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**THE GEOLOGY AND HYDROGEOLOGY
OF
BEAR CREEK VALLEY WASTE DISPOSAL
AREAS A AND B****DISCLAIMER**

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Report Prepared by
Bechtel National, Inc.
800 Oak Ridge Turnpike
Oak Ridge, Tennessee 37830
under
Purchase Order 86Y-47974C

for

Oak Ridge Y-12 Plant
Oak Ridge, Tennessee 37831
operated by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
Under Contract No. DE-AC05-84OR21400

PRODUCED BY
MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

THE GEOLOGY AND HYDROGEOLOGY
OF
BEAR CREEK VALLEY WASTE DISPOSAL
AREAS A AND B

*Work performed prior to April 1, 1984,
by Bechtel National, Inc. under sub-
contract to Union Carbide Corporation,
Nuclear Division for the U.S. Department
of Energy under Contract W-7405-eng-26.
The conclusions and recommendations
expressed in this report are those of
Bechtel National, Inc. and should not be
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Union Carbide Corporation, Nuclear
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REPORT
ON
BURIAL GROUNDS A AND B
GEOLOGY AND HYDROGEOLOGY

ENVIRONMENTAL FIELD STUDIES
BEAR CREEK WASTE DISPOSAL AREA

PREPARED FOR
UNION CARBIDE CORPORATION-NUCLEAR DIVISION
BY
BECHTEL CIVIL AND MINERALS INC.

MARCH 1984

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1.0 INTRODUCTION

In June 1983, at the request of the Union Carbide Corporation - Nuclear Division (UCC-ND), Bechtel National, Incorporated began a study of the Oil Landfarm and Burial Grounds A and B, which are three disposal sites within the Bear Creek Waste Disposal Area. The area is located west of the UCC-ND Y-12 plant, about 3 miles southwest of Oak Ridge, Tennessee (Figure 1).

The purpose of this interim report is to present data collected at the Burial Grounds A and B, and to provide the results of hydrogeologic analyses. The Oil Landfarm geologic and hydrogeologic data and analyses have been submitted to UCC-ND in a January 1984 interim report.

The overall objectives of the study were to characterize the types and extent of wastes present and to define the occurrence and movement of ground water beneath the sites. The intention of this work is to provide criteria on which a design for containing the waste can be developed. Specific activities performed by Bechtel included:

- o drilling for subsurface geologic data
- o installing monitoring wells
- o measuring permeability and ground-water flow directions
- o collecting soil, sediment, surface- and ground-water, and liquid-waste samples for chemical analysis.

The purpose of this interim report is to present results of the hydrogeologic field studies at Burial Grounds A and B completed in early November 1983. Results of similar studies at the Oil Landfarm site were submitted to UCC-ND in a January 1984 interim report.

Results of chemical analyses of soil and water samples have been submitted in Bechtel's weekly progress reports, as they became available from the laboratory, and are not addressed in this report.

2.0 SUMMARY AND RECOMMENDATIONS

Bedrock underlying the burial grounds area is a sequence of shale, limestone and sandstone interbeds that are part of the Conasauga Group. The beds have an average strike of about N60E and dip steeply to the southeast from 40 to 70 degrees. Weathered rock extends to depths of less than 10 to more than 50 feet, and is deepest beneath the hills at the site. Although the weathered zone is clayey, particularly the upper part, it is somewhat more fractured than the underlying fresh rock. Overlying the rock nearly everywhere are unconsolidated deposits that include alluvium, colluvium, residual soils, or fill placed as a result of the burial processes. These unconsolidated deposits are predominantly less than 5 feet thick, but an alluvial unit encountered between the burial grounds and Bear Creek was more than 19.5 feet thick.

In the vicinity of Burial Grounds A and B, water is present in the alluvium along stream channels. However, the main occurrence of ground water is in joints and fractures of the rock. The predominant fracture system is along partings parallel to bedding. This has resulted in a high degree of anisotropy in the permeability of the rock, with permeability greatest parallel to bedding and least in a direction normal to bedding. This directional permeability results in a net ground-water velocity vector which is at an angle to, rather than normal to, water-level contours.

Permeability tests indicate the unweathered rock is generally somewhat less permeable than weathered rock, but high permeability zones (2900 ft/yr) are present in the unweathered rock. Further, to the depths explored, the data do not suggest markedly lower permeability with depth. The highest permeability values were from borings adjacent to or near the two tributary creeks which cross the site. It is possible that the regional fracture patterns which control the location of these tributaries are also responsible for higher permeability along them. Further, down-hole measurements of ground-water flow in wells indicate that the regional direction of movement is to the southeast, and is probably controlled by fractures and other structures.

The slope of the water table, as determined from water levels in shallow observation wells, is toward Bear Creek and its tributaries. However, ground water levels near Bear Creek are lower than the creek channel, suggesting the creek is not a discharge boundary.

Before final design of remedial measures, it is recommended that the following be considered:

1. The present study has been concerned with hydrogeologic characterization of a small area within Bear Creek Valley. It is evident from the results that Burial Grounds A and B can not be readily isolated hydrologically from the rest of Bear Creek Valley. In order to have an effective remedial action plan for the burial grounds, the ground water regime in the valley needs to be understood. It is recommended that future studies define the regional flow of ground water in (and beneath) Bear Creek Valley and south to the Clinch River.
2. The potential for migration of contaminants out of Bear Creek Valley via solution cavities in limestone and dolomitic rocks needs to be evaluated. Such rocks have been mapped (Law, 1983, McMaster, 1963) south of Burial Ground A, and probably underlie parts of the channel of Bear Creek. Solution cavities and caves in the Knox Group are reported by McMaster (1963) and Morris (1973). Contaminated ground and surface waters could be leaving the valley through a system of interconnected fractures or cavities. It is strongly recommended that the presence of solution cavities in the rocks adjacent to the valley be investigated. If these are present, they need to be identified in order to design appropriate remedial or containment measures.

3. The deep down-dip migration of contaminants needs to be evaluated before appropriate remedial measures can be designed for the Burial Grounds area. This can be accomplished by assessing the site within the context of regional hydrogeology, and by construction of deep wells in key locations. Deep wells will provide data on the vertical hydraulic gradient, and will help in determining contamination at depth.

3.0 PREVIOUS STUDIES

A thorough understanding of geologic and ground-water conditions at the burial grounds is essential for design and implementation of an appropriate containment or site-closure system. To this end, available reports were reviewed prior to performing field studies. Key reports included a regional geologic map and report by McMaster (1963), and a report on the ORNL waste burial ground, by the U.S. Geological Survey (Webster, 1976). These reports provide important data on geology and the hydraulic properties of geologic units found at the site. The Law Engineering Testing Company report (1983) contains data on several parts of Bear Creek Valley. This report was provided after field studies were underway and was helpful in planning the later parts of the program. A paper recently presented by Ketelle and Lin (1984) summarizes results of a geophysical survey at the S-3 ponds. The study shows contaminant migration along strike from the ponds.

Before selecting locations for new boreholes and observation wells, data on existing wells at the site were reviewed. Construction details for existing wells are summarized by Law (1983). Water levels in these wells were used to supplement data from wells installed during this study.

4.0 FIELD STUDIES

The program of field exploration and testing included reconnaissance geologic mapping, drilling, installing observation wells, permeability testing, using a down-hole flowmeter, and making periodic water-level measurements.

The study began with a geologic reconnaissance of the waste disposal area to become familiar with the site. An exploration plan was formulated to define the geologic and hydrogeologic conditions at the Oil Landfarm and Burial Grounds A and B in support of developing facility closure concepts and remedial action plans, if required. During the reconnaissance, it was noted that the geology could be separated into three basic categories: unconsolidated alluvial and colluvial materials, weathered bedrock, and unweathered bedrock. It was considered during the field reconnaissance that each of these categories could have significantly different hydrogeologic characteristics. The exploration program was therefore formulated to define these characteristics.

Thirty-eight holes were drilled during September, October and November of 1983 (Figure 2): Thirty-five were vertical boreholes and three were angle boreholes. The vertical boreholes were drilled with either a Mobile 53 or a Mobile 61. Depths ranged from 7.9 to 75.7 feet. A 6-inch hollow stem auger was used through the overburden and weathered rock. All vertical holes except GW-30 were sampled continuously to refusal (50 blows/6-inches) using a 3-inch split spoon sampler and a 300-pound hammer. GW-30 was not sampled because it was immediately adjacent to GW-31, which had been sampled. In six of the boreholes, a tricone bit was used to advance the holes through hard strata to a depth below the water table. Ten other boreholes were cored into unweathered rock using NQ wireline equipment. All cores were carefully examined and placed in core boxes for storage. Cored boreholes were reamed to a minimum of 4-inch diameter in order to install 2-inch diameter observation well casing. The remaining 19 vertical boreholes were drilled with the auger only.

The angle boreholes were drilled with a Sprague and Henwood 400 to a depth (vertically) of about 55 feet. The angle boreholes were drilled at 60 degrees from horizontal on a bearing normal to the strike and opposite to the direction of dip. This permitted penetration of a greater part of the stratigraphic section than for a vertical hole of the same length, and doing so also allowed for comparison of packer test results in vertical and inclined holes. The angle holes were drilled with a tricone bit through unconsolidated materials, and were then cored with NQ wireline equipment.

Detailed drilling logs for each hole were prepared for each borehole (see Appendix). In addition to lithology, the spacing, frequency and nature of the filling material were noted for fractures and joints observed in split-spoon and core samples recovered from boreholes. The degree and depth of weathering were noted for each borehole. Sandstones were examined for degree and type of cementation; limey shales and limestones were closely examined for signs of dissolution.

Following drilling and packer testing (see below), observation wells were installed in all vertical boreholes, and in one of the angle boreholes (GW-32). The remaining two angle boreholes were grouted to the surface. Four wells were completed in the unconsolidated materials, 20 wells monitor principally the weathered zone, and 12 wells monitor mainly unweathered rock. Table 1 provides borehole data and completion details on all wells installed during the field program; locations are shown on Figure 2. All observation wells were constructed of 2-inch diameter stainless steel, with either a 2-foot or 5-foot length of Johnson wire-wound screen (slot size 0.010 inch), and a one- to two-foot sump at the bottom. The annulus between the borehole wall and the outside of the well casing and screen, was filled to a selected depth with clean sand, while water was slowly pumped through the well to further clean the sand pack and to help in cleaning the borehole wall. Bentonite pellets were then placed above the sand and allowed to swell to form a seal. The remaining annulus was filled with cement grout. After construction, all observation wells were developed by a combination of bailing and pumping. A minimum of 2-1/2 well volumes (the water contained in both the casing and the sand pack)

were removed from each well during development, except where the water level was at or below the bottom of the screen (as in wells GW-34, GW-45, GW-50 and GW-51). An additional three casing volumes were removed from wells which were sampled, immediately prior to sampling.

Hydraulic conductivity (permeability) values for subsurface materials were determined from packer tests in boreholes and bailer-recovery tests in observation wells. Eight permeameter tests were also performed at depths of 2 to 5 feet (see Figure 2 for locations).

Packer permeability tests were performed in nine of the ten vertical cored boreholes and in all of the angle boreholes. Tests were conducted, and the results analyzed, in accordance with procedures given in the U.S. Bureau of Reclamation Earth Manual (Designation E-18). Bailer-recovery permeability tests were performed in sixteen wells by slowly bailing the well until a significant drawdown was achieved, and then monitoring the water-level recovery in the well. Test data were analyzed using the recovery method given by McWhorter and Sunada (1977, p. 207, equation 5-45), and assuming an average pumping rate equal to the total quantity bailed divided by the total time of bailing. Results of field permeability testing are given in Tables 2 and 3.

Data from the permeameter tests have not been reported here because of questionable accuracy. Heavy rain and the difficulty of properly cleaning clayey materials from the auger holes walls precluded use of the data.

After completion of the observation wells, a down-hole flowmeter was placed in 23 of the wells, opposite the screens, to measure the direction and magnitude of ground-water flow. The flowmeter used was of the thermal pulse type (a K-V Associates Model 40L), which measures the response to a heat pulse recorded by a series of thermisters arranged in a circular pattern around the heat source. The velocity and direction of ground-water flow are computed using the differences in temperature recorded for each thermister. Because of constrictions inside the well, where threaded sections were welded to the casing and screen sections, it was difficult to lower the probe into some of the wells and not always possible to orient the probe as desired. However, consistent data were obtained and the results are reported in Section 6.0.

Water levels in new and existing observation wells were measured periodically during the field program, to ensure that they were functioning properly, and to observe changes due to precipitation. Weekly water level measurements of the GW wells were begun by UCC-ND at the end of February.

