2/4/92	90	4.25			24 - 34	
2/5/92	115	4.25			35 - 44	Changed auxilliary cable.
2/6/92	123.5	4.25			45 - 48	
2/14/92						Moved ODEX rig #5607 on hole. Hole crooked.
2/17/92			120		1 - 4	Relocated hole 5 ft north and redrilled as ST-2A with ODEX system.
2/18/92						Installed 4 in. PVC. Stemmed with 10-20 sand to 114 ft. Stemmed with bentonite and sand to 100 ft. Stemmed with 10-20 sand to 92.08 ft. Stemmed with bentonite and sand to 78.42 ft. Stemmed with 10-20 sand to 72 ft. Stemmed with bentonite and sand mix to 60.25 ft. Stemmed with 10-20 sand to 54 ft. Stemmed with bentonite and sand to 40 ft. Stemmed with 10-20 sand to 33.08 ft. Stemmed with bentonite and sand to 20.17 ft. Stemmed with 10-20 sand to 14.08 ft. Stemmed with bentonite and sand to 7.08 ft. Hole sloughed to 0.5 ft.

Table A.3. Chronological drilling summary for borehole ST-3.

Date	Auger depth (ft)	Auger inside diameter (in)	Casing depth (ft)	Casing size (in)	Core run numbers	Activities
1/15/92	7.5	4.25			1 - 4	Moved rig #5808 on hole. Damaged threads on sampler.
1/16/92						Poured cement.
1/28/92	13	4.25				Moved rig on hole. Broke off hammer sub. Used chisel bit on cobble.
1/29/92						Waiting on hammer sub and larger augers.
1/30/92	15	4.25				Could not fish out broken hammer sub from hole. Pulled out augers.

Table A.4. Chronological drilling summary for boreholes ST-4 and ST-4A and completion for borehole ST-4A.

Date	Auger depth (ft)	Auger inside diameter (in)	Casing depth (ft)	Casing size (in)	Core run numbers	Activities
1/16/92	10	4.25	8	10.75	1 - 4	Moved rig #5805 on and off hole. Poured cement.
2/6/92						Moved off hole. Cut casing down.
2/7/92	40	4.25		5 - 15		Lost plumb in hole.
2/10/92	62.5	4.25			16 - 25	Jack sank in hole.
2/11/92						Pulled out augers.
2/13/92	95.8	4.25			34 - 37	Air dryer filter plugged. Rain and lightning delays.
2/14/92	113	4.25			38 - 45	
2/17/92						
2/18/92						Moved ODEX rig #5607 on ST-4A.
2/19/92			120			Installed 4 in. PVC to 120 ft. Stemmed with 10-20 sand to 114 ft. Stemmed with bentonite and sand to 100.25 ft. Stemmed with 10-20 sand to 94.25 ft. Stemmed with bentonite and sand to 80.08 ft. Stemmed with 10-20 sand to 74.17 ft. Stemmed with bentonite and sand to 60 ft. Stemmed with 10-20 sand to 54.08 ft. Stemmed with bentonite and sand to 39.5 ft. Stemmed with 10-20 sand to 33.83 ft. Stemmed with bentonite and sand to 19.42 ft. Stemmed with 10-20 sand to 14 ft.
2/20/92						Stemmed with bentonite and sand to 3 ft. Moved off hole.

Table A.5. Chronological drilling summary for boreholes ST-5.

Date	Auger depth (ft)	Auger inside diameter (in)	Casing depth (ft)	Casing size (in)	Core run numbers	Activities
1/16/92	7.5	4.25 8.25	4.5	11	1 - 4	Moved rig # 5808 on and off hole. Poured cement.
2/11/92	15	4.25			5 - 6	Had to wait on steel plate to support rig.
2/20/92	35				7 - 11	Moved rig off hole.

Table A.6. Chronological drilling summary for boreholes ST-6 and ST-6A and completion summary for borehole ST-6A.

Date	Auger depth (ft)	Auger inside diameter (in)	Casing depth (ft)	Casing size (in)	Core run numbers	Activities
2/17/92						Moved rig # 5808 on hole. Driller smashed finger-shut down.
2/18/92	70	4.25			1 - 16	
2/19/92	115	4.25			17 - 21	Pulled out augers.
2/20/92			120			Moved ODEX rig # 5607 on hole ST-6A. Stemmed with 10-20 sand from 120.5 to 120 ft. Installed 4 in. PVC to bottom. Stemmed with 10-20 sand to 114.08 ft. Stemmed with bentonite and sand to 99 ft. Stemmed with 10-20 sand to 93.83 ft. Stemmed with bentonite and sand to 79.92 ft. Stemmed with 10-20 sand to 74 ft. Stemmed with bentonite and sand to 59.67 ft. Stemmed with 10-20 sand to 58.17 ft.
2/21/92						Stemmed with 10-20 sand to 54.08 ft. Stemmed with bentonite and sand to 40 ft. Stemmed with 10-20 sand to 34 ft. Stemmed with bentonite and sand to 20 ft. Stemmed with 10-20 sand to 13.42 ft. Stemmed with bentonite and sand to 0 ft. Moved rig off hole and demobilized.

Table A.7. Chronological drilling summary for borehole ST-7.

Date	Auger depth (ft)	Auger inside diameter (in)	Casing depth (ft)	Casing size (in)	Core run numbers	Activities
2/19/92	15	4.25			1 - 6	Moved rig #5808 on hole. boulder at 15 ft.
2/20/92	32.5	4.25			7 - 14	

Table A.8. Summary of materials added to boreholes during drilling and casing activities.

Borehole(s)	Borehole diameter (in)	Borehole depth (ft)	Casing diameter (ft)	Casing depth (ft)	Description of materials added to borehole
ST-1, ST-2, ST-3, ST-4, ST-5 recorded.	12.75	10	10.75	10	Approximately five gal of water were added to the borehole in an attempt to stabilize the borehole walls. Surface casing was cemented in place. Composition of cement was not
ST-1	12.75	25	NA	NA	Between 10 and 15 gal of water and 150 lbs of bentonite were added to keep the borehole open prior to resetting surface casings to 25 ft depth.
ST-1	12.75	25	10.75	19.33	Two-hundred gal of water were mixed with dry cement onsite to grout surface casing in place.
ST-1	7	45	NA	NA	Two and one-half gal of water and eight gal of sand were added to hole to recover a lost drilling tool.
ST-2	12.75	30	10.75	18.5	One hundred and ninety gal of water were mixed with dry cement onsite to grout surface casing in place.

APPENDIX B

Table B.1 Borehole log sheets for ST-1
Borehole Log Sheet

1) Hole Designation: ST-1										4) Drilling Method: PERCUSSION DRIVE CORE HOLLOW STEEL AUGER, HAMMER DROP DRIVE CORE									
2) Logged By: DANIEL BLOUT, EDITED BY: KEN DONNELSON										5) Checked By:									
3) Date and Time Log Completed: 1-17-92, 1000																			
6) Depth in Feet	7) Penetration Rate			8) Sampling Data		9) Color (Munsell Chart)	10) Moisture Content	11) Particle Size Distribution	12) Major Minerals in %	13) Sorting	14) Grain Shape	15) Cementation	16) HCL Reaction	17) USCS Group Name	18) VOC's in ppm	19) Radiometric Data	20) Comments:		
	7a) Penetration Rate	7b) Penetration Rate	7c) Penetration Rate	8a) Time	8b) Depth													8c) Depth	
0																	RE-CORED MATERIALS. NO SAMPLES SAVED. SILTY SAND.		
5																	FINE SILTY SAND.		
10																	WELL GRADED SAND WITH SILT & FINE GRAVEL.		
15																	GRAVEL AND COBBLES 10-11 FT.		
20																	MUST FROM CEMENT JOB		
25																	FINE SAND WITH SILT. SANDY & DARKER FROM 12.5-13.25 FT. Q72 COBBLE AT 14 FT. LARGE GRAVELS FROM 14.0-14.5 FT		

Table 8.1 (Continued)

Page 2 of 8

Borehole Log Sheet S

1) Hole Designation: ST-1		4) Drilling Method: HOLLOW STEM AUGER PERCUSSION DRIVE CORE											
2) Logged By: DANIEL BLOUT, EDITED BY: KEN BONNELSON		5) Checked By:											
3) Date and Time Log Completed: 1-20-92, 1045													
7) Penetration Rate	8) Sampling Date	9) Color (Munsell Chart)	10) Moisture Content	11) Particle Size Distribution	12) Major Minerals in %	13) Sorting	14) Grain Shape	15) Cementation	16) HCL Reaction	17) USCS Group Name	18) VOCs in ppm	19) Radiometric Data	20) Comments: a) PARTICLE SIZE INTERVAL FROM LAB ANALYSIS
AUGERED HOLE, NO SAMPLES													
DC 0.3 0.75		10YR 7/3		1						SM			SILTY SAND.
DC 2.5 0.75		NOT DESCRIBED, NO SAMPLES								SM			ROOTS, GRAVEL > 1 INCH WELDED TUFF (Tuff) FRAGMENTS PLUGGED CORE BARREL, SMALL AMOUNT OF ALLUVIUM (NOT DESCRIBED) FRAGMENTS ARCHIVED
DC 2.5 2.1		10YR 7/3 VERY PALE BROWN		1						SW			WELL GRADED SAND WITH FINE GRAVELS.
DC 2.5 2.2													1%+ QUARTZ.
DC 2.5 2.5		10YR 7/3 PALE BROWN		0						SP-SM			FINE SAND WITH SILT.
DC 2.5 2.5		10YR 7/3 VERY PALE BROWN											INCREASED MOISTURE 29-30 FT.

Table B.1 (Continued)

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Borehole Log Sheet

1) Hole Designation: ST-1		4) Drilling Method: HOLLOW STEM AUGER PERCUSSION DRIVE CORE												
2) Logged By: DANIEL BLAUT, EDITED BY: KEW DANIELSON		5) Checked By:												
3) Date and Time Log Completed: 1-20-92, 1600														
6) Depth in Feet	7) Penetration Rate	8) Sampling Data	9) Color (Munsell Chart)	10) Moisture Content	11) Particle Size Distribution	12) Major Minerals in %	13) Sorting	14) Grain Shape	15) Composition	16) ICL Location	17) USCS Group Name	18) VOC's in ppm	19) Radiometric Data	20) Comments: a) PARTICLE SIZE INTERVAL FROM LAB ANALYSIS
30	DC 2.5 2.5	10YR 7/3 VERY PALE BROWN	0 1 86 11	0 1 86 11	0 1 86 11	0 1 86 11	0 1 86 11	0 1 86 11	0 1 86 11	0 1 86 11	SP-SM			SEMI MOIST FINE SAND. FINE SAND WITH SILT.
35	DC 2.5 2.5	10YR 7/3 VERY PALE BROWN	5 87 11	5 87 11	5 87 11	5 87 11	5 87 11	5 87 11	5 87 11	5 87 11	SP-SM			SAMPLE FROM 32.75-32.5 FT (HALL) BLACK SUBSTANCE - ARCHIVED. FINE SAND WITH SILT.
	DC 2.5 2.5	10YR 7/3 VERY PALE BROWN	21 77 2	21 77 2	21 77 2	21 77 2	21 77 2	21 77 2	21 77 2	21 77 2	SW			WELL GRADED SAND WITH FINE GRAVEL.
	DC 2.5 2.3	10YR 7/3 VERY PALE BROWN	15 81 4	15 81 4	15 81 4	15 81 4	15 81 4	15 81 4	15 81 4	15 81 4	SP-SM			FINE SAND WITH SILT.
	DC 2.5 2.5	10YR 7/3 VERY PALE BROWN	13 79 8	13 79 8	13 79 8	13 79 8	13 79 8	13 79 8	13 79 8	13 79 8	SW			WELL GRADED SAND WITH FINE GRAVELS.
	DC 2.5 2.5	10YR 7/3 VERY PALE BROWN	13 79 8	13 79 8	13 79 8	13 79 8	13 79 8	13 79 8	13 79 8	13 79 8	SW-SM			WELL GRADED SAND WITH SILT.
	DC 2.5 1.75	10YR 7/3 VERY PALE BROWN	7	7	7	7	7	7	7	7	SW-SM			CORE WITTED FROM FISHING JOB

Borehole Log Sheet

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Borehole Log Sheet

1) Hole Designation: ST-1

2)Logged By: DANIEL BLOUT, EDITED BY: KEN DANIELSON

4) Drilling Method:
HOLLOW STEM AUGER,
PERCUSSION DRIVE CORE

3) Date and Time Log Completed: 1-21-92, 1500

5) Checked By:

[illegible]

Table B.1 (Continued)

Borehole Log Sheet

Page 5 of 8

1) Hole Designation: ST-1		4) Drilling Method: HOLLOW STEM AUGER.												
2) Logged By: DANIEL BLOUT, EDITED BY: KEN DOWNES		PERCUSSION DRIVE CORE, MOSS SAMPLER												
3) Date and Time Log Completed: 1-22-92, 1345		5) Checked By:												
6) Depth in Feet	7) Penetration Rate	8) Sampling Data	9) Color (Munsell Chart)	10) Moisture Content	11) Particle Size Distribution	12) Major Minerals in %	13) Sorting	14) Grain Shape	15) Cementation	16) FCL Reaction	17) USCS Group Name	18) VOC's in ppm	19) Radiometric Data	20) Comments:
60	DC 2.5 2.5	Gravel Sand Silt Clay	10 YR 7/3 VERY PALE BROWN	0	41 52 7		Well	Angular	Weak	Medium	SW-SM			DEPTH DISCREPANCY FROM 66 - 80.5 FT. PARTICLE SIZE INTERVAL FROM LAB ANALYSIS.
65	DC 2.5 2.5				13 81 6		Well	Subangular	Weak	Medium	SW			WELL GRADED SAND WITH SILT COARSE GRAVEL.
70	DC 2.5 2.5				20 69 11		Well	Subangular	Weak	Medium	SW-SM			WELL GRADED SAND WITH SILT & FINE GRAVEL.
75	MS 1.0 1.3				4 77 19		Well	Subangular	Weak	Medium	SM-SC			FINE SILTY SAND WITH CLAY.
	MS 2.5 1.3				10 81 9		Well	Subangular	Weak	Medium	SP-SM			FINE SAND WITH SILT.
	MS 2.5 1.4						Well	Subangular	Weak	Medium				

Table 8.1 (Continued)

Borehole Log Sheet

Page 6 of 8

1) Hole Designation: ST-1		4) Drilling Method: HOLLOW STEM AUGER, PERCUSSION DRIVE CORE, MOSS SAMPLER																		
2) Logged By: DANIEL BLOUT, EDITED BY: KEN DANIELSON		5) Checked By:																		
3) Date and Time Log Completed: 1-23-92, 1230																				
c) Depth in Feet	7) Penetration Rate	8) Sampling Data	9) Color (Munsell Chart)	10) Moisture Content	11) Particle Size Distribution	12) Major Minerals	13) Sorting	14) Grain Shape	15) Cementation	16) HCL Reaction	17) UCS Group Name	18) VOC's in ppm	19) Radiometric Data	20) Comments:						
															Normal	Recovery	Box Count	Gravel	Sand	SB-Clay
75		NO SAMPLES																		
77.91		1.0 1.3	10YR 7/3		0 8 82 10						SP-SM			FINE SAND WITH SILT						
79.91		?																		
80		DC 1.1 1.1	10YR 7/4		0															
85		NO SAMPLES AUGERED MOLE 2.5 2.5 DC	10YR 7/4 VERY PALE BROWN		0 31 63 6						SW-SM			WELL GRADED SAND WITH SILT & COARSE GRAVEL. LARGE PIECES OF WELDED TUFF (Tuff) AT 84.5 FT. LARGE Tuff FRAGMENTS.						
		DC 2.5 2.5			39 45 20						SM-SC			FINE SILTY SAND WITH COARSE GRAVEL & CLAY.						
		DC 2.5 2.2			54 41 4						GP			SANDY COARSE GRAVEL.						

Table 8.1 (Continued)

Page 7 of 8

Borehole Log Sheet

1) Hole Designation: ST-1		4) Drilling Method: Hollow Stem Auger		5) Checked By:										
2) Logged By: DANIEL BLOUT, EDITED BY: KEN DOWELSON		PERCUSSION DRIVE CORE												
3) Date and Time Log Completed: 1-24-92, 1130														
6) Depth in Feet	7) Penetration Rate	8) Sampling Data	9) Color (Munsell Chart)	10) Moisture Content	11) Particle Size Distribution	12) Major Minerals in %	13) Sorting	14) Grain Shape	15) Cementation	16) ICL Reaction	17) USCS Group Name	18) VOCs in ppm	19) Radiometric Data	20) Comments:
23-92	DC 2.5 2.5	10YR 7/3 VERY PALE BROWN	0	0	0	0	0	0	0	0	0	0	0	1.0 FT. DISCREPANCY FROM 96.75 - 112.5 FT. PARTICLE SIZE INTERVAL FROM LAB ANALYSIS.
90	DC 0.75 0.75				7 78 15						ISM-SC			LARGER GRAVELS AT 91 FT. FINE SILTY SAND WITH CLAY CORE BARREL REFUSED ON ROCK
95	NO SAMPLES, AUGERED HOLE													
13-92	DC 1.1 1.3 (FMS)				0 31 57 6						SUJ-SM			WELL GRADED SAND WITH SILT & FINE GRAVELS
24-92	NO SAMPLES, AUGERED HOLE													
	DC 0.75 0.9 (FMS)													
	DC 2.5 2.5	10YR 7/3 VERY PALE BROWN	0	0	12 81 6						SUB-SM			WELL GRADED SAND WITH SILT. DECREASE IN AMOUNT OF GRAVELS.
100	DC 2.5 2.5				3 92 5						SUB-SM			WELL GRADED SAND WITH SILT. STILL DRY, BUT SLIGHT VISIBLE INCREASE IN MOISTURE.
	DC 2.2 2.1	10YR 7/3 VERY PALE BROWN	0	0	3 87 10						SP-SM			FINE SAND WITH SILT. LESS VISIBLE MOISTURE.
105	NO SAMPLES, AUGERED HOLE													

Table B.2 Borehole log sheets for ST-2A

Borehole Log Sheet

Page 1 of 2

1) Hole Designation: ST-2A		4) Drilling Method: OPEX		PERCUSSION DRIVE CORE										20) Comments: 8 PARTICLE SIZE INTERVAL FROM LAB ANALYSIS.	
2) Logged By: DANIEL BLAUT, EDITED BY: KEN PENNELLSON		5) Checked By:													
3) Date and Time Log Completed: 2-17-92, 1300															
6) Depth in Feet	7) Penetration Rate (min/ft)	8) Sampling Data		9) Moisture Content (%)	10) Particle Size Distribution (%)	11) Major Minerals (%)	12) Sorting	13) Grain Shape	14) Cementation	15) Fracture	16) Fracture Location	17) USCS Group Name	18) Radiometric Data	19) Date	
		9) Sampling Date	10) Recovery												
2-17-92 24	0.4 2.5 2.2	10YR 7/3 VERY PALE BROWN	0	14 71 9	90 10	Well Sorted	Angular Subrounded	None	None	None	None	SW-SM			WELL GRADED SAND WITH SILT
26.5	NO SAMPLES														
35	0.4 2.5 2.0 DC	10YR 7/3 VERY PALE BROWN	0	47 48-5	90 10	Well Sorted	Angular Subrounded	None	None	None	None	SW			WELL GRADED SAND WITH COARSE GRAVEL
37.5	NO SAMPLES														
45.25	4.0 DC 2.5 2.0	10YR 7/3 VERY PALE BROWN	0	12 74 14	90 10	Well Sorted	Angular Subrounded	None	None	None	None	SM			FINE SILTY SAND
47.75	NO SAMPLES														
95															

Table B.2 (Continued)

Borehole Log Sheet		4) Drilling Method: ODEX PERCUSSION DRIVE CORE	
1) Hole Designation: ST-2A		5) Checked By:	
2) Logged By: DANIEL BLOUT, EDITED BY: KEN DONNELSON		3) Date and Time Log Completed: 2-17-92	
7) Penetration Rate	18 IDG 2.523	10) Moisture Content	0
8) Sampling Data	Recovery Type 18 IDG 2.523	11) Particle Size Distribution	Gravel Sand Silt Clay 0 45.47 8 90.10
9) Color (Munsell Chart)		12) Major Minerals	Other Carbonates Feldspar 90.10
13) Grain Shape	Angular Subangular Rounded	13) Sorting	Well Variable Poor
14) Cementation	None Weak Moderate Strong	15) ICL Reaction	None Weak Moderate Strong
17) USCS Group Name	SW-SM	18) VOC's in ppm	
19) Radiometric Data		20) Comments:	WELL GRADED SAND WITH SILT & COARSE GRAVEL.
21) Particle Size Interval From Lab Analysis			

Table B.3 Borehole log sheets for ST-2

Borehole Log Sheet

Page 1 of 9

1) Hole Designation: ST-2		4) Drilling Method: HOLLOW STEM AUGER HAMMER DROP DRIVE CORE, PERCUSSION DRIVE CORE										
2) Logged By: DANIEL BLOUT, EDITED BY: KENDON WELLS		5) Checked By:										
3) Date and Time Log Completed: 1-27-92, 1515												
7) Penetration Rate	8) Sampling Data	9) Moisture Content	10) Particle Size Distribution	11) Major Minerals	12) Void Ratio	13) Grain Shape	14) Cementation	15) Soil Reaction	16) UCS Group Name	17) Voids in ppm	18) Radiometric Data	19) Comments:
1-15-92	MC 2.1 10.7 138 Type: MC Interval: 10.7-138 Depth: 10.7-138	104R7/S VERY PALE BROWN	13 67 20	17 77 6	35 55 11	25 68 7	SM	SILTY SAND				
	NO SAMPLES											
	DC 2.5 2.0	104R7/S VERY PALE BROWN							SM-SC			FINE SILTY SAND WITH CLAY.
	DC 2.5 2.2								SW-SM			WELL GRADED SAND WITH SILT & FINE GRAVELS.
	DC 2.5 2.5								SW-SM			WELL GRADED SAND WITH SILT & COARSE TUFF GRAVELS.
	DC 2.5 2.0								SW-SM			WELL GRADED WITH SILT & COARSE TUFF, QTZ & LIMESTONE GRAVELS.
									SP			POORLY GRADED SAND

Table B.3 (Continued)

Borehole Log Sheet

4) Drilling Method: HOLLOW STEM AUGER PERCUSSION DRIVE CORE									
5) Checked By:									
1) Hole Designation: ST-2	2) Logged By: DANIEL BLOUT, EDITED BY: KEN DANIELSON								
3) Date and Time Log Completed: 1-28-92, 1130									
Depth in feet	Interval	Sampling Date	Flow Counts	Color (Munsell Chart)	Moisture %	Particle Size Distribution	Major Minerals %	Other	Soil
27-92	DC 2.5 2.0	10YR 7/3	VERY PALE BROWN	10YR 7/3	0 26 68 6	Volcanics	Other	Well	SP
27-91	DC 2.5 2.0	10YR 7/3	VERY PALE BROWN	10YR 7/3	0 26 68 6	Volcanics	Other	Well	SP
28-92	DC 2.5 2.0	10YR 7/3	VERY PALE BROWN	10YR 7/3	0 26 68 6	Volcanics	Other	Well	SP
20	DC 0.8 0.8	NO SAMPLES							
25	DC 2.5 2.5	10YR 7/3	VERY PALE BROWN	10YR 7/3	0 13 80 7	Volcanics	Other	Well	SP-SM
25	DC 2.5 2.2	10YR 7/3	VERY PALE BROWN	10YR 7/3	26 70 4	Volcanics	Other	Well	SW
30	DC 2.5 2.2	10YR 7/3	VERY PALE BROWN	10YR 7/3	6 84 10	Volcanics	Other	Well	SP-SM

20) Comments:
PARTICLE SIZE INTERVAL FROM LAB ANALYSIS.

USE TEFLON-BASED PIPE DOPE MIXED WITH OIL ON THREADS WELL GRADED SAND WITH SILT & FINE GRAVELS.

FINE SAND WITH SILT.

FINE SAND WITH SILT.

WELL GRADED SAND WITH GRAVEL.

FINE SAND WITH SILT. INCREASED MOISTURE FROM 28-30 FT.

Table B.3 (Continued)

Page 3 of 9

Borehole Log Sheet

1) Hole Designation: ST-2										4) Drilling Method: HOLLOW STEM AUGER PERCUSSION DRIVE CORE									
2) Logged By: DANIEL BLOUT, EDITED BY: KEN DONNELSON										5) Checked By:									
3) Date and Time Log Completed: 2-3-92, 0830										20) Comments: SAMPLES DO NOT REPRESENT COBBLES WHICH ARE PRESENT AS LARGE PIECES THAT FORM PLUGS IN THE SAMPLE SHOE. PARTICLE SIZE INTERVAL FROM LAB ANALYSIS:									
Depth in Feet	Penetration Rate		Sampling Data		Color (Munsell Chart)	Moisture Content	Particle Size Distribution in %		Major Minerals in %	Sorting	Grain Shape	Cementation	HCL Reaction	USCS Group Name	VOC's in ppm	Radiometric Data			
	SPN	Penetration	SPN	Penetration			Gravel	Sand										Silt & Clay	Gravel
1-31-92 30	DC	25 25	10YR 7/3 VERY PALE BROWN				8	83	9					SP-SM			FINE SAND WITH SILT SOME COARSE GRAVEL		
	DC	25 24					12	77	11					SP-SM			FINE SAND WITH SILT VERY SLIGHT MOISTURE AT 34.75 FT		
	DC	25 24					29	65	6					SW-SM			WELL GRADED SAND WITH SILT & COARSE GRAVEL		
	DC		10YR 6/2 LIGHT BROWNISH GRAY				14	82	4					SW			WELL GRADED SAND		
	DC	17 17	10YR 7/3 10YR 6/2 10YR 7/3											SW-SM SW? SW-SM			INCREASED MOISTURE FROM 38.75 - 39.25 FT		
40			NO SAMPLES														LARGE ROCK. POSSIBLE STREAM COBBLES & GRAVELS.		
	DC	18 15	10YR 7/3				0	21	73	6				SW-SM SW			WELL GRADED SAND WITH SILT FINE GRAVEL WELL GRADED SAND		
			AUGURED HOLE																

Table B.3 (Continued)

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Borehole Log Sheet

1) Hole Designation: ST. 2		4) Drilling Method: HOLLOW STEM AUGER SOLID & SPLIT TUBE PERCUSSION DRIVE CORE										
2) Logged By: BRIAN DOZIER, EDITED BY: KEN DUNNIELSON		5) Checked By:										
3) Date and Time Log Completed: 2-3-92												
2) Sampling Data	3) Color (Munsell Chart)	10) Moisture Content	11) Particle Size Distribution	12) Major Minerals in %	13) Sorting	14) Grain Shape	15) Cementation	16) IL Reaction	17) USCS Group Name	18) VOCs in ppm	19) Radiometric Data	20) Comments
DC 2.523	10YR 7/3 VERY PALE BROWN	10	0	0	0	0	0	0	SW-SM	0	0	WELL GRADED SAND WITH SILT & FINE GRAVEL
DC 2.515		16	72	12	0	0	0	0	SM	0	0	FINE SILTY SAND
DC 0.505												
NO SAMPLE DUE TO GRAVEL												
DC 1.010									SM			SILTY SAND
INTERVAL ABOVE STOPPED DUE TO SLOW PENETRATION												
DC 1.010		1	23	65	8	0	0	0	SW-SM	0	0	WELL GRADED SAND WITH SILT & COARSE GRAVEL
DC 0.507												
NO SAMPLE RECOVERED												
DC 0.507												
NO SAMPLE												
												GRAVELLY

Table B.3 (Continued)

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Borehole Log Sheet

1) Hole Designation: ST-2		4) Drilling Method: HOLLOW STEM AUGER											
2) Logged By: BRIAN DEZIER / DANIEL BLAUT K. DOWELL		5) Checked By:											
3) Date and Time Log Completed: 2-4-92, 1145		20) Comments: B PARTICLE SIZE INTERVAL FROM LAB ANALYSIS. AUGERED TO 60.75 FT L RESAMPLE.											
7) Penetration Rate (min/ft)	8) Sample Interval	9) Sampling Date	10) Color (Munsell Chart)	11) Moisture Content (%)	12) Particle Size Distribution (%)	13) Major Minerals	14) Clay	15) Organic Matter	16) Cation Exchange Capacity (meq/100g)	17) USCS Group Name	18) USCS Group Name	19) USCS Group Name	20) Comments
1.57	DC 2.5 2.3	2.5 2.3	10YR 7/3 VERY PALE BROWN	10YR 7/3	17 79 4 16 78 6	92 6 2	0	0	0	SW	SW-SM	SW-SM	WELL GRADED SAND WITH FINE GRAVEL
1.57	DC 2.5 2.4	2.5 2.4	10YR 7/3 VERY PALE BROWN	10YR 7/3	27 66 7	0	0	0	0	SW	SW-SM	SW-SM	WELL GRADED SAND WITH SILT FINE GRAVEL
1.57	DC 2.5 2.5	2.5 2.5	10YR 7/3 VERY PALE BROWN	10YR 7/3	6 83 11	0	0	0	0	SW	SW-SM	SW-SM	WELL GRADED SAND FINE SAND WITH SILT
2.21	DC 2.5 2.1	2.5 2.1	10YR 7/3 VERY PALE BROWN	10YR 7/3	0	0	0	0	0	SW	SW-SM	SW-SM	WELL GRADED SAND FINE SAND WITH SILT

Table B.3 (Continued)

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Corehole Log Sheet

1) Hole Designation: ST-2				4) Drilling Method: HOLLOW STEM AUGER PERCUSSION DRIVE CORE										
2) Logged By: DANIEL BLOUT, EDITED BY: KEN DONNELSON				5) Checked By:										
3) Date and Time Log Completed: 2-4-92, 1600														
Corehole No. (mm/ft)	Depth (m)	Sampling Date	USCSP	Color (Munsell Chart)	Moisture Content (%)	Particle Size Distribution (%)	Minerals in %	Boiling	Grain Shape	Commentation	USCS Group Name	10 VOC in ppm	18) Radiometric Data	20) Comments
103	75	2.5.2.5	DC	10YR7/3 VERY PALE BROWN	0	3 85 -12	Volcanics Chert Other	With Moderate	Subangular to rounded	Weak to moderate	SP-SM			FINE SAND WITH SILT
154	80	2.5.2.5	DC	10YR6/2 LIGHT BROWN	4	88 8					SP-SM			MOIST FROM 76.75 - 77 MET
154	80	2.5.2.4	DC	10YR7/3 VERY PALE BROWN	17	78 -5					SW			FINE SAND WITH SILT
154	80	2.5.2.5	DC	10YR7/3 VERY PALE BROWN	12	76 -12					SP-SM			WELL GRADED SAND WITH FINE GRAVEL
154	85	2.5.2.5	DC	10YR4/2 LIGHT BROWN	17	74 9					SW-SM			FINE SAND WITH SILT
154	85	2.5.2.3	DC	10YR7/3 VERY PALE BROWN	1	74 -5					SP			CORE HAD TO BE BEATEN & POURED OUT OF SAMPLER - LINERS PLUGGED OFF BY ROCK.
154	85	2.5.2.4	DC	10YR7/3 VERY PALE BROWN	1	74 -5					SW-SM			WELL GRADED SAND WITH SILT & FINE GRAVEL
154	90	2.5.2.4	DC	10YR7/3 VERY PALE BROWN	1	74 -5					SW			FINE SAND
154	90	2.5.2.4	DC	10YR7/3 VERY PALE BROWN	1	74 -5					SW-SM			WELL GRADED SAND WITH SILT
154	90	2.5.2.4	DC	10YR7/3 VERY PALE BROWN	1	74 -5					SW			WELL GRADED SAND
154	90	2.5.2.4	DC	10YR7/3 VERY PALE BROWN	1	74 -5					SW			VERY MOIST FROM R9 Test

Table B.3 (Continued)

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Borehole Log Sheet

1) Title Designation: ST-2		4) Drilling Method: HOLLOW STEM AUGER PERCUSSION DRIVE CORE													
2) Logged By: DANIEL BLOUT, EDITED BY KEN DANNELSON		5) Checked By:													
3) Date and Time Log Completed: 2-5-92															
1) Depth in Feet	2) Penetration Rate (min/ft)	3) Sampling Date	4) Color (Munsell Chart)	5) Moisture Content (%)	6) Particle Size Distribution	7) Clay	8) Major Minerals in %	9) Sorting	10) Grain Shape	11) Cementation	12) Fossil	13) Notes	14) USCS Group Name	15) Notes	16) Particle Size Interval from Lab Analysis
25-91	18 DC 25 25		10YR 7/3 VERY PALE BROWN	10	5 82 13	SA Clay	92		Subangular	None			SM		FINE SILTY SAND
95	215 DC 25 25		10YR 6/3 PALE BROWN		12 75 13				Subangular	None			SM		FINE SILTY SAND
	228 DC 25 25		10YR 7/3 LIGHT YELLOW BROWN		9 77 14				Subangular	None			SM		COBBLES FINE SILTY SAND
	235 DC 25 25		10YR 7/3 VERY PALE BROWN		5 86 9				Subangular	None			SP-SM		FINE SAND WITH SILT
100	173 DC 25 25				23 68 9				Subangular	None			SW-SM		WELL GRADED SAND WITH SILT & FINE GRAVEL
	20 DC 075 075								Subangular	None					
	NO SAMPLES, AUGERED HOLE								Subangular	None					

Table B.3 (Continued)

Borehole Log Sheet

1) Hole Designation: ST-2										4) Drilling Method: HOLLOW STEM AUGER PERCUSSION DRIVE CORE									
2) Logged By: DANIEL BLOUT / BRIAN DOZIER, K. DANIELSON										5) Checked By:									
3) Date and Time Log Completed: 2-6-92, 1300																			
(1) Depth in Feet	(2) Penetration Rate (Min/ft)	(3) Sampling Date	(4) Type	(5) Recovery	(6) Color (Munsell Chart)	(7) Moisture Content (%)	(8) Particle Size Distribution (%)	(9) Major Minerals	(10) Other	(11) Sorting	(12) Grain Shape	(13) Cementation	(14) Fines	(15) Plasticity	(16) USCS Group Name	(17) Data	(18) Gamma	(19) Particle Size Interval From Lab Analysis	
2-5-92 105	2.47 DC 2.52.1	10YR 7/3 VERY PALE BROWN					0	4 89 7	92 6 2						SP-SM			FINE SAND WITH SILT	
	3.0 DC 2.0 2.0	10YR 7/3 VERY PALE BROWN					1 25 69 6	95 3 2							SW-SM			WELL GRADED SAND WITH SILT & COARSE TUFT GRAVEL & BASALT FRAGMENT	
110	1.11 DC 2.4 2.4	10YR 6/3 PALE BROWN					0		95 3 2						SM			SILTY SAND	
	1.75 DC 2.52.5	10YR 6/4 LIGHT YELLOW BROWN					23 69 8								SW-SM			WELL GRADED SAND WITH SILT & FINE GRAVEL	
2-5-92 115 2-6-92	NO SAMPLE ON AUGER TO 116.4 FT.	6 INCH PENETRATION																	
	2.83 DC 1.1 1.1	10YR 6/4					0		98 1 1										
	1.47 DC 2.52.5	10YR 7/6 YELLOW					21 74 5								SW-SM			WELL GRADED SAND WITH SILT & FINE GRAVEL	
120																			

Table B.3 (Continued)

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Borehole Log Sheet

1) Hole Designation: ST-2		4) Drilling Method: Hollow Stem Auger PERCUSSION DRIVE CORE										
2) Logged By: BRIAN DOZIER, EDITED BY: KEN DONNELSON		5) Checked By:										
3) Date and Time Log Completed: ?												
7) Penetration Rate (in/min/ft)	8) Sampling Data	9) Color (Munsell Chart)	10) Moisture Content (%)	11) Particle Size Distribution (%)	12) Major Minerals in %	13) Sorting	14) Grain Shape	15) Composition	16) IICL Description	17) USCS Group Name	18) Radiometric Data	19) Comments:
2-6-92 120	2522	10YR 7/6 Yellow		0	23 TS 5							WELL GRADED SAND WITH SILT FINE GRAVEL
18 DEC 1012				25 CL 9						SWI SW		WELL GRADED SAND WITH SILT FINE GRAVEL
TOTAL DEPTH 123.5 FT., 2-6-92												

Table 8.4 Borehole log sheets for Ue55T-3
Borehole Log Sheet

1) Hole Designation: ST-3		4) Drilling Method: HOLLOW STEM AUGER PERCUSSION DRIVE CORE												
2) Logged By: DANIEL BLAUT, EDITED BY: KEN DONNELSON		5) Checked By:												
3) Date and Time Log Completed: 1-15-92, 1440														
6) Depth in Feet	7) Penetration Rate	8) Sampling Data	9) Color (Munsell Chart)	10) Moisture Content	11) Particle Size Distribution	12) Major Minerals in %	13) Sorting	14) Grain Shape	15) Cementation	16) ICL Reaction	17) USCS Group Name	18) VOC in ppm	19) Radiometric Data	20) Comments: 8 PARTICLE SIZE INTERVAL FROM LAB ANALYSIS
0		DC 2.518	10YR 4/3 VERY PALE BROWN								SM			WESBOM OIL OIL THREADS 0.0 - 0.8 FT LIGHTER & DRIER SILTY SAND
5		DC 2.523												WELL GRADED SAND SILTY SAND
10		DC 2.520	10YR 4/3 PALE BROWN											
15		DC 2.521	10YR 4/3 VERY PALE BROWN											
15		NO SAMPLES												
15		LOST CHISEL IN HOLE												PROBABLE STREAM COBBLES FROM 11 - 13 FT ±
TOTAL DEPTH 15 FT														

Table B.5 Borehole log sheets for ST-4

Page 1 of 8

Borehole Log Sheet

1) Hole Designation: ST-4		4) Drilling Method: HOLLOW STEM AUGER PERCUSSION DRIVE CORE, MESS SAMPLER													
2) Logged By: DANIEL BLOUT, EDITED BY KEN DONNELSON		5) Checked By:													
3) Date and Time Log Completed: 2-7-92, 0930															
8) Depth in Feet	7) Penetration Rate (Min/FT)	6) Sampling Data		9) Color (Munsell Chart)	10) Moisture Content (%)	11) Particle Size Distribution (%)	12) Major Minerals in %	13) Borings	14) Grains Shape	15) Cementation	16) ICL Resection	17) UCS Group Name	18) VOC's in ppm	19) Radiometric Data	20) Comments:
		Time	Moisture												
0	DC 12.5 1.9			10YR 7/3 VERY PALE BROWN	5.2	6 71 23						SM-SC			8 PARTICLE SIZE INTERVAL FROM LAB ANALYSIS. ROOT, 1 FT MOIST. FINE SILTY SAND WITH CLAY. FINE SILTY SAND. FINE SAND WITH SILT VERY DRY. FINE SILTY SAND WITH CLAY. VERY UNCONSOLIDATED. FINE SAND WITH SILT. WELL GRADED SAND WITH SILT COARSE GRAVEL. THIS WELL GRADED SAND ZONE AT 11.0-11.1 FT & 11.3-11.4 FT CONTAINS PLUGGED DABBLE LINER.
5	DC 12.5 2.2					6 82 12 5 84 11						SM-SC SM-SP-EM			
10	DC 12.5 1.0					14 64 22						SM-SC			
15	DC 12.5 2.35														
1-16-92	0.9 DC 12.5 1.9			10YR 6/4 LIGHT YELLOW BROWN		6 83 11 25 67 8						SP-SM SW-SM			
2-7-92	1.88 DC 12.5 1.5			10YR 7/1 VERY PALE BROWN											
NO SAMPLES															

Table B.5 (Continued)

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Borehole Log Sheet

1) Hole Designation: ST-4		4) Drilling Method: HOLLOW STEM AUGER											
2) Logged By: DANIEL BLOUT, EDITED BY: KEN DANIELSON		PERCUSSION DRIVE CORE											
3) Date and Time Log Completed: 2-7-92, 12:45		5) Checked By:											
7) Depth in Feet	8) Sampling Data	9) Color (Munsell Chart)	10) Moisture Content (%)	11) Particle Size Distribution (%)	12) Major Minerals in %	13) Sorting	14) Grain Shape	15) Cementation	16) Felsic Reaction	17) USCS Group Name	18) Volumetric Data	19) Descriptive Data	20) Comments:
15	NO SAMPLES AUGERED HOLE												
19.8	DC 2.52.3	10YR 7/1 VERY PALE BROWN		13 74 13 12 81 7						SM SW-SM			FINE SILTY SAND WELL GRADED SAND WITH SILT
20.3	DC 2.52.5			3 90 7						SP-SM			FINE SAND WITH SILT VERY THIN GRAVEL LAYER AT 2 FT
21.9	DC 2.52.4	10YR 8/4 LIGHT MEL. BROWN		18 76 6 10 84 6						SW-SM SP-SM			WELL GRADED SAND WITH SILT & FINE GRAVEL FINE SAND WITH SILT
24.7	DC 2.52.2	10YR 7/3 VERY PALE BROWN		5 90 5						SP			FINE SAND
25.2				9 86 5						SP-SM			FINE SAND WITH SILT
28.5	DC 2.52.5			18 75 5						SP-SM			FINE SAND WITH SILT & FINE GRAVEL
29.0				8 86 5						SP			FINE SAND

Table 8.5 (Continued)

Page 3 of 8

Borehole Log Sheet

1) Hole Designation: ST-4		4) Drilling Method: HOLLOW STEM AUGER PERCUSSION DRIVE CORE												
2) Logged By: DANIEL BLOU, EDITED BY: KEN PENNELSON		5) Checked By:												
3) Date and Time Log Completed: 2-10-92, 1100														
6) Depth in Feet	7) Penetration Rate (min/ft)	8) Sampling Date	9) Color (Munsell Chart)	10) Moisture Content (%)	11) Particle Size Distribution (%)	12) Major Minerals in %	13) Sorting	14) Grain Shape	15) Cementation	16) ICL Reaction	17) USCS Group Name	18) Neofluorite	19) VOCs in ppm	20) Comments: 8 PARTICLE SIZE INTERVAL FROM LAB ANALYSIS
2-7-92 30	2.2 DC 2.5 2.5	10YR 7/3 VERY PALE BROWN	10YR 7/3 VERY PALE BROWN	10YR 7/3 VERY PALE BROWN	0	8 04 8	0	0	0	0	SP-SM	0	0	VERY SLIGHT MOISTURE AT 32 FT FINE SAND WITH SILT LARGE NON-WELDED TUFF FRAGMENTS
35	1.53 DC 2.5 2.5				30 61 9						SW-SM			WELL GRADED SAND WITH SILT & COARSE GRAVEL
	2.09 DC 2.5 2.0				33 60 7 25 67 8						SW-SM SW-SM			WELL GRADED SAND WITH SILT COARSE GRAVEL THIN WELL GRADED SAND ZONES AT 38.0-38.1, 38.5-38.6 & 37.5-37.6 FT. FINE SILTY SAND
2-7-92 40	2.6 DC 2.4 2.3	10YR 5/4 LIGHT YEL. BROWN	10YR 7/3 VERY PALE BROWN	10YR 7/3 VERY PALE BROWN	9 70 13						SM			WELL GRADED SAND WITH SILT & COARSE GRAVEL
2-10-92	1.55 DC 2.5 2.2				19 72 9						SW-SM			WELL GRADED SAND WITH SILT & COARSE GRAVEL
45	2.78 DC 2.5 2.7				23 70 7						SW-SM			WELL GRADED SAND WITH SILT & GRAVEL. LARGE NON-WELDED TUFF FRAGMENTS.

Table B.5 (Continued)

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Borehole Log Sheet

1) Hole Designation: ST-4										4) Drilling Method: HOLLOW STEM AUGER PERCUSSION DRIVE CORE			
2) Logged By: DANIEL BLAUT, EDITED BY: KEN DANNENLON										5) Checked By:			
3) Date and Time Log Completed: 2-10-92, 1430													
7) Penetration Rate (MPY/FT)	8) Sampling Date	9) Color (Munsell Chart)	10) Moisture Content (%)	11) Particle Size Distribution (%)	12) Moister Minerals in %	13) Sorting	14) Grain Shape	15) Cementation	16) Fines	17) USCS Group Name	18) Radiometric Data	20) Comments:	
	Core No.			Gravel Sand Silt Clay	Volcanics Silt Clay	Other	Angular Subangular Rounded	None Weak Moderate Strong	None Weak Moderate Strong				
1.31 DC 2.52.2	10YR 5/4	VERY PALE BROWN		20 70 10	90 10					SW-SM		WELL GRADED SAND WITH SILT & FINE GRAVEL	
2.18 DC 2.32.3													
2.47 DC 2.52.2	10YR 7/5	VERY PALE BROWN		18 74 8 11 78 11	90 10					SW-SM SW-SM		WELL GRADED SAND WITH SILT & FINE GRAVEL	
1.83 DC 2.52.5	10YR 6/4	LIGHT YELLOW BROWN		14 79 7						SW-SM		WELL GRADED SAND & SILT	
1.78 DC 2.52.1	10YR 7/5			13 76 11						SP-SM		FINE SAND WITH SILT	
1.76 DC 2.52.3	10YR 5/4	VERY PALE BROWN		19 73 8						SW-SM		WELL GRADED SAND WITH SILT & FINE GRAVEL	
	10YR 7/5	VERY PALE BROWN		10 80 10						SP-SM		FINE SAND WITH SILT	

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4) Drilling Method:
HOLLOW STEM AUGER
PERCUSSION DRIVE CORE

2)Logged By: DANIEL BLOUT, EDITED BY: KEN DONNELSON

5) Checked By:

(f) Depth in feet	(g) Penetration Rate (N)/P	(h) Sampling Data		Dye Color (Munsell Chart)	(i) Moisture Content	(j) Particle Size Distribution	(k) Major Minerals in %	(l) Sorting	(m) Grain Shape	(n) Cementation	(o) Physical Reaction		(p) USCS Group Name	(q) VOC's in ppm	(r) Radiometric Data	(s) Date	(t) Comments:
		Type	Recovery								Thin Counts	Weak					
60	1.68 DC 2.5 1.9			10YR 7/1	0	0	0	0	0	0	0	0	SW-SM				10' CORE FROM 62 - 62.5 FT. WELL GRADED SAND WITH SILT & FINE GRAVEL.
65	1.57 DC 2.5 2.5			10YR 6/4 10YR 7/3 10YR 7/3	0	26 68 6 2 80 18	0	0	0	0	0	0	SW-SM SM				WELL GRADED SAND WITH SILT & COARSE GRAVEL. FINE SILTY SAND
65	1.67 DC 2.5 2.3			10YR 6/4 10YR 7/3 10YR 7/3	0	17 78 -5	0	0	0	0	0	0	SW				STORM IN AREA, HIGH HUMIDITY 2-12-92 WELL GRADED SAND WITH FINE GRAVEL
70	2.0 DC 2.5 2.5			10YR 6/4 10YR 7/3 10YR 7/3	0	13 76 11 22 68 10	0	0	0	0	0	0	SW-SM SP-SM				WELL GRADED SAND WITH SILT FINE SAND WITH SILT & FINE GRAVEL
70	1.95 DC 2.5 2.5			10YR 6/4 10YR 7/3 10YR 7/3	0	11 72 17	0	0	0	0	0	0	SW-SM				WELL GRADED SAND WITH SILT.
75	2.42 DC 2.5 2.3			10YR 6/4 10YR 7/3 10YR 7/3	0	53 35 12 1 13 74 13	0	0	0	0	0	0	GM SM				SILTY GRAVEL, COARSE GRAVEL GRAVELS 2-3 INCH., VOLCANIC FRAGMENTS, PINK, GRAY. FINE SILTY SAND.

Table B.5 (Continued)

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Borehole Log Sheet

1) Hole Designation: ST-4		4) Drilling Method: HOLLOW STEM AUGER PERCUSSION DRIVE CORE														
2) Logged By: O'BRIEN & DANIEL BLOUT, EDITED BY: DANIEL BLOUT		5) Checked By:														
3) Date and Time Log Completed: 2-13-92, 10:35																
Core Depth in Feet	Sampling Date	7) Penetration Rate (Min/ft)	8) Color (Munsell Chart)	9) Moisture Content (%)	10) Particle Size Distribution (%)	11) Major Minerals in %	12) Borings	13) Grain Shape	14) Cementation	15) Fractures	16) IICL Reaction	17) USCS Group Name	18) VOCs in ppm	19) Radiometric Data	20) Comments:	
																21) Particle Size Interval From Lab Analysis
2-12-92 75	1177 DC 1 C 1 C	10YR 7/1 VERY PALE BROWN	0	12 77 11	0	0	0	0	0	0	0	SP-SM	0	0	0	FINE SAND WITH SILT
NO SAMPLES, AUGERED HOLE																
80	3.5 DC 15 1.5	10YR 7/1 VERY PALE BROWN	1	30 62 8	1	1	1	1	1	1	1	SW-SM	1	1	1	RAISING SOME LIPS WITH COMPRESSOR PRODUCING MUCKY WATER LEACHING INTO TOP OF SAMPLE
NO SAMPLES, AUGERED HOLE																
80	2.11 DC 2.5 2.5	10YR 7/1 VERY PALE BROWN	0	8 83 9	0	0	0	0	0	0	0	SP-SM	0	0	0	RAISING, ATTEMPTING TO KEEP LIPS DRY. WELL GRADED SAND WITH SILT & COARSE GRAVEL.
85	1.56 DC 2.1 1.0		1	12 75 13	1	1	1	1	1	1	1	SM	1	1	1	FINE SAND WITH SILT
85	2.14 DC 2.3 2.5	10YR 7/1 VERY PALE BROWN	0	3 70 19	0	0	0	0	0	0	0	SM	0	0	0	FINE SILTY SAND.
85			1	6 84 10	1	1	1	1	1	1	1	SW-SM	1	1	1	WELL GRADED SAND WITH SILT.
85			1	0 95 5	1	1	1	1	1	1	1	SP	1	1	1	FINE SAND.
90	1.94 DC 2.5 2.5	10YR 6/4 LIGHT YELLOW BROWN	1	23 70 7	1	1	1	1	1	1	1	SW-SM	1	1	1	WELL GRADED SAND WITH SILT & FINE GRAVEL.

Table B.5 (Continued)

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Borehole Log Sheet

1) Hole Designation: ST-4		4) Drilling Method: HOLLOW STEM AUGER PERCUSSION DRIVE CORE												
2) Logged By: DANIEL BLOWT, EDITED BY: KEN DONNELSON		5) Checked By:												
3) Date and Time Log Completed: 2-14-92, 12.00														
6) Depth in Feet	7) Orientation Note (Mag/Tr)	8) Sampling Data	9) Color (Munsell Chart)	10) Moisture Content	11) Particle Size Distribution	12) Major Minerals	13) Sorting	14) Grain Shape	15) Cementation	16) ICL Reaction	17) USCS Group Name	18) Voids in ppm	19) Radiometric Data	20) Comments:
89.0	2.5 DC 2.5 2.9	10YR7/1 VERY PALE BROWN	5	0	31 61 8						SW-SM			20) Comments: B PARTICLE SIZE INTERVAL FROM LAB ANALYSIS. 2-13-92 RAINY WEATHER. RAINED CONTINUOUSLY AFTER 12PM
90.0	4.0 DC 0.4 0.4				22 66 8						SW-SM			WELL GRADED SAND WITH SILT & COARSE GRAVEL.
91.0	4.0 DC 0.4 0.4				SB 36 6						SW-SM			WELL GRADED SAND WITH SILT & COARSE GRAVEL.
92.0											SW-SM			WELL GRADED SAND WITH SILT & COARSE GRAVEL.
93.0											SW-SM			WELL GRADED SAND WITH SILT & COARSE GRAVEL.
94.0											SW-SM			WELL GRADED SAND WITH SILT & COARSE GRAVEL.
95.0											SW-SM			WELL GRADED SAND WITH SILT & COARSE GRAVEL.
96.0											SW-SM			WELL GRADED SAND WITH SILT & COARSE GRAVEL.
97.0											SW-SM			WELL GRADED SAND WITH SILT & COARSE GRAVEL.
98.0											SW-SM			WELL GRADED SAND WITH SILT & COARSE GRAVEL.
99.0											SW-SM			WELL GRADED SAND WITH SILT & COARSE GRAVEL.
100.0											SW-SM			WELL GRADED SAND WITH SILT & COARSE GRAVEL.
101.0											SW-SM			WELL GRADED SAND WITH SILT & COARSE GRAVEL.
102.0											SW-SM			WELL GRADED SAND WITH SILT & COARSE GRAVEL.
103.0											SW-SM			WELL GRADED SAND WITH SILT & COARSE GRAVEL.
104.0											SW-SM			WELL GRADED SAND WITH SILT & COARSE GRAVEL.
105.0											SW-SM			WELL GRADED SAND WITH SILT & COARSE GRAVEL.

Table B.5 (Continued)

Borehole Log Sheet

Page 8 of 8

1) Hole Designation: ST-4		4) Drilling Method: HOLLOW STEM AUGER PERCUSSION DRIVE CORE		
2) Logged By: DANIEL BLOUT, EDITED BY: KEN DONNELSON		5) Checked By:		
3) Date and Time Log Completed: 2-14-92, 1430				
(1) Penetration Rate (min/ft)	(2) Sampling Data	(3) Color (Munsell Chart)	(4) Moisture Content (%)	
	Type Recovery Loss Count			
(5) Depth in Feet	(6) Particle Size Distribution	(7) Major Minerals	(8) Sorting	
	(9) Grain Shape	(10) Cementation	(11) CL Reaction	
	(12) USCS Group Name	(13) VOCs in ppm	(14) Data	
	(15) Comments:			
105	1.2 DC 2.5 2.5	10YR 7/1 VERY PALE Brown	7 83 10	Well graded sand with silt.
110	1.8 DC 2.5 2.5		3 90 7	Fine sand with silt core beaten out of sampler poured.
			23 68 9	Well graded sand with silt & fine gravel.
	2.0 DC 2.5 2.5	10YR 6/4 LIGHT YELLOW Brown	2 82 16	Fine silty sand core beaten & poured out of cone barrel. Large gravel at 111 ft.
	4.0 DC 2.5 1.5		14 76 10	Well graded sand with silt. core beaten & poured out.
	TOTAL DEPTH 113.75 FT. 2-14-92			

Table 8.6 Borehole log sheets for ST-5

Borehole Log Sheet

1) Hole Designation: ST-5										4) Drilling Method: HOLLOW STEM AUGER PERCUSSION DRIVE CORE									
2) Logged By: DANIEL BLOUT, EDITED BY: KEN DANIELSON										5) Checked By:									
3) Date and Time Log Completed: 2-11-92, 1430																			
Depth in Feet	Penetration Rate (min/ft)	Sampling Data		Color (Munsell Chart)	Moisture Content (%)	Particle Size Distribution (%)	Major Minerals (%)	Boring	Grain Shape	Cementation	Fract. Reaction	USCS Group Name	10) VOC's in ppm	Name Data	20) Comments: 8 PARTICLE SIZE INTERVAL FROM LAB ANALYSIS.				
		Type	Recovery													Grain	Moisture	Grain	Moisture
0		DC 2.5 1.8		10YR 6/6 BROWN YELLOW		6 73 21						SM			EXCESS WEISSON OIL 0-0.4 FT. ROOTS FINE SILTY SAND				
5		DC 2.5 1.7		10YR 7/5 VERY PALE BROWN		12 77 11						SP-SM			FINE SAND WITH SILT				
		DC 2.5 2.4										SM			GRAVELS + 1 INCH MEDIUM SILTY SAND WITH FINE GRAVELS				
		DC 2.5 2.1				6 76 18						SM			FINE SILTY SAND				
10		DC 2.5 2.1				0 10 70 10	70 10					SP-SM			FINE SAND WITH SILT & FINE GRAVELS ROOTS AT 12 FT.				
15		DC 2.5 1.6				1 8 86 6						SP-SM			FINE SAND WITH SILT				

Table B.6 (Continued)

Borehole Log Sheet

1) Hole Designation: ST-5		4) Drilling Method: HOLLOW STEM AUGER PERCUSSION DRIVE CORE															
2) Logged By: DANIEL BLOUT, EDITED BY: KEN DONNELSON		5) Checked By:															
3) Date and Time Log Completed: 2-20-92, 1400																	
(i) Depth in Feet	(7) Penetration Rate (Min/Ft)	Type	Interval	Recovery	Blow Counts	(8) Color (Munsell Chart)	(9) Moisture Content	(11) Particle Size Distribution	(12) Major Minerals in %	(13) Sorting	(14) Grain Shape	(15) Cementation	(16) Reaction	(17) USCS Group Name	(18) VOC's in ppm	(19) Radiometric Data	(20) Comments: PARTICLE SIZE INTERVAL FROM LAB ANALYSIS
2-20-92 15	1.41 DC 2.5 2.3					10YR 7/3 10YR 6/4 LIGHT YELLOW BROWN	0	0	100	Well Moderate	Spherical Subangular	None Weak Moderate Strong	None Weak Moderate Strong				
	NO SAMPLE, AUGERED HOLE																
20	1.04 DC 2.5 2.5					10YR 6/4 10YR 7/3 VERY PALE BROWN	0	0 12 83 -5 18 75 7	97 2 1	Well Moderate	Spherical Subangular	None Weak Moderate Strong	None Weak Moderate Strong	SW SW-SM			WELL GRADED SAND WELL GRADED SAND WITH SILT & FINE GRAVEL
	NO SAMPLE, AUGERED HOLE																
25	0.71 DC 2.5 2.5					10YR 7/3 VERY PALE BROWN	0	0	97 2 1	Well Moderate	Spherical Subangular	None Weak Moderate Strong	None Weak Moderate Strong	SP			SEMI-CLEAN FINE SAND
	NO SAMPLE, AUGERED HOLE					10YR 6/4											
30																	

Table 8.7 Borehole log sheets for SI-6

Borehole Log Sheet

4) Drilling Method: HOLLOW STEM AUGER PERCUSSION DRIVE CORE															
1) Hole Designation: SI-6															
2) Logged By: DANIEL BLAUT, EDITED BY: KEN DONNELSON															
3) Date and Time Log Completed: 2-10-92, 1100															
5) Checked By:	7) Penetration Rate (mm/ft)	8) Depth in Feet	9) Sampling Date	10) Color (Munsell Chart)	11) Particle Size Distribution	12) Water Content	13) Swell	14) Shape	15) Cementation	16) Fract. Position	17) UCS Group Name	18) Voids in pores	19) Date	20) Comments: B PARTICLE SIZE INTERVAL FROM LAB ANALYSIS	
															21) Moisture Content
	0.55	2.5	2-10-92	10YR 7/6 pale yellowish gray	0	0	0	0	0	0	0	0	0	0	0
	0.38	2.5	2-10-92	10YR 7/4 pale yellowish gray	0	0	0	0	0	0	0	0	0	0	0
	0.77	2.5	2-10-92	10YR 7/5 pale yellowish gray	0	0	0	0	0	0	0	0	0	0	0
	0.96	2.5	2-10-92	10YR 7/5 pale yellowish gray	0	0	0	0	0	0	0	0	0	0	0
	1.21	2.5	2-10-92	10YR 7/5 pale yellowish gray	0	0	0	0	0	0	0	0	0	0	0

Table 8.7 (Continued)

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Borehole Log Sheet

1) Hole Designation: ST-6		4) Drilling Method: HOLLOW STEM AUGER																
2) Logged By: DANIEL BLOUT, EDITED BY: KEN DANIELSON		PERCUSSION DRIVE CORE																
3) Date and Time Log Completed: 2-18-92, 1325		5) Checked By:																
C) Depth in Feet	7) Penetration Rate (Min/Ft)	8) Sampling Date	9) Color (Munsell Chart)	10) Moisture Content (%)	11) Particle Size Distribution (%)	12) Major Minerals in %	13) Borings	14) Grain Slope	15) Compaction	16) Reaction	17) USCS Group Name	18) Radiometric Data	19) Comments: PARTICLE SIZE INTERVAL FROM LAB ANALYSIS.					
														2) Clay	3) Sand	4) Gravel	5) Silt	6) Clay
15	0.71	DC 2.5 2.9	10YR 7/4 VERY PALE BROWN	10YR 7/4 VERY PALE BROWN	38 57 5	90 10					SW		WELL GRADED SAND WITH GRAVELS CLEAN SAND WITH INTERBEDDED LARGE GRAVELS					
16	1.29	DC 2.5 2.3	10YR 7/3 PALE BROWN	10YR 7/3 PALE BROWN	49 46 5						SW		CEMENTED(?) AT 18 FT LARGE GRAVEL LAYERS WELL GRADED SAND WITH FINE GRAVEL CLEAN SAND WITH GRAVEL LAYERS MEDIUM SAND					
20	1.21	DC 2.5 2.5	10YR 6/1 PALE BROWN	10YR 6/1 PALE BROWN	10 88 2						SP		WELL GRADED SAND WITH SILT					
25	1.27	DC 2.5 2.5	10YR 7/4 VERY PALE BROWN	10YR 7/4 VERY PALE BROWN	8 82 10						SW-SM		FINE SAND					
26	1.21	DC 2.5 2.5	10YR 7/3 PALE BROWN	10YR 7/3 PALE BROWN	13 83 4						SP		WELL GRADED SAND WITH FINE GRAVEL					
30	1.28	DC 2.5 2.3	10YR 7/3 PALE BROWN	10YR 7/3 PALE BROWN	19 77 2						SW		FINE SAND WITH SILT					

Table B.7 (Continued)