5.0 GEOLOGY

The burial grounds lie on the north side of Bear Creek Valley, which is within the Valley and Ridge Physiographic Province. This province is characterized by a series of subparallel valleys and ridges that trend

approximately N60°E. The valleys have been produced by differential weathering, solution activity and erosion of the faulted and folded sedimentary rocks. Rocks in the vicinity of Bear Creek Valley range in age from Cambrian to Silurian, and dip to the southeast. Figure 1 shows the distribution of major geologic units present in the site area.

The burial grounds are underlain by rocks of the Conasauga Group of Cambrian age. South of Bear Creek Road, the Conasauga rocks are in contact with the overlying Knox Group, which consists principally of limestone and dolomite. The Knox Group regionally is known to contain caves and cavities resulting from dissolution along joints and fractures in the carbonate rock (Moore, 1973).

Burial Grounds A and B are underlain by several members of the Conasauga Group, consisting of interbedded shale, sandstone, limestone and siltstone. According to Law (1983), the southern unit of Burial Ground A is underlain by the Nolichucky Shale Member. The northern unit of Burial Ground A is underlain by the Maynardville Limestone Member, and Burial Ground B is underlain by the Maryville Limestone and Rogersville Shale Members. The rocks are all steeply dipping to the southeast. The angle of dip noted in core and split spoon samples ranged from 35 degrees to vertical, but was most commonly in the range of 45 to 70 degrees.

The relationship of rock units and overlying alluvium to the burial areas is shown in the geologic sections on Figures 3 and 4. The distribution and characteristics of unconsolidated and rock materials are described below.

5.1 Unconsolidated Materials

Fill

Various types of fill are present at the site. Roads are surfaced with crushed limestone fill. The burial ground trenches and pits are covered with reworked shale and clay.

Alluvium

Two distinct types of alluvium were noted - one associated with active tributaries to Bear Creek, and the other in the broad, gently sloping area between the southern unit of Burial Ground A and Bear Creek. The first type of alluvium consists typically of soft to medium stiff, organic, plastic silty clay, which is found mainly along the lower reaches of the small creeks that traverse the burial grounds site (see logs of boreholes GW-15, GW-22, GW-48). The thickness of this material varies but is typically about 3 to 7 feet.

The second type of alluvium is an orange-brown, dense pebbly silt found in boreholes drilled along the north side of Bear Creek. Pebbles are subrounded clasts of chert and limestone. Borehole GW-52 was terminated in this material at a depth of 19.5 feet. It is possible that the pebbly silt represents older Bear Creek alluvium.

Colluvium

Steeper slopes are covered by a veneer of colluvium, which consists of deeply weathered rock and clayey to silty residual soil. In vegetated

areas, such as the slopes around Burial Ground B, the colluvium contains humus.

5.2 Weathered Rock

Weathered rock is exposed on hills, in roadcuts, in stream banks and in stripped areas where no burial has yet taken place. This material consists principally of weak, thin-bedded shale and sandstone, with some siltstone beds.

Weathered shale beds retain residual bedding structure, but are largely altered to clay that has a moderate brown color. In the burial grounds, the weathered zone is characteristically a zone of leaching where limestone beds and carbonate cement in sandstone beds have been dissolved by rainwater infiltrating to the water table. Except along Bear Creek, the weathered zone only rarely contains limestone beds, although calcareous material often fills joints and fractures in the weathered zone. In most of the boreholes, the weathered to fresh rock transition occurs over a relatively short interval, usually less than 10 feet, and in many cases less than 5 feet. South of the burial grounds, where limestone is the predominant rock type, it is more difficult to determine a distinct weathered/unweathered interface. In Borehole GW-53, along Bear Creek, hard limestone was encountered beneath a shallow alluvial cover. Although this limestone appeared fresh, weathered sandstone and shale interbeds were found in core recovered from greater depths in this same hole. In other borings along Bear Creek, hard limestone was also found immediately beneath the

alluvium. These data suggest that limestones in the Maynardville Limestone Member of the Conasauga Group may be harder (possibly dolomitic) and less susceptible to weathering than limestones in the Nolichucky Shale and Maryville Limestone Members, which underlie the burial grounds.

The weathered rock has partings along bedding planes and joints normal to the bedding planes, resulting in a blocky fracture pattern. A small cavity was noted in the weathered shale and sandstone in Borehole GW-46 during drilling. Although permeability testing in the completed well did not show a high permeability, testing in the adjacent angle borehole (GW-19) showed a high permeability in weathered rock, at the same depth as the cavity in GW-46.

5.3 Unweathered Rock

Beneath the weathered rock, the bedrock comprises a sequence of interbedded shale, limestone, sandstone and siltstone. The shale is olive green to dark gray in color and has minor amounts of brown oxidation along thin fractures and partings. The limestone is light to medium gray in color; evidence of slight weathering was found only along open fractures. The sandstone and siltstone are variable in color, but are most commonly gray to brown. The rocks are thinly interbedded to laminated. Core from Borehole GW-53 suggests beds may be thicker along Bear Creek, where rocks of the Maynardville Limestone Member (of the Conasauga Group) are present.

The limestone interbeds are hard to very hard, very fine-grained to sandy, with crystalline to oolitic structure. The shale ranges from weak to strong, and is fissile and laminated. The sandstone and siltstone are moderately hard to hard and fracture in a blocky pattern. Some of the sandstone and limestone is glauconitic.

The rocks dip steeply, with 45 to 70 degrees being the typical range of the dip. Drilling logs show an apparent trend of steeper dips in the northern portion of the site, and less steep dips near Bear Creek. Folding and soft-sediment deformation structures result in locally divergent attitudes (dip). Fractures in the fresh rock are predominantly bedding plane fractures (partings along bedding). There are also fractures normal to bedding, but these are less abundant and are commonly calcite-filled.

Open joints and cavities were found in core from a few boreholes at the burial grounds. Open joints showed oxidation colors (brown to red) along the sides, and carbonate crystals on the joint walls. In angle Borehole GW-19, a cavity was encountered at a vertical depth of about 41 feet. In Borehole GW-53, small solution cavities were noted in the limestone core that was recovered.

Zones of crushed and brecciated shale were also found in several core holes. The shear zones were generally less than two feet thick, and they consisted of small angular shale fragments within a plastic gray matrix.

6.0 GROUND WATER

The studies have shown that water is present in the pore spaces of the unconsolidated materials. However, although alluvium along stream channels is saturated, ground water is mainly contained in joints and fractures of the weathered and unweathered rock. Weathered sandstones that have been leached of their carbonate cement also contain intergranular pore water, but these beds are commonly only a few inches thick and are probably lenticular. Unweathered sandstone is commonly cemented and hard. As discussed in Section 5.0, both the weathered and unweathered rocks are thin-bedded and dip steeply to the southeast. Although shale beds may locally restrict the flow of water across bedding, the unconsolidated units, weathered zone, and unweathered zone appear to form a single hydrogeologic unit.

Water levels in the observation wells indicate that the water table is at a depth of about 10 to 20 feet below ground surface beneath Burial Ground A and at a depth of 20 to 50 feet beneath Burial Ground B. The water table is most commonly found within the weathered zone or within the alluvium in creek bottoms. Contours of the water table, based on March 1984 water levels, are shown on Figure 5. Water-level measurements taken in November 1983 and in early March 1984 indicate that a rise in level of one to three feet occurred in most wells during that period. However, water levels in wells on the south and west side of Burial Ground B had changes of eight to 10 feet during the same period. The water level in Well GW-22, which is in unweathered rock, is slightly above ground surface.

The configuration of the water table conforms to the topography and indicates a gradient toward Bear Creek and its tributaries. The water level in Well GW-34 appears anomalous when compared to the level in nearby wells, which are 15 to nearly 22 feet higher. The most likely hypothesis of this apparent anomaly is that the well intercepts a fracture or highly permeable zone and the zone acts as a drain discharging to one of the creeks west or east of the well. Another possible explanation is that the water level may be influenced by one of the burial trenches in this area.

Recharge to the ground-water system in the study area occurs mainly as infiltration of precipitation. Bear Creek is a possible second source of recharge. Water levels in observation wells near the creek and south of Burial Grounds A and B are lower than the creek channel, indicating a potential gradient to ground water from the creek (Figure 5). Alternative explanations are that Bear Creek is hydraulically separated from the ground water body, or that the predominant direction of ground-water movement is not normal to water level contours. Discharge of ground water from beneath the site is to the tributary creeks locally, and either to Bear Creek or by subsurface flow off site.

6.1 Permeability

The permeability tests of weathered and unweathered rock are summarized in Tables 2 and 3. These data were carefully examined to see whether any generalizations were possible, regarding the distribution of permeability. They indicate that the unweathered rock is generally

less permeable than the weathered rock. However, they also show that relatively high permeability zones (2900 ft/yr) are present in both the unweathered and weathered rock. Further, such zones are present at least to the depth of exploration; the data do not indicate lower permeability in relation to depth within the unweathered rock. High permeability zones in GW-19 are at depths where solution cavities were encountered in the unweathered rock during drilling, and where a cavity was noted in the weathered rock in the adjacent hole, GW-46. The poor core recovery encountered in zones of high permeability in GW-20 and GW-53, together with the unstable hole conditions present during drilling, suggests that the zones also contain many open fractures or small cavities.

The highest permeability values measured (greater than 100 ft/yr or 1×10^{-4} cm/sec) in both weathered and unweathered rock, were in boreholes or wells which are near or adjacent to the tributary creeks passing through the site (see Figure 2). This suggests that the rocks may be more fractured adjacent to these creeks than beneath the areas between creeks. Since the tributaries draining the south side of Pine Ridge have a common trend to the south, it is possible that they were eroded along a regional joint system, which could be characterized by locally increased permeabilities in the subsurface.

6.2 Ground-water Flow

An understanding of the direction and rate of ground-water flow is important to the design and implementation of remedial measures because ground water is one of the principal means by which contaminants can be

transported from the waste disposal area. In a fracture flow system, such as is present at the site, the orientation, spacing, and open width of the fractures determine the anisotropy, and variations in these characteristics can control flow direction and rock permeability.

The significance of anisotropy in evaluating the ground-water flow regime is that in highly anisotropic systems, the direction of the flow may not be parallel to the direction of the hydraulic gradient (perpendicular to water level contours). It can be seen in Figure 5 that the hydraulic gradient is generally toward Bear Creek and its tributaries. If, however, the preferred flow path is along strike, the direction of ground-water flow in the weathered rock is probably not everywhere perpendicular to the contours shown in Figure 5.

The presence of anisotropy and the direction of maximum permeability is indicated from study of samples recovered during the drilling program at the burial grounds. The cored rocks indicate that the principal fracture set and, thus the most likely direction of maximum permeability, in both the weathered and unweathered zones, consists of partings along bedding planes. Several other joint sets were noted, especially in the weathered zone, but they are not as prominent as bedding plane partings. The degree of fracturing across bedding, which varies with lithology, is the greatest in siltstone and cemented sandstone, and the least in the limestone and shale. These fracture systems are believed to be consistent within the Conasauga Group throughout Bear Creek Valley, so that studies of anisotropy elsewhere in the valley provide a measure for the study area.

Two studies (Webster, 1976; Law Engineering, 1983) demonstrated that the Conasauga Group in Bear Creek Valley is anisotropic with respect to permeability, with the most permeable direction being parallel to bedding, and the least permeable being normal to bedding. Both studies dealt principally with the unweathered zone, and assumed that anisotropy was minimal in the weathered zone. Webster (1976) summarized the results of several studies where the migration rate of liquid waste from pits excavated in the Conasauga Group was monitored both parallel to and across strike. Migration rates reported were 5 to 100 times greater along strike than across strike. A ratio of at least 1 to 10 between permeability normal to and parallel to bedding is considered to be reasonable for the site stratigraphy and structure.

A more recent study by Ketelle and Pin (1984) showed that contaminants migrating in the weathered zone from the S-3 ponds (about 1.5 miles to the northeast of Burial Grounds A and B) have moved mainly along strike. This is not parallel to the direction of maximum potential gradient which would be south to Bear Creek, as suggested by the potentiometric surface contours presented by Law (1983). It can be seen that the direction of migration has not been normal to potentiometric contours, but at an acute angle to it. These data support the concept that the weathered zone is also anisotropic and suggest that a ratio of 1 to 10 is reasonable.

Direct measurement of ground-water flow direction and velocity was attempted in several of the wells constructed during this study with a down-hole flowmeter. However, because of difficulties encountered in placing the instrument within the well screen (see Section 3.0) and

calibration problems, the measurements are considered only qualitatively; the velocity measurements are not considered accurate. These data indicate that ground-water flow beneath the tributary creeks is southeasterly in both the unweathered and weathered rock. Near the water table, flow in the weathered rock is influenced by surface water courses and topographically lower areas, but may still tend to flow along strike toward these discharge points. In the alluvial materials, the flow appears to be generally perpendicular to contours. Calibration and operational problems are believed to have been resolved. The preliminary results presented above will be confirmed during field studies to be performed in April 1984.