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Borehole Log Sheet

1) Hole Designation: ST-C		4) Drilling Method: HOLLOW STEM AUGER PERCUSSION DRIVE CORE											
2) Logged By: DANIEL BLAUT, EDITED BY: KEN DONNELSON		5) Checked By:											
3) Date and Time Log Completed: 2-19-92, 0930													
7) Penetration Rate (Min/ft)	8) Sampling Data Type Interval Recovery Box Count	9) Color (Munsell Chart)	10) Moisture Content (%)	11) Particle Size Distribution (%)	12) Major Minerals in %	13) Sorting	14) Grain Shape	15) Cementation	16) ICL Reaction	17) USCS Group Name	18) VOCs in ppm	19) Radiometric Data	20) Comments: B PARTICLE SIZE INTERVAL FROM LAB ANALYSIS NO SAMPLES FROM 30-40 FT
49	DC 2.5 2.2	10YR7/3 VERY PALE BROWN	0	0	90 10	Well Sorted	Subangular	Weak	Moderate	SW-SM			WELL GRADED SAND WITH SILT COARSE GRAVEL
49	DC 2.5 2.5	10YR7/4 VERY PALE BROWN	0	21 70 9	90 10	Well Sorted	Subangular	Weak	Moderate	SP-SM			SLIGHTLY MUD MEDIUM SAND WITH SILT FINE GRAVEL
52.5	NO SAMPLE, AUGERED HOLE												
60	DC 2.5 2.0	10YR7/3 VERY PALE BROWN	0	0	90 10	Well Sorted	Subangular	Weak	Moderate	SP-SM			SAND WITH SILT
62.5	NO SAMPLE, AUGERED HOLE												

Table 8.7 (Continued)

Borehole Log Sheet

Page 4 of 5

4) Drilling Method: HOLLOW STEM AUGER PERCUSSION DRIVE CORE															
5) Checked By:															
20) Comments: 8 PARTICLE SIZE INTERVAL FROM LAB ANALYSIS.															
19) Radiometric Data															
18) VOC's in ppm															
17) USCS Group Name															
16) USCS Reaction															
15) Cementation															
14) Grain Shape															
13) Sorting															
12) Major Minerals in %															
11) Particle Size Distribution in %															
10) Moisture Content															
9) Color (Munsell Chart)															
8) Grain Size Distribution in %															
7) Orientation Note (N/S/E/T)															
6) Depth in feet															
2-10-92															
70															
2-10-92															
72.5															
2-19-92															
80															
82.5															
90															
92.5															
100															

Table B.7 (Continued)

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Borehole Log Sheet

1) Hole Designation: ST-C		4) Drilling Method: HOLLOW STEM AUGER PERCUSSION DRIVE CORE										
2) Logged By: DANIEL BLOUT, EDITED BY: KEN DOWNES		5) Checked By:										
3) Date and Time Log Completed: 2-19-92, 1145		20) Comments: PARTICLE SIZE INTERVAL FROM LAB ANALYSIS										
1) Depth in feet	2) Sampling Data	3) Color (Munsell Chart)	4) Moisture Content (%)	5) Particle Size Distribution	6) Major Minerals	7) Borings	8) Grain Shape	9) Cementation	10) Fossil Reaction	11) USCS Group Name	12) Radiometric Data	13) Comments
	Grain Size Distribution	Grain Size	Grain Shape	Grain Size	Grain Shape	Grain Size	Grain Shape	Grain Size	Grain Shape	Grain Size	Grain Shape	Grain Size
100	DC 2.5 2.5	10YR 7/3 VERY PALE BROWN	10	25 66 9	90 10	Very fine sand	Angular to subangular	Weak to medium	Weak to medium	SW-SM		WELL GRADED SAND WITH SILT & COARSE GRAVEL
102.5	NO SAMPLE	AUGERED HOLE										
110	DC 2.5 2.5	10YR 7/3 VERY PALE BROWN	10	9 79 12	90 10	Fine sand	Angular to subangular	Weak to medium	Weak to medium	SM		FINE SILTY SAND
115	DC 1.5 1.4	10YR 7/3 VERY PALE BROWN	10		90 10	Silty sand	Angular to subangular	Weak to medium	Weak to medium	SM		SILTY SAND
120	NO SAMPLE	AUGERED HOLE										
TOTAL DEPTH 120 FT, 2-20-92												

Table 8.8 Borehole log sheets for ST-7

Page 1 of 3

Borehole Log Sheet										4) Drilling Method: HOLLOW STEM AUGER PERCUSSION DRIVE CORE		20) Comments: 8 PARTICLE SIZE FROM LAB ANALYSIS FOR SAMPLE INTERVAL HOLE LOCATED IN CHANNEL. ROUGH CORING.				
1) Hole Designation: ST-7										17) USCS Group Name		19) Radiometric				
2) Logged By: DANIEL BLAUT, EDITED BY: KEN DANIELSON										18) USCS Group Name		19) Radiometric				
3) Date and Time Log Completed: 2-19-92, 1600										5) Checked By:						
5) Depth in Feet	7) Penetration Rate (min/ft)			8) Sampling Data	9) Color (Munsell Chart)	10) Moisture Content (%)	11) Particle Size Distribution	12) Mineralogy	13) Sorting	14) Grain Shape	15) Cementation	16) Fracture	17) USCS Group Name	18) USCS Group Name	19) Radiometric	20) Comments
	7) Penetration Rate (min/ft)	Recovery	Grain Size													
0.37	DC 2.5 1.3				10YR 5/6 YEL. BROWN	100	0 6 70 4	100	100	100	100	100	SP	SP		FINE SAND. MOST FROM RECENT RAIN.
1.3	DC 1.5 1.3				10YR 7/3 VERY PALE BROWN	100	0 6 70 4	100	100	100	100	100	SW-SM	SW-SM		ROOTS.
1.85	DC 1.0 0.8				10YR 7/3 VERY PALE BROWN	100	0 6 70 4	100	100	100	100	100	SW-SM	SW-SM		WELL GRADED SAND WITH SILT. FINE GRAVEL. TUFF COBBLE INSIDE.
1.99	DC 2.5 2.2				10YR 7/3 VERY PALE BROWN	100	0 6 85 7	100	100	100	100	100	SP-SM	SP-SM		FINE SAND WITH SILT. COARSE SAND AT 8.75 FT.
6.74	DC 2.5 1.5				10YR 7/3 VERY PALE BROWN	100	0 6 85 7	100	100	100	100	100	GW	GW		WELL GRADED SANDY GRAVELS WITH DENSELY WELDED COBBLES.
11.3	DC 2.5 2.4				10YR 7/3 VERY PALE BROWN	100	0 6 85 7	100	100	100	100	100	SN	SN		WELL GRADED SAND WITH FINE GRAVEL. MAGNETITE AT 14.5-15.0 FT.

Table B.8 (Continued)

Page 2 of 3

Borehole Log Sheet

4) Drilling Method: YELLOW STEM AUGER PERCUSSION DRIVE CORE												
1) Hole Designation: S T-7												
2) Logged By: DANIEL BLOUT, EDITED BY: KEN DONNELSON												
3) Date and Time Log Completed: 2-20-92, 1030												
5) Checked By:												
(7) Penetration Rate (MPH/FT)	(8) Sampling Data	(9) Color (Munsell Chart)	(10) Moisture Content	(11) Particle Size Distribution	(12) Major Minerals	(13) Sorting	(14) Grain Shape	(15) Cementation	(16) ICL Reaction	(17) USCS Group Name	(18) Radiometric Data	(19) Comments:
1.34	DC 2.5 2.4	10YR 6/4 LIGHT YELLOWISH BROWN	10	0 23 73 4	97 2	1	Subrounded	Weak	Weak	SW		WELL GRADED SAND WITH FINE GRAVEL
1.4	DC 2.5 2.5			19 75 6						SW-SM		WELL GRADED SAND WITH SILT & FINE GRAVEL
1.11	DC 2.5 2.5	10YR 7/3 VERY PALE BROWN		13 81 6						SW-SM		WELL GRADED SAND WITH SILT & FINE GRAVEL
1.41	DC 2.5 2.5	10YR 6/4 LIGHT YELLOWISH BROWN		11 85 4						SW		WELL GRADED SAND, SLIGHTLY MOIST?
1.08	DC 2.5 1.9			10 85 -5						SP		MEDIUM SAND
1.10	DC 2.5 2.5	10YR 7/3 VERY PALE BROWN		5 89 7						SP-SM		FINE SAND WITH SILT, SLIGHTLY MOIST, INTERBEDDED SMALL GRAVEL LAYERS

Table B.8 (Continued)

Borehole Log Sheet

Page 3 of 3

1) Hole Designation: ST-7		4) Drilling Method: HOLLOW STEM AUGER PERCUSSION DRIVE CORE										
2) Logged By: DANIEL BLOUT, EDITED BY: KEN DONNELSON		5) Checked By:										
3) Date and Time Log Completed: ?												
7) Penetration Rate (min/ft)	8) Depth in Feet	9) Type of Sample	10) Moisture Content (%)	11) Particle Size Distribution (%)	12) Major Minerals in %	13) Sorting	14) Grain Shape	15) Cementation	16) ICL Reaction	17) USCS Group Name	18) Radiometric Data	20) Comments:
113	29.25	DC 2.5 2.4	5	0	97.2	Very Poor	Subangular	None	Weak	SP-SM		FINE SAND WITH SILT
123	30.25	DC 2.5 2.4	5	0	97.2	Very Poor	Subangular	None	Weak	SP-SM		FINE SAND WITH SILT
TOTAL DEPTH 35 FT												

APPENDIX C

Table C.1. Core record for borehole ST-1.

Date	Run No.	<u>Core depth interval</u>		<u>Core recovery</u>		Penetration rate	Core type ¹	Laboratory tests ²
	(ft)	from (ft)	to (ft)	(ft)	(%)	(ft/min)		
1/14/92	1	0.00	2.50	0.00	0		P	
1/14/92	2	2.50	4.50	1.25	63		P	A,B,D,F,G
1/14/92	3	4.50	6.50	1.40	70		P	A,B,D,F,G
1/14/92	4	6.50	8.50	1.50	75		P	A,B,D,F,G
1/14/92	5	8.50	10.00	1.10	73		P	A,D,F,G
1/17/92	6	11.50	12.50	1.00	100		P	A,F,G,I
1/17/92	7	12.50	15.00	2.10	84		P	A,B,C,E,F,G,I
1/17/92	8	16.75	17.50	0.75	100		P	D,G
1/17/92	9	17.50	20.00	0.75	30	0.36	P	
1/17/92	10	20.00	22.50	2.40	96		P	A,B,C,D,E,F,G,H,I
1/17/92	11	22.50	25.00	2.20	88	2.50	P	A,C,D,E,F,G,H,I
1/17/92	12	25.00	27.50	2.50	100	1.67	P	A,B,C,D,E,F,G,H,I
1/20/92	13	27.50	30.00	2.50	100	1.25	P	A,C,D,E,F,G,H,I
1/20/92	14	30.00	32.50	2.50	100	0.83	P	A,B,C,D,E,F,G,H,I
1/20/92	15	32.50	35.00	2.50	100	1.50	P	A,B,C,D,E,F,G,H,I
1/20/92	16	35.00	37.50	2.50	100	2.50	P	A,B,C,D,E,F,G,H
1/20/92	17	37.50	40.00	2.30	92	0.83	P	A,B,C,D,E,F,G,I
1/20/92	18	40.00	42.50	2.50	100	2.50	P	A,B,C,D,E,F,G,H,I
1/20/92	19	42.50	45.00	1.75	70	2.50	P	I
1/21/92	20	45.00	47.50	2.50	100	2.50	P	A,B,C,D,E,F,G,H,I
1/21/92	21	47.50	50.00	2.40	96	2.50	P	A,B,C,D,E,F,G,I
1/21/92	22	50.00	52.50	2.50	100	1.25	P	A,B,C,D,F,H,I
1/21/92	23	52.50	55.00	2.40	96	2.50	P	A,B,C,D,E,F,G,H,I
1/21/92	24	55.00	56.10	1.10	100	1.10	P	A,B,D,E,I
1/21/92	25	57.50	60.00	2.30	92	0.83	P	A,B,C,D,E,F,G,I
1/21/92	26	60.00	62.50	2.50	100	1.25	P	A,B,C,D,E,F,G,H,I
1/21/92	27	62.50	65.00	2.50	100	0.83	P	A,B,C,D,E,F,G,H,I
1/22/92	28	65.00	66.00	1.25	125	0.33	P	A,B,C,D,I
1/22/92	29	66.00	67.50	1.30	87	0.50	M	A,B,D,E,I
1/22/92	30	67.50	70.00	1.30	52	2.50	M	A,B,E,F,I
1/22/92	31	72.50	75.00	1.40	56	1.25	M	A,C,G,H,I
1/22/92	32	77.50	78.50	1.30	130	1.00	M	A,B,D,E,I
1/23/92	33	80.50	81.70	1.10	92	0.60	P	A,B,C,D,I
1/23/92	34	82.50	85.00	2.30	92	0.63	P	A,B,C,D,E,F,G,H,I
1/23/92	35	85.00	87.50	2.50	100	0.83	P	A,B,C,D,E,F,G,H,I
1/23/92	36	87.50	90.00	2.20	88	0.83	P	A,B,C,D,E,F,H,I
1/23/92	37	90.00	92.50	2.50	100	0.25	P	A,B,C,D,E,F,G,H,I
1/23/92	38	92.50	93.25	0.75	100		P	A,B,D
1/23/92	39	95.00	96.10	1.30	118	0.55	P	A,B,D,E
1/24/92	40	96.75	97.50	0.90	120	0.75	P	A,B,D,I

Table C.1. (Continued).

Date	Run No.	<u>Core depth interval</u>		<u>Core recovery</u>		Penetration rate	Core type ¹	Laboratory tests ²
	(ft)	from (ft)	to (ft)	(ft)	(%)	(ft/min)		
1/24/92	41	97.50	100.00	2.50	100	0.17	P	A,B,C,D,E,F,G,H,I
1/24/92	42	100.00	102.50	2.50	100	0.57	P	A,B,C,D,E,F,G,H,I
1/24/92	43	102.50	104.70	2.10	95	0.31	P	A,B,C,D,E,F,I
1/24/92	44	105.00	107.30	2.50	109	0.53	P	A,B,C,D,E,F,G,H,I
1/24/92	45	107.50	108.90	1.40	100	0.67	P	A,B,C,D,E,I
1/24/92	46	110.00	112.30	2.50	109	0.66	P	A,B,C,D,E,F,G,H,I
1/24/92	47	115.00	116.40	1.40	100	0.40	P	A,B,C,D,E,I

²A: Saturated hydraulic conductivity, water content, and water characteristic curves

B: Chloride, bromide, and carbon

C: Stable isotopes

D: Water potential and matric potential

E: Particle size analysis

F: ³⁶Chlorine

G: Mineralogy, stable isotopes, soluble and adsorbed sulfate

H: Bulk density and porosity

I: Archived

¹P: Percussion hammer

M: Moss sampler

Table C.2. Core record for borehole ST-2A.

Date	Run No.	<u>Core depth interval</u>		<u>Core recovery</u>		Penetration rate (ft/min)	Laboratory tests ¹
		from (ft)	to (ft)	(ft)	(%)		
2/17/92	1	24.00	26.50	2.20	88		A,B,C,D,E,F,G,H
2/17/92	2	35.00	37.50	2.00	80		A,B,C,D,E,F,G
2/17/92	3	45.25	47.75	2.40	96		A,B,C,D,E,F,G,H,I
2/17/92	4	95.00	97.50	2.30	92		A,B,C,D,E,F,G,H,I

¹A: Saturated hydraulic conductivity, water content, and water characteristic curves

B: Chloride, bromide, and carbon

C: Stable isotopes

D: Water potential and matric potential

E: Particle size analysis

F: ³⁶Chlorine

G: Mineralogy, stable isotopes, soluble and adsorbed sulfate

H: Bulk density and porosity

I: Archived

Table C.3. Core record for borehole ST-2.

Date	Run No.	<u>Core depth interval</u>		<u>Core recovery</u>		Penetration rate (ft/min)	Laboratory tests ¹
		from (ft)	to (ft)	(ft)	(%)		
1/15/92	1	0.00	2.10	0.90	43		A,B,C
1/15/92	2	5.00	7.50	2.00	80		A,B,C,D,E,F,G,H,I
1/15/92	3	7.50	10.00	2.20	88		A,B,C,D,E,G,H,I
1/27/92	4	10.00	12.50	2.30	92	0.89	A,B,C,D,E,G,I
1/27/92	5	12.50	15.00	2.00	80	0.69	B,C,D,E,F,H
1/27/92	6	15.00	17.50	2.00	80		B,C,D,F,G,H,I
1/28/92	7	17.50	20.00	2.00	80	0.71	A,B,D,E,F,I
1/28/92	8	20.00	20.80	0.80	100	2.19	A,E,I
1/28/92	9	22.50	25.00	2.50	100	1.35	A,B,C,D,E
1/28/92	10	25.00	27.50	2.20	88	1.63	A,B,C,D,E,F,G,H
1/28/92	11	27.50	30.00	2.20	88		A,B,C,D,F,G,H
1/31/92	12	30.00	32.50	2.50	100		A,B,C,D,E,F,G,H,I
1/31/92	13	32.50	35.00	2.40	96	1.97	A,B,C,D,E,F,G,H,I
1/31/92	14	35.00	37.50	2.20	88	2.07	A,B,D,E,I
1/31/92	15	37.50	39.20	1.70	100	2.21	A,B,D,I
1/31/92	16	42.50	44.30	1.50	83	2.84	A,B,C,E,G,H
2/3/92	17	45.00	47.50	2.30	92		A,B,C,D,E,F,G,H
2/3/92	18	47.50	50.00	1.50	60	2.23	A,B,C,D,E,G
2/3/92	19	50.00	50.50	0.50	100	5.00	B,D
2/3/92	20	52.50	53.50	1.00	100	4.35	A,B,F
2/3/92	21	55.00	56.00	1.00	100	2.30	A,B,C,E
2/3/92	22	59.00	59.50	0.70	140	4.46	F,I
2/3/92	23	60.75	62.50	1.50	86	1.55	B,C,D,G
2/4/92	24	62.50	65.00	2.50	100	1.00	A,B,C,D,E,G,H
2/4/92	25	65.00	67.50	2.30	92	3.40	A,B,C,D,F,G
2/4/92	26	67.50	70.00	2.40	96	1.57	A,B,C,D,E,F,G,H,I
2/4/92	27	70.00	72.50	2.50	100	1.85	A,B,C,D,E,F,G,H,I
2/4/92	28	72.50	75.00	2.10	84	2.21	A,D,G,H,I
2/4/92	29	75.00	77.50	2.50	100	1.03	A,B,C,D,E,F,G,H,I
2/4/92	30	77.50	80.00	2.50	100	1.54	A,B,C,D,E,G,I
2/4/92	31	80.00	82.50	2.40	96	1.14	A,B,C,D,E,F,G,H,I
2/4/92	32	82.50	85.00	2.50	100	1.90	B,C,D,E,F,G,H
2/4/92	33	85.00	87.50	2.30	92	2.03	A,B,C,D,E,G,H,I
2/4/92	34	87.50	90.00	2.40	96	1.47	A,B,C,D,H,I
2/5/92	35	90.00	92.50	2.50	100	1.80	A,B,C,D,E,F,G,H,I
2/5/92	36	92.50	95.00	2.40	96	2.75	A,B,C,D,E,F,G,H,I
2/5/92	37	95.00	97.50	2.50	100	2.28	A,B,C,D,E,F,G,H,I
2/5/92	38	97.50	100.00	2.50	100	2.25	A,B,C,D,E,F,G,H,I
2/5/92	39	100.00	102.50	2.40	96	1.73	A,B,C,D,E,F,G,H,I
2/5/92	40	102.50	103.25	0.75	100	2.00	A,D,I

Table C.3. (Continued).

Date	Run No.	<u>Core depth interval</u>		<u>Core recovery</u>		Penetration rate (ft/min)	Laboratory tests ¹
		from (ft)	to (ft)	(ft)	(%)		
2/5/92	41	105.00	107.50	2.10	84	2.42	A,B,C,D,E,F,G,H
2/5/92	42	107.75	109.75	2.00	100	3.00	A,B,C,D,E,G,H,I
2/5/92	43	110.00	112.40	2.40	100	1.92	A,B,C,D,G
2/5/92	44	112.50	115.00	2.50	100	1.75	A,B,C,D,E,F,G,H
2/6/92	45	116.50	117.60	1.10	100	2.84	B,D,G,I
2/6/92	46	117.50	120.00	2.50	100	1.47	A,B,C,D,E,F,G,H,I
2/6/92	47	120.00	122.50	2.30	92	2.81	A,B,C,D,E,F,G,I
2/6/92	48	122.50	123.50	1.20	120	4.38	A,B,D,E,G

¹A: Saturated hydraulic conductivity, water content, and water characteristic curves

B: Chloride, bromide, and carbon

C: Stable isotopes

D: Water potential and matric potential

E: Particle size analysis

F: ³⁶Chlorine

G: Mineralogy, stable isotopes, soluble and adsorbed sulfate

H: Bulk density and porosity

I: Archived

Table C.4. Core record for borehole ST-3.

Date	Run No.	<u>Core depth interval</u>		<u>Core recovery</u>		Penetration rate (ft/min)	Laboratory tests ¹
		from (ft)	to (ft)	(ft)	(%)		
1/15/92	1	0.00	2.50	1.80	72		A,B,C,D,E,G
1/15/92	2	2.50	5.00	2.30	92		A,B,C,D,E,G,H,I
1/15/92	3	5.00	7.50	2.00	80		A,B,C,D,E,G,H,I
1/15/92	4	7.50	10.00	2.00	80		A,B,C,D,E,G,H,I

¹A: Saturated hydraulic conductivity, water content, and water characteristic curves

B: Chloride, bromide, and carbon

C: Stable isotopes

D: Water potential and matric potential

E: Particle size analysis

F: ³⁶Chlorine

G: Mineralogy, stable isotopes, soluble and adsorbed sulfate

H: Bulk density and porosity

I: Archived

Table C.5. Core record for borehole ST-4.

Date	Run No.	<u>Core depth interval</u>		<u>Core recovery</u>		Penetration rate (ft/min)	Laboratory tests ¹
		from (ft)	to (ft)	(ft)	(%)		
1/16/92	1	0.00	2.50	1.90	76		A,B,C,D,E,G,H
1/16/92	2	2.50	5.00	2.20	88		A,B,C,D,E,G,H,I
1/16/92	3	5.00	7.50	1.00	40		B,C,D,E
1/16/92	4	7.50	10.00	0.25	10		I
2/7/92	5	10.00	12.50	1.90	76	2.50	B,D,E,G,I
2/7/92	6	12.50	15.00	1.50	60	0.59	F,G,H
2/7/92	7	17.50	20.00	2.30	92	0.67	A,B,C,D,E,F,G,H
2/7/92	8	20.00	22.50	2.50	100	0.77	A,B,C,D,E,F,G,H,I
2/7/92	9	22.50	25.00	2.40	96	0.63	A,B,C,D,E,F,G,H,I
2/7/92	10	25.00	27.50	2.20	88	0.68	A,B,D,E,F,G,H
2/7/92	11	27.50	30.00	2.50	100	0.75	A,B,C,D,E,F,G,H,I
2/7/92	12	30.00	32.50	2.40	96	0.45	A,B,C,D,E,F,G,H,I
2/7/92	13	32.50	35.00	2.50	100	0.65	A,B,C,D,E,F,G,H,I
2/7/92	14	35.00	37.50	2.00	80	0.48	A,B,C,D,E,F,G
2/7/92	15	37.50	39.90	2.30	96	0.38	A,B,C,D,E,F,G,H
2/10/92	16	40.00	42.50	2.20	88	0.64	A,B,C,D,E,F,G,H
2/10/92	17	42.50	45.00	2.20	88	0.36	A,B,C,D,E,F,G
2/10/92	18	45.00	47.50	2.20	88	0.77	A,B,C,D,E,F,G,H
2/10/92	19	47.50	49.80	2.30	100	0.46	A,B,C,D,E,F,G,H
2/10/92	20	50.00	52.50	2.20	88	0.41	A,B,C,D,E,F,G,H
2/10/92	21	52.50	55.00	2.50	100	0.55	A,B,C,D,E,F,G,H,I
2/10/92	22	55.50	57.50	2.10	84	0.56	A,B,C,D,E,F,G,H
2/10/92	23	57.50	60.00	2.30	92	0.57	A,B,C,D,E,F,G,H
2/10/92	24	60.00	62.50	1.90	76	0.60	A,B,C,D,E,F,G,H,I
2/10/92	25	62.50	65.00	2.50	100	0.64	A,B,D,E,G,H
2/12/92	26	65.00	67.50	2.30	92	0.60	A,B,C,D,E,F,G,H,I
2/12/92	27	67.50	70.00	2.50	100	0.50	A,B,C,D,E,F,G,H,I
2/12/92	28	70.00	72.50	2.50	100	0.51	A,B,C,D,E,F,G,H,I
2/12/92	29	72.50	75.00	2.30	92	0.41	A,B,C,D,E,F,G,I
2/12/92	30	75.00	76.50	1.50	100	0.53	A,B,C,D,E,H
2/12/92	31	77.50	79.00	1.50	100	0.29	A,B,C,D,E,G
2/12/92	32	80.00	82.50	2.50	100	0.47	A,B,C,D,E,F,G,H,I
2/12/92	33	82.50	84.60	1.80	86	0.64	A,B,C,D,E,F
2/13/92	34	85.00	87.30	2.50	109	0.56	A,B,C,D,E,F,G,H,I
2/13/92	35	87.50	90.00	2.50	100	0.52	A,B,C,D,E,F,G,H,I
2/13/92	36	90.00	92.50	2.40	96	0.38	A,B,C,D,E,F,G,H,I
2/13/92	37	92.50	92.90	0.40	100	0.21	E,I
2/14/92	38	97.50	97.90	0.40	100	0.16	D,I
2/14/92	39	98.00	100.00	2.50	125	0.36	A,B,C,D,E,F,G,H,I
2/14/92	40	100.00	102.50	2.50	100	0.63	A,B,C,D,E,F,G,H,I

Table C.5. (Continued).

Date	Run No.	<u>Core depth interval</u>		<u>Core recovery</u>		Penetration rate (ft/min)	Laboratory tests ¹
		from (ft)	to (ft)	(ft)	(%)		
2/14/92	41	102.50	105.00	2.50	100	0.45	A,B,C,D,E,F,G,H,I
2/14/92	42	105.00	107.50	2.50	100	0.83	A,B,C,D,E,F,G,H,I
2/14/92	43	107.50	110.00	2.50	100	0.56	B,C,E,F,G,H,I
2/14/92	44	110.00	112.50	2.50	100	0.50	A,B,C,D,E,F,G,H,I
2/14/92	45	112.50	113.75	1.25	100	0.25	C,E,G,I

¹A: Saturated hydraulic conductivity, water content, and water characteristic curves

B: Chloride, bromide, and carbon

C: Stable isotopes

D: Water potential and matric potential

E: Particle size analysis

F: ³⁶Chlorine

G: Mineralogy, stable isotopes, soluble and adsorbed sulfate

H: Bulk density and porosity

I: Archived

Table C.6. Core record for borehole ST-5.

Date	Run No.	<u>Core depth interval</u>		<u>Core recovery</u>		Penetration rate (ft/min)	Laboratory tests ¹
		from (ft)	to (ft)	(ft)	(%)		
1/16/92	1	0.00	2.50	1.80	72		A,B,C,D,E,G,H
1/16/92	2	2.50	5.00	1.70	68		A,B,C,D,E,G,H
1/16/92	3	5.00	7.50	2.40	96		A,B,C,D,E,H,I
1/16/92	4	7.50	10.00	2.10	84		A,B,C,D,E,G,H,I
2/11/92	5	10.00	12.50	2.10	84		A,B,C,D,E,F,H,I
2/11/92	6	12.50	13.30	0.60	75		B,E,I
2/20/92	7	15.00	17.50	2.30	92		A,B,C,D,F,I
2/20/92	8	22.50	25.00	2.50	100		A,B,C,D,E,F,G,I
2/20/92	9	25.00	27.70	2.50	93		A,B,D,E,F,H,I
2/20/92	10	30.00	32.50	2.50	100		A,B,C,D,E,F,I
2/20/92	11	35.00	37.50	2.00	80		A,B,C,D,F,G,H

¹A: Saturated hydraulic conductivity, water content, and water characteristic curves

B: Chloride, bromide, and carbon

C: Stable isotopes

D: Water potential and matric potential

E: Particle size analysis

F: ³⁶Chlorine

G: Mineralogy, stable isotopes, soluble and adsorbed sulfate

H: Bulk density and porosity

I: Archived

Table C.7. Core record for borehole ST-6.

Date	Run No.	<u>Core depth interval</u>		<u>Core recovery</u>		Penetration rate	Laboratory tests ¹
	(ft)	from (ft)	to (ft)	(ft)	(%)	(ft/min)	
2/18/92	1	0.00	2.50	2.20	88		A,B,C,D,E,F,G,H
2/18/92	2	2.50	5.00	2.20	88		A,B,C,D,E,F,G,H,I
2/18/92	3	5.00	7.50	0.00	0		
2/18/92	4	7.50	10.00	2.40	96		A,B,C,D,E,F,G,H,I
2/18/92	5	10.00	12.50	1.80	72		B,D,E,G,H
2/18/92	6	12.50	15.00	1.80	72		A,B,C,D,E,F,G,H,I
2/18/92	7	15.00	17.50	2.40	86		A,B,C,D,E,F,G,H,I
2/18/92	8	17.50	20.00	2.30	92		A,B,C,D,E,F,G,H,I
2/18/92	9	20.00	22.50	2.40	86		A,B,C,D,E,F,G,H,I
2/18/92	10	22.50	25.00	2.50	100		A,B,C,D,E,F,G,H,I
2/18/92	11	25.00	27.50	2.50	100		A,B,C,D,E,F,G,H,I
2/18/92	12	27.50	30.00	2.40	96		A,B,C,D,E,I
2/18/92	13	40.00	42.50	2.20	88		A,B,C,D,E,F,G,H
2/18/92	14	50.00	52.50	2.50	100		A,B,C,D,E,F,G,H,I
2/18/92	15	60.00	62.50	2.00	80		A,B,C,D,F,G,I
2/18/92	16	70.00	72.50	2.30	86		A,B,C,D,E,F,G,H
2/19/92	17	80.00	82.50	2.30	86		A,B,C,D,E,F,G,H
2/19/92	18	90.00	92.50	2.30	86		A,B,D,F,G,H,I
2/19/92	19	100.00	102.50	2.50	100		A,B,C,D,E,F,G,H,I
2/19/92	20	110.00	112.50	2.50	100		A,B,C,D,E,F,G,H,I
2/19/92	21	115.00	116.50	1.40	56		A,B,D,G,H,I

¹A: Saturated hydraulic conductivity, water content, and water characteristic curves

B: Chloride, bromide, and carbon

C: Stable isotopes

D: Water potential and matric potential

E: Particle size analysis

F: ³⁶Chlorine

G: Mineralogy, stable isotopes, soluble and adsorbed sulfate

H: Bulk density and porosity

I: Archived

Table C.8. Core record for borehole ST-7.