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- BURIAL GROUNDS A AND B

	<u>Open Interval</u>		<u>Top of Screen</u>	<u>Bottom of Screen</u>	<u>Depth to Water 11/7/83¹</u>	<u>Depth to Water March 1984¹</u>
	5.0	13.2	10.0	12.0	2.9	1.6
	1.0	7.9	1.7	6.7	1.0	0.3
	6.5	17.1	13.9	15.9	10.3	6.5
	35.6	61.5	54.2	59.2	13.3	9.4
	12.0	18.9	15.7	17.7	12.0	8.0
0)	-	-	-	-	-	-
	37.0	60.1	55.9	57.9	3.7	2.9
	5.5	14.2	11.0	13.0	1.4	1.0
	20.0	52.4	49.0	51.4	+0.6	+1.7
	31.0	53.5	50.4	52.4	12.4	7.6
	45.0	75.7	72.6	74.6	12.0	10.5
8)	-	-	-	-	-	-
	10.0	20.2	17.0	19.0	16.9	13.7
	18.5	30.5	27.3	29.3	14.7	14.3
	5.5	21.4	15.2	20.2	14.7	6.4
	6.0	19.5	15.3	17.3	7.9	4.4
	27.0	39.0	27.8	37.8	32.2	23.6
	47.0	67.0	63.7	65.7	32.1	25.3
0)	26.0 (30.0)	50.5 (58.3)	45.1 (52.1)	49.5 (57.1)	31.4	20.8
	30.0	37.9	34.7	36.7	28.0	19.2
	27.0	45.2	34.0	44.0	Dry	40.6
	37.5	60.3	49.1	59.1	27.2	24.3
	8.5	39.1	34.9	36.9	31.8	30.1
	42.0	68.7	64.5	66.5	43.5	42.3
	38.9	52.4	41.2	51.2	Dry	45.8
	6.0	21.1	17.9	19.9	11.4	9.5
	21.0	29.0	25.7	27.7	16.5	11.2
	6.0	39.8	36.6	38.6	20.9	14.7
	13.4	28.2	24.9	26.9	18.7	14.8
	1.8	15.2	3.0	13.0	13.1	4.7
	5.0	20.3	8.1	18.1	6.8	3.1
	12.5	25.5	18.5	23.5	6.2	3.6
	2.0	8.7	2.3	7.3	1.3	0.9
	6.3	20.2	13.6	18.6	12.6	5.7
	6.0	14.2	11.0	13.0	in Sump	in Sump
	2.0	10.8	4.6	9.6	3.4+	8.1
	4.0	19.5	13.3	18.3	12.8	8.4
	11.4	32.8	26.6	31.6	7.1	4.6

level is probably

TABLE 2
SUMMARY OF FIELD PERMEABILITY TESTING
IN WEATHERED ROCK AND ALLUVIUM - BURIAL GROUNDS A AND B

Boring or Well No.	Test Type	Vertical Depth Interval	Lithology	Field Permeability	
				ft/yr	cm/sec
GW-14	Bailer-Recovery	5.0-13.2	Weathered shale	44	4.3×10^{-5}
GW-15	Bailer-Recovery	1.0-7.9	1'-5.1' Sandy silt 5.1'-7.9' Weathered shale & sandstone	13	1.3×10^{-5}
GW-16	Bailer-Recovery	10.1-17.1	Weathered shale	119	1.4×10^{-4}
GW-17	Packer	22.95-34.65	Top 6' Weathered Rest (5.7') Un- weathered limestone and shale	34	3.3×10^{-5}
GW-18	Bailer-Recovery	12.3-18.9	Weathered shale and sandstone	19	1.9×10^{-5}
GW-19	Packer	12.69-22.73	Weathered shale and sandstone	960	9.3×10^{-4}
GW-21	Bailer-Recovery	5.5-14.2	Weathered shale	22	2.1×10^{-5}
GW-25	Packer	15.4-25.6	Weathered shale and siltstone	520	5.0×10^{-4}
GW-25	Packer	7.4-17.6	Weathered shale and siltstone	760	7.3×10^{-4}
GW-27	Bailer-Recovery	18.5-30.5	Weathered shale and sandstone and limestone	51	4.9×10^{-5}
GW-28	Bailer-Recovery	15.2-21.4	Weathered shale and siltstone	80	7.7×10^{-5}
GW-29	Bailer-Recovery	7.9-19.5	Weathered shale	11	1.1×10^{-5}
GW-30	Bailer-Recovery	32.4-40.0	Weathered shale and limestone	14	1.4×10^{-5}
GW-31	Packer	22.2-33.9	Weathered shale and sandstone	44	4.3×10^{-5}
GW-31	Packer	32.7-44.4	Top 5.8' Weathered shale and sandstone Rest (5.9') is fresh shale and limestone	76	7.3×10^{-5}

TABLE 2 (Cont'd)
SUMMARY OF FIELD PERMEABILITY TESTING
IN WEATHERED ROCK AND ALLUVIUM - BURIAL GROUNDS A AND B

Boring or Well No.	Test Type	Vertical Depth Interval	Lithology	Field Permeability	
				ft/yr	cm/sec
GW-32	Packer	9.1-19.2	Weathered shale and sandstone	58	5.6×10^{-5}
GW-32	Packer	18.2-28.3	Weathered shale and sandstone	60	5.8×10^{-5}
GW-36	Bailer-Recovery	32.2-39.1	Weathered shale	40	3.9×10^{-5}
GW-37	Packer	24.7-36.3	Weathered shale with some sand- stone beds	32	3.1×10^{-5}
GW-46	Bailer-Recovery	6.7-20.3	Top 1' Organic clay; Res ⁺ (13.6') weathered shale and sandstone	89	8.6×10^{-5}
GW-47	Bailer-Recovery	12.5-25.5	Weathered shale with sandstone and siltstone beds	53	5.1×10^{-5}
GW-49	Bailer-Recovery	12.7-20.2	Hard limestone	220	2.1×10^{-4}
GW-52	Bailer-Recovery	12.6-19.5	Dense pebbly clay silt	23	2.2×10^{-5}
GW-53	Packer	5.4-17.1	Weathered sand- stone, siltstone, limestone, and shale	2900	2.8×10^{-3}
GW-53	Packer	13.8-25.5	Limestone with weathered sand- stone and shale	2300	2.2×10^{-3}
GW-53	Packer	25.8-26.5	Limestone with weathered sand- stone and shale	300	2.9×10^{-4}

Legend

Geometric Mean = 85 ft/yr (8.2×10^{-5} cm/sec)
Median Value = 55 ft/yr (5.3×10^{-5} cm/sec)

Minimum = 11 ft/yr (1.1×10^{-5} cm/sec)
Maximum = 2900 ft/yr (2.8×10^{-3} cm/sec)

TABLE 3
SUMMARY OF FIELD PERMEABILITY TESTING
IN UNWEATHERED ROCK - BURIAL GROUNDS A AND B

Boring or Well No.	Test Type	Test Interval (Vertical Depth)	Lithology	Field Permeability	
				ft/yr	cm/sec
GW-17	Packer	22.95-34.65	Top 6' weathered shale; Lower 5.7' unweathered limestone and shale	34	3.3×10^{-5}
GW-17	Packer	26.90-38.60	Top 2.1' weathered shale; Lower 9.6' is interbedded limestone and shale	19	1.8×10^{-5}
GW-17	Packer	37.40-49.10	Interbedded limestone and shale	6	5.6×10^{-6}
GW-17	Packer	47.90-59.60	Interbedded limestone and shale	8	8.1×10^{-6}
GW-19	Packer	24.08-34.12	Top 1' weathered Lower 9' is interbedded shale and limestone	1	1.0×10^{-5}
GW-19	Packer	33.17-43.21*	Shale and limestone	1200	1.2×10^{-3}
GW-19	Packer	43.47-53.87	Shale and limestone	1	1.0×10^{-6}
GW-20	Packer	36.75-43.85	Interbedded shale, limestone and sandstone	2900	2.8×10^{-3}
GW-20	Packer	39.90-65.00	Interbedded shale, limestone and sandstone	890	8.6×10^{-4}
GW-20	Packer	54.70-65.00	Interbedded shale, limestone and sandstone	3	2.9×10^{-6}
GW-22	Packer	15.80-27.60	Limestone and shale	120	1.2×10^{-4}
GW-22	Packer	26.30-38.10	Shale and limestone	40	3.9×10^{-5}

TABLE 3 (Cont'd)
SUMMARY OF FIELD PERMEABILITY TESTING
IN UNWEATHERED ROCK - BURIAL GROUNDS A AND B

Boring or Well No.	Test Type	Test Interval (Vertical Depth)	Lithology	Field Permeability	
				ft/yr	cm/sec
GW-22	Packer	36.20-48.00	Limestone with some shale	35	3.4×10^{-4}
GW-23	Packer	33.0-43.7	Shale and lime- stone	29	2.8×10^{-5}
GW-23	Packer	41.2-52.9	Shale and lime- stone	11	1.0×10^{-5}
GW-24	Packer	33.6-45.3	Shale and lime- stone	80	7.7×10^{-5}
GW-24	Packer	41.8-53.5	Shale and lime- stone	1	1.0×10^{-6}
GW-24	Packer	52.3-64.0	Shale and lime- stone	1	1.0×10^{-6}
GW-24	Packer	61.5-73.2	Limestone	11	1.0×10^{-5}
GW-25	Packer	34.0-44.1	Interbedded shale, limestone and sandstone	11	1.0×10^{-5}
GW-25	Packer	43.3-53.4	Interbedded shale, limestone and sandstone	120	1.2×10^{-4}
GW-31	Packer	32.7-44.4	Top 5.8' weathered shale and sandstone Lower 5.9' is fresh shale and lime- stone	76	7.3×10^{-5}
GW-31	Packer	43.2-54.9	Limestone with some shale	1	1.0×10^{-6}
GW-31	Packer	53.7-65.4	Interbedded lime- stone and shale	4	3.9×10^{-6}
GW-32	Packer	27.3-37.4	Top 1.3' weathered shale and sandstone Lower 8.8' fresh shale and limestone	8	7.7×10^{-6}
GW-32	Packer	36.4-46.5	Limestone and shale	18	1.7×10^{-5}

TABLE 3 (Cont'd)
SUMMARY OF FIELD PERMEABILITY TESTING
IN UNWEATHERED ROCK - BURIAL GROUNDS A AND B

Boring or Well No.	Test Type	Test Interval (Vertical Depth)	Lithology	Field Permeability	
				ft/yr	cm/sec
GW-32	Packer	44.9-54.1	Shale and limestone	0.6	6.2×10^{-7}
GW-33	Bailer-Recovery	30.0-38.0	Interbedded shale and sandstone	11	1.0×10^{-5}
GW-35	Packer	27.0-38.8	Shale with sandy interbeds	24	2.3×10^{-5}
GW-35	Packer	34.9-46.7	Interbedded shale and sandstone	1	1×10^{-6}
GW-35	Packer	45.7-57.5	Interbedded shale and sandstone	1	1×10^{-6}
GW-37	Packer	35.2-46.8	Top 3.8' is weathered shale Lower 7.8' is shale, sandstone and limestone	9	8.7×10^{-6}
GW-37	Packer	45.7-57.3	Interbedded shale, sandstone and lime- stone	190	1.8×10^{-4}
GW-37	Packer	55.2-66.8	Interbedded shale, sandstone and lime- stone	200	1.9×10^{-4}
GW-40	Bailer-Recovery	21.0-29.0	Interbedded shale and sandstone	7	6.6×10^{-6}

* Includes cavity zone noted by driller at 41' (vertical).

Geometric Mean = 1.3 ft/yr (1.3×10^{-6} cm/sec)

Median Value = 11 ft/yr (1.0×10^{-5} cm/sec)

Minimum = 0.6 ft/yr (6.2×10^{-7} cm/sec)

Maximum = 2900 ft/yr (2.8×10^{-3} cm/sec)

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SCALE 1" = 2000		DESIGNED T. W. Crosby	DRAWN	CHIEF ENGR	
ORIGIN		REGIONAL GEOLOGY		JOB No.	16218
				DRAWING No.	
				REV.	
				FIGURE 1	

-A- SIZE

EXPLANATION

- GW-25 Hole drilled during the characteristic study; arrow indicates 60° angle hole bearing.
- BG-10 Observation well drilled during ground investigations by others. Additional designations noted, as appropriate.
- WP-6 Well Permeameter Test Site
- Geologic Section
- Approximate location of Burial Ground Area.

NOTES

1. Logs for holes drilled during this study are in Appendix to report.
2. Geologic Sections are shown on Figures 3 and 4.
3. Wells and borholes are located by pit coordinates, as reported by surveys except BG-4, BG-5, BG-10, BG-19 and BG-20 which are approximate locations.

0 100 200 300 400 500
SCALE IN FEET
CONTOUR INTERVAL 5 FEET

Base Map from Union Carbide Corporation Nuclear Division.

BECHTEL NATIONAL, INC.
ONE BECHTEL, TORRANCE

**BURIAL GROUNDS A AND B
ENVIRONMENTAL FIELD STUDIES
BEAR CREEK WASTE DISPOSAL AREA**

DRILL HOLE LOCATIONS

PROJECT AND NO.
18218

FIGURE 2

OUND A-NORTHERN UNIT

EXPLANATION

- Alluvium, typically silt or clay; locally includes fill.
- Weathered shale with some siltstone and sandstone interbeds. Locally includes fill and colluvium.
- Unweathered shale, with interbedded limestone, sandstone and siltstone.
- Approximate geologic contact, queried where inferred.
- Boring or monitoring well with open interval and March 1984 water level.
- Approximate location of ground water-table in the section, March 1984. Interpolation of water levels was required on projected wells, especially where well elevations were above or below those of the section.

NOTES

1. Location of sections is shown on Figure 2.
2. The lithology shown is diagrammatic based on drill logs. See text for description of units.
3. Drill logs for GW series holes are in the appendix to the report.
4. Data on BG series holes are based on information in "Subsurface Investigation for Y-12 Waste Burial Area" by Geotek Engineering Company, October 31, 1979, and "Results of Ground-Water Monitoring Studies" by Law Engineering Testing Company, September 18, 1983.

HORIZONTAL SCALE IN FEET
VERTICAL EXAGGERATION 2x

BECHTEL NATIONAL, INC.
OAK RIDGE, TENNESSEE

BURIAL GROUNDS A AND B
ENVIRONMENTAL FIELD STUDIES
BEAR CREEK WASTE DISPOSAL AREA

**GEOLOGIC SECTIONS
C-C' AND D-D'**

BECHTEL JOB NO.

16218

DRAWING NO.

REV. DATE

FIGURE 4

0 100 200 300 400

HORIZONTAL SCALE IN FEET
VERTICAL EXAGGERATION 2x

EXPLANATION

- Alluvium, typically silt or clay, pebbly near Bear Creek. Includes some fill.
- Weathered shale with some siltstone and sandstone interbeds. Locally includes fill and colluvium. Near Bear Creek, also includes limestone.
- Unweathered shale, with interbedded limestone, sandstone and siltstone.
- Limestone and dolomite, (south of Bear Creek; Note 5).
- Approximate geologic contact, queried where inferred.
- Boring or monitoring well with open interval and March, 1984 water level.
- Approximate location of March, 1984 ground-water table in the section. Interpolation of water levels was required on projected wells, especially where well elevations were above or below those of the section.

BECHTEL NATIONAL, INC.
OAK RIDGE, TENNESSEE

BURIAL GROUNDS A AND B
ENVIRONMENTAL FIELD STUDIES
BEAR CREEK WASTE DISPOSAL AREA

GEOLOGIC SECTIONS A-A' AND B-B'

BECHTEL JOB NO.

16218

DRAWING NO.

FIGURE 3

REV. DATE

EXPLANATION

- GW-15
927.7 ● Observation well installed during this characterization study, with water elevation.
- BG-1
923.4 ○ Observation well installed during previous investigations by others, with water elevation. Additional designations noted, as appropriate.
- Water table contour, approximate. Contour interval, 10 feet.
- Approximate location of Burial Ground Area.

NOTES:

- All water levels were measured March 1-6, 1984.
- GW-32 is an angle hole (arrow denotes bearing) drilled at 60 degrees from horizontal and completed as an observation well.
- Locations of wells BG-4, BG-5, BG-18, BG-19 and BG-20 are approximate.
- All elevations are relative to mean sea level.
- Wells with no water elevation had a water level below the screen.

SCALE IN FEET
CONTOUR INTERVAL 5 FEET

Base Map from Union Carbide Corporation Nuclear Division.

BECHTEL NATIONAL, INC.
ONE BECHTEL, TOWNSEND

BURIAL GROUNDS A AND B
ENVIRONMENTAL FIELD STUDIES
BEAR CREEK WASTE DISPOSAL AREA
**WATER-TABLE CONTOURS
MARCH 1984**

16218

FIGURE 5

EXPLANATION

- GW-15
982.7 ● Observation well installed during this characterization study, with water elevation.
- BG-1
993.9 ○ Observation well installed during previous investigations by others, with water elevation. Additional designations noted, as appropriate.
- Water table contour, approximate. Contour interval, 10 feet.
- Approximate location of Burial Ground Area.

NOTES:

- All water levels were measured March 1-6, 1984.
- GW-32 is an angle hole (arrow denotes bearing) drilled at 60 degrees from horizontal and completed as an observation well.
- Locations of wells BG-4, BG-5, BG-18, BG-19 and BG-20 are approximate.
- All elevations are relative to mean sea level.
- Wells with no water elevation had a water level below the screen.

0 100 200 300 400 500
SCALE IN FEET
CONTOUR INTERVAL 5 FEET

Base Map from Union Carbide Corporation Nuclear Division.

BECHTEL NATIONAL, INC.
One Market, Fremont, CA 94555

BURIAL GROUNDS A AND B
ENVIRONMENTAL FIELD STUDIES
BEAR CREEK WASTE DISPOSAL AREA
WATER-TABLE CONTOURS
MARCH 1984

16218

FIGURE 5

NOTES

1. Location of sections is shown on Figure 2.
2. The lithology shown is diagrammatic based on drill logs. See text for description of units.
3. Drill logs for GW series holes are in the appendix to the report.
4. Data on BG series holes are based on information in "Subsurface Investigation for Y-12 Waste Burial Area" by Geotek Engineering Company, October 31, 1979, and "Results of Ground-Water Monitoring Studies" by Law Engineering Testing Company, September 18, 1983.
5. Geology south of Bear Creek is from "Geologic Map of The Oak Ridge Area" by W. M. McMaster, 1963. Scale 1:31,680.
6. In Section B-B', drill holes have been projected along the regional strike direction, approximately N56° E.

HORIZONTAL SCALE IN FEET
VERTICAL EXAGGERATION 2x

EXPLANATION

- Alluvium, typically silt or clay, pebbly near Bear Creek. Includes some fill.
- Weathered shale with some siltstone and sandstone interbeds. Locally includes fill and colluvium. Near Bear Creek, also includes limestone.
- Unweathered shale, with interbedded limestone, sandstone and siltstone.
- Limestone and dolomite, (south of Bear Creek; Note 5).
- Approximate geologic contact, queried where inferred.
- Boring or monitoring well with open interval and March, 1984 water level.
- Approximate location of March, 1984 ground-water table in the section. Interpolation of water levels was required on projected wells, especially where well elevations were above or below those of the section.

BECHTEL NATIONAL, INC.
OAK RIDGE, TENNESSEE

**BURIAL GROUNDS A AND B
ENVIRONMENTAL FIELD STUDIES
BEAR CREEK WASTE DISPOSAL AREA**

**GEOLOGIC SECTIONS
A-A' AND B-B'**

BECHTEL JOB NO.

16218

DRAWING NO.

FIGURE 3

REV.

DATE

D A-NORTHERN UNIT

EXPLANATION

- Alluvium, typically silt or clay; locally includes fill.
- Weathered shale with some siltstone and sandstone interbeds. Locally includes fill and colluvium.
- Unweathered shale, with interbedded limestone, sandstone and siltstone.
- Approximate geologic contact, queried where inferred.
- Boring or monitoring well with open interval and March 1984 water level.
- Approximate location of ground water-table in the section, March 1984. Interpolation of water levels was required on projected wells, especially where well elevations were above or below those of the section.

NOTES

1. Location of sections is shown on Figure 2.
2. The lithology shown is diagrammatic based on drill logs. See text for description of units.
3. Drill logs for GW series holes are in the appendix to the report.
4. Data on BG series holes are based on information in "Subsurface Investigation for Y-12 Waste Burial Area" by Geotek Engineering Company, October 31, 1979, and "Results of Ground-Water Monitoring Studies" by Law Engineering Testing Company, September 18, 1983.

HORIZONTAL SCALE IN FEET
VERTICAL EXAGGERATION 2x

BECHTEL NATIONAL, INC.
OAK RIDGE, TENNESSEE

BURIAL GROUNDS A AND B
ENVIRONMENTAL FIELD STUDIES
BEAR CREEK WASTE DISPOSAL AREA

**GEOLOGIC SECTIONS
C-C' AND D-D'**

BECHTEL JOB NO.

16218

DRAWING NO.

FIGURE 4

REV.

DATE

EXPLANATION

- GW-25 Hole drilled during this characteristic study; arrow indicates 60° angle hole bearing.
- BG-10 Observation well drilled during prior investigations by others. Additional designations noted, as appropriate.
- WP-6 Well Permeability Test Site
- Geologic Section
- Approximate location of Burial Ground Area.

NOTES

- Logs for holes drilled during this study are in Appendix to report.
- Geologic Sections are shown on Figures 3 and 4.
- Wells and boreholes are located by pit coordinates, as reported by survey except BG-4, BG-5, BG-16, BG-19 and BG-20 which are approximately located.

0 100 200 300 400 500
SCALE IN FEET
CONTOUR INTERVAL 5 FEET

Base Map from Union Carbide Corporation Nuclear Division.

BECHTEL NATIONAL, INC.
ONE BECHTEL WAY, BERKELEY, CALIF. 94705

BURIAL GROUNDS A AND B
ENVIRONMENTAL FIELD STUDIES
BEAR CREEK WASTE DISPOSAL AREA

DRILL HOLE LOCATIONS

PROJECT AND NO.	DATE	REV.	BY
16218			
FIGURE 2			

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"A" SIZE

APPENDIX

GEOLOGIC DRILL LOGS

GEOLOGIC DRILL LOG										PROJECT ENVIRONMENTAL FIELD STUDIES		JOB NO. 16218	SHEET NO. 1 OF 1	HOLE NO. GW-14	
SITE BURIAL GROUND A					COORDINATES N 29.848 E 44.308					ANGLE FROM HORIZ. 90°		BEARING			
BEGIN 29 SEPT. 83		COMPLETED 29 SEPT. 83		DRILLER R. GOSSAGE/GEOTEK		DRILL MAKE AND MODEL MOBILE 53		HOLE SIZE 6"		OVERBURDEN (FT.) +WEATH. ROCK 13.2'		ROCK (FT.)		TOTAL DEPTH 13.2'	
CORE RECOVERY (FT./%)			CORE BOXES 0		SAMPLES 7		EL. TOP OF CASING 933.9		GROUND EL. 931.5		DEPTH/EL. GROUND WATER 3'/928.5			DEPTH/EL. TOP OF ROCK	
SAMPLE HAMMER WEIGHT/FALL 300LB./30 IN.					CASING LEFT IN HOLE: DIA./LENGTH 2" STAINLESS STEEL OBSERVATION WELL					LOGGED BY: E.M. PANELLI					
SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLER RECOVERY CORE RECOVERY	SAMPLER BLOWS "N"	PERCENT CORE RECOVERY	WATER PRESSURE TESTS				ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.	
					LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES								
6 - inch hollow stem auger									927.5	5	[Hatched pattern]	[Hatched pattern]	0-4' <u>OVERBURDEN</u> : Mottled dark yellowish orange (10YR6/6) and moderate yellowish brown (10YR5/4) silt, dry friable, contains manganese and secondary calcareous concretions, material is very weathered oxidized and contains gravel to boulder sized clasts (F411).	@ 8.0' - Got gas coming from the hole. It irritated helpers eyes.*	
	1.5	1.5	20/100%												
	1.5	1.3	13/87%												
	1.5	1.5	20/100%												
	1.5	1.5	40/100%												
	1.5	1.5	42/100%												
	1.5	1.5	60/100%												
	1.5	1.5	104/100%												
3-inch split spoon								921.5	10	[Hatched pattern]	[Hatched pattern]	4-13.2' <u>WEATHERED SHALE</u> : Pale olive (10YR6/2) to greenish gray (5YR6/1) and medium gray (N5) to medium dark gray (N4) shale, friable, clayey, highly weathered and shows relict, steeply dipping, bedding. Bedding becomes more distinct with depth, oxide staining on bedding surfaces, core is dense where clayey, becomes less clayey and less weathered with depth. Material is slightly calcareous.			
6" auger								928.3					Bottom of Hole 13.2' Installed observation and and sampling well with open interval 5.0'-13.2'.	@ 13.2' - Auger refusal probably on limestone. * Gas was monitored by Bechtel Oak Ridge personnel. No toxic gas was detected but some hydrocarbon and carbon monoxide was. However majority of the gas had probably already escaped from the hole in the time lag from detection to monitoring	