Date	Run No.	<u>Core depth interval</u>		<u>Core recovery</u>		Penetration rate	Laboratory tests ¹
	(ft)	from (ft)	to (ft)	(ft)	(%)	(ft/min)	
2/19/92	1	0.00	2.50	1.30	52		A,B,C,E,G
2/19/92	2	3.50	5.00	1.30	87		A,B,D,F,I
2/19/92	3	5.00	6.00	0.80	80		C,E,F,H
2/19/92	4	7.50	10.00	2.20	88		A,B,C,D,E,F,G,H,I
2/19/92	5	10.00	12.50	1.50	60		B,C,E,F,G
2/19/92	6	12.50	15.00	2.40	96		A,B,C,D,E,F,G,H,I
2/20/92	7	15.00	17.50	2.40	96		A,B,C,D,E,F,G,H,I
2/20/92	8	17.50	20.00	2.50	100		A,B,C,D,E,F,G,H,I
2/20/92	9	20.00	22.50	2.50	100		A,B,C,D,E,F,G,H,I
2/20/92	10	22.50	25.00	2.50	100		A,B,C,D,E,F,G,H,I
2/20/92	11	25.00	27.50	1.90	76		B,C,D,E,F,G
2/20/92	12	27.50	30.00	2.50	100		A,B,C,D,E,F,G,H,I
2/20/92	13	30.00	32.50	2.40	96		A,B,C,D,E,F,G,H,I
2/20/92	14	32.50	35.00	2.40	96		A,B,C,D,E,F,G,H,I

¹A: Saturated hydraulic conductivity, water content, and water characteristic curves

B: Chloride, bromide, and carbon

C: Stable isotopes

D: Water potential and matric potential

E: Particle size analysis

F: ³⁶Chlorine

G: Mineralogy, stable isotopes, soluble and adsorbed sulfate

H: Bulk density and porosity

I: Archived

APPENDIX D

Table D.1. Physical and hydraulic parameter data for core samples from borehole ST-1.

Depth ¹ (ft)	K (cm/s)	ρ_b (g/cm ³)	w (%)	d ₁₀ (mm)	d ₅₀ (mm)	d ₆₀ (mm)	3/4	3/8	4	<u>Percent passing indicated sieve size</u>					70	140	200
2.50	7.5x10 ⁻⁴	1.44	9.2														
4.50																	
5.50			5.5		0.22	0.35			92.67	89.99	85.94	81.67	69.40	49.22		23.54	16.32
6.50																	
7.50			4.0		0.40	0.68			84.72	81.99	76.84	70.67	51.54	31.53		16.09	11.48
8.50																	
12.00	3.5x10 ⁻⁴	1.55	3.4														
13.50			3.6	0.08	0.29	0.39	100.00	95.27	93.11	90.07	86.71	82.35	63.92	39.44		16.03	7.77
21.00	3.0x10 ⁻⁴		2.2	0.13	3.30	15.00	61.65	56.36	52.73	50.70	47.87	44.56	33.26	17.92		6.48	3.83
21.25		1.59															
23.50	9.2x10 ⁻⁴	1.53	4.5														
25.75	9.8x10 ⁻⁴	1.52	4.1														
26.00	1.4x10 ⁻³		4.0	0.10	0.31	0.42	100.00	95.57	92.88	89.33	85.51	80.42	60.79	33.02		11.11	5.50
28.00		1.54	4.0														
30.25			4.0		0.29	0.37	100.00	94.44	90.92	88.34	84.72	80.54	65.49	38.47		11.88	10.99
30.50	1.1x10 ⁻³	1.48	3.8														
33.25	4.0x10 ⁻⁴	1.46	4.6														
34.00			5.1	0.08	0.25	0.33	100.00	98.47	94.73	89.16	84.49	79.72	66.73	45.02		17.39	8.04
35.50	1.5x10 ⁻³	1.95	3.1														
35.75	2.4x10 ⁻³	1.59	3.8														
36.00			4.6	0.16	1.60	2.40	100.00	92.93	78.55	68.42	56.00	45.93	29.70	14.75		4.57	2.54
38.25	3.0x10 ⁻³	1.92	3.5														
38.50			4.3	0.11	1.60	2.20	100.00	94.22	85.16	69.91	56.43	45.69	29.60	18.18		7.85	4.39
41.25	3.4x10 ⁻⁴	1.64	4.3														
41.50			4.5	0.11	0.70	1.10	100.00	97.65	86.89	80.46	70.84	61.33	38.93	20.55		9.10	8.22
46.25			4.4	0.10	0.75	1.80											
46.50	6.7x10 ⁻⁵	1.81	3.7														
48.25	1.5x10 ⁻⁴	1.63	5.2														
49.00			6.0		0.30	0.50											

¹Uppermost depth of 0.25 ft long sampling interval

Table D.1. (Continued).

Depth ¹ (ft)	K (cm/s)	ρ _b (g/cm ³)	w (%)	d ₁₀ (mm)	d ₃₀ (mm)	d ₆₀ (mm)	<u>Percent passing indicated seive size</u>									
							3/4	3/8	4	6	10	16	40	70	140	200
51.00	5.4x10 ⁻⁴	1.62	4.6													
52.75			4.8	0.10	0.60	1.00										
53.00	3.8x10 ⁻⁴	1.61	5.4													
55.50	8.8x10 ⁻⁵	1.60	4.8													
55.75			4.8	0.09	0.37	0.59										
58.75	1.3x10 ⁻⁴	1.66	6.0													
59.00			5.4		0.34	0.55										
60.50			3.9	0.10	1.90	4.80										
60.75	5.3x10 ⁻⁴	1.62	4.6													
62.25	4.9x10 ⁻³	1.52	4.8	0.10	0.48	0.75	100.00	94.25	87.30	83.46	76.87	69.54	48.46	24.69	10.32	6.37
62.75			4.7		0.55	1.00										
63.75	5.4x10 ⁻⁴	1.68	4.3													
65.50	4.8x10 ⁻⁴	1.61	3.9													
66.50	1.9x10 ⁻⁴	1.41	6.5													
66.75			5.9		0.21	0.30										
67.75			4.9	0.08	0.29	0.39										
68.50	1.2x10 ⁻³	1.40	5.5													
73.50	3.3x10 ⁻⁵	1.55	5.7													
77.50			3.7	0.07	0.30	0.40										
78.25	1.9x10 ⁻⁴	1.44	8.3													
80.75	2.6x10 ⁻⁴	1.47	7.6													
83.50	1.4x10 ⁻³	1.44	5.2													
83.75			8.6	0.10	1.30	2.90										
85.75	8.9x10 ⁻⁴	1.47	5.2													
87.00			4.7		0.30	0.95										
89.00	6.7x10 ⁻⁵	1.55	6.8													
89.25			7.5	0.13	19.00											
92.00	1.5x10 ⁻⁴	1.64	5.7													
92.25			7.2		0.21	0.30										

¹Uppermost depth of 0.25 ft long sampling interval

Table D.1. (Continued).

Depth' (ft)	K (cm/s)	ρ _b (g/cm ³)	w (%)	d ₁₀ (mm)	d ₅₀ (mm)	d ₆₀ (mm)	Percent passing indicated seive size									
							3/4	3/8	4	6	10	16	40	70	140	200
93.00	5.4x10 ⁻⁴	1.61	6.1													
95.25	3.8x10 ⁻⁴	1.72	4.7													
95.75	8.8x10 ⁻⁵		4.3	0.10	2.10	4.10										
97.25	1.3x10 ⁻⁴	1.53	5.3													
97.25			6.3	0.10	0.35	0.61										
97.50	1.3x10 ⁻⁴	1.64	5.7													
100.00			7.9	0.12	0.67	1.00										
100.25	5.3x10 ⁻⁴	1.52	7.1													
103.50	5.4x10 ⁻⁴	1.43	4.6													
103.75			5.2	0.08	0.21	0.28										
105.50			5.0	0.09	0.34	0.60										
105.75	4.8x10 ⁻⁴	1.52	7.3													
108.00			7.3	0.08	0.51	0.95										
108.25	1.9x10 ⁻⁴	1.60	4.5													
110.75	1.2x10 ⁻³	1.36	5.9													
111.75			7.3		0.16	0.19										
115.50			7.8	0.16	5.20	8.00										
116.00	3.3x10 ⁻⁵	1.48	7.9													

¹Uppermost depth of 0.25 ft long sampling interval

Table D.2. Physical and hydraulic parameter data for core and drill cuttings samples from borehole ST-2A.

Depth ¹ (ft)	K (cm/s)	ρ _b (g/cm ³)	w (%)	d ₁₀ (mm)	d ₅₀ (mm)	d ₆₀ (mm)	Percent passing indicated seive size									
							3/4	3/8	4	6	10	16	40	70	140	200
2.50c	9.0x10 ⁻⁴	1.46	4.7	0.09	0.29	0.38	100.00	99.50	97.04	94.77	90.65	85.00	65.11	38.46	13.61	7.22
10.00c			3.6	0.09	0.32	0.43	100.00	98.80	93.83	90.71	85.96	80.08	59.83	35.56	13.56	7.42
12.50c			3.5	0.11	0.61	1.00	98.45	93.28	85.68	78.12	71.25	63.16	42.48	22.29	8.55	5.77
15.00c			3.0	0.15	1.50	3.00	100.00	87.87	68.46	61.51	54.37	47.19	30.50	14.84	5.70	3.52
17.50c			3.3	0.15	0.62	0.95	100.00	97.73	89.44	80.97	73.04	64.78	40.24	16.95	4.77	2.92
22.50c	1.1x10 ⁻⁴	1.56	4.1	0.08	0.25	0.32	100.00	98.00	95.16	93.98	92.16	89.14	71.65	43.79	15.52	8.70
25.00			4.8													
25.00c			3.6	0.11	0.55	0.95	100.00	93.48	87.23	80.09	72.62	64.30	45.18	24.24	8.59	5.66
25.25			5.3	0.08	0.43	0.80	100.00	95.38	86.17	80.92	73.40	66.78	49.15	30.99	14.12	9.19
27.50c			4.1	0.10	0.30	0.40	100.00	98.62	95.41	93.00	88.92	82.87	62.37	36.14	12.17	6.78
30.00c			5.3	0.11	0.80	1.50	100.00	94.05	84.93	74.66	65.24	56.42	39.95	23.50	8.36	5.52
32.50c			4.8	0.08	0.28	0.37	100.00	96.24	92.02	89.99	86.72	82.13	65.95	40.78	14.96	8.76
35.00c			4.8	0.09	0.80	1.90	100.00	91.68	80.73	70.24	61.13	54.15	42.58	30.75	11.65	6.61
35.25			5.2	0.11	3.30	9.50	66.42	61.18	53.17	50.78	47.59	44.42	36.53	24.40	8.79	4.66
36.25			2.9x10 ⁻⁴	1.67	3.9											
37.50c	4.8	0.08			0.30	0.43	100.00	97.59	92.73	88.44	82.75	75.72	59.68	41.61	17.55	9.66
40.00c	4.9				0.42	0.75	100.00	96.43	89.75	82.47	75.39	67.37	50.42	32.90	15.89	11.88
42.50c	4.3	0.09			0.40	0.69	100.00	97.79	90.09	84.55	77.43	70.32	51.39	31.14	13.81	8.12
45.00c	4.2	0.10			0.58	1.20	100.00	93.01	85.97	77.58	69.63	61.73	45.19	29.20	10.85	7.46
46.50	2.1x10 ⁻⁵	1.67	4.7		0.30	0.50	98.53	92.62	88.00	81.35	75.67	70.74	58.00	41.56	19.91	13.70
47.25			4.6													
47.50c			5.1		0.23	0.38	100.00	97.84	90.82	86.61	81.06	74.90	62.96	47.36	23.26	14.44
50.00c			4.6		0.30	0.43	100.00	98.37	93.11	86.61	80.73	74.55	59.76	40.87	17.62	10.35
52.50c			4.6	0.08	0.32	0.42	100.00	97.11	92.06	89.81	85.84	80.00	60.37	36.27	15.17	9.25
55.00c			4.9		0.28	0.39	100.00	98.75	93.99	89.72	85.99	8.15	63.04	41.18	18.10	12.28
57.50c			4.8		0.17	0.20	100.00	98.77	97.42	95.95	94.65	92.68	84.24	62.07	25.93	15.71
60.00c			5.7	0.10	0.90	1.50	100.00	93.58	83.88	77.04	66.46	54.65	35.25	21.25	11.13	7.77
62.50c			4.8	0.15	1.10	1.80	100.00	93.56	86.16	4.57	62.94	50.86	29.15	15.41	6.50	4.32

¹Uppermost depth of 0.25 ft long (core) and 2.5 ft long (drill cuttings indicated by "c") sampling interval

Table D.2. (Continued).

Depth ¹ (ft)	K (cm/s)	ρ_b (g/cm ³)	w (%)	d ₁₀ (mm)	d ₃₀ (mm)	d ₆₀ (mm)	Percent passing indicated sieve size									
							3/4	3/8	4	6	10	16	40	70	140	200
65.00c	4.5x10 ⁻⁴	1.55	5.0	0.09	0.38	0.55	100.00	97.73	93.45	88.04	82.10	74.42	54.93	33.33	11.98	8.35
67.50c			5.5		0.32	0.55	100.00	94.21	89.31	85.87	80.53	73.34	56.16	38.67	19.62	13.63
70.00c			5.0	0.09	0.48	0.70	100.00	98.24	92.83	88.81	82.21	71.43	47.36	28.25	11.98	8.44
72.50c			5.2	0.08	0.75	1.30	100.00	95.22	82.27	76.04	67.43	57.90	39.83	25.54	13.11	9.25
75.00c			4.4		0.22	0.30	100.00	98.93	96.41	93.84	91.01	86.64	71.80	47.66	21.84	14.78
77.50c			4.5	0.11	0.65	0.95	100.00	98.22	90.17	84.97	76.76	65.92	38.95	20.22	8.58	5.65
80.00c			6.0		0.26	0.36	100.00	98.88	96.76	93.37	89.03	82.50	65.66	43.82	18.11	12.72
82.50c			6.9		0.43	0.85	100.00	96.50	90.68	83.78	75.62	65.49	49.00	32.63	14.43	10.67
85.00c			4.5	0.09	0.29	0.38	100.00	97.98	95.48	92.26	88.95	83.83	65.53	38.00	12.86	7.63
87.50c			5.2	0.10	0.45	0.90	100.00	91.43	83.93	77.21	70.73	63.96	48.77	30.43	10.99	7.21
90.00c			5.6	0.12	1.30	2.30	100.00	91.88	75.35	67.19	57.35	47.68	32.28	20.14	7.82	4.68
92.50c			4.5	0.11	1.90	3.00	100.00	92.24	73.77	63.18	50.94	43.55	30.43	19.04	.19	4.89
95.00c			4.6		0.43	0.90	100.00	93.91	88.99	81.36	72.54	63.98	49.09	34.53	15.21	10.51
96.00			5.7	0.09	1.60	10.00	72.28	59.79	55.03	53.05	50.86	48.91	42.08	29.74	13.38	7.80
96.75	2.5x10 ⁻⁵	1.69	5.9													
97.50c			5.5	0.08	0.32	0.46	100.00	98.35	95.91	91.53	85.21	76.51	58.75	38.21	14.33	9.69
100.0c			6.4		0.23	0.31	100.00	96.46	93.90	92.44	89.35	84.07	70.05	47.60	16.96	10.20
102.5c			4.8	0.08	0.27	0.37	100.00	98.35	94.68	90.11	84.99	78.78	64.66	42.74	14.19	9.08
105.0c			4.4	0.10	0.39	0.65	100.00	98.56	65.12	88.01	79.37	70.04	52.99	33.61	10.24	6.55
107.5c			4.7	0.14	1.90	3.00	100.00	94.47	73.37	62.65	50.50	40.25	26.06	15.93	5.66	3.42
110.0c			5.6		0.42	0.80	100.00	92.57	85.62	78.77	72.19	65.23	50.36	33.28	16.09	11.69

¹Uppermost depth of 0.25 ft long (core) and 2.5 ft long (drill cuttings indicated by "c") sampling interval

Table D.3. Physical and hydraulic parameter data for core samples from borehole ST-2.

Depth ¹ (ft)	K (cm/s)	ρ_b (g/cm ³)	w (%)	d_{10} (mm)	d_{30} (mm)	d_{60} (mm)	Percent passing indicated seive size									
							3/4	3/8	4	6	10	16	40	70	140	200
6.00			5.2		0.28	0.41			87.27	83.90	78.90	73.43	60.33	43.66	24.63	20.35
8.50			4.5	0.14	1.00	1.60			82.80	76.36	66.21	54.36	28.04	14.11	7.82	6.15
10.75			3.4		0.59	1.90	73.41	69.06	65.83	63.59	60.85	57.57	46.93	31.84	15.52	10.78
11.00	1.2x10 ⁻⁴	1.66	5.0													
13.25			3.1	0.10	0.50	0.90	79.04	77.63	74.93	72.53	69.65	65.40	7.02	27.00	11.80	7.37
18.50	1.1x10 ⁻⁴	1.69	5.4													
18.75			3.6	0.11	0.65	1.20	83.03	79.19	74.42	71.10	66.13	60.54	42.63	22.25	9.06	6.49
20.25	7.2x10 ⁻⁴	1.69	5.6													
20.50			4.2	0.11	0.39	0.60	100.00	95.79	93.35	87.02	81.22	74.58	53.70	29.36	9.96	5.75
23.50	3.7x10 ⁻³	1.63	4.9													
24.25	4.0x10 ⁻⁴	1.48	6.1													
24.50			4.3	0.09	0.29	0.39	100.00	94.64	87.27	84.37	80.51	76.87	64.26	39.43	12.57	7.43
26.50	6.0x10 ⁻⁴	1.55	6.0													
26.75			3.6	0.11	0.75	1.90	93.23	81.18	74.34	66.65	60.85	55.85	42.66	24.82	8.21	4.39
28.75			4.5		0.27	0.35	98.79	97.16	94.17	91.29	87.38	82.84	67.77	41.50	15.56	10.23
29.50	2.1x10 ⁻⁴	1.53	6.0													
30.50			4.3	0.08	0.21	0.28	95.16	93.70	92.03	89.89	88.19	86.06	77.15	50.83	17.68	9.37
32.00	7.2x10 ⁻⁴	1.49	6.4													
32.25			4.3	0.10	0.60	1.80	83.97	77.88	70.98	65.50	61.11	57.22	46.91	30.98	11.46	6.14
33.75			5.0		0.29	0.40	100.00	95.40	87.65	84.09	79.65	74.99	62.07	40.38	15.95	10.60
34.50	1.3x10 ⁻⁴	1.50	7.0													
35.50	8.1x10 ⁻⁴	1.50	6.6													
36.25			4.3	0.14	0.65	1.00	100.00	97.47	86.11	80.30	71.96	62.96	41.20	19.54	6.04	3.62
36.50	1.6x10 ⁻³	1.64	6.1													
39.00	1.3x10 ⁻⁴	1.52	7.6													
43.00			2.9	0.10	0.52	1.00	96.39	85.02	79.10	73.26	67.29	61.85	46.70	27.38	10.45	6.16
43.75	4.4x10 ⁻⁴	1.64	6.0													
46.00			5.0		0.39	0.74	100.00	94.50	84.42	79.11	71.87	66.16	52.87	36.71	17.82	11.94

¹Uppermost depth of 0.25 ft long sampling interval

Table D.3. (Continued).

Depth ¹ (ft)	K (cm/s)	ρ_b (g/cm ³)	w (%)	d_{10} (mm)	d_{50} (mm)	d_{60} (mm)	Percent passing indicated sieve size									
							3/4	3/8	4	6	10	16	40	70	140	200
47.00	2.1x10 ⁻⁴	1.53	7.3													
47.75			5.6		0.22	0.30	100.00	99.31	96.75	91.90	87.01	82.22	69.43	49.43	21.45	12.34
48.75	9.9x10 ⁻⁵	1.54	7.2													
53.00	1.6x10 ⁻⁴	1.59	6.9													
55.00			4.5	0.09	0.59	1.20	86.16	77.76	72.96	70.29	65.66	60.01	45.61	28.33	12.13	8.16
55.50	4.2x10 ⁻⁴	1.57	6.6													
62.50			4.1	0.16	0.81	1.20	100.00	89.22	82.83	76.01	68.35	59.21	33.41	15.04	5.44	3.48
62.75	3.0x10 ⁻⁴	1.76	5.1													
63.00	4.1x10 ⁻³	1.57	4.4	0.10	0.58	0.91	100.00	93.78	83.56	78.80	71.69	64.74	44.50	24.90	10.96	6.44
64.00	2.0x10 ⁻⁴	1.63	5.7													
66.50	8.6x10 ⁻⁵	1.60	6.6													
67.75			6.5	0.11	0.85	3.30	89.57	83.57	72.89	67.41	60.62	54.39	40.35	23.57	9.72	6.91
69.25	4.6x10 ⁻⁴	1.49	5.6													
70.25			5.6		0.29	0.40	100.00	97.02	94.14	89.37	84.40	7.87	61.74	41.28	17.46	11.45
72.00	4.1x10 ⁻⁵	1.56	7.7													
74.25	3.9x10 ⁻⁴	1.41	7.7													
75.25			7.2		0.26	0.35	100.00	98.90	96.63	94.44	90.32	84.12	67.31	42.87	17.49	11.94
77.00	5.3x10 ⁻⁴	1.48	6.6													
78.00			4.8	0.09	0.31	0.40	100.00	98.21	95.61	91.69	87.37	81.28	61.45	35.78	13.54	7.75
78.25	1.5x10 ⁻³	1.44	6.8													
79.50	1.2x10 ⁻³	1.56	4.6	0.12	0.65	1.10	100.00	94.47	81.74	77.10	68.66	62.06	41.92	21.55	8.26	4.96
79.75	6.5x10 ⁻⁴	1.53	6.5													
81.75	2.1x10 ⁻⁴	1.45	9.0													
82.00			7.2		0.28	0.40	97.88	93.27	88.51	85.23	80.20	74.52	62.47	42.83	17.57	11.75
84.50			5.7	0.08	0.43	0.90	95.87	92.48	83.45	79.03	71.66	64.05	49.15	32.09	13.53	8.95
85.75	9.4x10 ⁻⁴	1.43	7.8													
87.25			2.5	0.11	0.30	0.35	100.00	99.60	99.60	99.58	99.37	97.84	72.08	30.93	8.87	4.69
88.00	2.5x10 ⁻³	1.43	7.5													
89.25	9.0x10 ⁻⁵	1.46	10.5													
91.25			6.0		0.21	0.30	100.00	97.91	94.98	91.07	86.93	82.13	69.61	50.19	20.75	12.96

¹Uppermost depth of 0.25 ft long sampling interval

Table D.3. (Continued).

Depth ¹ (ft)	K (cm/s)	ρ_b (g/cm ³)	w (%)	d_{10} (mm)	d_{30} (mm)	d_{60} (mm)	Percent passing indicated sieve size									
							3/4	3/8	4	6	10	16	40	70	140	200
92.25	1.4x10 ⁻⁴	1.58	8.4													
93.75			7.0		0.30	0.48	100.00	93.48	87.79	83.40	77.18	71.28	58.63	42.70	18.13	12.57
94.50	1.9x10 ⁻⁴	1.62	7.3													
96.25			5.4		0.22	0.35	100.00	94.55	90.58	83.26	78.76	75.23	64.52	49.37	23.16	13.66
97.00	1.2x10 ⁻⁴	1.61	8.7													
98.75			9.0	0.08	0.28	0.39	100.00	97.91	94.80	8.97	83.25	77.19	62.98	42.66	15.43	8.91
99.50	1.1x10 ⁻⁴	1.52														
101.25			7.9	0.09	0.68	1.40	93.13	88.58	77.20	72.38	64.92	57.26	43.97	30.33	12.66	8.58
102.00	1.2x10 ⁻⁴	1.45	10.1													
103.00	3.3x10 ⁻⁴	1.41	8.6													
106.00			4.1	0.09	0.20	0.26	100.00	100.00	96.22	91.35	87.77	84.08	74.39	55.94	16.40	7.31
106.50	8.6x10 ⁻⁴	1.55	6.6													
108.25			5.0	0.11	0.80	1.70	96.21	90.87	74.90	69.60	62.62	55.76	40.03	25.06	9.24	6.13
108.50	7.6x10 ⁻⁴	1.37	9.9													
110.25	1.3x10 ⁻⁴	1.61	7.1													
112.00	7.2x10 ⁻⁵															
113.50			4.8	0.10	2.50	3.50	100.00	91.14	77.32	58.76	44.19	34.81	24.23	18.14	10.77	7.89
114.50	2.2x10 ⁻³	1.56	8.3													
119.00			6.8	0.17	2.20	2.90	100.00	94.36	79.36	67.78	44.87	30.37	18.95	12.36	6.99	5.38
119.50	4.1x10 ⁻⁴	1.47	21.4													
121.25			7.5	0.20	2.00	3.00	95.54	88.33	77.43	63.27	48.76	34.09	16.63	10.90	6.63	5.17
121.75	3.6x10 ⁻⁴	1.53	10.1													
122.75			10.2	0.09	0.90	1.90	97.00	86.40	74.81	68.82	60.94	53.26	39.32	26.37	12.59	9.00
123.25	2.8x10 ⁻⁴	1.37	13.0													

¹Uppermost depth of 0.25 ft long sampling interval

Table D.4. Physical and hydraulic parameter data for core samples from borehole ST-3.

Depth ¹ (ft)	K (cm/s)	ρ_b (g/cm ³)	w (%)	d_{10} (mm)	d_{30} (mm)	d_{60} (mm)	Percent passing indicated sieve size									
							3/4	3/8	4	6	10	16	40	70	140	200
1.00			3.2		0.20	0.28			97.22	93.98	89.16	84.86	71.85	53.22	29.16	20.82
3.50			5.4		0.24	0.32			91.90	88.78	84.66	79.99	67.48	46.39	25.08	24.11
6.25			5.2		0.27	0.40			92.70	87.25	82.26	76.01	61.00	43.62	23.90	16.90
8.50			4.6	0.1	0.64	1.10			90.36	83.58	72.15	61.56	41.79	25.03	12.75	9.71

¹Uppermost depth of 0.25 ft long sampling interval

Table D.5. Physical and hydraulic parameter data for drill cuttings samples from borehole ST-4A.

Depth ¹ (ft)	K (cm/s)	ρ_b (g/cm ³)	w (%)	d_{10} (mm)	d_{50} (mm)	d_{60} (mm)	Percent passing indicated seive size									
							3/4	3/8	4	6	10	16	40	70	140	200
10.00			3.9	0.11	0.42	0.65	100.00	98.10	91.95	88.20	82.19	74.29	50.27	26.04	9.31	5.15
20.00			4.1	0.11	0.39	0.59	100.00	98.59	94.60	89.14	82.96	75.50	53.25	26.68	9.05	6.15
30.00			4.2	0.11	0.39	0.55	100.00	99.68	97.90	92.87	86.90	78.43	53.73	27.30	9.41	6.24
40.00			5.3		0.55	0.90	100.00	98.76	91.28	84.35	76.49	66.08	44.52	28.79	14.60	10.25
50.00			5.1		0.59	1.10	100.00	96.81	87.61	81.21	71.99	61.48	45.10	31.90	17.14	11.55
60.00			5.4	0.10	0.80	1.50	100.00	90.33	82.26	73.77	65.85	57.25	38.65	23.00	11.23	8.29
70.00			6.2	0.08	0.62	1.20	100.00	94.78	81.84	76.02	67.98	59.48	43.96	28.35	14.02	9.95
80.00			6.8		0.19	0.25	100.00	97.64	95.41	93.01	90.14	85.96	75.95	56.01	25.10	18.57
90.00			5.4		0.29	0.43	100.00	98.47	92.07	88.38	81.55	74.29	59.49	42.54	17.94	11.14
100.00			7.1		0.22	0.34	100.00	97.15	94.18	90.10	84.39	77.53	64.51	48.30	21.67	15.16
110.00			5.7		0.58	1.00	100.00	95.26	85.17	80.17	71.95	61.97	45.45	30.26	15.37	10.70
117.50			5.1	0.18	2.70	3.60	100.00	94.31	76.66	56.37	40.29	27.96	16.45	11.59	6.96	5.55

¹Uppermost depth of 2.5 ft long sampling interval

Table D.6. Physical and hydraulic parameter data for core samples from borehole ST-4.

Depth ¹ (ft)	K (cm/s)	ρ_b (g/cm ³)	w (%)	d_{10} (mm)	d_{50} (mm)	d_{80} (mm)	Percent passing indicated seive size									
							3/4	3/8	4	6	10	16	40	70	140	200
0.00	1.6x10 ⁻³	1.37	5.7													
1.00			1.2		0.20	0.29			94.47	91.11	86.63	82.29	70.39	52.53	29.27	22.59
2.50	5.4x10 ⁻⁴	1.41	2.9													
3.50			4.6		0.39	0.57			97.94	94.70	91.29	77.68	53.54	29.84	23.16	15.91
3.75	1.4x10 ⁻⁴	1.48	4.8	0.07	0.25	0.32	100.00	98.09	94.83	92.72	88.58	84.58	69.69	45.69	18.11	11.30
5.75			5.0		0.23	0.39			86.43	82.91	78.97	74.39	62.76	47.36	28.22	21.88
10.75			4.6		0.30	0.42	100.00	97.65	93.76	90.99	85.98	79.65	60.47	38.54	16.73	11.13
11.75			4.0	0.09	0.52	1.10	88.20	80.13	74.78	70.04	66.13	61.72	46.87	29.05	12.69	7.60
18.50			4.0		0.34	0.50	100.00	92.67	86.96	83.28	78.01	72.83	56.91	36.14	17.95	12.90
19.00	1.1x10 ⁻³	1.60	3.6	0.10	0.39	0.60	93.89	92.60	87.72	84.56	79.63	74.04	53.33	28.02	11.19	7.13
19.50	1.2x10 ⁻⁴	1.56	6.7													
20.75			3.6	0.10	0.36	0.46	100.00	99.54	96.89	93.96	89.92	83.85	58.50	28.90	10.64	7.09
22.25			4.6	0.11	0.49	0.90	100.00	89.50	81.95	76.82	70.10	63.92	48.28	27.31	9.57	6.13
22.25	4.6x10 ⁻⁴	1.57	4.1													
23.00	2.6x10 ⁻³	1.45	4.9	0.10	0.32	0.44	100.00	97.00	89.66	85.12	79.16	74.59	59.60	34.68	11.18	5.90
24.25	2.6x10 ⁻³	1.60	3.9	0.11	0.36	0.45	98.24	98.24	94.88	92.29	87.63	82.44	59.36	27.25	8.47	4.88
24.50	1.9x10 ⁻³	1.59	3.3													
26.00			3.8	0.11	0.40	0.62	100.00	96.33	91.19	84.71	78.75	72.27	52.11	28.43	9.08	5.03
26.50	3.1x10 ⁻⁴	1.56	4.3													
28.25			4.5	0.11	0.30	0.42	97.54	92.65	82.28	75.59	65.53	57.18	42.17	24.73	10.02	6.98
29.25	1.5x10 ⁻³	1.53	4.1	0.11	0.36	0.49	100.00	97.70	91.92	89.06	84.79	79.39	59.14	30.64	9.70	4.96
29.75	3.9x10 ⁻⁴	1.55	4.1													
30.75			5.2	0.08	0.30	0.42	100.00	96.38	91.55	86.09	80.67	75.23	60.62	38.89	14.60	8.27
32.25	2.9x10 ⁻⁴	1.53	4.3													
33.25			4.3	0.09	0.43	1.50	85.11	75.64	69.50	66.24	62.32	58.69	49.25	33.40	13.25	8.55
34.75	3.3x10 ⁻⁴	1.54	4.3													
36.00	8.0x10 ⁻⁴	1.51	4.3													
36.25			5.6	0.09	0.43	1.60	74.45	68.86	67.20	64.43	61.60	58.83	49.34	33.26	12.54	6.75
36.75	2.4x10 ⁻³	1.53	4.9	0.09	0.75	1.70	96.65	86.63	75.35	69.28	61.90	55.96	43.07	27.83	12.54	7.82

¹Uppermost depth of 0.25 ft long sampling interval

Table D.6. (Continued).