SS = SPLIT SPOON; ST = SHELBY TUBE;
D = DENNISON; P = PITCHER; O = OTHER

SITE
BURIAL GROUND A

HOLE NO.
GW-14

GEOLOGIC DRILL LOG										PROJECT		JOB NO.	SHEET NO.	HOLE NO.
ENVIRONMENTAL FIELD STUDIES										16218	1 OF 1	GW-15		
SITE EASTERN SIDE OF BURIAL GROUND A SOUTH-ISOLATION AREA										COORDINATES		ANGLE FROM HORIZ.	BEARING	
N29,659 E44,331										90°				
BEGIN		COMPLETED		DRILLER		DRILL MAKE AND MODEL		HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH			
10/5/83		10/5/83		R. Goßsage/Géotek		Mobile 53		6"	+Weath. 7.9		7.9'			
CORE RECOVERY (FT./%)		CORE BOXES		SAMPLES		EL. TOP OF CASING		GROUND EL.		DEPTH/EL. GROUND WATER		DEPTH/EL. TOP OF ROCK		
				4		925.6		922.0		1.0'/921.0				
SAMPLE HAMMER WEIGHT/FALL				CASING LEFT IN HOLE: DIA./LENGTH				LOGGED BY:						
300 lb./30-inch				Observation Well 2-inch stainless steel				Thomas W. Crosby						
SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLER RECOVERY CORE RECOVERY	SAMPLER BLOW "N"	PERCENT CORE RECOVERY	WATER PRESSURE TESTS				ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
					LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES							
3-inch split spoon	1.5	1.5		7/100Z					920.0				0-20' ROCKY SILT: Moderate yellowish brown to greyish orange, plastic silt and clay soil with weathered shale fragments, moist, roots organic at base.	High toxic and explosive gas content, minor organic solvent odor, oily film on water.
	1.5	0.7		3/100Z					916.9			2.0- 5.1' SANDY SILT: Brownish Gray (5 YR 4/1) soft, plastic saturated, chemically contaminated fine sandy silt. Material not sampled but is retained in a auger.		
	NO SAMPLE													
	1.5	1.3		7/87Z									5.1-7.9' WEATHERED SHALE AND SANDSTONE: Light gray to brownish gray (5 YR 4/1), moderately weathered thin bedded shale and sandstone, oxidized fractures, no chemical odor, dip 50°, damp.	No oil or gas detected.
	1.5	1.4		102/93Z										
									914.1				Bottom of Hole 7.9 ft. Installed observation and sampling well, open from 1.0-7.9'.	

SS = SPLIT SPOON; ST = SHELBY TUBE;
D = DENNISON; P = PITCHER; O = OTHER

SITE
BURIAL GROUND A - ISOLATION AREA

HOLE NO.
GW-15

BECHTEL

GEOLOGIC DRILL LOG										PROJECT		JOB NO.		SHEET NO.		HOLE NO.	
										ENVIRONMENTAL FIELD STUDIES		16218		1 OF 1		GW-16	
SITE					COORDINATES					ANGLE FROM HORIZ.				BEARING			
BURIAL GROUND A-ISOLATION AREA					N 29,539 E 44,194					90°							
BEGIN		COMPLETED		DRILLER		DRILL MAKE AND MODEL		HOLE SIZE		OVERBURDEN (FT.)		ROCK (FT.)		TOTAL DEPTH			
10/3/83		10/3/83		R. Gossage/Geotek		Mobile 53		6"		17'				17'			
CORE RECOVERY (FT./%)				CORE BOXES		SAMPLES		EL. TOP OF CASING		GROUND EL.		DEPTH/EL. GROUND WATER		DEPTH/EL. TOP OF ROCK			
						11		928.2		926.5		10.3/916.2					
SAMPLE HAMMER WEIGHT/FALL					CASING LEFT IN HOLE: DIA./LENGTH					LOGGED BY:							
300 lb./30-inch					2-inch Stainless Steel Observation Well					E.M. FANELLI							
SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLER RECOVERY CORE RECOVERY	SAMPLER BLOWS "N"	PERCENT CORE RECOVERY	WATER PRESSURE TESTS				ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.			
					LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES										
3-inch Split Spoon	1.5	1.1		18/73%					926.5				0-3.5' FILL: Mottled dark yellowish orange (10YR6/6) and moderate yellowish brown (10YR5/4) organic rich, dry, structureless, clayey silt. Overlying a greenish gray clay that has faint shale structure, material contains oxidized shale fragments. Material appears disturbed.	Clean out hole with 6-inch augers after sample. @ 6.5' - some gas in hole, toxic but non-combustible. 10.3' 11/7/83 Hit water at 13.5'. Sample and auger refusal at 17'. Bottom of hole 17.0' Installed observation and sampling well in new hole 5' south of GW-16. Off-set hole was drilled because of caving conditions in GW-16. Open interval 6.5'-17.1'.			
	1.5	1.5		20/100%					923.0				3.5-7.7' CLAY: Mottled dark yellowish-orange (10YR6/6) and moderate yellowish brown (10YR5/4), structureless organic-rich, silty clay. Material contains some manganese, secondary calcite concretions, and shows blocky fracture, represents residual soil.				
	1.5	1.4		11/93%					918.8				7.7-17' WEATHERED SHALE: Light greenish gray (5G8/1) to greenish gray (5G6/1) highly weathered shale. Material is clayey, shows relict bedding. Bedding planes are steeply dipping and iron oxide stained, dark yellowish orange (10YR6/6). Shale fragments are generally soft and friable, material becomes less clayey with depth, shale fragments become more common, harder.				
	1.5	1.5		13/100%					916.5				@9.5' shale fragments become moderately hard, are stained reddish brown (10R4/6) to light brown (5YR6/6) and are fractured.				
	1.5	1.5		25/100%									@13.5 color changes to dusky yellowish brown (10YR2/2) (possibly indicating water table). Shale is softer, friable and fractured although moderately hard fragments are common, bedding is more distinct.				
	1.5	1.5		21/100%									@15.2 pale olive (10YR6/2) clay seam, distinct bedding soft, semi-plastic.				
	1.5	1.5		41/100%													
	1.5	1.5		25/100%													
	1.5	1.5		51/100%													
	1.5	1.5		24/100%													
									909.5								

SS = SPLIT SPOON; ST = SHELBY TUBE;
D = DENNISON; P = PITCHER; O = OTHER

SITE

BURIAL GROUND A-ISOLATION AREA

HOLE NO.
GW-16

GEOLOGIC DRILL LOG

PROJECT

ENVIRONMENTAL FIELD STUDIES

JOB NO.

16218

SHEET NO.

2 OF 2

HOLE NO.

GW-17

SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLER RECOVERY CORE RECOVERY	SAMPLE BLOWS "N"	PERCENT CORE RECOVERY	WATER PRESSURE TESTS				ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
					LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES							
	3.7	3.7		100%									29 - 61.5' LESTONE AND SHALE: (Cont'd) Shale is brownish gray (5 YR 4/1) to olive black (5 YR 2/1), strongly parted. Prominent joint set at 30 to core axis. Also joint at 45°. Carbonate on some bedding surfaces. Above 32.5 feet, bedding and joint surfaces show brown staining. Core alternates between shale and limestone about every 1-4 feet (along core axis, not $\perp$ to bedding).	
NQ Core	5.3	4.5		85%	0.04 0.08 0.10 0.06 0.03	6 13.5 20 14.5 6	10 9 5 7 10		886.4	40				
Box 2				43.3										
	5.5	5.1		93%						45				
				48.8										
	3.2	2.9		91%	0.07 0.11 0.14 0.08 0.06	8 15 24 15 9	8 6 15 9 8		876.4	50				10/3/83 Rig broke down @ 6 PM. Hole is complete, but not packer tested.
	3.0	2.8		93%										
				55.0						55			55-60' shale contains limestone fragments.	10/6/83 Rig operational again - finished hole. Overreamed to 61.5' with 4" tricone.
Box 3	5.0	5.0		100%					866.4	60				
	4-inch tricone													
									864.9				Bottom of hole 61.5' Installed observation and sampling well with open interval 35-61.5.	

SS = SPLIT SPOON; ST = SHELBY TUBE;
D = DENNISON; P = PITCHER; O = OTHER

SITE

S. OF BURIAL GROUND A - SOUTHERN UNIT

HOLE NO.

GW-17

GEOLOGIC DRILL LOG										PROJECT		JOB NO.	SHEET NO.	HOLE NO.
ENVIRONMENTAL FIELD STUDIES										16218		1 OF 1	GW-18	
SITE					COORDINATES					ANGLE FROM HORIZ.		BEARING		
S. OF BURIAL GROUND A					N 29, 497 E 43,615					90°				
BEGUN	COMPLETED	DRILLER			DRILL MAKE AND MODEL			HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH			
10/5/83	10/5/83	R. Gossage/ Geotek			Mobile 53			6"	20.8'	0	20.8'			
CORE RECOVERY (FT./%)		CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER			DEPTH/EL. TOP OF ROCK					
			14	924.5	921.6	12'/909.6								
SAMPLE HAMMER WEIGHT/FALL				CASING LEFT IN HOLE: DIA./LENGTH				LOGGED BY:						
300 lb /30-inch				2" stainless steel observation well				B.L.TURNER						
SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLER RECOVERY CORE RECOVERY	SAMPLE BLOWS "N"	PERCENT CORE RECOVERY	WATER PRESSURE TESTS			ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.	
					LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES							
6-inch Auger	1.5	1.5		29/100%				911.6	5			0.0-20.75 WEATHERED SHALE AND SANDSTONE: Light brown (5YR5/6) shale and dark yellow orange (10YR6/6) to medium yellow brown (10YR5/4) sandstone. Shale weathered to stiff, orange mottled clay in some zones above ~11 feet. Shale is fissile with micaceous sheen on fresh bedding surfaces, partings stained with black and/or red-orange. Sandstone is fine-grained, weak; blocky fractures. Some clay coatings on partings in both lithologies. Bedding at 30° to vertical. Wet below ~11 feet.	Auger to 0.5 ft. through rock on road. Clean out hole with 6-inch auger after sampling	
	1.5	1.3		37/87%										
	1.5	1.5		33/100%										
	1.5	1.4		55/93%										
	1.5	0.8		70/53%										
	1.5	1.1		65/73%										
	1.5	1.0		36/67%										
	1.5	1.3		51/87%										
	1.5	1.1		42/73%										
	1.5	1.1		27/73%										
	1.5	0.7		41/47%										
	1.5	1.3		72/87%										
	1.5	0.9		27/60%										
	0.75	0.75		44/100%										
3-inch Split Spoon								901.6	20			Bottom of hole 20.8'. Installed 2-inch observation and sampling well, open 12 - 18.9'.		

SS = SPLIT SPOON; ST = SHELBY TUBE;
D = DENNISON; P = PITCHER; O = OTHER

SITE

S. OF BURIAL GROUND A

HOLE NO.

GW-18

HOLE NO.	GW-19
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H&CF 12-2

BECHTEL

GEOLOGIC DRILL LOG										PROJECT		JOB NO.		SHEET NO.		HOLE NO.	
										ENVIRONMENTAL FIELD STUDIES		16218		1 OF 2		GW-20	
SITE										COORDINATES				ANGLE FROM HORIZ. BEARING			
ADJACENT TO LARGE OIL POND #1 BURIAL GROUND A										N 29,736 E 43,332				90			
BEGIN		COMPLETED		DRILLER		DRILL MAKE AND MODEL		HOLE SIZE		OVERBURDEN (FT.) +Heath. Rock		ROCK (FT.)		TOTAL DEPTH			
10/1/83		10/4/83		Ronnie Ray/Geotek		Mobile 53		6"/4"		35.5		30.6'		66.1'			
CORE RECOVERY (FT./%)				CORE BOXES		SAMPLES		EL. TOP OF CASING		GROUND EL.		DEPTH/EL. GROUND WATER		DEPTH/EL. TOP OF ROCK			
21.4/69%				2		6		922.1		919.7		3.7/916.0		35.5'/884.2			
SAMPLE HAMMER WEIGHT/FALL				CASING LEFT IN HOLE: DIA./LENGTH				LOGGED BY:									
300lb/30-inch				2" Stainless Steel Observation Well				E. M. Fanelli									
SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLER RECOVERY CORE RECOVERY	SAMPLER BLOWS "H"	PERCENT CORE RECOVERY	WATER PRESSURE TESTS			ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.				
					LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES										
6-inch Auger	6-inch Auger											0-5.5' FILL: Mottled dark yellowish orange (10YR6/6) to medium yellow brown (10YR5/4), dry, silty clay, weathered, oxidized, contains some manganese and secondary calcite concretions, and a few shale fragments @3.5' color change to light olive gray (5YR7/4), noncalcareous silty clay semiplastic, oxidized pale reddish brown (10YR5/4) contains coarse silt and shale fragments.	@ 4.0' get burst of gas from hole.				
	1.5	1.1	11/73%														
	1.5	1.5	20/100%														
	1.5	1.1	7/ 73%														
	1.5	1.5	9/100%														
	1.5	1.5	33/100%														
3-inch split spoon	3-inch split spoon											5.5 - 7.0 CLAY: Mottled yellowish brown to yellowish orange (10 YR 5/4) oxidized. Silty clay. (Possibly residual soil).					
	1.5	1.5	33/100%														
	1.5	1.5	31/100%														
6-inch auger	6-inch auger											7.0 - 35.5 WEATHERED SHALE: Dusky yellowish brown (10 YR 2/12) shale with dark yellowish orange (10 YR 6/6) oxide staining shale is highly weathered, soft to moderately hard, steeply dipping, contains olive green seams of soft clay. Material has distinct relict bedding.	@ 9' water in hole.				
NQ Core	2.7	1.45	53%									Bedding surfaces are generally oxidized and stained; becomes less weathered, more competent, less clayey with depth.	@ 10' split spoon refusal.				
SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER										SITE				HOLE NO.			
BURIAL GROUND A-OIL POND #1										GW-20

GEOLOGIC DRILL LOG

PROJECT

ENVIRONMENTAL FIELD STUDIES

JOB NO.