Depth ¹ (ft)	K (cm/s)	ρ _b (g/cm ³)	w (%)	d ₁₀ (mm)	d ₅₀ (mm)	d ₆₀ (mm)	Percent passing indicated sieve size									
							3/4	3/8	4	6	10	16	40	70	140	200
39.00			6.0		0.26	0.37	100.00	93.74	90.73	88.48	84.20	78.67	64.98	44.66	19.02	12.84
39.25	1.2x10 ⁻³	1.51	5.6													
41.00			8.1	0.09	0.50	0.95	90.43	88.82	80.71	76.58	70.27	63.12	46.78	28.36	11.00	8.98
41.75	1.4x10 ⁻⁴	1.54	5.5													
42.75			4.6	0.11	1.00	2.00	95.99	84.63	77.11	67.76	59.91	52.69	35.99	21.67	10.10	6.60
43.50	3.5x10 ⁻⁴	1.59	4.4													
46.00			5.6		0.70	1	100.00	87.95	79.61	70.67	63.64	57.39	44.02	31.51	16.23	10.36
47.00	4.2x10 ⁻⁵	1.69	4.5													
49.00	2.9x10 ⁻⁴	1.52	5.4													
49.25																
51.00			5.9	0.09	0.53	1.10	91.95	85.33	81.99	75.25	68.30	61.64	46.54	30.76	12.52	7.92
51.50	7.8x10 ⁻⁴	1.49	6.1	0.07	0.29	0.43	100.00	96.96	89.30	84.44	77.49	72.82	59.85	44.00	21.34	11.44
51.75	6.1x10 ⁻⁴	1.56	5.1													
53.75			6.2	0.10	0.54	0.90	96.13	93.49	85.80	80.06	72.41	64.76	45.62	25.64	10.31	6.63
54.75	1.5x10 ⁻⁴	1.56	5.8													
56.00			5.2		0.27	0.38	100.00	92.39	86.98	83.92	80.02	75.87	64.07	44.43	19.71	11.02
56.50	9.8x10 ⁻⁴	1.53	4.3													
57.00	5.1x10 ⁻⁴	1.48	6.4	0.09	0.60	1.20	98.88	93.16	81.40	74.63	66.15	59.83	45.39	29.24	12.87	7.96
58.75			6.1		0.28	0.40	95.53	95.29	89.53	86.61	82.35	76.99	62.08	41.90	18.31	10.32
59.25	2.8x10 ⁻⁵	1.56	5.4													
60.75			5.9	0.10	0.70	1.10	94.91	86.14	82.61	75.90	68.91	60.88	39.24	23.00	10.44	6.97
61.00	3.5x10 ⁻³	1.43	4.7													
62.50	7.5x10 ⁻⁴	1.59	3.4													
62.75			4.0	0.11	0.57	0.95	84.78	78.30	73.78	71.51	68.09	63.60	44.73	24.00	9.47	5.49
63.50			4.6		0.20	0.28	100.00	98.89	97.46	94.39	91.16	86.81	72.84	52.63	26.20	17.94
63.75	2.8x10 ⁻⁴	1.54	4.1													
66.00			4.2	0.14	1.10	2.20	100.00	97.02	82.55	67.75	58.07	51.00	32.47	16.71	6.73	4.74
66.50	1.5x10 ⁻⁴	1.53	5.1													
67.25	2.0x10 ⁻⁴	1.52	5.6	0.08	0.35	0.55	100.00	94.15	87.21	83.08	77.39	71.22	55.85	36.11	16.44	11.51

¹Uppermost depth of 0.25 ft long sampling interval

Table D.6. (Continued).

Depth ¹ (ft)	K (cm/s)	ρ_b (g/cm ³)	w (%)	d_{10} (mm)	d_{50} (mm)	d_{60} (mm)	Percent passing indicated sieve size										140 15.65	200 10.14
							3/4	3/8	4	6	10	16	40	70	100	150		
68.25			8.0		0.38	0.79	96.46	90.19	77.47	73.91	69.38	64.47	53.68	36.70	15.65	10.14		
69.00	1.2x10 ⁻⁴	1.53	5.5															
70.50			6.8	0.10	0.37	0.58	97.85	95.84	88.80	84.76	78.95	72.09	55.09	32.01	11.74	7.05		
71.25	7.5x10 ⁻⁵	1.55	6.5															
72.25	1.9x10 ⁻⁵	1.48	4.3	0.42	8.10	19.00	60.16	51.48	46.62	44.86	42.82	40.45	34.86	27.67	16.67	12.04		
73.25			5.4		0.27	0.38	97.75	91.72	87.10	84.97	81.27	76.62	63.67	44.41	20.89	12.76		
74.00	2.0x10 ⁻⁴	1.56	5.2															
75.75	4.5x10 ⁻⁴	1.47	12.1															
76.00			8.6		0.30	0.42	95.67	92.16	88.33	84.04	79.64	74.41	60.35	40.10	17.35	11.45		
78.25	1.2x10 ⁻³	1.51	5.0															
80.75			8.4	0.10	0.60	1.50	77.37	73.72	69.91	67.37	63.55	58.42	45.55	28.13	11.61	7.47		
82.00	6.3x10 ⁻⁵	1.55	7.1															
82.25	2.8x10 ⁻⁴	1.54	7.2	0.08	0.29	0.41	97.42	96.72	91.66	87.63	80.63	74.69	61.42	42.32	16.27	8.99		
83.75			8.6		0.26	0.39	90.92	90.05	88.54	86.62	83.08	77.03	62.51	45.09	18.91	13.40		
84.00	1.8x10 ⁻⁴	1.47	9.3															
85.75			6.3		0.19	0.26	100.00	98.44	97.25	94.96	91.63	86.84	73.83	55.13	26.96	19.30		
86.75	1.3x10 ⁻³	1.51	5.9	0.08	0.36	0.52	100.00	98.84	94.24	90.48	84.25	76.69	55.33	36.54	17.25	9.88		
87.00	4.3x10 ⁻³	1.54	3.1	0.11	0.28	0.31	100.00	100.00	100.00	99.95	99.70	98.23	78.49	36.36	9.65	4.57		
87.25	3.1x10 ⁻³	1.49	5.4															
88.25			7.0	0.10	1.30	2.30	100.00	90.35	77.03	67.81	57.02	48.00	33.28	20.80	10.35	7.04		
89.50	3.0x10 ⁻⁴	1.50	6.4															
90.75			7.6	0.09	1.10	2.80	78.74	74.33	68.71	62.53	57.28	50.74	38.07	26.17	11.94	8.54		
91.75	1.0x10 ⁻³	1.49	6.4	0.08	0.32	0.75	87.87	78.32	73.52	70.80	67.58	64.11	55.09	41.11	16.27	8.46		
92.25	2.2x10 ⁻⁴	1.57	5.6															
92.75			6.7	0.11	11.00		57.06	47.18	42.11	39.57	36.58	33.86	28.75	21.58	9.26	5.63		
98.00			6.2		0.22	0.34	100.00	97.82	93.38	89.56	83.45	78.01	65.15	48.59	21.74	12.99		
99.25	7.6x10 ⁻⁴	1.45	6.1															
100.75			6.4	0.08	0.20	0.43	100.00	98.69	94.83	88.34	81.19	73.86	59.90	40.95	14.10	8.84		
102.00	2.0x10 ⁻⁴	1.49	7.5															
103.50			6.9		0.26	0.39	90.45	87.33	82.71	79.98	76.17	71.97	62.62	44.98	18.04	10.82		

¹Uppermost depth of 0.25 ft long sampling interval

Table D.6. (Continued).

Depth ¹ (ft)	K (cm/s)	ρ_b (g/cm ³)	w (%)	d ₁₀ (mm)	d ₅₀ (mm)	d ₆₀ (mm)	<u>Percent passing indicated seive size</u>									
							3/4	3/8	4	6	10	16	40	70	140	200
104.25	1.0x10 ⁻³	1.40	5.4													
105.75			6.1		0.28	0.43	100.00	98.51	93.31	86.80	79.13	71.13	59.92	43.18	15.84	10.52
106.25	9.8x10 ⁻⁴	1.46	4.8													
107.00	4.3x10 ⁻⁴	1.51	6.1	0.09	0.27	0.38	100.00	99.19	96.75	93.31	85.67	79.10	64.32	44.09	13.57	7.40
108.75			7.8	0.08	0.30	0.53	83.00	80.17	77.41	75.42	71.96	67.79	57.80	41.90	15.13	8.72
110.75			5.4		0.21	0.28										
112.00	1.5x10 ⁻³	1.45	5.2													
112.75			6.7		0.31	0.50										

¹Uppermost depth of 0.25 ft long sampling interval

Table D.7. Physical and hydraulic parameter data for core samples from borehole ST-5.

Depth ¹ (ft)	K (cm/s)	ρ_b (g/cm ³)	w (%)	d ₁₀ (mm)	d ₃₀ (mm)	d ₆₀ (mm)	<u>Percent passing indicated sieve size</u>									
							3/4	3/8	4	6	10	16	40	70	140	200
0.75	2.3x10 ⁻⁴	1.76	2.1													
1.00			3.1		0.20	0.28	100.00	100.00	94.37	91.22	87.70	83.66	71.05	52.95	29.51	21.38
3.25	4.4x10 ⁻⁴	1.57	3.6													
3.50			4.9		0.32	0.43	100.00	100.00	88.25	85.07	80.45	74.68	59.24	36.15	15.85	10.82
6.50	3.5x10 ⁻⁴	1.70	3.9													
6.75			4.1		0.43	0.90	100.00	100.00	80.65	74.36	69.59	63.84	49.10	33.05	17.50	12.63
8.25			3.9		0.27	0.37	100.00	100.00	94.08	91.87	88.02	82.36	64.82	41.86	18.80	17.62
8.50	6.9x10 ⁻⁴	1.56	3.5													
10.50			3.6		0.38	0.65	90.20	83.03	80.00	76.01	73.01	68.96	53.77	34.09	15.18	10.28
11.72	3.3x10 ⁻⁴	1.60	3.0													
12.75			3.3	0.11	0.40	0.60	100.00	96.42	92.15	87.02	81.72	75.08	51.44	26.36	9.88	6.40
16.75	1.2x10 ⁻³	1.78	2.4													
20.75			4.1	0.11	0.50	0.80	100.00	95.57	87.69	82.72	76.00	68.60	47.02	23.59	8.08	4.89
21.00			4.0	0.10	0.36	0.60	97.03	88.71	81.71	75.77	71.86	67.85	55.76	33.80	11.13	6.89
21.75	1.4x10 ⁻³	1.58	3.4													
22.00	1.5x10 ⁻³	1.62	3.2													
30.75				0.22	0.60	0.75	100.00	100.00	99.53	99.02	95.96	83.79	30.93	7.17	1.74	1.16
32.25	9.3x10 ⁻⁴	1.54	3.6													
36.00	1.3x10 ⁻³	1.49	4.0													

¹Uppermost depth of 0.25 ft long sampling interval

Table D.8. Physical and hydraulic parameter data for core samples from borehole ST-6.

Depth ¹ (ft)	K (cm/s)	ρ_b (g/cm ³)	w (%)	d_{10} (mm)	d_{50} (mm)	d_{60} (mm)	Percent passing indicated sieve size									
							3/4	3/8	4	6	10	16	40	70	140	200
1.00			6.7		0.19	0.23	100.00	99.54	98.81	95.78	92.19	87.78	76.60	56.79	24.99	16.18
1.75	1.1×10^{-4}	1.60	2.8													
3.25			5.2		0.27	0.37	100.00	96.47	93.86	89.80	84.69	79.36	65.04	40.82	15.99	10.44
4.25	1.2×10^{-4}	1.58	1.3													
8.50			4.6		0.26	0.35	100.00	97.96	92.76	89.66	85.69	81.03	65.91	43.57	19.33	10.92
9.50	1.1×10^{-4}	1.58	4.4													
10.75			4.1	0.10	0.59	1.05	84.51	80.71	76.28	71.11	66.62	61.66	45.06	25.62	11.22	7.57
13.25			3.2	0.16	0.55	0.80	100.00	94.68	91.26	85.26	78.97	69.85	43.30	16.59	5.20	3.45
13.75			3.2	0.15	2.40	4.10	92.99	79.27	62.29	55.52	46.94	38.79	23.16	13.50	6.94	4.96
14.25	1.1×10^{-3}	1.68	2.7													
16.25	5.7×10^{-4}	1.75	3.0													
18.75	3.7×10^{-3}	1.68	3.3													
19.00			4.2	0.02	4.30	7.20	90.39	64.99	51.21	46.36	41.38	36.25	24.43	13.80	6.70	4.84
20.75			3.8	0.16	0.43	0.63	100.00	94.10	89.96	85.51	81.60	76.66	49.01	15.02	3.66	2.46
21.50	2.9×10^{-3}	1.60	2.9													
23.25			4.8	0.08	0.36	0.52	100.00	97.01	92.26	87.35	82.77	76.05	55.70	31.42	13.80	9.98
24.50	1.2×10^{-3}	1.60	3.9													
25.75			3.7	0.17	0.12	0.84	96.75	92.33	87.29	84.26	79.34	71.58	36.64	13.05	5.01	3.62
26.50	1.2×10^{-3}	1.64	3.7													
27.75			3.9	0.18	0.90	1.60	97.40	88.52	80.98	71.58	64.12	56.10	33.27	12.55	3.73	2.52
29.25			5.3	0.10	0.29	0.36	100.00	98.98	97.35	93.21	89.08	84.06	66.79	37.66	11.69	7.17
29.50	9.8×10^{-4}	1.48	4.5													
41.25	2.7×10^{-4}	1.55	4.8													
42.00			3.4	0.08	1.10	4.70	75.69	66.96	60.04	57.74	54.36	50.82	40.99	28.75	14.19	8.98
50.75			5.7	0.08	0.55	1.20	92.77	87.37	78.81	72.40	65.62	59.45	46.97	33.01	15.44	8.95
51.50	3.2×10^{-4}	1.55	5.5													
61.00	9.1×10^{-4}	1.56	4.0													
71.00			5.4		0.32	0.56	88.08	83.86	79.20	76.74	73.38	68.89	56.24	39.44	17.60	10.68

¹Uppermost depth of 0.25 ft long sampling interval

Table D.8. (Continued).

Depth ¹ (ft)	K (cm/s)	ρ _b (g/cm ³)	w (%)	d ₁₀ (mm)	d ₅₀ (mm)	d ₆₀ (mm)	Percent passing indicated seive size									
							3/4	3/8	4	6	10	16	40	70	140	200
71.75	9.0x10 ⁻⁵	1.56	5.0													
81.00			9.8		0.38	0.65	100.00	93.26	85.61	81.67	76.71	70.06	53.37	34.10	15.57	10.72
81.75	6.9x10 ⁻⁵	1.54	6.1													
91.00	5.6x10 ⁻⁴	1.48	5.4													
101.00			7.1	0.08	0.34	0.75	83.85	78.02	74.64	71.96	68.40	63.68	54.90	40.05	15.46	9.20
102.00	5.8x10 ⁻⁵	1.50	6.7													
110.75			5.9		0.27	0.37	100.00	94.35	90.69	88.64	84.76	79.80	65.21	42.83	19.28	12.31
112.00	1.0x10 ⁻⁵	1.62	6.2													
116.00	4.8x10 ⁻⁴	1.47	8.4													

¹Uppermost depth of 0.25 ft long sampling interval

Table D.9. Physical and hydraulic parameter data for core samples from borehole ST-7.

Depth ¹ (ft)	K (cm/s)	ρ_b (g/cm ³)	w (%)	d ₁₀ (mm)	d ₅₀ (mm)	d ₆₀ (mm)	Percent passing indicated seive size									
							3/4	3/8	4	6	10	16	40	70	140	200
0.25			9.6	0.11	0.40	0.60	100.00	97.61	94.15	88.02	81.03	73.38	51.63	27.78	8.20	4.05
0.75	1.8x10 ⁻³	1.51	9.1													
4.25	3.1x10 ⁻⁴	1.56	2.7													
5.00			3.6	0.08	0.35	0.58	100.00	90.50	83.40	79.88	75.25	70.12	55.84	36.81	16.06	8.13
7.75	9.9x10 ⁻⁴	1.57	3.6													
8.00			4.3	0.10	0.40	0.51	100.00	95.15	91.63	86.47	80.86	73.75	51.44	27.61	10.44	6.62
10.50			2.3	0.11	4.70		56.10	53.22	50.90	49.64	47.48	44.77	34.43	21.17	8.45	4.56
13.25			3.5	0.15	2.10	4.20	86.45	72.32	62.31	55.25	49.31	43.34	29.10	13.89	6.18	4.41
14.50	1.8x10 ⁻³	1.75	2.2													
15.75			2.6	0.15	0.80	1.20	89.11	84.50	76.83	73.18	67.38	59.76	35.74	15.46	5.96	3.96
16.25	1.1x10 ⁻³	1.75	2.5													
18.25			4.2	0.13	1.50	2.30	100.00	89.78	80.57	68.24	56.63	46.15	27.94	16.14	7.85	5.89
19.00	8.7x10 ⁻⁴	1.79	2.3													
20.75			3.4	0.11	0.40	0.65	98.68	92.63	86.64	82.69	77.28	71.28	52.33	28.22	9.99	5.99
21.50	1.2x10 ⁻⁴	1.59	3.4													
23.25			3.6	0.16	0.70	1.00	100.00	94.59	89.11	80.67	73.12	64.17	35.51	13.16	5.43	3.92
24.50	5.0x10 ⁻⁴	1.57	3.1													
25.25				0.11	0.43	0.65	100.00	96.74	89.48	85.93	80.82	73.96	50.00	25.00	8.10	4.59
28.25			4.1	0.09	0.24	0.30	100.00	97.33	95.16	2.12	89.27	86.03	73.15	45.27	12.93	7.23
29.50	2.1x10 ⁻³	1.41	3.4													
30.75			4.1	0.08	0.29	0.38	100.00	96.80	91.03	87.78	83.59	79.15	64.32	39.77	15.31	9.20
31.50	6.6x10 ⁻⁴	1.55	3.3													
33.25			4.7	0.08	0.30	0.43	100.00	97.66	91.81	84.53	78.67	73.02	59.81	39.68	14.48	8.73
34.25	3.6x10 ⁻⁴	1.54	3.7													

¹Uppermost depth of 0.25 ft long sampling interval

APPENDIX E

Table E.1. Water characteristic curve data for core samples from boreholes ST-1 and ST-4.

ST-1 Depth = 53 ft	
h	Θ
(cm)	(cm ³ /cm ³)
0	0.3510
20	0.3140
50	0.2854
100	0.2333
3480	0.1358
15900	0.0841

ST-1 Depth = 78 ft	
h	Θ
(cm)	(cm ³ /cm ³)
0	0.3992
20	0.3373
50	0.3157
100	0.2773
3480	0.1721
18700	0.1142

ST-1 Depth = 93 ft	
h	Θ
(cm)	(cm ³ /cm ³)
0	0.3553
20	0.3314
50	0.3121
100	0.2654
3480	0.1397
18700	0.0884

ST-1 Depth = 97 ft	
h	Θ
(cm)	(cm ³ /cm ³)
0	0.3490
20	0.3194
50	0.3057
100	0.2435
3480	0.1429
16500	0.0887

ST-1 Depth = 108 ft	
h	Θ
(cm)	(cm ³ /cm ³)
0	0.3600
20	0.2813
50	0.2442
100	0.1928
3480	0.1407
21600	0.0644

ST-4 = 4 ft	
h	Θ
(cm)	(cm ³ /cm ³)
0	0.3633
36	0.3522
51	0.3370
102	0.2737
510	0.1882
3835	0.1190
15501	0.0881

ST-4 = 19 ft	
h	Θ
(cm)	(cm ³ /cm ³)
0	0.3406
36	0.3128
51	0.2846
102	0.1918
510	0.1270
3947	0.0757
14277	0.0602

Table E.1. Water characteristic curve data for core samples from boreholes ST-1 and ST-4
(Continued).

ST-4 Depth = 23 ft		ST-4 Depth = 24 ft	
h	Θ	h	Θ
(cm)	(cm ³ /cm ³)	(cm)	(cm ³ /cm ³)
0	0.3705	0	0.3604
36	0.3543	38	0.2991
51	0.3243	71	0.2095
102	0.1963	135	0.1635
510	0.1490	510	0.1322
4416	0.0957	3427	0.0951
18428	0.0707	15195	0.0675

ST-4 Depth = 29 ft		ST-4 Depth = 37 ft	
h	Θ	h	Θ
(cm)	(cm ³ /cm ³)	(cm)	(cm ³ /cm ³)
0	0.3576	0	0.3281
31	0.3354	38	0.2968
56	0.2589	71	0.2360
102	0.1783	135	0.1897
500	0.1367	510	0.1554
4191	0.0966	3763	0.1099
24853	0.0623	16174	0.0800

ST-4 Depth = 51 ft		ST-4 Depth = 57 ft	
h	Θ	h	Θ
(cm)	(cm ³ /cm ³)	(cm)	(cm ³ /cm ³)
0	0.3534	0	0.3816
31	0.3261	38	0.3602
56	0.3096	71	0.2835
102	0.2492	135	0.2379
500	0.1648	510	0.1931
2550	0.1175	3161	0.1379
15980	0.0868	14532	0.0978

ST-4 Depth = 67 ft		ST-4 Depth = 72 ft	
h	Θ	h	Θ
(cm)	(cm ³ /cm ³)	(cm)	(cm ³ /cm ³)
0	0.3480	0	0.3603
36	0.3363	38	0.3305
51	0.3249	71	0.3054
102	0.2759	135	0.2915
510	0.1880	510	0.2657
3814	0.1086	2580	0.1495
15572	0.0804	22018	0.0594

Table E.1. Water characteristic curve data for core samples from boreholes ST-1 and ST-4
(Continued).

ST-4 Depth = 82 ft		ST-4 Depth = 86 ft	
h	Θ	h	Θ
(cm)	(cm ³ /cm ³)	(cm)	(cm ³ /cm ³)
0	0.3776	0	0.3704
31	0.3582	38	0.3606
56	0.3222	71	0.2989
102	0.2507	135	0.2186
500	0.1926	510	0.1635
3141	0.1431	2794	0.1283
29615	0.0766	15511	0.0850

ST-4 Depth = 87 ft		ST-4 Depth = 92 ft	
h	Θ	h	Θ
(cm)	(cm ³ /cm ³)	(cm)	(cm ³ /cm ³)
0	0.4030	0	0.3367
36	0.3671	31	0.3165
51	0.2856	56	0.2912
102	0.1516	102	0.2331
510	0.1146	500	0.1708
3274	0.0595	5201	0.1169
17734	0.0449	16123	0.0867

ST-4 Depth = 107 ft	
h	Θ
(cm)	(cm ³ /cm ³)
0	0.3915
38	0.3620
71	0.2602
135	0.2031
510	0.1598
2774	0.1296
20488	0.0753

APPENDIX F

Table F.1. Geochemical, water content, water potential, and matric potential data for core samples from borehole ST-1.

Sample depths:			Carbon content			Dry soil	Soil water	Dry soil	Soil water	[Cl]/[Br]	Sulfate		Water potential	
from	to	w	Organic	Inorganic	Total	[Cl]	[Cl]	[Br]	[Br]		Adsorbed	Soluble	Chilled mirror	Filter paper
(ft)	(ft)	(%)	(%)	(%)	(%)	(ppm)	(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(bars)	(bars)
2.75	3.00	3.51				1.55	40	0	0	0			-83.8	-316.1
3.25	3.50	3.80												
4.50	4.75		0.097	0.80	0.897						40	180		
4.75	5.00	4.41				595	12694	3.2	68	186			-69.4	-322.2
5.25	5.50	5.30												
5.50	5.75	5.50									90	2300		
6.50	6.75		0.115	0.60	0.715									
6.75	7.00	3.45				409	9766	2.39	57	171			-80.9	-175.1
7.25	7.50	4.30												
7.50	7.75	4.00									60	60		
8.50	8.75		0.080	0.80	0.880									
8.75	9.00	4.09				355	7194	2.12	43	167			-70.8	-105.7
9.25	9.50	5.50												
11.50	11.75	5.26				336	5931	2	35	168				
12.00	12.25	3.40												
12.75	13.00	3.46				289	7665	1.8	48	161				
13.50	13.75	3.60	0.092	0.70	0.792						30	180	-59.5	-123.5
16.75	17.00	2.50												
17.00	17.25	2.84				211	5925	1.31	37	162				
20.00	20.25	3.02	0.041	0.76	0.801						30	380		
20.25	20.50	3.19				204	5791	1.34	38	151				
20.50	20.75												-35.7	-50.6
20.75	21.00	3.80									30	220		
21.00	21.25	2.20	0.062	0.70	0.762									
21.25	21.50	4.00												
22.75	23.00	1.89				256	10967	1.56	67	164			-30.1	-58.6
23.25	23.50	4.60												
23.50	23.75	4.50												
25.00	25.25	4.33				254	5171	1.5	30	170			-27.3	-52.7
25.50	25.75	4.10												

Table F.1. (Continued).

<u>Sample depths:</u>			<u>Carbon content</u>			<u>Dry soil</u>	<u>Soil water</u>	<u>Dry soil</u>	<u>Soil water</u>	<u>[Cl]/[Br]</u>	<u>Sulfate</u>		<u>Water potential</u>	
<u>from</u>	<u>to</u>	<u>w</u>	<u>Organic</u>	<u>Inorganic</u>	<u>Total</u>	<u>[Cl]</u>	<u>[Cl]</u>	<u>[Br]</u>	<u>[Br]</u>		<u>Adsorbed</u>	<u>Soluble</u>	<u>Chilled</u>	<u>Filter</u>
<u>(ft)</u>	<u>(ft)</u>	<u>(%)</u>	<u>(%)</u>	<u>(%)</u>	<u>(%)</u>	<u>(ppm)</u>	<u>(ppm)</u>	<u>(ppm)</u>	<u>(ppm)</u>		<u>(ppm)</u>	<u>(ppm)</u>	<u>mirror</u>	<u>paper</u>
25.75	26.00	4.10									240	5000		
26.00	26.25	4.00	0.055	0.60	0.655									
27.50	27.75	3.44				241	6045	1.41	35	171				
28.00	28.25	4.00											-28.7	-69.5
28.25	28.50	4.60									40	150		
30.25	30.50	4.00	0.075	0.60	0.675									
30.50	30.75	3.80											-27.3	-47.4
31.25	31.50	4.20												
31.50	31.75	4.49				249	4988	1.49	30	167				
32.50	32.75	4.70				249	5201	1.48	31	168			-31.5	-47.4
33.00	33.25	4.80												
33.25	33.50	4.60									30	460		
34.00	34.25	5.10	0.074	0.60	0.674									
35.00	35.25	4.25				262	5630	1.61	35	163				
35.50	35.75	3.10												
35.75	36.00	3.80									30	60		
36.00	36.25	4.60	0.043	0.50	0.543								-24.6	-59.5
36.25	36.50	4.50												
36.50	36.75													
36.75	37.00													
37.00	37.25													
37.25	37.50													
37.50	37.75	3.59				204	4787	1.3	31	157	20	120		
37.75	38.00												-21.8	-51.8
38.00	38.25	4.80												
38.25	38.50	3.50									20	60		
38.50	38.75	4.30	0.044	0.50	0.544									
38.75	39.00													
39.00	39.25													
39.25	39.50													

Table F.1. (Continued).[illegible]

[illegible]

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Table F.1. (Continued).[illegible]

Table F.1. (Continued).

Sample depths:			Carbon content			Dry soil	Soil water	Dry soil	Soil water	[Cl]/[Br]	Sulfate		Water potential	
from (ft)	to (ft)	w (%)	Organic (%)	Inorganic (%)	Total (%)	[Cl] (ppm)	[Cl] (ppm)	[Br] (ppm)	[Br] (ppm)		Adsorbed (ppm)	Soluble (ppm)	Chilled mirror (bars)	Filter paper (bars)
73.50	73.75	5.70	0.045	0.30	0.345	121	1990	0.86	14	141	20	30	-19.8	-21.9
77.50	77.75	3.70												
77.75	78.00	5.37												
78.00	78.25	5.80												
78.25	78.50	8.30												
80.50	80.75	5.95	0.083	1.00	1.083	211	2751	1.21	16	174	20	40	-17.7	-25.1
80.75	81.00	7.60												
81.00	81.25	7.60												
82.75	83.00	8.60												
83.00	83.25													
83.25	83.50	6.50	0.083	0.66	0.743	100	1547	0.65	10	153	10	10	-21.8	-23.2
83.50	83.75	5.20												
85.25	85.50	5.83												
85.50	85.75													
85.75	86.00	5.20												
86.00	86.25	6.00	0.045	0.74	0.785	107	2418	0.66	15	162	10	20	-16.3	-28.2
87.00	87.25	4.70												
87.25	87.50													
87.50	87.75													
87.75	88.00	4.09												
88.75	89.00	7.90	0.060	0.92	0.980	144	2168	0.82	12	175	10	10	-18.4	-22.0
89.00	89.25	6.80												
89.25	89.50	7.50												
90.25	90.50	5.84												
91.25	91.50	5.60												
91.50	91.75		0.060	0.92	0.980	167	2057	0.99	12	169	10	10		
91.75	92.00													
92.00	92.25	5.70												
92.25	92.50	7.20												
92.50	92.75	6.65												

Table F.1. (Continued).