16218

SHEET NO.

2 OF 2

HOLE NO.

GW-20

ENVIRONMENTAL FIELD NOTES													
SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS "N"	PERCENT CORE RECOVERY	WATER PRESSURE TESTS			ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
					LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES						
NQ Core				36.5				884.7				<p>35.5 - 65.0 <u>SHALE</u>: Medium light gray (N6) to dark gray (N3) shale interbedded with light gray (N7) limestone and scattered thin beds of calcareously cemented sandstone. Shale is thin bedded steeply dipping (45°-60°) soft to moderately hard, generally non-calcareous. Fractured where moderately hard, friable where soft. Contains chlorite and/or glauconite. Limestone is medium to fine grained, detrital, partially recrystallized. Oolitic in places, hard, fractured contains some glauconite. Has secondary-calcite filled fractures, generally perpendicular to bedding. Sandstone is medium to fine grained, carbonate-cemented, angular, quartzose, friable, and typically occurs in thin beds.</p>	After core drilling hole was reamed to 4" diameter to a depth of 66.1'. Caved back to 65'.
	3.6	2.6	72%	9.5 12.2 15.1 11.5 8.2	6 11 18 11 6	↓	879.7	40					
			40.1							test interval 39.9-65.0			
	3.2	2.2	69%										
			43.3							↑			
	3.1	.9	29%										
										45			

BECHTEL

GEOLOGIC DRILL LOG										PROJECT ENVIRONMENTAL FIELD STUDIES		JOB NO. 16218	SHEET NO. 1 OF 1	HOLE NO. GW-21
SITE BURIAL GROUND A - Near large oil pond					COORDINATES N 29,902 E 44,356					ANGLE FROM HORIZ. 90°		BEARING		
BEGUN 10/6/83		COMPLETED 10/6/83		DRILLER R. Gossage/Geotek		DRILL MAKE AND MODEL Mobile 53		HOLE SIZE 6 1/4"	OVERBURDEN (FT.) +Weath Rock 15'	ROCK (FT.)	TOTAL DEPTH 15'			
CORE RECOVERY (FT./%)			CORE BOXES		SAMPLES	EL. TOP OF CASING		GROUND EL.		DEPTH/EL. GROUND WATER		DEPTH/EL. TOP OF ROCK		
					6	924.0		920.7		1.43/919.27				
SAMPLE HAMMER WEIGHT/FALL 300lb./30-inch					CASING LEFT IN HOLE: DIA./LENGTH 2" stainless steel observation well					LOGGED BY: E.M.FANELLI				
SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS "N"	PERCENT CORE RECOVERY	WATER PRESSURE TESTS				ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
					LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES							
3" split spoon/6" auger	1.5	1.5	18/100Z						920.7				0-2.0' SILT: Brownish gray (5YR4/1) and dark yellowish orange (10YR6/6) clayey silt, dry, friable, organic-rich, contains manganese, and some secondary calcite concretions.	
	1.5	1.5	9/100Z						918.7					
	1.5	1.5	11/100Z											
	1.5	1.2	25/80Z											@ 6' water in hole.
	1.5	1.5	34/100Z											
	1.5	1.5	53/100Z											@ 8' auger refusal
4 1/4" tricone									910.7	10			2.0-15.0' WEATHERED SHALE: Light olive gray (5Y6/1) to light bluish gray (5B7/1), stained moderate yellowish-brown (10YR5/4) silty clay to clayey silt shows distinct relict bedding, contains soft to moderately hard shale fragments, shale is fractured where moderately hard, friable where soft, semi-plastic where soft and moist. Soft shale is lighter colored and clayey, dark gray (N3) to blackish gray (N2). Material becomes less clayey, less weathered and more competent with depth. Possibly in fresh rock @ 10'.	@ 9' advanced hole to 15' with 4 1/4" roller bit; cuttings dark gray, possibly represents fresh unweathered rock; observed oil in the hole.
									905.7	15			Bottom of hole 15.0' Installed observation and sampling with open interval 5.5-14.2'.	

SS = SPLIT SPOON; ST = SHELBY TUBE;
D = DENNISON; P = PITCHER; O = OTHER

SITE
BURIAL GROUND A- Near Large Oil Pond #1

HOLE NO.
GW-21

GEOLOGIC DRILL LOG										PROJECT		JOB NO.	SHEET NO.	HOLE NO.
ENVIRONMENTAL FIELD STUDIES										16218		1 OF 2	GW-22	
SITE					COORDINATES					ANGLE FROM HORIZ.		BEARING		
NORTH OF LARGE OIL POND BURIAL GROUNDS					N 30,005 E 43.323					90°				
BEGUN	COMPLETED	DRILLER			DRILL MAKE AND MODEL			HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH			
10/7/83	10/10/83	Ron Tatum/Geotek			Mobile 61			6"/4"	Weather. Rock 7.5'	44.9'	52.4'			
CORE RECOVERY (FT./%)		CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER			DEPTH/EL. TOP OF ROCK					
19.6'/48%		2	6	926.2	923.1	+6'/923.7			7.5'/915.6					
SAMPLE HAMMER WEIGHT/FALL				CASING LEFT IN HOLE: DIA./LENGTH				LOGGED BY:						
300 lb/30-inch				2" Stainless Steel Observation Well				Thomas W. Crosby						
SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLER RECOVERY CORE RECOVERY	SAMPLE BLOWS "N"	PERCENT CORE RECOVERY	WATER PRESSURE TESTS			ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.	
					LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES							
3-inch split spoon	1.5	1.5		9/100%				920.6				0 - 2.5' <u>SILTY SAND</u> : Dusky yellow (5 YR 6/4), moist silty sand with shale fragments, roots, non-plastic, crumbles.	Blocked off and ground core.	
	1.5	0.9		8/60%							2.5 - 6.0' <u>ORGANIC CLAY</u> : Grayish brown to medium light grey (N6) moderately stiff, plastic organic clay, abundant plant debris and humus in upper portion.			
	1.5	-0-		4/-0-										
	1.5	0.9		5/60%				917.1						
	1.5	1.3		32/87%				915.6			6.0 - 7.5' <u>WEATHERED SHALE</u> : Moderate yellowish brown (10 YR 5/4), oxidized shale, parting along bedding and joints, oxidized to reddish brown, dips at ~45°. Fractures into blocks and plates. Moderately hard.			
	1.5	0.8		100+/53%										
Drilled in HW casing														
NQ Core	3.5	3.1		86%				913.1	10			7.5 - 15.5' <u>SHALE-SILTSTONE</u> : Brownish grey to greenish black (5 G 2/1), fresh-unweathered shale to siltstone with local fine sandy limestone interbeds. Moderately hard to hard 10-11' limestone interbed; with ovoid 'fossils' slight oxidation along tight calcite lined fracture.		
	4.5	3.4		76%				907.6	15			15.5 - 22.2' <u>LIMESTONE</u> : Light gray (N7) limestone interbedded with thin shale beds, limestone is hard to very hard, shale moderately hard; fractures primarily along bedding. Secondary fractures are perpendicular to bedding. Air slaking of shale.		
	4.0	0.5		12%	.57	7	10	903.1	20					
					.70	10	15							
					.57	7	5	900.9						
									25			22.2 - 31.4' <u>SHALE</u> : Brownish grey (5 YR 4/1) to greenish black (5 G 2/1), shale, bedding dips at 50° from core length, locally highly fractured to crushed.		
												23.7-30.5' Closely fractured to crushed shale breccia, angular fragments in clayey matrix.		
	11.0	4.8		43%					30					
					.24	8	7	893.1						
					.30	12.5	7	891.7						
				.37	16	9					31.4 - 45.0' <u>LIMESTONE</u> : Light grey (N7) limestone with thin shale interbeds and laminations, bedding dips at ~45°. Fractured primarily along bedding. Calcite healed orthogonal fractures abundant, on reorientation of the majority trend, N60E-vertical. Parting primarily along bedding.			
				.24	12.5	10								
				.20	8	8			35					

SS = SPLIT SPOON; ST = SHELBY TUBE;
D = DENNISON; P = PITCHER; O = OTHER

SITE
BURIAL GROUNDS NORTH OF LARGE OIL POND

HOLE NO.
GW-22

GEOLOGIC DRILL LOG										PROJECT		JOB NO.	SHEET NO.	HOLE NO.					
										ENVIRONMENTAL FIELD STUDIES		16218	2 OF 2	GH-22					
SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLER RECOVERY CORE RECOVERY	SAMPLER BLOWS "N"	PERCENT CORE RECOVERY	WATER PRESSURE TESTS			ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.						
					LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES												
NQ Core	8.0	3.6	45%	40.5			36.2	883.1	40
							38.1												
	3.5	1.1	31%	44.0	.25	10	10							878.1	45
					.30	15	10												
					.36	20	15												
					.30	15	5												
	6.0	3.1	52%	50.0	.20	10	6							873.1	50
	4" tricone																		
	45.0 - 52.4' SHALE: Greenish black (5 G 1/2), poorly developed bedding, partings along bedding, dips ~45°. Pyrite mineralization along bedding planes. Air slaking along 1/4" beds. Shale is hard, moderately fractured.													Over-reamed with 4-inch tricone to 52.4'.					
Bottom of hole 52.4' Installed observation and sampling well open from 20.0 - 52.4'.																			

H&CF 19-2

H&CF 19-1

BECHTEL

GEOLOGIC DRILL LOG										PROJECT		JOB NO.		SHEET NO.		HOLE NO.			
										ENVIRONMENTAL FIELD STUDIES		16218		1 OF 1		GW-26			
SITE										COORDINATES									
BURIAL GROUND A - WEST OF NORTHERN UNIT										N 30,389 E 43,756									
										ANGLE FROM HORIZ. BEARING									
										90°									
BEGIN		COMPLETED		DRILLER		DRILL MAKE AND MODEL		HOLE SIZE		OVERBURDEN (FT.)		ROCK (FT.)		TOTAL DEPTH					
10/17/83		10/17/83		Tom Huffaker, Jr./Geotek		Mobile 53		6"		+Weath. Rock 20.2'		-0-		20.2'					
CORE RECOVERY (FT./%)		CORE BOXES		SAMPLES		EL. TOP OF CASING		GROUND EL.		DEPTH/EL. GROUND WATER		DEPTH/EL. TOP OF ROCK							
—		—		7		964.1		961.5		12.2'/949.3		All 20.2' in weathered rock							
SAMPLE HAMMER WEIGHT/FALL				CASING LEFT IN HOLE: DIA./LENGTH				LOGGED BY:											
30 lb./30-inch				2-inch Stainless Steel Observation/Sampling Well				THOMAS W. CROSBY											
SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLER RECOVERY CORE RECOVERY	SAMPLER SLOWS "N"	PERCENT CORE RECOVERY	WATER PRESSURE TESTS			ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.						
					LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES												
3-inch split spoon and auger	6-inch Auger							960.5				0 - 1' LIMESTONE ROADFILL: Light gray crushed limestone	High levels of toxic gas measured from hole during augering. Filled hole with water and collected split spoon sample, to displace toxic gasses from drill hole.						
	1.5	1.5		18/100Z				958.4				1 - 3.1' SHALEY SOIL: Moderate olive brown (5 YR 4/4) loose, moist silty matrix with shale and sandy siltstone rock fragments, roots.							
	1.5	1.5		35/100Z							3.1 - 20.2' WEATHERED SHALE: Dark greenish orange (10 YR 6/6) to light olive grey. Highly to moderately weathered. Soft to moderately hard, thin bedded shale with fine sandy interbeds up to 1/4" thick. Bedding dips at 60°.								
	1.5	1.4		52/ 93Z							Slight oxidation, only along fractures and bedding planes.								
	1.5	1.4		74/ 93Z							Hardness, and less oxidation increases with depth.								
	1.5	1.2		62/ 80Z															
	1.5	1.3		64/ 86Z															
	1.5	1.3		98/ 86Z															
6-inch hollow stem auger																			
							941.3					Bottom of hole 20.2'. Installed a 2" stainless steel observation and sampling well. Open interval 10.0' to 20.2'.							

SS = SPLIT SPOON; ST = SHELBY TUBE;
D = DENNISON; P = PITCHER; O = OTHER

SITE
BURIAL GROUND A - WEST OF NORTHERN UNIT

HOLE NO.
GW-26

BECHTEL

GEOLOGIC DRILL LOG										PROJECT ENVIRONMENTAL FIELD STUDIES		JOB NO. 16218	SHEET NO. 1 OF 1	HOLE NO. GW-27
SITE BURIAL GROUND A WEST OF NORTHERN UNIT					COORDINATES N 30,454 E 43,741					ANGLE FROM HORIZ. 90°		BEARING -		
BEGUN 10/11/83	COMPLETED 10/12/83	DRILLER R. Tatum/Geotek			DRILL MAKE AND MODEL Mobile 61			HOLE SIZE 6"/4"	OVERBURDEN (FT.) weathered rock 30.5	ROCK (FT.) -	TOTAL DEPTH 30.5'			
CORE RECOVERY (FT./%) -		CORE BOXES -	SAMPLES 11	EL. TOP OF CASING 965.3	GROUND EL. 961.6	DEPTH/EL. GROUND WATER 15'/946.6			DEPTH/EL. TOP OF ROCK Hole did not reach fresh rock.					
SAMPLE HAMMER WEIGHT/FALL 300lb./30-inch			CASING LEFT IN HOLE: DIA./LENGTH 2-inch Stainless Steel Observation Well				LOGGED BY: B.L. TURNER							
SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS "N"	PERCENT CORE RECOVERY	WATER PRESSURE TESTS				ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
					LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES							
3-inch split spoon	1.5	1.0	6/67%						957.1	5			0.0-4.5' ROAD FILL: Gravelly sand and clay. Moderate yellowish brown (10YR5/4) soft and loose to medium dense. Gravel is only 20%. Broken shale and limestone pieces to 3". Roots to 3/8" diameter, moist.	
	1.5	0.8	16/53%											
	1.5	1.0	19/67%											
	1.5	1.0	18/67%										4.5-30.5' WEATHERED SHALE AND SANDSTONE: Light olive brown (5Y5/6) to light olive gray (5Y5/2), bedding at 25° - 30° to vertical. Shale is fissile; sandstone friable, with some pieces hard. Most partings and fractures stained reddish brown to black, moist.	
	1.5	1.0	39/67%										4.5-6.0' mostly siltstone beds, dusky yellow (5Y6/4), hard.	
	1.5	1.0	49/67%						951.6	10			9.0-10.5' very fine, thin sand beds.	
	1.5	1.1	57/73%										13.5-15' thin sandstone interbeds, olive gray (5Y3/2), loose	
	1.5	1.2	72/80%											
	1.5	1.2	96/80%							15				
	1.5	1.5	99/100%											
	1.4	1.0	112/71%											
	1.2	0.9	130/75%											
6-inch auger									941.6	20			20' becoming wet. 21-30.5' harder, may be some limestone beds. Grading fresher, grayer.	Auger 17.7 to 20.0' Set 20' of HW casing in the ground and drill with 4-inch roller bit.
4-inch tricone										25				Wash water gray
									931.1	30				
										35			Bottom of hole 30.5' Installed observation and sampling well with open interval 18.5-30.5'.	

 SS = SPLIT SPOON; ST = SHELBY TUBE;
 D = DENNISON; P = PITCHER; O = OTHER

SITE

BURIAL GROUND A - WEST OF NORTHERN UNIT

HOLE NO.

GW-27

BECHTEL

GEOLOGIC DRILL LOG										PROJECT		JOB NO.	SHEET NO.	WELL NO.
										ENVIRONMENTAL FIELD STUDIES		16218	1 OF 1	GW-28
SITE					COORDINATES					ANGLE FROM HORIZ.		BEARING		
BURIAL GROUND A - NORTH OF NORTHERN UNIT					N 30,536 E 43,899					90°		—		
BEGUN	COMPLETED	DRILLER			DRILL MAKE AND MODEL			MOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH			
10/14/83	10/14/83	Tom Huffaker, Jr./Geotek			Mobile 53			6"/4 1/2"	+Weath. Rock 21.4'	-0-	21.4'			
CORE RECOVERY (FT./%)		CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER			DEPTH/EL. TOP OF ROCK					
—		—	7	981.8	979.1	14.7'/964.4			All 21.4' in weathered rock.					
SAMPLE HAMMER WEIGHT/FALL				CASING LEFT IN HOLE: DIA./LENGTH				LOGGED BY:						
300 lb/30-inch				2-inch stainless steel observation well				Thomas W. Crosby						
SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLER RECOVERY CORE RECOVERY	SAMPLE BLOWS "N"	PERCENT CORE RECOVERY	WATER PRESSURE TESTS			ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.	
					LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES							
3" Split Spoon	1.5	1.5	26/100%					975.4				0 - 3.7' SHALE SOIL: Dark yellowish orange (10 YR 6/6), silty soil with shale rock fragments, weathered, loose, crumbles in hand, dry, no bedding structure, contains root hairs and charcoal.		
	1.5	1.5	18 100%											
	1.5	1.3	25/ 87%											
	1.5	1.5	69/100%											
	1.5	1.3	110/87%											
	1.5	1.2	111/80%											
	1.5	1.4	112/93%											
6" Auger								969.1	10					
									15					
4 1/2" Tricone								959.1	20			Slow rough drilling indication of possible limestone.		
								957.7				Bottom of hole 21.4' Installed observation and sampling well with open interval 5.5 - 21.4'		

SS = SPLIT SPOON; ST = SHELBY TUBE;
D = DENNISON; P = PITCHER; O = OTHER

SITE
BURIAL GROUND A - NORTH OF NORTHERN UNIT

WELL NO.
GW-28

BECHTEL

GEOLOGIC DRILL LOG										PROJECT		JOB NO.	SHEET NO.	HOLE NO.
ENVIRONMENTAL FIELD STUDIES										16218		1 OF 1	GW-29	
SITE					COORDINATES					ANGLE FROM HORIZ.		BEARING		
BURIAL GROUND A - EAST SIDE OF NORTHERN UNIT					N 30,431 E 44,501					90°		—		
BEGUN	COMPLETED	DRILLER			DRILL MAKE AND MODEL		HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH				
10/11/83	10/11/83	Ron Gossage /Geotek			Mobile 53		6"/4 1/2"	22.4'	—	22.4'				
CORE RECOVERY (FT./%)		CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER		DEPTH/EL. TOP OF ROCK						
—		—	7	968.1	964.7	7.88'/956.82		—						
SAMPLE HAMMER WEIGHT/FALL			CASING LEFT IN HOLE: DIA./LENGTH			LOGGED BY:								
300 lb./30-inch			2-inch Stainless Steel Observation Well			E. M. Fanelli								
SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLER RECOVERY CORE RECOVERY	SAMPLER BLOWS "N"	PERCENT CORE RECOVERY	WATER PRESSURE TESTS				ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
					LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES							
3-inch split spoon	1.5	1.5	15/100Z						961.7				0 - 3.0' SILT: Grayish orange (10 YR 7/4) very dry, friable, uncompacted, silt contains some roots, irregular iron oxide concretions.	Drilled with 3" diameter split spoons and 6" diameter auger. Split spoon refusal @ 10.5 feet. Auger refusal at 16.0 feet. 13.5' (10/13/83) Decided to drill deeper with roller bit to obtain an adequate saturated thickness. Oil in return water during rotary drilling.
	1.5	1.5	24/100Z											
	1.5	1.5	30/100Z											
	1.5	1.1	47/ 73Z											
	1.5	1.1	50/ 73Z											
	1.5	1.0	51/ 67Z											
	1.5	1.0	110/67Z											
6-inch hollow stem auger												3.0 - 22.4' WEATHERED SHALE: Light bluish grey (5 B 7/1) clay to moderate reddish brown (10 R 4/6) silt containing abundant moderately hard shale fragments. Fragments are stained dusty yellow (5 YR 6/4) to very dusky red (10 R 2/2). Material shows relict bedding. Bedding becomes more prominent and material less clayey with depth. Shale is friable, very silty, semi-plastic where clayey and moist. 17' - possibly into fresh rock (Cuttings appear unweathered).		
4 1/2-inch Tricone									944.7	20				
									942.3				Bottom of hole at 22.4 feet. Installed 2" observation and sampling well with open interval 6.0-21.1'.	

SS = SPLIT SPOON; ST = SHELLEY TUBE;
D = DENNISON; P = PITCHER; O = OTHER

SITE

BURIAL GROUND A - EAST SIDE OF NORTHERN UNIT

HOLE NO.

GW-29

SECTION

GEOLOGIC DRILL LOG										PROJECT ENVIRONMENTAL FIELD STUDIES										JOB NO. 16218					SHEET NO. 1 OF 1					HOLE NO. GW-30																			
SITE SOUTH OF BURIAL GROUND B										COORDINATES N 30.247 E 43.110										ANGLE FROM HORIZ. —										BEARING —																			
BEGUN 10/21/83					COMPLETED 10/21/83					DRILLER Ron Tatum/Geotek										DRILL MAKE AND MODEL Mobile 61										HOLE SIZE 6"					OVERBURDEN (FT.) +Weath. Rock ~ 38.5'					ROCK (FT.) ~ 1.5'					TOTAL DEPTH 40.0'				
CORE RECOVERY (FT./%) —										CORE BOXES —					SAMPLES —					EL. TOP OF CASING 973.6					GROUND EL. 970.2					DEPTH/EL. GROUND WATER 32.2'/938.0										DEPTH/EL. TOP OF ROCK ~ 38.5'/931.7									
SAMPLE HAMMER WEIGHT/FALL —										CASING LEFT IN HOLE: DIA./LENGTH 2-inch Stainless Steel Observation Well										LOGGED BY: B. L. Turner																													
SAMPLER TYPE AND DIAMETER		SAMPLER ADVANCE LENGTH CORE RUN		SAMPLER RECOVERY CORE RECOVERY		SAMPLER RECOVERY CORE RECOVERY		SAMPLE BLOWS "N"		PERCENT CORE RECOVERY		WATER PRESSURE TESTS				ELEVATION		DEPTH		GRAPHIC LOG		SAMPLE		DESCRIPTION AND CLASSIFICATION										NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.															
												LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES																																			
6-inch hollow stem auger																								<p>This hole was drilled for installation of an observation well in weathered rock. For description of geologic units see log for adjacent hole, GW-31.</p>																									
																								<p>Bottom of hole 40.0' Installed 2-inch observation and sampling well open from 27 - 39'</p>																									

SS = SPLIT SPOON; ST = SHELBY TUBE;
D = DENNISON; P = PITCHER; O = OTHER

SITE

SOUTH OF BURIAL GROUND B - ADJACENT TO GW-31.

HOLE NO.