Sample depths:			Carbon content			Dry soil	Soil water	Dry soil	Soil water	[Cl]/[Br]	Sulfate		Water potential	
from	to	w	Organic	Inorganic	Total	[Cl]	[Cl]	[Br]	[Br]		Adsorbed	Soluble	Chilled mirror	Filter paper
(ft)	(ft)	(%)	(%)	(%)	(%)	(ppm)	(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(bars)	(bars)
92.75	93.00	7.70												
93.00	93.25	6.10				124	1890	0.76	12	164				
95.00	95.25	4.69												
95.25	95.50	4.70											-19.1	-27.7
95.50	95.75	4.60									10	>10		
95.75	96.00	4.30	0.050	0.22	0.270	154	2017	0.95	12	162			-16.3	-19.8
96.75	97.00	6.68												
97.00	97.25	6.50												
97.25	97.50	5.30												
97.50	97.75	5.70									10	10		
97.75	98.00	6.30	0.052	0.98	1.032								-19.1	-16.0
98.00	98.25													
98.25	98.50	6.40				145	2038	0.86	12	169				
98.50	98.75	6.14									>10	>10		
100.00	100.25	7.90	0.034	0.30	0.334								-16.3	-18.8
100.25	100.50	7.10												
100.50	100.75	8.30				146	2415	0.84	14	173				
101.50	101.75					110	2105	0.83	16	132				
102.75	103.00	4.85											-19.8	-23.4
103.00	103.25													
103.25	103.50	5.50												
103.50	103.75	4.60									20	>10	-19.1	-22.6
103.75	104.00	5.20	0.032	0.37	0.402									
105.25	105.50	5.00									20	>10		
105.50	105.75	5.00	0.030	0.51	0.540									
105.75	106.00	7.30				202	2467	1.12	14	180				
106.50	106.75	7.69									20	20		
108.00	108.25	7.30	0.058	0.98	1.038									
108.25	108.50	4.50				88	2294	0.58	15	152				
108.50	108.75	3.59												

Table F.1. (Continued).

<u>Sample depths:</u>			<u>Carbon content</u>			Dry soil [Cl] (ppm)	Soil water [Cl] (ppm)	Dry soil [Br] (ppm)	Soil water [Br] (ppm)	[Cl]/[Br]	<u>Sulfate</u>		<u>Water potential</u>	
from (ft)	to (ft)	w (%)	Organic (%)	Inorganic (%)	Total (%)						Adsorbed (ppm)	Soluble (ppm)	Chilled mirror (bars)	Filter paper (bars)
108.75	109.00	6.40											-18.4	-23.8
110.50	110.75	6.20											-17.0	-23.4
110.75	111.00	5.90												
111.50	111.75	5.88				130	273	0.77	2	167				
111.75	112.00	7.30	0.030	0.55	0.580						20	20		
115.25	115.50	6.76				189	2050	1.13	12	167				
115.50	115.75	7.80	0.093	2.00	2.093						20	30		
115.75	116.00	8.80											-15.0	-27.0
116.00	116.25	7.90												

Table F.2. Geochemical, water content, water potential, and matric potential data for core and drill cutting samples from borehole ST-2A. Entry "c" under sample depth indicates drill cutting sample.

Sample depths:			Carbon content			Dry soil	Soil water	Dry soil	Soil water	[Cl]/[Br]	Sulfate		Water potential	
from (ft)	to (ft)	w (%)	Organic (%)	Inorganic (%)	Total (%)	[Cl] (ppm)	[Cl] (ppm)	[Br] (ppm)	[Br] (ppm)		Adsorbed (ppm)	Soluble (ppm)	Chilled mirror (bars)	Filter paper (bars)
2.50	5.00	4.7	0.09	0.58	0.67									
2.50	5.00c	3.9				118	2607	0.86	19	137	10	200	-66.5	-18.9
10.00	10.25		0.07	0.68	0.75								-69.4	-11.9
10.00	12.50c	3.5				153	3677	1.04	25	148	30	190		
10.00	12.50c	3.6												
12.50	12.75		0.07	0.77	0.84								-62.3	
12.50	15.00c	3.7				135	2745	0.95	19	142	20	160		
12.50	15.00c	3.5												
15.00	15.25		0.07	0.78	0.85								-55.2	
15.00	17.50c	2.9				99	2233	0.7	16	143	60	870		
15.00	17.50c	3.0												
17.50	17.75		0.04	1.00	1.04								-45.4	
17.50	20.00c	3.4				115	2428	0.83	17	139	20	70		
17.50	20.00c	3.3											-42.6	
20.00	22.50c	3.6				119	2502	0.89	19	133			-48.2	
20.00	22.50c	3.5											-44.0	
22.50	25.00c	3.8												
22.50	22.75		0.06	0.71	0.77									
22.50	25.00c	4.1				158	3665	1.15	26	138	230	1800		
24.00	24.25													
24.25	24.50													
24.50	24.75													
24.75	25.00													
25.00	25.25	4.8	0.05	0.69	0.74						600	11500		
25.25	25.50	5.3	0.05	0.59	0.64								-38.4	
25.50	25.75	4.0												
26.00	26.25	4.2												
26.25	26.50					126	2529	0.89	18	142				
25.00	27.50c	4.3											-39.1	

Table F.2. (Continued).

Sample depths:			Carbon content			Dry soil	Soil water	Dry soil	Soil water	[Cl]/[Br]	Sulfate		Water potential	
from	to	w	Organic	Inorganic	Total	[Cl]	[Cl]	[Br]	[Br]		Adsorbed	Soluble	Chilled	Filter
(ft)	(ft)	(%)	(%)	(%)	(%)	(ppm)	(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(bars)	(bars)
42.50	45.00c	4.3				95	1292	0.66	9	144	10	80	-38.4	
45.00	47.50c	4.3												
45.00	47.50c		0.04	0.58	0.62									
45.25	45.50													
45.50	45.75													
45.75	46.00													
46.00	46.25													
46.25	46.50										10	80		
46.50	46.75	4.7	0.03	0.32	0.35								-27.3	
46.75	47.00	4.7												
47.00	47.25													
47.25	47.50	4.6												
47.50	47.75		0.06	0.97	1.03						20	90		
45.00	47.50c	4.2				138	2211	0.96	15	143	10	120		
47.50	50.00c	5.1												
50.00	50.25		0.05	0.54	0.59								-34.9	
50.00	52.50c	4.8				109	1930	0.75	13	146	10	80		
50.00	52.50c	4.6												
52.50	52.75		0.05	1.04	1.09								-32.9	
52.50	55.00c	5.1				94	1237	0.66	9	143	10	100		
52.50	55.00c	4.6												
55.00	55.25		0.06	0.93	0.99								-28.0	
55.00	57.50c	6.0				114	1475	0.77	10	149	10	100		
55.00	57.50c	4.9												
57.50	57.75		0.05	0.59	0.64								-30.8	
57.50	60.00c	5.0				113	814	0.77	12	147	10	90		
57.50	60.00c	4.8												
60.00	60.25		0.06	0.87	0.93								-34.9	
60.00	62.50c	4.4				94	1653	0.67	12	140	10	80		
60.00	62.50c	5.7												

Table F.2. (Continued).

Sample depths:			Carbon content			Dry soil	Soil water	Dry soil	Soil water	[Cl]/[Br]	Sulfate		Water potential	
from	to	w	Organic	Inorganic	Total	[Cl]	[Cl]	[Br]	[Br]		Adsorbed	Soluble	Chilled mirror	Filter paper
(ft)	(ft)	(%)	(%)	(%)	(%)	(ppm)	(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(bars)	(bars)
62.50	62.75		0.04	0.71	0.75								-32.2	
62.50	65.00c	4.0				75	1225	0.52	9	144	20	70		
62.50	65.00c	4.8												
65.00	65.25		0.04	0.71	0.75								-38.4	
65.00	67.50c	4.6				88	1810	0.63	13	141	10	70		
65.00	67.50c	5.0												
67.50	67.75		0.05	1.13	1.18								-28.7	
67.50	70.00c	6.3				105	1427	0.7	10	150	10	90		
67.50	70.00c	5.5												
70.00	70.25		0.04	0.83	0.87								-31.5	
70.00	72.50c	5.7				95	1479	0.66	10	144	10	70		
70.00	72.50c	5.0												
72.50	72.75		0.04	0.75	0.79								-28.7	
72.50	75.00c	4.8				78	1022	0.56	7	141	10	70		
72.50	75.00c	5.2												
75.00	75.25		0.05	0.70	0.75								-32.9	
75.00	77.50c	4.9				87	1146	0.6	8	149	10	60		
75.00	77.50c	4.4												
77.50	77.75		0.03	0.51	0.54								-31.5	
77.50	80.00c	3.8				77	1742	0.55	12	141	10	40		
77.50	80.00c	4.5												
80.00	80.25		0.04	0.90	0.94								-26.6	
80.00	82.50c	6.4				130	1971	0.85	13	153	10	70		
80.00	82.50c	6.0												
82.50	82.75		0.04	0.92	0.96								-26.6	
82.50	85.00c	7.4				107	1347	0.63	8	170	10	60		
82.50	85.00c	6.9												
85.00	87.50	4.5	0.04	0.55	0.59									
85.00	87.50c	4.6				63	1263	0.42	8	150	10	30		
85.00	87.50c	4.5											-36.3	

Table F.2. (Continued).

Sample depths:			Carbon content			Dry soil	Soil water	Dry soil	Soil water	[Cl]/[Br]	Sulfate		Water potential	
from (ft)	to (ft)	w (%)	Organic (%)	Inorganic (%)	Total (%)	[Cl] (ppm)	[Cl] (ppm)	[Br] (ppm)	[Br] (ppm)		Adsorbed (ppm)	Soluble (ppm)	Chilled mirror (bars)	Filter paper (bars)
87.50	87.75		0.04	0.63	0.67								-29.4	
87.50	90.00c	5.0				73	1199	0.5	8	146	10	20		
87.50	90.00c	5.2	0.04	0.70	0.74								-23.2	
90.00	90.25													
90.00	92.50c	5.6				82	1434	0.55	10	149	10	20		
90.00	92.50c	5.6	0.04	0.56	0.60								-25.9	
92.50	92.75													
92.50	95.00c	4.9				62	869	0.44	6	139	10	10	-21.8	
92.50	95.00c	4.5												
95.00	97.50c	5.1				81	1088	0.55	7	146	10	20		
95.00	97.50c	4.6												
95.00	95.25													
95.25	95.50													
95.50	95.75													
95.75	96.00		0.09	0.77	0.86								-19.8	
96.00	96.25	5.7												
96.25	96.50	4.7												
96.50	96.75													
96.75	97.00	5.9				106	1419	0.71	9	150	10	20		
97.00	97.25												-19.1	
97.50	100.0c	6.0				86	1567	0.58	11	148	10	10		
97.50	100.0c	5.5	0.03	0.58	0.61								-19.1	
97.50	97.75		0.05	0.43	0.48									
100.00	102.5c	7.0				101	1463	0.67	10	150	10	20	-19.1	
100.00	102.5c	6.4	0.05	0.82	0.87									
102.50	105.0c	5.6				121	1500	0.79	10	153	10	10		
102.50	105.0c	4.8	0.04	0.54	0.58								-23.2	
105.00	105.25		0.02	0.42	0.44									
105.00	107.5c	4.4				68	984	0.49	7	139	10	10		
105.00	107.5c													

Table F.2. (Continued).

<u>Sample depths:</u>			<u>Carbon content</u>			Dry soil [Cl] (ppm)	Soil water [Cl] (ppm)	Dry soil [Br] (ppm)	Soil water [Br] (ppm)	[Cl]/[Br]	<u>Sulfate</u>		<u>Water potential</u>	
from (ft)	to (ft)	w (%)	Organic (%)	Inorganic (%)	Total (%)						Adsorbed (ppm)	Soluble (ppm)	Chilled mirror (bars)	Filter paper (bars)
107.5	110.0c	5.7				78	1102	0.53	7	149	10	10	-19.1	
107.5	110.0c	4.7	0.03	0.45	0.48									
110.0	110.25	5.6	0.04	0.59	0.63								-19.8	
110.0	112.5c	6.0				79	1227	0.53	8	151	10	10	-21.8	
110.0	112.5c	5.5											-17.0	
113.5	113.75	5.6											-14.3	
117.0	117.25	6.0											-15.6	
119.5	119.75	6.7											-17.7	
121.5	121.75	7.9												
123.0	123.25	11.0												

Table F.3. Geochemical, water content, water potential, and matric potential data for core samples from borehole ST-2.

Sample depths:		w (%)	Carbon content			Dry soil [Cl] (ppm)	Soil water [Cl] (ppm)	Dry soil [Br] (ppm)	Soil water [Br] (ppm)	[Cl]/[Br]	Sulfate		Water potential	
from (ft)	to (ft)		Organic (%)	Inorganic (%)	Total (%)						Adsorbed (ppm)	Soluble (ppm)	Chilled mirror (bars)	Filter paper (bars)
0.00	0.25		0.11	0.20	0.31						40	10		
5.00	5.25		0.09	0.70	0.79						30	60		
5.25	5.50	4.56				410.3	7845	2.36	45.15	174			-66.5	-189.0
5.75	6.00	4.70									30	40		
7.50	7.75		0.07	0.90	0.97	311.39	7571	2.28	49.16	154			-70.1	-119.4
7.75	8.00	3.33									30	740		
8.25	8.50	3.40												
10.75	11.00	3.40	0.08	0.79	0.87	217.68	5378	1.71	42.23	127			-63.7	
11.25	11.50	3.83												
11.50	11.75	3.20				181.78	5065	1.41	39.34	129			-69.4	
12.50	12.75	3.29									120	1600		
13.00	13.25	3.30												
13.25	13.50	3.10	0.07	0.78	0.85	150.01	4876	1.15	37.34	131			-55.9	
15.00	15.25													
15.75	16.00	2.80				156.55	3630	1.2	27.71	131				
17.75	18.00	3.17									20	80		
18.75	19.00	3.60	0.05	0.64	0.69								-48.2	
19.00	19.25	3.20									120	570		
20.50	20.75	4.20	0.07	1.20	1.27	146.66	3363	1.09	24.88	135				
22.50	22.75	4.18				159.57	3952	1.17	29.07	136			-47.5	
23.00	23.25	2.70												
23.25	23.50	2.70				187.37	3636	1.38	26.78	136			-39.8	
23.75	24.00	4.83												
24.00	24.25	5.00									80	460		
24.50	24.75	4.30	0.06	0.61	0.67								-34.2	
26.25	26.50	4.20									70	900		
26.75	27.00	3.60	0.05	0.63	0.68	171.51	3441	1.22	24.44	141			-32.9	
27.00	27.25	4.27												
28.25	28.50	3.90				193.94	4123	1.38	29.31	141				
28.50	28.75	4.38												

Table F.3. (Continued).

[illegible]

Table F.3. (Continued).

Sample depths:			Carbon content			Dry soil	Soil water	Dry soil	Soil water	[Cl]/[Br]	Sulfate		Water potential	
from	to	w	Organic	Inorganic	Total	[Cl]	[Cl]	[Br]	[Br]		Adsorbed	Soluble	Chilled	Filter
(ft)	(ft)	(%)	(%)	(%)	(%)	(ppm)	(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	(bars)	paper
											20	100		(bars)
55.00	55.25	4.50	0.07	0.85	0.92									
55.75	56.00	5.19				139.54	2217	0.98	15.54	143			-28.0	
61.25	61.50	3.90												
61.50	61.75	4.67				104.00	1854	0.7	12.45	149				
61.75	62.00	5.11				101.13	1436	0.68	9.68	148			-32.9	
62.00	62.25	4.30									30	60		
62.50	62.75	4.10	0.06	0.68	0.74									
63.25	63.50	4.25				103.11	1907	0.7	13.01	147			-30.1	
63.50	63.75	4.50												
65.00	65.25	3.94				98.48	1871	0.66	12.58	149			-30.1	
65.25	65.50	4.00												
65.50	65.75	4.50				109.37	2123	0.8	15.47	137			-25.3	
65.75	66.00	4.50									30	100		
67.75	68.00	6.50	0.08	1.04	1.12								-24.6	
68.75	69.00	6.20												
69.00	69.25	5.86				137.85	2011	0.94	13.78	146	20	80		
70.25	70.50	5.60	0.07	0.79	0.86									
71.00	71.25	5.75				122.27	2030	0.82	13.58	149			-25.9	
71.25	71.50	5.00											-24.6	
73.00	73.25	4.50											-26.6	
73.25	73.50	5.10												
73.50	73.75	5.22				103.96	1552	0.71	10.64	146			-24.6	
73.75	74.00	5.00												
74.00	74.25	6.08				117.29	1828	0.78	12.21	150				
75.25	75.50	7.20	0.06	0.68	0.74						20	30		
75.75	76.00	5.47				129.54	2226	0.88	15.05	148			-24.6	
76.75	77.00	4.60									20	10		
78.00	78.25	4.80	0.07	0.43	0.50									
78.50	78.75	4.54				101.69	2120	0.68	14.2	149			-23.9	
78.75	79.00	4.20												

[illegible]

Table F.3. (Continued).

[illegible]

Table F.4. Geochemical, water content, water potential, and matric potential data for core samples from borehole ST-3.

<u>Sample depths:</u>			<u>Carbon content</u>			<u>Dry soil</u>	<u>Soil water</u>	<u>Dry soil</u>	<u>Soil water</u>	<u>[Cl]/[Br]</u>	<u>Sulfate</u>		<u>Water potential</u>	
<u>from</u>	<u>to</u>	<u>w</u>	<u>Organic</u>	<u>Inorganic</u>	<u>Total</u>	<u>[Cl]</u>	<u>[Cl]</u>	<u>[Br]</u>	<u>[Br]</u>		<u>Adsorbed</u>	<u>Soluble</u>	<u>Chilled</u>	<u>Filter</u>
<u>(ft)</u>	<u>(ft)</u>	<u>(%)</u>	<u>(%)</u>	<u>(%)</u>	<u>(%)</u>	<u>(ppm)</u>	<u>(ppm)</u>	<u>(ppm)</u>	<u>(ppm)</u>		<u>(ppm)</u>	<u>(ppm)</u>	<u>mirror</u>	<u>paper</u>
0.00	0.25	4.33	0.14	0.80	0.94						20	10	-244.0	-605.3
0.75	1.00										20	10		
2.50	2.75		0.10	0.70	0.80	181.42	3982	1.20	26	151				
2.75	3.00	3.61											-66.6	-140.7
3.25	3.50										40	180		
5.25	5.50		0.11	1.20	1.31	562.90	13,540	3.43	82	164				
5.50	5.75	3.66											-60.9	-147.0
6.00	6.25										30	60		
7.50	7.75		0.12	0.90	1.02	497.72	9674	3.08	60	162				
7.75	8.00	4.11											-66.6	-157.5
8.25	8.50													

Table F.5. Geochemical, water content, water potential, and matric potential data for core samples from borehole ST-4A.

<u>Sample depths:</u>			<u>Carbon content</u>			Dry soil	Soil water	Dry soil	Soil water	[Cl]/[Br]	<u>Sulfate</u>		Water potential
from	to	w	Organic	Inorganic	Total	[Cl]	[Cl]	[Br]	[Br]		Adsorbed	Soluble	(bars)
(ft)	(ft)	(%)	(%)	(%)	(%)	(ppm)	(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	
10.00	12.50	4.8	0.86	0.77	1.63						20	240	-59.5
20.00	22.50	3.3	0.64	0.79	1.43	142	2551	0.99	18	144	20	140	-39.8
30.00	32.50	4.3	0.58	0.81	1.39	138	2503	0.97	17	143	80	620	-39.1
40.00	42.50	4.7	0.61	0.75	1.36	120	1725	0.81	12	148	20	110	-28.0
50.00	52.50	5.2	0.5	0.68	1.18	107	1769	0.84	14	127	10	100	-23.2
60.00	62.50	5.0	0.57	0.88	1.45	76	1386	0.6	11	126	10	90	-20.4
70.00	72.50	6.0	0.61	0.97	1.58	68	840	0.59	7	115	10	100	-17.0
80.00	82.50	7.3	0.72	0.84	1.56	81	1221	0.61	9	134	20	110	-15.0
90.00	92.50	5.5	0.58	0.72	1.30	52	688	0.53	7	98	10	70	-14.3
100.00	102.50	7.3	0.57	0.92	1.49	62	892	0.5	7	124	10	60	-12.9
110.00	112.50	5.4	0.41	0.69	1.10	53	869	0.39	6	137	20	40	-15.6
117.50	120.00	5.4	0.48	0.61	1.09	65	350	0.52	3	125	10	30	-15.6

Table F.6. Geochemical, water content, water potential, and matric potential for core samples data from borehole ST-4.

Sample depths: from (ft)	to (ft)	w (%)	Carbon content			Dry soil [Cl] (ppm)	Soil water [Cl] (ppm)	Dry soil [Br] (ppm)	Soil water [Br] (ppm)	[Cl]/[Br]	Sulfate		Water potential (bars)	Matric potential (bars)
			Organic (%)	Inorganic (%)	Total (%)						Adsorbed (ppm)	Soluble (ppm)		
0.75	1.00										30	10		
1.00	1.25	1.20	0.13	0.40	0.53	13.71	439	0.18	6	78			-84.4	-198.2
2.75	3.00	2.85									50	290		
3.25	3.50													
3.50	3.75	4.60	0.11	1.30	1.41	561.85	13215	3.35	79	168			-69.4	-112.6
5.00	5.25	3.81									30	120		
5.50	5.75										20	150		
5.75	6.00	5.00	0.11	1.10	1.21									
10.50	10.75		0.09	0.77	0.86	174	3027	1.19	21	146			-110.6	
11.00	11.25	4.68											-74.4	
11.25	11.50	3.60												
11.50	11.75	3.40									20	50		
11.75	12.00	4.00	0.07	0.65	0.72						20	470		
18.50	18.75	4.00	0.07	0.54	0.61								-42.6	
18.75	19.00	3.60				150	3298	1.09	24	138				
19.25	19.50	3.97									20	60		
20.75	21.00	3.60	0.05	0.89	0.94								-65.8	
21.50	21.75	3.60				190	3922	1.44	30	132				
22.00	22.25	4.44												
22.25	22.50	4.10	0.06	0.71	0.77								-52.4	
24.00	24.50	5.80				202	4049	1.53	31	132				
24.75	25.00	4.27									20	60		
26.00	26.25	3.80	0.07	0.70	0.76								-51.0	
26.25	26.50	4.50				155	3111	1.08	22	143				
26.75	27.00	4.36									1600	12200		
28.25	28.50	4.50	0.06	0.71	0.77								-46.1	
29.00	29.25	3.50				141	3255	0.97	22	145				
29.50	29.75	3.95				210	3898	1.44	27	146				
30.00	30.25	5.06												
30.75	31.00	5.20	0.08	0.65	0.73									

Table F.6. (Continued).

Sample depths:			Carbon content			Dry soil	Soil water	Dry soil	Soil water	[Cl]/[Br]	Sulfate		Water potential	Matric potential
from	to	w	Organic	Inorganic	Total	[Cl]	[Cl]	[Br]	[Br]		Adsorbed	Soluble	(bars)	(bars)
(ft)	(ft)	(%)	(%)	(%)	(%)	(ppm)	(ppm)	(ppm)	(ppm)		(ppm)	(ppm)	-40.5	
31.50	31.75	3.20									20	90		
33.25	33.50	4.30	0.08	0.81	0.89								-33.6	
34.00	34.25	6.20				157	3148	1.07	22	146			-34.2	
34.50	34.75	4.44												
35.25	35.50	4.70				145	2870	1.03	20	140				
35.75	36.00	4.50									30	110		
36.25	36.50	5.60	0.07	0.86	0.93								-25.9	
38.75	39.00	5.90									20	150		
39.00	39.25	6.00	0.09	1.49	1.58									
39.50	39.75	6.21				184	2740	1.22	18	151	20	70		
41.00	41.25	8.10	0.05	0.48	0.53								-28.7	
41.25	41.50	5.20												
42.00	42.25	6.57				170	2347	1.21	17	140	20	90		
42.75	43.00	4.60	0.05	0.60	0.65								-27.3	
44.00	44.25	4.70									20	140		
46.00	46.25	5.60	0.05	0.88	0.93								-26.6	
46.25	46.50	4.80											-25.9	
48.50	48.75	5.70									10	120		
49.25	49.50		0.07	1.02	1.09									
49.50	49.75	5.89				109	1609	0.78	12	139	10	100		
51.00	51.25	5.90	0.05	0.59	0.64								-25.9	
51.25	51.50	5.80												
52.00	52.25	6.28				100	1338	0.66	9	150	10	100		
53.75	54.00	6.20	0.02	0.30	0.32								-23.2	
54.00	54.25	6.80												
54.50	54.75	6.38				123	1885	0.9	14	136	10	90		
56.00	56.25	5.20	0.08	0.81	0.89								-22.5	
56.25	56.50	4.70												
56.75	57.00	5.60				71	1095	0.53	8	135			-21.8	
58.25	58.75	6.10												

Table F.6. (Continued).

Sample depths:			Carbon content			Dry soil [Cl] (ppm)	Soil water [Cl] (ppm)	Dry soil [Br] (ppm)	Soil water [Br] (ppm)	[Cl]/[Br]	Sulfate		Water potential (bars)	Matric potential (bars)
from (ft)	to (ft)	w (%)	Organic (%)	Inorganic (%)	Total (%)						Adsorbed (ppm) 20	Soluble (ppm) 110		
58.75	59.00	6.10	0.06	0.72	0.78	84	1201	0.56	8	151				
59.50	59.75	6.39									30	100		
60.75	61.00	5.90	0.09	0.87	0.96								-32.2	
61.25	61.50	5.00									20	80		
62.75	63.00	4.00	0.11	0.74	0.85								-34.9	
63.00	63.25	3.70				52	982	0.37	7	141	20	90		
63.50	63.75	4.60	0.11	0.79	0.90								-25.3	
64.25	64.50	4.40									20	90		
66.00	66.25	4.20	0.05	0.56	0.61									
66.25	66.50	4.69											-23.2	
67.00	67.25	5.70				61	924	0.46	7	131				
67.50	67.75	5.57											-20.4	
68.00	68.25	7.10									30	170		
68.25	68.50	8.00	0.07	1.37	1.44						20	120		
70.50	70.75	6.80	0.06	0.94	1.00								-21.8	
70.75	71.00	5.70				76	1099	0.53	8	143				
72.00	72.25	6.77									20	80		
73.25	73.50	5.40	0.07	0.69	0.76								-20.4	
75.00	75.25	5.30									30	120		
76.00	76.25	8.60	0.05	0.91	0.96								-19.1	
78.50	78.75	4.50				69	578	0.51	4	136			-17.7	
80.50	80.75	6.30									20	110		
80.75	81.00	8.40	0.04	0.91	0.95								-19.1	
82.75	83.00	9.71												
83.00	83.25	8.88									20	110		
83.75	84.00	8.60	0.07	1.87	1.94	40.78	771	0.29	5	141	20	100		
85.75	86.00	6.30	0.06	1.16	1.22								-21.1	
86.50	86.75	5.50												
87.00	87.25	3.06									20	60		
88.25	88.50	7.00	0.07	0.67	0.74									

Table F.6. (Continued).

	<u>Sample depths:</u>		<u>Carbon content</u>			Dry soil	Soil water	Dry soil	Soil water	[Cl]/[Br]	<u>Sulfate</u>		Water potential	Matric potential
	from (ft)	to (ft)	w (%)	Organic (%)	Inorganic (%)	Total (%)	[Cl] (ppm)	[Cl] (ppm)	[Br] (ppm)	[Br] (ppm)	Adsorbed (ppm)	Soluble (ppm)	(bars)	(bars)
200	89.00	89.25	5.80										-18.4	
	89.75	90.00	7.55				50	583	0.34	4	148			
	90.75	91.00	7.60	0.03	0.86	0.89					20	110		
	91.50	91.75	5.20										-17.0	
	92.00	92.25	5.53				42.21	728	0.26	5	160			
	92.75	93.00	6.70	0.05	0.82	0.87					20	80		
	97.75	98.00	8.70										-15.0	
	98.00	98.25	6.20	0.03	0.44	0.47					10	70		
	99.00	99.25	6.40										-15.7	
	100.75	101.00	6.40	0.05	0.75	0.80	44.17	580	0.28	4	157	20	70	
	103.50	103.75	6.90	0.04	0.68	0.72					10	70		
	104.00	104.25	5.91				41.04	666	0.25	4	163			
	105.75	106.00	6.10	0.02	0.32	0.34					10	60		
	106.75	107.00	5.60										-16.3	
	107.25	107.50	6.78				36.03	487	0.21	3	169			
	108.75	109.00		0.05	0.91	0.96					10	80		
	110.75	111.00	5.40	0.05	0.66	0.71					10	60		
	111.50	111.75	4.70										-17.7	
	112.25	112.50	5.92				35.75	570	0.23	4	159			
	112.75	113.00	6.70	0.02	0.32	0.34					10	80		

Table F.7. Geochemical, water content, water potential, and matric potential data for core samples from borehole ST-5.

Sample depths:			Carbon content			Dry soil	Soil water	Dry soil	Soil water	[Cl]/[Br]	Sulfate		Water potential	Matric potential
from (ft)	to (ft)	w (%)	Organic (%)	Inorganic (%)	Total (%)	[Cl] (ppm)	[Cl] (ppm)	[Br] (ppm)	[Br] (ppm)		Adsorbed (ppm)	Soluble (ppm)	(bars)	(bars)
													-38.4	-77.6
0.50	0.75	4.00												
1.00	1.25	3.10	0.15	0.4	0.55									
2.50	2.75	3.26				11.76	312	0.16	4	73	40	480		
3.00	3.25	3.80											-79.4	-175.3
3.50	3.75	4.90	0.11	0.70	0.81						40	440		
5.00	5.25	4.48				494	10058	3.63	74	136			-64.4	-122.0
5.50	5.75	4.80									30	60		
6.75	7.00	4.10	0.08	0.50	0.58									
7.50	7.75	3.63				343	7924	2.55	59	135			-65.8	-101.2
8.00	8.25	3.70									20	50		
8.25	8.50	3.90	0.08	0.50	0.58						20	130		
10.50	10.75	3.60	0.08	0.85	0.93									
11.50	11.75	4.85				196	3616	1.36	25	144			-90.9	
12.00	12.25	2.90									20	50		
12.75	13.00	3.30	0.06	0.73	0.79									
13.00	13.25	2.80				174	5537	1.22	39	142				
15.00	15.25	3.91				270	6130	2.12	48	127			-63.0	
15.25	15.50	3.60				267	6457	2.05	49	131			-62.3	
15.75	16.00	2.90												
20.25	20.50	3.47				161	3959	1.11	27	145			-57.3	
20.50	20.75	3.60									10	60		
20.75	21.00	4.10	0.06	0.97	1.03						110	2300		
21.00	21.25	4.00	0.05	0.70	0.73									
21.25	21.50	3.68				132	3291	0.98	25	134				
21.50	21.75	3.71				166	3779	1.32	30	126			-49.6	
21.75	22.00	2.40												
22.00	22.25	3.20				117	3564	0.88	27	133			-38.4	
26.50	26.75	4.20											-51.7	
27.25	27.50	2.50											-38.4	
30.25	30.50	4.60												

Table F.7. (Continued).

<u>Sample depths:</u>			<u>Carbon content</u>			Dry soil	Soil water	Dry soil	Soil water	[Cl]/[Br]	<u>Sulfate</u>		Water potential	Matric potential
from	to	w	Organic	Inorganic	Total	[Cl] (ppm)	[Cl] (ppm)	[Br] (ppm)	[Br] (ppm)		Adsorbed (ppm)	Soluble (ppm)	(bars)	(bars)
(ft)	(ft)	(%)	(%)	(%)	(%)									
30.50	30.75	3.76				112	2775	0.77	19	146	20	20		
30.75	31.00	3.40	0.04	0.54	0.58								-34.9	
31.75	32.00	3.60												
32.00	32.25	4.43				132	2707	1.04	21	128			-30.8	
36.25	36.50	4.70												
36.50	36.75	4.26				102	2313	0.83	19	122				

Table F.8. Geochemical, water content, and water potential data for core samples from borehole ST-6.

Sample depths:			Carbon content			Dry soil	Soil water	Dry soil	Soil water	[Cl]/[Br]	Sulfate		Water potential (bars)
from (ft)	to (ft)	w (%)	Organic (%)	Inorganic (%)	Total (%)	[Cl] (ppm)	[Cl] (ppm)	[Br] (ppm)	[Br] (ppm)		Adsorbed (ppm)	Soluble (ppm)	
1.00	1.25	6.70	0.12	0.33	0.45						10	10	-150.8
1.25	1.50	3.80									10	100	-55.2
3.25	3.50	5.20	0.1	0.86	0.96						10	100	-63.0
4.00	4.25	6.60											
8.50	8.75	4.60	0.101	1.00	1.071								
8.75	9.00	4.40				321	6958	2.1	45	153			-70.8
9.25	9.50	4.31											
10.25	10.50	4.20									20	700	-75.1
10.75	11.00	4.10	0.05	0.68	0.73								
11.00	11.25	4.60									20	70	-87.3
13.25	13.50	3.20	0.059	0.80	0.859								
14.00	14.25	2.70											
14.50	14.75	2.80				180	6134	1.34	46	134	10	360	-54.5
15.75	16.00	3.20	0.064	1.14	1.204								
16.50	16.75	2.50											
17.00	17.25	3.58				199	5265	1.44	38	138	20	120	-63.7
19.00	19.25	3.60	0.074	0.89	0.964						10	160	-43.3
20.75	21.00	3.80	0.031	0.64	0.671								
21.75	22.00	4.30											
22.00	22.25	3.87				191	4397	1.3	30	147	20	100	-35.6
23.25	23.50	4.80	0.041	0.85	0.891								
24.00	24.25	4.30											
24.75	25.00	4.00				186	4061	1.36	30	137	60	1200	-34.9
25.75	26.00	3.70	0.045	0.74	0.785								
26.75	27.00	4.50											
27.50	27.75	3.80				177	4170	1.3	31	137	20	410	-35.6
27.75	28.00	3.90	0.04	0.76	0.8								
28.00	28.25	3.90											
28.25	28.50	5.54				172	2960	1.15	20	149			-31.5
28.50	28.75	4.50											

Table F.8. (Continued).

[illegible]

Table F.9. Geochemical, water content, and water potential data for core samples from borehole ST-7.

Sample depths:			Carbon content			Dry soil	Soil water	Dry soil	Soil water	[Cl]/[Br]	Sulfate		Water potential (bars)
from (ft)	to (ft)	w (%)	Organic (%)	Inorganic (%)	Total (%)	[Cl] (ppm)	[Cl] (ppm)	[Br] (ppm)	[Br] (ppm)		Adsorbed (ppm)	Soluble (ppm)	
0.25	0.50	9.60	0.08	0.29	0.37						10		
4.00	4.25	3.79				8.63	193	0.12	3	74			-101.1
4.50	4.75	3.40									20	420	
5.00	5.25	3.60	0.10	1.01	1.11								
7.50	7.75	4.53				218	4387	1.68	34	130	10	40	
8.00	8.25	4.30	0.06	0.71	0.77								-97.4
8.75	9.00	3.30											
10.00	10.25	3.13				171	5055	1.33	39	129			
10.50	10.75	2.30	0.09	0.78	0.87						10	40	
13.25	13.50	3.50	0.08	0.78	0.86						10	10	-65.1
13.75	14.00	3.00											
14.25	14.50	2.42				71	2198	0.64	20	111			
15.75	16.00	2.60	0.05	0.73	0.78						10		
16.50	16.75	1.89				44	1790	0.46	19	96			-54.5
16.75	17.00	3.20											
18.25	18.50	4.20	0.06	0.64	0.70						10		
18.50	18.75	1.99				30	1291	0.33	14	89			-57.3
18.75	19.00	2.60											
19.50	19.75	2.26				25	843	0.24	8	105			
20.75	21.00	3.40	0.07	0.83	0.90						10		-46.8
21.75	22.00	3.50											
22.25	22.50	2.91				21	677	0.22	7	96			
23.25	23.50	3.60	0.04	0.70	0.74						10		-44.0
24.00	24.25	3.90											
24.75	25.00	3.25				13	496	0.21	5	91			
25.25	25.50		0.07	0.67	0.74						10		-53.1
26.00	26.25	2.70											
26.25	26.50	3.04				13	358	0.13	4	96			
28.25	28.50	4.10	0.07	0.59	0.66						10		-44.7
29.00	29.25	4.40											

Table F.9. (Continued).

<u>Sample depths:</u>			<u>Carbon content</u>			Dry soil	Soil water	Dry soil	Soil water	[Cl]/[Br]	<u>Sulfate</u>		Water potential (bars)
from (ft)	to (ft)	w (%)	Organic (%)	Inorganic (%)	Total (%)	[Cl] (ppm)	[Cl] (ppm)	[Br] (ppm)	[Br] (ppm)		Adsorbed (ppm)	Soluble (ppm)	
29.75	30.00	3.01				9.9	312	0.1	3	95	10		
30.75	31.00	4.10	0.07	0.59	0.66								-44.0
31.75	32.00	4.10				7.33	173	0.08	2	95			
32.25	32.50	4.22									10		
33.25	33.50	4.70	0.10	0.64	0.74								
34.75	35.00	3.48				5.5	129	0.06	1	90			

APPENDIX G

Table G.1. Stable isotope and chlorine-36 data for core samples from borehole ST-1.

<u>Depth interval</u>		$\delta^{18}\text{O}$	δD	$^{36}\text{Cl}/^{35}\text{Cl}$
from (ft)	to (ft)			
12.50	12.75	-5.1	-82	7.72×10^{-13}
20.50	20.75	-5.0	-83	
21.75	22.00			
29.50	29.75	-6.0	-86	
37.75	38.00	-7.0	-91	6.90×10^{-13}
41.00	41.25			
49.75	50.00	-8.0	-95	
58.25	58.50	-9.1	-98	
61.75	62.00			7.05×10^{-13}
67.50	67.75	-9.7	-98	
81.25	81.50	-10.5	-101	
86.50	87.00			
91.00	91.25	-10.8	-102	5.66×10^{-13}
98.00	98.25	-11.0	-104	
106.25	106.50			
110.25	110.50			
110.25	110.50	-111.0	-105	5.33×10^{-13}
116.25	116.50	-11.1	-103	

Table G.2. Stable isotope data for core and drill cuttings samples from borehole ST-2A.

<u>Depth interval</u>		$\delta^{18}\text{O}$	δD
from (ft)	to (ft)		
10.00	12.50c ¹	-3.6	-75
25.75	26.00	-5.7	-83
36.50	36.75	-7.7	-90
60.00	62.25c	-9.1	-95
77.50	80.00c	-9.3	-98
96.50	96.75	-10.8	-104
110.00	112.50c	-5.4	-90

¹"c" indicates a drill cuttings sample

Table G.3. Stable isotope data for core samples from borehole ST-2.

<u>Depth interval</u>		$\delta^{18}\text{O}$	δD
from (ft)	to (ft)		
11.75	12.00	-3.4	-77
15.25	15.50	-5.3	-82
42.50	42.75	-7.6	-90
61.00	61.25	-8.9	-99
80.50	80.75	-10.4	-104
99.25	99.50	-10.5	-103
121.00	121.25	-10.6	-105

Table G.4. Stable isotope data for core samples from borehole ST-4.

<u>Depth interval</u>		$\delta^{18}\text{O}$	δD
from (ft)	to (ft)		
12.50	12.75	-4.6	-78
21.75	22.00	-5.7	-85
41.50	41.75	-7.7	-93
66.75	67.00	-10.2	-103
80.25	80.50	-10.6	-102
101.50	101.75	-11.8	-110
112.50	112.75	-12.0	-111

APPENDIX H

Table H.1. Oxide composition data determined by major element XRF and INAA methods for core samples from borehole ST-1.

Depth interval		% Composition by weight													
from (ft)	to (ft)	SiO	TiO ₂	Al ₂ O ₃	Fe ₂ O ₃	MnO	MgO	CaO	Na ₂ O	K ₂ O	P ₂ O ₅	LOI ¹	H ₂ O	FeO ²	Na ₂ O ²
4.50	4.75	62.85	0.28	12.01	1.94	0.06	1.27	5.76	2.76	3.33	0.05	8.97	2.70	1.66	2.57
6.50	6.75	61.38	0.26	11.14	2.10	0.06	1.68	8.35	2.65	3.13	0.06	9.59	1.90	1.70	2.54
8.50	8.75	58.99	0.26	11.20	2.08	0.06	1.28	9.51	2.61	3.00	0.06	10.76	1.82	1.76	2.52
13.50	13.75	65.04	0.37	12.83	2.68	0.07	1.15	4.84	3.18	3.28	0.06	5.99	1.48	2.44	3.12
21.00	21.25	78.63	0.17	7.15	1.22	0.04	0.55	3.59	1.68	1.86	0.03	4.08	0.63	1.15	1.76
30.25	30.50	65.34	0.26	13.24	1.96	0.06	1.07	4.64	3.03	3.59	0.05	6.37	1.73	1.67	2.96
34.00	34.25	65.48	0.26	12.94	1.77	0.08	1.08	4.57	2.84	3.73	0.06	7.34	2.34	1.57	2.84
36.00	36.25	68.14	0.24	12.62	1.63	0.07	0.78	3.85	3.05	3.87	0.07	5.37	1.62	1.36	2.95
38.50	38.75	67.08	0.24	12.32	1.62	0.06	0.90	4.67	2.94	3.78	0.07	5.74	1.49	1.43	2.96
41.50	41.75	66.78	0.25	12.32	1.63	0.05	0.92	4.36	2.78	3.91	0.05	6.34	1.74	1.47	2.78
46.25	46.50	70.11	0.22	11.36	1.45	0.05	1.01	3.35	2.50	3.40	0.05	5.35	1.78	1.30	2.54
49.00	49.25	63.24	0.29	12.46	2.03	0.05	1.78	5.55	2.77	3.50	0.06	9.02	3.31	1.78	2.54
52.75	53.00	63.05	0.25	12.42	1.84	0.04	1.31	6.06	2.81	3.51	0.05	8.25	2.54	1.54	2.71
55.75	56.00	64.58	0.25	12.27	1.83	0.05	1.28	5.26	2.90	3.54	0.05	7.30	2.07	1.59	2.74
59.00	59.25	64.33	0.29	12.36	2.08	0.06	1.26	5.32	2.83	3.42	0.05	7.70	2.07	1.80	2.82
60.50	60.75	64.38	0.29	12.08	2.12	0.08	1.13	5.82	2.77	3.32	0.05	7.28	1.64	1.72	2.70
62.75	63.00	64.31	0.27	11.70	1.92	0.05	1.39	6.76	2.74	3.34	0.06	7.46	1.45	1.63	2.76
66.75	67.00	65.44	0.28	12.80	1.90	0.06	1.48	4.02	2.97	3.99	0.05	7.64	2.93	1.62	2.77
67.75	68.00	64.17	0.29	12.53	1.83	0.05	1.43	5.30	2.84	3.54	0.05	7.89	2.30	1.68	2.82
77.50	77.75	67.61	0.25	13.54	1.81	0.05	1.34	3.44	3.19	3.80	0.06	5.18	1.57	1.57	3.15
82.75	83.00	59.47	0.23	11.44	1.87	0.06	1.87	6.00	2.43	3.35	0.05	12.30	5.55	1.64	2.35
87.00	87.25	65.41	0.33	12.76	2.13	0.05	1.96	4.18	2.97	3.61	0.06	7.00	2.36		
89.25	89.50	61.90	0.23	11.70	1.71	0.05	1.74	5.30	2.62	3.61	0.07	10.70	4.81		
92.25	92.50	61.68	0.32	12.17	2.13	0.06	1.40	5.92	2.61	3.65	0.12	8.80	3.06		
95.75	96.00	67.70	0.37	12.94	2.32	0.05	1.09	2.89	3.07	3.75	0.07	5.08	2.31		
97.75	98.00	62.45	0.24	11.95	1.74	0.05	1.01	5.47	2.68	3.60	0.05	9.33	3.49		
100.00	100.25	65.34	0.19	12.67	1.57	0.04	1.18	2.51	2.87	3.94	0.05	8.63	4.48		
103.75	104.00	66.79	0.23	12.54	1.62	0.05	0.89	2.87	3.00	3.97	0.04	6.78	2.66		

¹LOI means "loss on ignition"

²Analyzed by INAA methods

Table H.1. (Continued).

<u>Depth interval</u>		<u>% Composition by weight</u>														
from	to															
(ft)	(ft)	SiO	TiO ₂	Al ₂ O ₃	Fe ₂ O ₃	MnO	MgO	CaO	Na ₂ O	K ₂ O	P ₂ O ₅	LOI ¹	H ₂ O	FeO ²	Na ₂ O ²	
105.50	105.75	67.53	0.24	12.18	1.79	0.05	1.62	3.18	2.65	4.14	0.08	7.11	2.98			
108.00	108.25	64.06	0.24	11.88	1.69	0.05	1.03	5.25	2.76	3.46	0.05	8.08	2.67			
111.75	112.00	62.75	0.38	13.04	2.57	0.06	1.55	4.01	2.51	3.56	0.06	8.52	3.87			
115.50	115.75	62.12	0.20	11.33	1.54	0.05	1.22	7.35	2.56	3.59	0.04	8.77	1.90			

¹LOI means "loss on ignition"

²Analyzed by INAA methods

Table H.2. Elemental composition data determined by INAA and trace element XRF methods for core samples from borehole ST-1.

Depth interval		% Composition by weight												
from (ft)	to (ft)	Sc	Cr	Zn	As	Br	Rb	Rb ¹	Sr ¹	Y ¹	Zr ¹	Nb ¹	Sb	Cs
4.50	4.75	4.08	14.00	46.00	5.40	4.60	111.00	109.00	354.00	23.00	166.00	18.00	0.52	3.42
6.50	6.75	3.47	15.00	33.00	5.20	5.20	91.00	92.00	360.00	23.00	138.00	14.00	0.59	2.59
8.50	8.75	3.45	12.00	44.00	6.60	3.70	89.00	90.00	367.00	21.00	165.00	15.00	0.37	2.42
13.50	13.75	4.47	15.00	50.00	4.10	2.40	103.00	105.00	386.00	24.00	213.00	17.00	0.42	3.01
21.00	21.25	2.38	7.00	25.00	2.90	1.90	70.00	58.00	282.00	18.00	131.00	12.00	0.23	1.64
30.25	30.50	3.89	12.00	49.00	4.50	2.20	110.00	108.00	347.00	24.00	169.00	17.00	0.40	2.99
34.00	34.25	3.78	9.00	39.00	4.80	2.50	118.00	119.00	348.00	28.00	188.00	19.00	0.47	3.38
36.00	36.25	3.31	7.00	81.00	3.80	2.20	129.00	123.00	300.00	25.00	150.00	20.00	0.38	2.69
38.50	38.75	3.30	10.00	38.00	4.50	2.00	117.00	121.00	331.00	25.00	152.00	18.00	0.42	2.90
41.50	41.75	3.29	8.00	32.00	4.20	1.90	119.00	115.00	336.00	25.00	159.00	19.00	0.34	2.72
46.25	46.50	3.45	9.00	32.00	4.10	1.80	104.00	115.00	298.00	22.00	147.00	16.00	0.41	2.90
49.00	49.25	4.44	14.00	45.00	5.10	2.95	117.00	120.00	359.00	24.00	198.00	19.00	0.55	3.72
52.75	53.00	3.76	12.00	41.00	5.00	2.12	117.00	111.00	361.00	24.00	165.00	18.00	0.46	3.21
55.75	56.00	3.84	9.00	51.00	4.70	1.98	111.00	110.00	368.00	25.00	176.00	18.00	0.38	2.98
59.00	59.25	4.09	9.00	42.00	4.90	1.94	108.00	115.00	374.00	23.00	186.00	18.00	0.46	3.39
60.50	60.75	3.64	11.00	39.00	4.70	2.00	100.00	97.00	366.00	24.00	175.00	16.00	0.05	2.99
62.75	63.00	3.71	10.00	42.00	3.70	1.50	104.00	105.00	365.00	23.00	184.00	17.00	0.43	2.90
66.75	67.00	4.06	12.00	48.00	4.60	1.86	122.00	118.00	339.00	25.00	184.00	19.00	0.51	3.62
67.75	68.00	4.05	12.00	48.00	4.80	2.17	112.00	115.00	347.00	25.00	190.00	18.00	0.55	3.39
77.50	77.75	3.56	9.00	36.00	3.90	1.34	114.00	105.00	369.00	24.00	174.00	18.00	0.40	2.90
82.75	83.00	4.05	13.00	75.00	5.60	2.90	119.00	116.00	331.00	24.00	159.00	19.00	0.53	4.13
87.00	87.25	4.96	17.00	49.00	5.50	1.40	121.00	120.00	319.00	26.00	240.00	19.00	0.50	3.90
89.25	89.50	4.01	10.00	46.00	5.30	2.40	129.00	138.00	319.00	25.00	167.00	20.00	0.60	3.90
92.25	92.50	5.33	15.00	40.00	5.40	2.00	141.00	136.00	258.00	29.00	200.00	21.00	0.70	4.30

¹Analyzed by trace element XRF method

Table H.2. (Continued).

<u>Depth interval</u>		<u>% Composition by weight</u>													
from	to	Sc	Cr	Zn	As	Br	Rb	Rb ¹	Sr ¹	Y ¹	Zr ¹	Nb ¹	Sb	Cs	
(ft)	(ft)														
95.75	96.00	6.05	15.00	40.00	5.50	1.20	136.00	142.00	323.00	30.00	250.00	22.00	0.70	3.50	
97.75	98.00	3.80	11.00	41.00	4.90	2.40	119.00	128.00	319.00	22.00	161.00	18.00	0.60	3.70	
100.00	100.25	3.48	10.00	41.00	4.80	1.80	135.00	141.00	322.00	26.00	136.00	20.00	0.60	4.20	
103.75	104.00	4.17	10.00	43.00	5.70	1.70	136.00	141.00	236.00	25.00	180.00	21.00	0.60	4.20	
105.50	105.75	3.89	13.00	45.00	5.60	1.60	136.00	137.00	272.00	28.00	160.00	20.00	0.60	3.60	
108.00	108.25	3.47	14.00	37.00	5.10	1.70	111.00	112.00	366.00	24.00	167.00	18.00	0.50	3.10	
111.75	112.00	6.11	25.00	61.00	7.00	1.50	135.00	153.00	340.00	26.00	202.00	20.00	0.60	5.40	
115.50	115.75	4.53	15.00	45.00	7.10	3.60	170.00	171.00	162.00	26.00	114.00	24.00	0.60	5.30	

<u>Depth interval</u>		<u>% Composition by weight</u>														
from	to	Ba	La	Ce	Nd	Sm	Eu	Tb	Yb	Lu	Hf	Ta	Pb	Th ¹	Th	U
(ft)	(ft)															
4.50	4.75	580.00	40.30	76.10	24.90	5.05	0.65	2.20	0.32	5.10	1.30	21.00	14.00	13.90	3.30	
6.50	6.75	581.00	36.40	67.20	20.60	4.52	0.56	1.98	0.28	4.65	1.22	19.00	13.00	11.70	3.40	
8.50	8.75	581.00	53.30	96.60	34.60	5.63	0.67	2.06	0.29	4.90	1.15	20.00	13.00	13.40	2.80	
13.50	13.75	675.00	58.80	110.90	39.10	6.24	0.68	2.19	0.31	6.60	1.24	23.00	16.00	15.20	3.10	
21.00	21.25	416.00	31.50	61.80	23.50	3.46	0.40	1.30	0.21	3.23	1.31	14.00	8.00	8.00	1.70	
30.25	30.50	687.00	43.80	82.40	30.90	5.43	0.62	2.39	0.34	5.43	1.17	21.00	15.00	13.80	3.00	
34.00	34.25	645.00	43.90	86.90	46.20	5.77	0.72	2.71	0.40	5.66	1.19	24.00	15.00	14.50	3.50	
36.00	36.25	555.00	39.40	72.50	26.30	4.88	0.65	2.31	0.33	4.85	1.37	24.00	16.00	14.00	3.20	
38.50	38.75	617.00	43.20	80.60	30.60	5.44	0.70	2.38	0.32	4.74	1.39	24.00	16.00	14.40	3.30	
41.50	41.75	607.00	42.40	80.00	29.00	5.20	0.67	2.21	0.31	4.94	1.48	22.00	16.00	14.30	3.20	
46.25	46.50	551.00	34.80	65.30	26.10	4.52	0.57	2.03	0.31	4.82	1.44	18.00	14.00	12.40	3.10	
49.00	49.25	621.00	42.60	81.40	27.40	5.37	0.61	2.23	0.31	5.83	1.31	22.00	16.00	15.50	3.90	
52.75	53.00	616.00	41.20	77.20	27.60	4.90	0.61	2.14	0.31	5.24	1.21	23.00	16.00	13.50	3.30	
55.75	56.00	624.00	71.60	130.30	39.50	6.34	0.74	2.49	0.37	5.72	1.18	22.00	14.00	15.70	3.70	
59.00	59.25	690.00	43.50	81.20	30.60	5.74	0.75	2.47	0.37	6.11	1.23	22.00	15.00	13.90	3.10	
60.50	60.75	654.00	55.00	102.20	35.00	5.71	0.63	2.20	0.30	6.01	1.32	21.00	15.00	14.40	3.20	
62.75	63.00	650.00	39.00	72.00	27.90	4.88	0.61	2.10	0.31	5.37	1.21	21.00	14.00	12.20	3.30	

¹Analyzed by trace element XRF method

Table H.2. (Continued).

<u>Depth interval</u>		<u>% Composition by weight</u>															
from	to	Ba	La	Ce	Nd	Sm	% Composition by weight							Pb ¹	Th ¹	Th	U
(ft)	(ft)						Eu	Tb	Yb	Lu	Hf	Ta					
66.75	67.00	620.00	40.20	77.00	28.90	5.23	0.65	2.37	0.34	5.06	1.23	25.00	18.00	14.80	3.30		
67.75	68.00	671.00	42.10	79.50	27.20	5.53	0.73	2.33	0.35	5.97	1.39	21.00	15.00	15.10	3.34		
77.50	77.75	708.00	49.10	89.80	34.40	5.39	0.64	2.18	0.32	5.33	1.23	22.00	14.00	14.60	2.90		
82.75	83.00	506.00	38.90	76.40	26.40	5.30	0.66	2.11	0.28	4.79	1.01	19.00	16.00	14.00	3.80		
87.00	87.25	631.00	48.10	88.10	26.00	5.51	0.67	2.46	0.32	7.61	1.42	22.00	16.00	14.40	3.70		
89.25	89.50	387.00	33.00	62.80	24.00	4.77	0.65	2.26	0.33	5.26	1.44	20.00	16.00	14.70	3.80		
92.25	92.50	471.00	47.40	91.70	32.00	6.10	0.78	2.45	0.37	5.90	1.69	22.00	16.00	16.80	3.70		
95.75	96.00	514.00	50.10	95.60	34.00	7.00	0.92	2.90	0.42	8.46	1.71	23.00	17.00	16.80	4.10		
97.75	98.00	503.00	35.00	68.40	21.00	4.72	0.61	2.13	0.42	4.72	1.45	23.00	17.00	15.10	3.70		
100.00	100.25	495.00	34.50	69.00	22.00	4.96	0.67	2.29	0.33	4.71	1.60	23.00	18.00	16.60	3.80		
103.75	104.00	403.00	35.90	69.00	26.00	5.02	0.64	2.35	0.36	5.49	1.59	24.00	18.00	16.80	4.40		
105.50	105.75	484.00	39.70	78.60	21.00	5.48	0.71	2.69	0.34	4.75	1.59	25.00	18.00	17.30	4.40		
108.00	108.25	580.00	44.80	83.50	26.00	5.37	0.65	2.14	0.31	4.49	1.34	22.00	16.00	14.60	3.30		
111.75	112.00	737.00	42.30	85.80	24.00	5.56	0.75	2.66	0.38	6.96	1.38	22.00	15.00	15.70	3.10		
115.50	115.75	197.00	29.70	60.00	16.00	4.69	0.65	2.55	0.33	4.66	1.75	24.00	19.00	16.70	5.70		

¹Analyzed by trace element XRF method

Table H.3. Oxide composition data determined by major element XRF and INAA methods for core samples from borehole ST-2.

<u>Depth interval</u>		<u>% Composition by weight</u>													
from	to	SiO	TiO ₂	Al ₂ O ₃	Fe ₂ O ₃	MnO	MgO	CaO	Na ₂ O	K ₂ O	P ₂ O ₅	LOI ¹	H ₂ O	FeO ²	Na ₂ O ²
(ft)	(ft)														
0.00	0.25	64.62	0.36	13.74	2.45	0.07	1.47	3.12	2.67	3.65	0.11	6.89	3.39	2.25	2.49
5.00	5.25	65.00	0.28	13.26	2.06	0.05	1.47	5.42	2.70	3.38	0.05	7.14	2.36	1.84	2.64
7.50	7.75	60.91	0.22	10.60	1.69	0.06	1.06	8.66	2.55	3.06	0.06	9.89	2.04	1.66	2.51
10.75	11.00	67.98	0.30	10.99	2.24	0.06	1.05	4.74	2.50	2.84	0.07	6.10	1.52	1.80	2.31
13.25	13.50	65.15	0.31	12.34	2.45	0.07	0.90	4.99	2.87	3.46	0.06	6.00	1.61	2.24	3.20
18.75	19.00	63.41	0.30	12.57	2.33	0.07	0.98	5.46	2.99	3.37	0.05	6.90	1.90	2.03	3.06
20.50	20.75	59.32	0.29	11.55	2.17	0.07	1.47	8.87	2.50	3.14	0.05	10.21	1.83	1.80	2.63
24.50	24.75	64.50	0.25	12.50	1.81	0.05	1.03	5.10	3.12	3.46	0.05	7.45	2.26	1.61	2.96
26.75	27.00	64.15	0.26	12.29	1.89	0.06	1.00	5.86	2.93	3.37	0.08	7.19	1.98	1.74	2.92
28.75	29.00	64.32	0.21	12.36	1.52	0.05	0.87	4.73	2.52	3.45	0.05	7.98	2.80	1.49	2.81
30.50	30.75	64.25	0.26	12.93	1.97	0.06	1.12	4.25	2.75	3.53	0.04	7.85	2.49	1.73	3.08
33.75	34.00	64.64	0.23	12.58	1.60	0.05	1.00	4.49	2.99	3.66	0.04	7.88	2.77	1.48	2.90
35.25	35.50	64.01	0.28	12.56	1.96	0.05	1.03	4.87	2.80	3.65	0.05	7.66	2.52	1.63	2.85
36.25	36.50	66.85	0.25	12.71	1.69	0.06	0.96	4.03	3.19	3.84	0.06	5.90	1.93	1.47	3.03
43.00	43.25	65.84	0.26	12.71	1.86	0.05	0.99	3.73	2.79	3.76	0.06	6.60	1.24	1.59	3.05
46.00	46.25	65.84	0.26	12.71	1.86	0.05	0.99	3.73	2.79	3.76	0.06	6.60	1.24	1.65	2.91
47.75	48.00	62.46	0.29	12.17	2.14	0.06	1.45	6.04	2.53	3.55	0.06	9.13	3.12	1.85	2.60
55.00	55.25	64.09	0.28	12.62	2.06	0.05	1.17	5.29	2.77	3.50	0.04	7.44	1.75	1.70	2.78
62.50	62.75	66.70	0.22	12.37	1.81	0.06	0.87	4.72	3.20	3.61	0.07	6.22	1.65	1.53	3.12
67.75	68.00	61.27	0.21	11.46	1.58	0.05	1.30	6.90	2.64	3.39	0.05	9.89	2.74	1.42	2.67
70.25	70.50	63.48	0.28	12.40	2.13	0.06	2.58	5.15	2.77	3.46	0.05	8.09	3.42	1.82	2.75
75.25	75.50	62.80	0.32	12.79	2.41	0.06	1.26	4.30	2.72	3.63	0.06	9.32	4.55	1.99	2.69
78.00	78.25	65.85	0.25	12.81	1.90	0.06	0.89	3.86	3.13	3.80	0.06	6.66	2.42	1.55	3.13
82.00	82.25	63.30	0.24	11.95	1.88	0.05	1.23	4.50	2.62	3.62	0.05	9.72	4.29	1.59	2.83
84.50	84.75	66.50	0.29	12.86	2.10	0.06	1.82	3.75	2.74	3.72	0.05	6.11	0.96	1.79	2.93
87.25	87.50	67.89	0.26	13.21	2.01	0.06	0.68	3.66	3.46	3.83	0.05	4.59	0.98	1.64	3.38
91.25	91.50	63.92	0.30	12.21	2.13	0.05	1.12	4.74	2.78	3.60	0.05	8.60		1.83	2.87

¹LOI means "loss on ignition"

²Analyzed by INAA methods

Table H.3. (Continued).

<u>Depth interval</u>		<u>% Composition by weight</u>													
from	to	SiO	TiO ₂	Al ₂ O ₃	Fe ₂ O ₃	MnO	MgO	CaO	Na ₂ O	K ₂ O	P ₂ O ₅	LOI ¹	H ₂ O	FeO ²	Na ₂ O ²
(ft)	(ft)														
93.75	94.00	62.74	0.33	12.33	2.44	0.06	1.36	5.22	2.46	3.61	0.09	8.84		2.36	2.59
96.25	96.50	65.18	0.36	13.08	2.58	0.07	1.13	3.76	2.81	3.70	0.11	6.25		2.26	2.89
98.75	99.00	61.77	0.26	11.96	1.94	0.05	0.97	5.96	2.43	3.60	0.06	10.52		1.64	2.69
101.25	101.50	63.50	0.20	11.81	1.69	0.04	1.05	4.26	2.94	3.78	0.05	9.70		1.38	2.83
106.00	106.25													1.67	3.13
108.25	108.50	63.28	0.28	12.15	2.08	0.06	1.33	4.94	2.79	3.66	0.07	8.89		1.90	2.75
113.50	113.75	70.62	0.24	12.87	1.55	0.05	0.71	1.42	3.10	4.33	0.05	4.42		1.42	3.16
119.00	119.25	67.92	0.25	12.73	2.00	0.06	1.00	1.95	2.84	4.14	0.10	6.87		1.80	2.84
121.25	121.50	64.15	0.28	12.68	2.31	0.06	1.20	2.70	2.46	3.79	0.10	9.25		2.12	2.51
122.75	123.00	55.62	0.24	11.58	2.12	0.05	1.60	7.57	2.11	3.10	0.05	16.50		1.97	2.17

¹LOI means "loss on ignition"

²Analyzed by INAA methods

Table H.4. Elemental composition data determined by INAA and trace element XRF methods for core samples from borehole ST-2.

<u>Depth interval</u>		<u>% Composition by weight</u>												
from	to	Sc	Cr	Zn	As	Br	Rb	Rb ¹	Sr ¹	Y ¹	Zr ¹	Nb ¹	Sb	Cs
(ft)	(ft)													
0.00	0.25	5.42	20.00	53.00	4.80	0.50	122.00	123.00	352.00	27.00	256.00	21.00	0.7	3.75
5.00	5.25	3.97	19.00	105.00	6.50	3.70	104.00	101.00	391.00	23.00	167.00	17.00	0.6	2.89
7.50	7.75	3.09	10.00	39.00	7.40	4.00	94.00	91.00	360.00	24.00	150.00	17.00	0.5	2.32
10.75	11.00	3.74	22.90	45.00	8.30	2.9	82.00	85.00	287.00	22.00	176.00	14.00	0.5	2.60
13.25	13.50	3.92	11.90	56.00	5.20	2.3	108.00	104.00	331.00	25.00	208.00	18.00	0.4	3.02
18.75	19.00	3.74	11.60	51.00	4.10	2.9	94.00	93.00	380.00	21.00	166.00	16.00	0.3	2.70
20.50	20.75	3.65	12.90	42.00	4.60	3.8	93.00	93.00	361.00	21.00	170.00	16.00	0.4	2.70
24.50	24.75	3.62	9.30	42.00	4.70	2.7	111.00	106.00	348.00	24.00	169.00	18.00	0.4	3.06
26.75	27.00	3.88	8.00	44.00	4.40	2.5	104.00	98.00	360.00	26.00	172.00	18.00	0.4	2.74
28.75	29.00	3.42	7.90	41.00	4.60	3.2	109.00	106.00	361.00	25.00	166.00	18.00	0.6	2.97
30.50	30.75	4.09	11.40	47.00	4.00	2.0	115.00	114.00	348.00	23.00	187.00	18.00	0.5	3.51
33.75	34.00	3.62	8.80	37.00	4.60	2.6	121.00	117.00	327.00	24.00	162.00	18.00	0.4	3.38
35.25	35.50	4.02	11.20	44.00	5.10	3.0	119.00	115.00	333.00	25.00	186.00	19.00	0.7	3.30
36.25	36.50	3.52	8.50	39.00	4.50	2.2	117.00	115.00	338.00	25.00	162.00	18.00	0.5	2.69
43.00	43.25	3.88	7.80	43.00	4.10	1.8	121.00	121.00	370.00	26.00	187.00	19.00	0.5	3.26
46.00	46.25	4.24	11.00	41.00	4.60	1.9	121.00	119.00	370.00	26.00	187.00	19.00	0.5	3.67
47.75	48.00	4.61	15.10	44.00	5.30	2.5	115.00	111.00	361.00	24.00	199.00	19.00	0.5	3.70
55.00	55.25	4.08	14.50	43.00	5.40	2.5	108.00	109.00	379.00	24.00	162.00	18.00	0.5	3.47
62.50	62.75	3.36	9.70	49.00	3.70	1.6	100.00	98.00	405.00	24.00	151.00	17.00	0.3	2.59
67.75	68.00	3.32	8.40	43.00	4.80	3.3	106.00	106.00	345.00	23.00	154.00	17.00	0.4	3.16

¹Analyzed by trace element XRF methods

Table H.4. (Continued).

<u>Depth interval</u>		<u>% Composition by weight</u>													
from	to	Sc	Cr	Zn	As	Br	Rb	Rb ¹	Sr ¹	Y ¹	Zr ¹	Nb ¹	Sb	Cs	
(ft)	(ft)														
70.25	70.50	4.18	12.5	49.0	5.0	1.8	113.00	109.00	363.00	25.00	181.00	18.00	0.6	3.66	
75.25	75.50	4.79	15.1	63.0	5.4	2.2	123.00	119.00	358.00	24.00	195.00	19.00	0.6	4.13	
78.00	78.25	3.83	10.3	43.0	4.2	1.5	118.00	120.00	347.00	24.00	168.00	19.00	0.4	3.40	
82.00	82.25	4.13	12.0	44.0	4.4	2.4	121.00	118.00	361.00	24.00	172.00	19.00	0.5	3.98	
84.50	84.75	4.31	12.3	48.0	5.7	1.8	124.00	122.00	331.00	26.00	200.00	19.00	3.8	3.80	
87.25	87.50	3.58	7.8	45.0	3.4	1.1	100.00	99.00	380.00	22.00	180.00	16.00	0.4	2.48	
91.25	91.50	4.59	13.2	51.0	5.0	1.7	122.00	119.00	324.00	26.00	214.00	19.00	0.6	3.80	
93.75	94.00	5.39	20.4	60.0	6.4	2.2	133.00	126.00	300.00	28.00	212.00	21.00	0.7	4.46	
96.25	96.50	5.35	17.2	53.0	6.1	1.4	130.00	126.00	337.00	30.00	230.00	21.00	0.6	3.78	
98.75	99.00	4.21	14.7	44.0	5.8	2.3	118.00	121.00	306.00	23.00	175.00	18.00	0.6	3.85	
101.25	101.50	3.67	6.7	39.0	5.3	1.8	120.00	121.00	337.00	26.00	151.00	19.00	0.5	3.46	
106.00	106.25	4.32	11.3	45.0	5.4	1.4	132.00	127.00	237.00	25.00	183.00	19.00	0.6	3.90	
108.25	108.50	4.38	14.3	53.0	5.7	1.7	127.00	116.00	310.00	26.00	181.00	20.00	0.7	3.85	
113.50	113.75	4.04	7.6	39.0	5.8	1.3	163.00	161.00	270.00	30.00	165.00	24.00	0.6	3.78	
119.00	119.25	5.09	14.5	56.0	6.5	1.5	172.00	175.00	196.00	34.00	153.00	25.00	0.7	5.01	
121.25	121.50	5.58	18.1	58.0	7.3	1.8	154.00	162.00	276.00	29.00	162.00	22.00	0.6	5.08	
122.75	123.00	4.93	16.5	52.0	7.6	2.9	132.00	125.00	284.00	25.00	153.00	20.00	0.6	5.50	

<u>Depth interval</u>		<u>% Composition by weight</u>														
from	to	Ba	La	Ce	Nd	Sm	Eu	Tb	Yb	Lu	Hf	Ta	Pb ¹	Th ¹	Th	U
(ft)	(ft)															
0.00	0.25	776.00	49.00	93.70	30.00	6.30		0.77	2.64	0.36	7.84	1.34	26.00	18.00	15.00	3.00
5.00	5.25	623.00	45.20	80.90	32.60	5.19		0.64	2.13	0.31	5.56	1.21	18.00	13.00	13.20	3.00
7.50	7.75	609.00	53.20	97.50	32.60	5.56		0.62	2.04	0.30	4.24	1.12	24.00	12.00	14.60	3.10
10.75	11.00	665.00	43.30	81.10	28.00	4.86	0.85	0.59	1.87	0.27	5.77	1.25	14.00	9.00	11.40	2.50
13.25	13.50	639.00	53.10	108.40	36.00	6.13	0.87	0.73	2.52	0.35	5.90	1.52	22.00	15.00	15.10	3.20
18.75	19.00	710.00	49.30	90.40	28.00	5.39	0.96	0.65	2.04	0.29	5.04	1.23	20.00	13.00	12.90	2.80
20.50	20.75	649.00	50.00	89.60	32.00	5.34	0.88	0.62	1.84	0.28	5.09	1.10	19.00	11.00	11.90	2.60

¹Analyzed by trace element XRF method

Table H.4. (Continued).

Depth interval		% Composition by weight														
from	to	Ba	La	Ce	Nd	Sm	Eu	Tb	Yb	Lu	Hf	Ta	Pb ¹	Th ¹	Th	U
(ft)	(ft)															
24.50	24.75	643.0	45.90	86.00	24.00	5.41	0.87	0.62	2.27	0.32	5.78	1.34	21.00	15.00	14.90	3.10
26.75	27.00	668.0	63.90	117.10	29.00	6.99	0.93	0.73	2.39	0.31	5.94	1.23	21.00	13.00	14.90	2.90
28.75	29.00	750.0	46.00	84.70	32.00	5.89	0.84	0.71	2.46	0.33	5.30	1.38	22.00	15.00	15.00	3.30
30.50	30.75	664.0	53.40	97.50	31.00	5.92	0.90	0.68	2.16	0.31	6.71	1.27	21.00	15.00	15.40	3.30
33.75	34.00	633.0	38.70	72.20	26.00	4.96	0.81	0.63	2.16	0.33	5.33	1.28	22.00	16.00	14.40	3.10
35.25	35.50	642.0	44.20	87.20	30.00	5.80	0.85	0.75	2.54	0.35	5.91	1.43	22.00	15.00	15.10	3.40
36.25	36.50	639.0	66.40	122.20	41.00	6.75	0.86	0.70	2.53	0.32	4.85	1.55	24.00	15.00	16.80	3.10
43.00	43.25	598.0	42.60	79.40	27.00	5.16	0.85	0.64	2.13	0.32	5.55	1.45	22.00	15.00	15.00	3.50
46.00	46.25	664.0	39.30	72.90	35.00	5.23	0.82	0.68	2.24	0.33	5.52	1.49	20.00	14.00	14.80	3.50
47.75	48.00	652.0	41.50	79.30	27.00	5.84	0.87	0.76	2.31	0.30	5.86	1.40	21.00	15.00	13.90	3.50
55.00	55.25	713.0	37.60	67.90	26.00	5.05	0.84	0.64	2.41	0.34	5.92	1.19	20.00	13.00	13.00	3.50
62.50	62.75	653.0	37.10	68.50	22.00	4.84	0.87	0.61	2.23	0.34	4.63	1.26	22.00	13.00	12.60	3.00
67.75	68.00	607.0	34.80	65.60	27.00	4.72	0.74	0.58	1.99	0.34	5.14	1.24	20.00	13.00	12.90	3.40
70.25	70.50	657.0	56.20	103.10	32.00	5.89	0.82	0.63	2.12	0.33	6.39	1.23	23.00	15.00	15.90	3.40
75.25	75.50	840.0	58.10	109.30	37.00	6.45	0.91	0.73	2.30	0.33	5.96	1.35	23.00	15.00	15.60	3.30
78.00	78.25	636.0	49.50	91.90	35.00	5.63	0.82	0.64	2.18	0.33	6.27	1.45	23.00	16.00	16.60	3.40
82.00	82.25	534.0	51.20	97.60	30.00	5.78	0.75	0.67	3.25	0.37	5.84	1.39	22.00	17.00	16.60	3.70
84.50	84.75	616.0	39.60	74.30	30.00	5.50	0.79	0.70	2.30	0.37	6.32	1.44	24.00	16.00	14.90	3.80
87.25	87.50	718.0	60.60	110.30	36.00	5.90	0.98	0.66	2.10	0.31	6.49	1.23	20.00	12.00	14.30	3.20
91.25	91.50	608.0	60.40	106.30	33.00	5.78	0.85	0.67	2.12	0.32	6.65	1.36	22.00	15.00	16.30	3.70
93.75	94.00	532.0	50.30	94.60	35.00	7.30	0.90	0.89	2.57	0.40	6.38	1.46	22.00	17.00	16.40	3.80
96.25	96.50	663.0	52.40	96.80	34.00	6.30	0.99	0.76	2.61	0.36	7.26	1.61	24.00	17.00	16.00	3.50
98.75	99.00	519.0	50.10	95.40	32.00	5.97	0.73	0.75	2.31	0.32	5.14	1.48	22.00	15.00	15.80	3.60
101.25	101.50	516.0	37.30	70.60	28.00	5.09	0.64	0.62	2.29	0.34	5.26	1.44	23.00	18.00	15.60	3.60
106.00	106.25	474.0	52.90	95.80	34.00	5.85	0.68	0.69	2.24	0.31	5.29	1.57	23.00	17.00	17.20	3.80
108.25	108.50	474.0	36.60	66.10	27.00	5.12	0.73	0.66	2.15	0.31	5.53	1.38	22.00	17.00	14.40	3.50
113.50	113.75	411.0	42.20	83.50	31.00	6.32	0.72	0.89	2.92	0.42	5.94	1.86	24.00	22.00	18.50	4.00
119.00	119.25	428.0	48.00	92.30	33.00	6.35	0.71	0.82	2.82	0.43	4.83	1.76	26.00	21.00	20.20	4.60
121.25	121.50	599.0	46.60	93.20	35.0	6.59	0.81	0.83	2.73	0.39	5.27	1.69	25.00	20.00	19.60	4.10
122.75	123.00	502.0	34.40	66.20	22.0	4.92	0.64	0.66	2.12	0.31	5.13	1.26	22.00	16.00	14.90	3.90

¹Analyzed by trace element XRF method

Table H.5. Element and oxide composition data for core samples from borehole ST-3.

Depth interval		% Composition by weight														
from	to	SiO ¹	TiO ₂ ¹	Al ₂ O ₃ ¹	Fe ₂ O ₃ ¹	MnO ¹	MgO ¹	CaO ¹	Na ₂ O ¹	K ₂ O ¹	P ₂ O ₅ ¹	LOI ²	H ₂ O ¹	FeO ³	Na ₂ O ₂ ³	
(ft)	(ft)															
0.00	0.25	61.33	0.38	12.76	2.48	0.07	1.77	5.23	2.41	3.70	0.13	9.03	3.65	2.13	2.22	
2.50	2.75	61.87	0.25	12.06	1.78	0.06	1.09	6.93	2.69	3.77	0.08	8.31	1.68	1.58	2.70	
5.25	5.50	59.76	0.28	11.53	2.02	0.05	1.62	8.01	2.48	3.11	0.05	10.14	2.54	1.71	2.36	
7.50	7.75	66.82	0.27	10.01	2.13	0.06	1.09	6.19	2.28	2.75	0.06	8.44	2.11	1.88	2.36	

<u>Depth interval</u>		<u>% Composition by weight</u>												
from	to	Sc ³	Cr ³	Zn ³	As ³	Br ³	Rb ⁴	Rb ³	Sr ⁴	Y ⁴	Zr ⁴	Nb ⁴	Sb ³	Cs ³
(ft)	(ft)													
0.00	0.25	5.24	19.00	64.00	5.30	0.80	119.00	116.00	300.00	25.00	220.00	19.00	0.67	3.67
2.50	2.75	3.70	11.00	43.00	4.40	2.80	112.00	108.00	358.00	23.00	195.00	18.00	0.59	2.90
5.25	5.50	4.12	14.00	47.00	5.40	5.40	99.00	96.00	355.00	22.00	166.00	15.00	0.58	3.20
7.50	7.75	3.44	14.00	51.00	7.50	4.10	89.00	90.00	345.00	21.00	167.00	16.00	0.51	2.56

<u>Depth interval</u>		<u>% Composition by weight</u>														
from	to	Ba ³	La ³	Ce ³	Nd ³	Sm ³	Eu ³	Tb ³	Yb ³	Lu ³	Hf ³	Ta ³	Pb ⁴	Th ⁴	Th ³	U
(ft)	(ft)															
0.00	0.25	612.00	44.00	82.50	29.20	5.72	0.91	0.70	2.43	0.34	6.29	1.25	26.00	16.00	14.10	2.70
2.50	2.75	618.00	44.00	81.50	26.90	5.54	0.84	0.65	2.19	0.33	5.65	1.40	22.00	15.00	14.30	3.20
5.25	5.50	563.00	34.20	64.10	21.80	4.41	0.71	0.57	1.86	0.28	5.09	1.31	19.00	14.00	11.90	3.00
7.50	7.75	568.00	40.10	74.60	30.60	4.87	0.72	0.58	1.93	0.28	5.05	1.23	18.00	12.00	12.90	3.00

¹Analyzed by major element XRF methods

²LOI means "loss on ignition"

³Analyzed by INAA methods

⁴Analyzed by trace element XRF methods

Table H.6. Element and oxide composition data for core samples from borehole ST-4.

<u>Depth interval</u>		<u>% Composition by weight</u>													
from	to	SiO ¹	TiO ₂ ¹	Al ₂ O ₃ ¹	Fe ₂ O ₃ ¹	MnO ¹	MgO ¹	CaO ¹	Na ₂ O ¹	K ₂ O ¹	P ₂ O ₅ ¹	LOI ²	H ₂ O ¹	FeO ³	Na ₂ O ³
(ft)	(ft)														
1.00	1.25	65.54	0.30	13.04	2.09	0.06	1.24	4.10	2.63	4.04	0.07	6.27	1.82	1.88	2.58
3.50	3.75	60.82	0.29	12.19	1.99	0.06	1.33	7.58	2.65	3.39	0.06	10.05	2.25	1.86	2.56
5.75	6.00	61.68	0.29	11.74	2.08	0.06	1.56	6.65	2.56	3.19	0.05	9.38	2.66	1.83	2.54

<u>Depth interval</u>		<u>% Composition by weight</u>													
from	to	Sc ³	Cr ³	Zn ³	As ³	Br ³	Rb ⁴	Rb ³	Sr ⁴	Y ⁴	Zr ⁴	Nb ⁴	Sb ³	Cs ³	
(ft)	(ft)														
1.00	1.25	4.65	15.00	49.00	4.90	1.90	118.00	136.00	336.00	25.00	191.00	18.00	0.60	3.58	
3.50	3.75	4.39	17.00	48.00	6.40	6.60	118.00	131.00	340.00	24.00	176.00	19.00	0.50	4.15	
5.75	6.00	4.03	13.00	42.00	5.50	5.40	101.00	102.00	383.00	23.00	186.00	17.00	0.40	3.26	

<u>Depth interval</u>		<u>% Composition by weight</u>													
from	to	Ba ³	La ³	Ce ³	Nd ³	Sm ³	Eu ³	Tb ³	Yb ³	Lu ³	Hf ³	Ta ³	Pb ⁴	Th ⁴	Th ³
(ft)	(ft)														
1.00	1.25	714.00	41.60	80.40	24.50	5.68	0.65	2.36	0.34	6.32	1.44	21.00	14.00	14.90	3.40
3.50	3.75	598.00	45.10	85.70	24.90	5.57	0.60	2.22	0.32	5.56	1.40	22.00	17.00	15.70	3.80
5.75	6.00	610.00	49.70	91.90	26.50	5.12	0.55	2.04	0.29	5.42	1.13	20.00	13.00	13.60	3.20

¹Analyzed by major element XRF methods

²LOI means "loss on ignition"

³Analyzed by INAA methods

⁴Analyzed by trace element XRF methods

Table H.7. Element and oxide composition data for core samples from borehole ST-5.

Depth interval		% Composition by weight													
from	to	SiO ¹	TiO ₂ ¹	Al ₂ O ₃ ¹	Fe ₂ O ₃ ¹	MnO ¹	MgO ¹	CaO ¹	Na ₂ O ¹	K ₂ O ¹	P ₂ O ₅ ¹	LOI ²	H ₂ O ¹	FeO ³	Na ₂ O ³
(ft)	(ft)														
1.00	1.25	66.11	0.33	13.47	2.19	0.06	1.23	3.47	2.76	4.06	0.05	5.59	1.77	1.90	2.56
3.50	3.75	64.51	0.30	12.86	2.00	0.06	1.25	4.68	2.85	3.60	0.04	7.51	2.43	1.74	2.78
6.75	7.00	61.33	0.67	13.19	2.74	0.09	4.01	6.03	2.79	2.75	0.12	5.88	1.74		
8.25	8.50	62.97	0.31	12.33	2.11	0.06	2.31	5.67	3.11	3.35	0.05	8.70	1.86	1.93	2.81

<u>Depth interval</u>		<u>% Composition by weight</u>													
from	to	Sc ³	Cr ³	Zn ³	As ³	Br ³	Rb ⁴	Rb ³	Sr ⁴	Y ⁴	Zr ⁴	Nb ⁴	Sb ³	Cs ³	
(ft)	(ft)														
1.00	1.25	4.58	17.00	47.00	4.60	3.10	116.00	113.00	378.00	24.00	216.00	18.00	0.60	3.44	
3.50	3.75	4.22	13.00	44.00	4.90	6.30	111.00	113.00	376.00	24.00	188.00	18.00	0.50	3.47	
6.75	7.00	5.51	57.00	46.00	5.50	2.80	97.00	91.00	409.00	23.00	174.00	17.00	0.40	2.62	
8.25	8.50	3.88	11.00	44.00	5.00	3.50	106.00	108.00	369.00	23.00	206.00	18.00	0.40	3.03	

Depth interval		% Composition by weight													
from	to	Ba ³	La ³	Ce ³	Nd ³	Sm ³	Eu ³	Tb ³	Yb ³	Lu ³	Hf ³	Ta ³	Pb ⁴	Th ⁴	Th ³
(ft)	(ft)														
1.00	1.25	743.00	39.90	71.90	24.10	4.96	0.91	0.60	2.11	0.31	5.86	1.28	21.00	15.00	13.60
3.50	3.75	638.00	44.40	84.20	28.30	5.39	0.86	0.64	2.15	0.30	5.96	1.40	21.00	14.00	14.30
6.75	7.00	635.00	45.20	83.10	27.40	5.05	0.88	0.57	2.07	0.29	5.49	1.19	21.00	14.00	12.40
8.25	8.50	643.00	43.90	81.50	23.80	5.10	0.88	0.60	2.11	0.31	5.57	1.36	20.00	14.00	13.80

¹Analyzed by major element XRF methods

²LOI means "loss on ignition"

³Analyzed by INAA methods

⁴Analyzed by trace element XRF methods

APPENDIX I

Figure I.1. Completion details for boreholes ST-1.

Figure I.2. Completion details for boreholes ST-2A.

Figure I.3. Completion details for boreholes ST-4A.

Figure I.4. Completion details for boreholes ST-6A.

Table I.5. Depths of the screened intervals in boreholes ST-1, ST-2A, ST-4A, and ST-6A.

	ST-1 (ft)	ST-2A (ft)	ST-4 (ft)	ST-6A (ft)
Depth from:	24.0	14.0	16.6	13.5
to:	29.0	20.1	22.1	20.0
	37.0	33.0	36.5	34.0
	44.0	40.0	42.1	40.0
	56.5	54.0	56.6	54.0
	64.5	60.3	62.6	59.7
	78.0	72.0	76.6	74.0
	81.1	79.5	82.6	80.0
	96.5	92.0	96.9	93.9
	104.5	100.0	102.9	99.9
	117.3	114.7	116.5	114.0
	119.7	119.3	119.5	119.5

Table I.6. Neutron logging records for boreholes ST-1, ST-2A, ST-4A, and ST-6A.

<u>ST-1</u>		<u>ST-2A</u>		<u>ST-4A</u>		<u>ST-6A</u>	
Depth	Counts	Depth	Counts	Depth	Counts	Depth	Counts
(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
3.5	1571	3.6	778	3.5	609	3.2	3435
4.5	1974	4.6	2618	4.5	892	4.2	2552
5.5	2037	5.6	2386	5.5	1101	5.2	2285
6.5	2050	6.6	2070	6.5	2028	6.2	2179
7.5	1938	7.6	2005	7.5	2059	7.2	2328
8.5	1908	8.6	2076	8.5	2015	8.2	2248
9.5	1992	9.6	2023	9.5	2079	9.2	2284
10.5	1948	10.6	2094	10.5	2185	10.2	2159
11.5	1924	11.6	2271	11.5	2124	11.2	2138
12.5	1878	12.6	2138	12.5	2058	12.2	2090
13.5	1848	13.6	2176	13.5	2170	13.2	2174
14.5	2055	14.6	2152	14.5	2036	14.2	2157
15.5	2638	15.6	2154	15.5	2283	15.2	2220
16.5	2540	16.6	2186	16.5	2251	16.2	1981
17.5	2326	17.6	1956	17.5	1837	17.2	1937
18.5	1691	18.6	1885	18.5	2018	18.2	1749
19.5	1754	19.6	1701	19.5	1839	19.2	1805
20.5	1727	20.6	1760	20.5	1789	20.2	1918
21.5	2010	21.6	1806	21.5	1900	21.2	1850
22.5	1928	22.6	1850	22.5	2058	22.2	2005
23.5	1904	23.6	2028	23.5	2236	23.2	2048
24.5	1925	24.6	2188	24.5	2157	24.2	2115
25.5	2048	25.6	2286	25.5	2183	25.2	2254
26.5	1920	26.6	2211	26.5	2212	26.2	2235
27.5	1897	27.6	2046	27.5	2313	27.2	2331
28.5	2305	28.6	2144	28.5	2234	28.2	2251
29.5	2315	29.6	2171	29.5	2248	29.2	2346
30.5	2246	30.6	2137	30.5	2204	30.2	2443
31.5	2342	31.6	2107	31.5	2226	31.2	2344
32.5	2225	32.6	2346	32.5	2283	32.2	2282
33.5	2312	33.6	2099	33.5	2287	33.2	2398
34.5	2341	34.6	2159	34.5	2317	34.2	2295
35.5	1907	35.6	2195	35.5	2332	35.2	2361
36.5	1990	36.6	1883	36.5	2339	36.2	2430
37.5	1940	37.6	1851	37.5	1874	37.2	2068
38.5	1948	38.6	1926	38.5	1924	38.2	1976
39.5	2056	39.6	2053	39.5	2135	39.2	1930
40.5	2054	40.6	2018	40.5	2003	40.2	2108

Table I.6. (Continued).

<u>ST-1</u>		<u>ST-2A</u>		<u>ST-4A</u>		<u>ST-6A</u>	
Depth	Counts	Depth	Counts	Depth	Counts	Depth	Counts
(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
41.5	2089	41.6	1942	41.5	2018	41.2	2052
42.5	2601	42.6	2067	42.5	2620	42.2	2190
43.5	2175	43.6	2336	43.5	2493	43.2	2430
44.5	2225	44.6	2214	44.5	2487	44.2	2569
45.5	2392	45.6	2318	45.5	2534	45.2	2443
46.5	2455	46.6	2274	46.5	2522	46.2	2575
47.5	2467	47.6	2225	47.5	2511	47.2	2567
48.5	2378	48.6	2398	48.5	2635	48.2	2751
49.5	2388	49.6	2317	49.5	2540	49.2	2477
50.5	2476	50.6	2453	50.5	2470	50.2	2550
51.5	2338	51.6	2338	51.2	2596	51.2	2525
52.5	2344	52.6	2484	52.5	2450	52.2	2621
53.5	2448	53.6	2485	53.5	2580	53.2	2447
54.5	2303	54.6	2424	54.5	2500	54.2	2682
55.5	2247	55.6	2566	55.5	2627	55.2	2585
56.5	2071	56.6	2463	56.5	2538	56.2	2510
57.5	2179	57.6	2206	57.5	2133	57.2	2002
58.5	2046	58.6	2248	58.5	2144	58.2	2098
59.5	1877	59.6	2113	59.5	2120	59.2	2188
60.5	2108	60.6	2174	60.5	2205	60.2	2133
61.5	2095	61.6	2034	61.5	2078	61.2	2028
62.5	2358	62.6	2035	62.5	2245	62.2	2306
63.5	2326	63.6	2144	63.5	2634	62.3	2463
64.5	2193	64.6	2407	64.5	2294	64.2	2413
65.5	2116	65.6	2441	65.5	2352	65.2	2390
66.5	2328	66.6	2406	66.5	2353	66.2	2393
67.5	2461	67.6	2427	67.5	2448	67.2	2428
68.5	2434	68.6	2426	68.5	2459	68.2	2485
69.5	2535	69.6	2529	69.5	2477	69.2	2622
70.5	2606	70.6	2550	70.5	2503	70.2	2620
71.5	2539	71.6	2789	71.5	2811	71.2	2822
72.5	2370	72.6	2727	72.5	2663	72.2	2564
73.5	2038	73.6	2658	73.5	2781	73.2	2672
74.5	1977	74.6	2549	74.5	2610	74.2	2436
75.5	1971	75.6	2065	75.5	2656	75.2	2500
76.5	2218	76.6	2006	76.5	2457	76.2	2470
77.5	1992	77.6	2016	77.5	2095	77.2	1982
78.5	1981	78.6	2040	78.5	2194	78.2	2184
79.5	2451	79.6	2063	79.5	2129	79.2	2057

Table I.6. (Continued).

<u>ST-1</u>		<u>ST-2A</u>		<u>ST-4A</u>		<u>ST-6A</u>	
Depth (ft)	Counts (ft)	Depth (ft)	Counts (ft)	Depth (ft)	Counts (ft)	Depth (ft)	Counts (ft)
80.5	2469	80.6	2046	80.5	1980	80.2	2069
81.5	2718	81.6	1908	81.5	2035	81.2	2014
82.5	2782	82.6	2406	82.5	2119	82.2	2049
83.5	2714	83.6	2599	83.5	2803	83.2	2673
84.5	2787	84.6	2707	84.5	2740	84.2	2843
85.5	2528	85.6	2683	85.5	2822	85.2	2940
86.5	2521	86.6	2838	86.5	2815	86.2	2950
87.5	2578	87.6	2498	87.5	2656	87.2	2673
88.5	2457	88.6	2287	88.5	2320	88.2	2513
89.5	2586	89.6	2321	89.5	2525	89.2	2504
90.5	2724	90.6	2232	90.5	2536	90.2	2520
91.5	2625	91.6	2472	91.5	2441	91.2	2528
92.5	2561	92.6	2500	92.5	2681	92.2	3029
93.5	2550	93.6	2516	93.5	2711	93.2	2626
94.5	2286	94.6	2561	94.5	2629	94.2	2555
95.5	2137	95.6	2111	95.5	2605	95.2	2634
96.5	2040	96.6	2175	96.5	2652	96.2	2901
97.5	2025	97.6	2102	97.5	2360	97.2	2014
98.5	2119	98.6	2039	98.5	2222	98.2	2042
99.5	2102	99.6	2166	99.5	2194	99.2	2065
100.5	2187	100.6	2098	100.5	2260	100.2	2062
101.5	2147	101.6	2090	101.5	2151	101.2	1998
102.5	2601	102.6	2062	102.5	2207	102.2	2180
103.5	2701	103.6	2757	103.5	2852	103.2	2782
104.5	2612	104.6	2587	104.5	2715	104.2	2753
105.5	2946	105.6	2752	105.5	3017	105.2	2707
106.5	3039	106.6	3436				
107.5	3080						

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