GW-30

BECHTEL

GEOLOGIC DRILL LOG										PROJECT		JOB NO.		SHEET NO.		HOLE NO.	
										ENVIRONMENTAL FIELD STUDIES		16218		1 OF 2		GW-32	
SITE										COORDINATES				ANGLE FROM HORIZ. BEARING			
WEST EDGE OF BURIAL GROUND B-ANGLE HOLE										N 30,394 E 42,850				60° N30 W			
BEGIN		COMPLETED		DRILLER		DRILL MAKE AND MODEL		HOLE SIZE		OVERBURDEN (FT.)		ROCK (FT.)		TOTAL DEPTH			
10/4/83		10/8/83		R. M. Collins/Geotek		Sprague & Henwood 400		3"		33'		29.5'		62.5'			
CORE RECOVERY (FT./%)				CORE BOXES		SAMPLES		EL. TOP OF CASING		GROUND EL.		DEPTH/EL. GROUND WATER		DEPTH/EL. TOP OF ROCK (fresh)			
45.5/81%				4		—		1001.1		999.0		36.3'(31.4')/967.6		33'(28.6')/970.4			
SAMPLE HAMMER WEIGHT/FALL				CASING LEFT IN HOLE: DIA./LENGTH				LOGGED BY:									
				2-inch Stainless Steel Observation Well				B. L. Turner									
SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS "N"	PERCENT CORE RECOVERY	WATER PRESSURE TESTS				ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.			
					LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES										
4 1/2-inch tricone				6.0									0.0 - 33' WEATHERED SHALE AND FINE-GRAINED SANDSTONE: Predominantly dark yellowish brown (10 YR 4/2) with black and orange staining on fractures and partings. Plastic clay coatings on some bedding and fracture surfaces. Thin-bedded, with banded appearance at 50'-70' to core axis. Shale has micaceous sheen on fresher bedding surfaces. Jointed at 50' to core axis. Core pieces generally 1" thick, easily broken, weak.	Drill with tricone; set 6' of NW casing (5.8' in ground).			
NQ	2.8	1.5		54%										Outcrops adjacent to hole have strike of 55°-60°E, dip nearly vertical.			
				8.8										Return water brown.			
Core	3.2	1.4		44%					10.5	990.3	10						
				12.0													
Box	6.0	2.5		42%	0.37	4	10				15		18-22' some siltstone beds; joints nearly parallel to core axis.				
					0.76	7.5	6										
1					0.36	4	10										
				18.0													
	4.0	4.0		100%						981.7	20						
				22.0										Return water still brown.			
	5.4	3.7		69%	0.48	4	15				25						
					0.59	7	10										
					0.72	10	8										
					0.56	7	10										
					0.41	4	8										
				27.4													
29.2																	
	5.3	5.3		100%						973.0	30		31.7 - 32.7' Very soft zone, core shattered and ground up.				
NQ				32.7						970.4							
Core																	
Box	1.5	1.3		87%									33-62.4' INTERBEDDED SHALE AND LIMESTONE: Olive gray (5 YR 3/2) to medium light gray (5N5).				
2				34.2													

SS = SPLIT SPOON; ST = SHELBY TUBE;
O = OENISON; P = PITCHER; O = OTHER

SITE

WEST EDGE OF BURIAL GROUND B - ANGLE HOLE

HOLE NO.

GW-32

H&CF 19-1

		0.01	15	12
		0.07	25	6
		0.0	15	8
		0.001	8	10
	57.0			

BECHTEL

GEOLOGIC DRILL LOG										PROJECT		JOB NO.	SHEET NO.	HOLE NO.	
										ENVIRONMENTAL FIELD STUDIES		16218	1 OF 2	GW-33	
SITE					COORDINATES					ANGLE FROM HORIZ.		BEARING			
BURIAL GROUND B - NORTHWEST EDGE					N 30,540 E 42,946					90°					
BEGIN		COMPLETED		DRILLER		DRILL MAKE AND MODEL		HOLE SIZE		OVERBURDEN (FT.)		ROCK (FT.)		TOTAL DEPTH	
10/15/83		10/17/83		T. Huffaker, Jr./Geotek		Mobile 53		6"		31'		7'		38'	
CORE RECOVERY (FT./%)				CORE BOXES		SAMPLES		EL. TOP OF CASING		GROUND EL.		DEPTH/EL. GROUND WATER		DEPTH/EL. TOP OF ROCK	
				6		997.3		995.7		29'/966.7		31'/964.7			
SAMPLE HAMMER WEIGHT/FALL					CASING LEFT IN HOLE: DIA./LENGTH					LOGGED BY:					
300 lb/30-inch					2-inch Stainless Steel Observation Well					B. L. Turner					
SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLER RECOVERY CORE RECOVERY	SAMPLER BLOWS "N"	PERCENT CORE RECOVERY	WATER PRESSURE TESTS			ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.		
					LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES								
3-inch split spoon	1.5	1.5	12/100Z					994.7				0.0 - 1.0' <u>SILTY CLAY</u> : With small pieces of weathered shale. Moderate yellowish brown (10 YR 5/4) rootlets, moist.			
	1.4	1.4	20/ 93Z								1.0 - 31' <u>WEATHERED SHALE AND SANDSTONE</u> : Shale is light olive gray with black and orange staining on partings and fractures, clayey, micaceous, thin bedded, soft to hard, moist. Sandstone is very fine grained, dusky brown (5 YR 2/2) to white, glauconitic, loose to hard (harder with depth). Bedding 25° to 35° to vertical. Shale and sandstone about equal proportions with sandstone sections generally less than 1 ft. thick.				
	1.5	1.5	53/100Z												
	1.5	1.3	49/ 87Z												
	1.5	1.4	74/93Z												
	1.5	1.1	108/73Z												
6-inch Hollow Stem Auger								985.7	10				Looks slightly damp below 23 feet; could be water table.		
								975.7	20						
								965.7	30						
								964.7	35						
												31 - 38' <u>SHALE AND SANDSTONE</u> : Gray, moderately hard to hard, auger brings up pieces to 2-inch diameter.

29.0'
10/19/83

SS = SPLIT SPOON; ST = SHELBY TUBE;
D = DENNISON; P = PITCHER; O = OTHER

SITE
BURIAL GROUND B - NORTHWEST EDGE

HOLE NO.
GW-33

GEOLOGIC DRILL LOG										PROJECT ENVIRONMENTAL FIELD STUDIES		JOB NO. 16218	SHEET NO. 2 OF 2	HOLE NO. GW-33
SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLER RECOVERY CORE RECOVERY	SAMPLER BLOWS "N"	PERCENT CORE RECOVERY	WATER PRESSURE TESTS				ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
					LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES							
6" Hollow Stem Auger													31 - 38' <u>SHALE AND SANDSTONE:</u> (Cont'd)	Definitely wet @ 38 ft.; augers bringing up mud.
								957.1					Bottom of hole 38.0' (Auger refusal) Installed 2" observation and sampling well open from 30.0 to 37.9 feet.	

SS = SPLIT SPOON; ST = SHELBY TUBE;
D = DENNISON; P = PITCHER; O = OTHER

SITE
BURIAL GROUND B - NORTHWEST EDGE

HOLE NO.
GW-33

BECHTEL

GEOLOGIC DRILL LOG				PROJECT		JOB NO.	SHEET NO.	HOLE NO.					
				ENVIRONMENTAL FIELD STUDIES		16218	1 OF 2	GW-34					
SITE			COORDINATES			ANGLE FROM HORIZ.		BEARING					
BURIAL GROUND B-NORTHERN SIDE			N 30,601 E 43,131			90°							
BEGIN	COMPLETED	DRILLER	DRILL MAKE AND MODEL		HOLE SIZE	OVERBURDEN (FT.) +weathered rock	ROCK (FT.)	TOTAL DEPTH					
10/13/83	10/31/83	R. Gossage/Geotek	Mobile 53		6" / 4 1/2"	45.5'	-0-	45.5'					
CORE RECOVERY (FT.%)		CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER		DEPTH/EL. TOP OF ROCK					
			6	998.1	995.3	Dry on Nov 11, 1983		All 45.5' in weathered rock					
SAMPLE HAMMER WEIGHT/FALL		CASING LEFT IN HOLE: DIA./LENGTH			LOGGED BY:								
300lb / 30-inch		2-inch Stainless Steel Observation/Sampling Well			THOMAS W. CROSBY								
SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH (CORE RUN)	SAMPLER RECOVERY CORE RECOVERY	SAMPLER BLOWS "N"	PERCENT CORE RECOVERY	WATER PRESSURE TESTS			ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
					LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES						
6-inch Auger								993.9				0-1.4' ROAD FILL: Clayey soil with crushed limestone fill.	Augered to 1.8' with 6-inch hollow stem augers.
3-inch Split Spoon	1.5	1.1	21/73Z									1.4-45.5' WEATHERED SHALE: Moderate yellowish orange to grayish yellow green (SGY7/2), highly to slightly weathered. Thin-bedded shale, siltstone to slightly sandy siltstone. Blocky fracture pattern along bedding and normal to it. Dark brown oxidation along fractures. Steeply dipping ~70°. 7' moderately hard, slightly to moderately weathered siltstone and shale, thin bedded.	
	1.5	0.9	53/60Z										
	1.5	1.5	110/100Z										
	1.0	0.9	105/90Z										
6-inch Auger													
S.S.	0.5	0.2	100/40Z										
6-inch Hollow Stem Auger								985.3	10			Moist, thinly interbedded, moderately hard shale and siltstone. Moderate to slight weathering. Moderate brown to light olive gray (SY6/1).	
6-inch Hollow Stem Auger								975.3	20				
									25				
									30				
4 1/2-inch Tricone								965.3	30			Observation/sampling well installed in adjacent hole 7' to the northeast. Filter sand from 9.6'-34.0'. After several days, hole was dry; pulled well casing and screen, deepened to 45.5'. Bottom of first hole 35.0'	

SS = SPLIT SPOON; ST = SHELBY TUBE;
D = DENNISON; P = PITCHER; O = OTHER

SITE

BURIAL GROUND B-NORTHERN SIDE

HOLE NO.
GW-34

BECHTEL

GEOLOGIC DRILL LOG										PROJECT ENVIRONMENTAL FIELD STUDIES		JOB NO. 16218	SHEET NO. 2 OF 2	HOLE NO. GW-34	
SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS "N"	PERCENT CORE RECOVERY	WATER PRESSURE TESTS				ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.	
					LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES								
6-inch Hollow Stem Auger									955.3	40
									949.8				Bottom of hole 45.5' (Redrilled 7' from original hole). Installed observation and sampling well with open interval 27.0-45.2'.		

SS = SPLIT SPOON; ST = SHELBY TUBE;
D = DENNISON; P = PITCHER; O = OTHER

SITE

BURIAL GROUND B-NORTHERN SIDE

HOLE NO.

GW-34

BECHTEL

GEOLOGIC DRILL LOG				PROJECT		JOB NO.	SHEET NO.	HOLE NO.						
				ENVIRONMENTAL FIELD STUDIES		16218	1 OF 2	GW-35						
SITE			COORDINATES			ANGLE FROM HORIZ.		BEARING						
BURIAL GROUND E-NORTHERN AREA			N 30,719 E 43,178			90°								
REQ'D	COMPLETED	DRILLER	DRILL MAKE AND MODEL		HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH						
10/15/83	10/19/83	R. Cossage/Geotek	Mobile 53		6"/4"	+weathered rock 17'	43'	62.0'						
CORE RECOVERY (FT./%)		CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER		DEPTH/EL. TOP OF ROCK (fresh)						
21.8/58%		2	7	996.5	994.2	27.2'/967.0		17'/977.2						
SAMPLE HAMMER WEIGHT/FALL			CASING LEFT IN HOLE: DIA./LENGTH			LOGGED BY:								
300lb./30-inch			2-inch Stainless Steel Observation/Sampling Well			THOMAS W. CROSBY								
SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLER RECOVERY CORE RECOVERY	SAMPLER BLOWS "N"	PERCENT CORE RECOVERY	WATER PRESSURE TESTS				ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
					LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES							
3-inch Split Spoon	1.5	1.3	23/87%										0-~17' WEATHERED SHALE: Light greenish gray (5G8/1) on freshly broken faces, oxidized rock is dark yellowish orange (10YR6/6), highly to moderately weathered. Several thin sandy interbeds, non-calcareous. Bedding dip at 50-65°. Rock breaks into blocks or blades. Stiff to moderately hard. 5.5' Light green clay seam 0.1' thick plastic.	
	1.5	1.0	45/67%											
	1.5	1.3	100/87%											
	1.5	1.2	70/80%											
	1.5	1.0	53/67%											
	1.0	1.0	100/100%											
6-inch Auger	0.7	0.5	70/100%											
6-inch Hollow Stem Auger													17-60' FRESH SHALE: Olive gray (5Y4/1) where fresh, few fractures are oxidized to moderate reddish brown (10YR4/6). Thinly laminated shale and fine sandy interbeds. Slightly weathered to 26'. Interbeds are calcareous sandstone with dark green mineral grains. Bedding dips at 60-65°. Moderately hard. Fracture pattern dominated by N60°W-20°S on reorientation.	Core blocked off.
BOX 1	3.3	0.3	9%										27.2' 11/7/83	
NQ CORE	10.0	5.1	50%										28-32' Highly fractured to crushed, poor recovery.	

SS = SPLIT SPOON; ST = SHELBY TUBE;
D = DENNISON; P = PITCHER; O = OTHER

SITE

BURIAL GROUND E-NORTHERN AREA

HOLE NO.
GW-35

GEOLOGIC DRILL LOG										PROJECT	JOB NO.	SHEET NO.	HOLE NO.	
										ENVIRONMENTAL FIELD STUDIES	16218	2 OF 2	GW-35	
SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLER RECOVERY CORE RECOVERY	SAMPLER BLOWS "N"	PERCENT CORE RECOVERY	WATER PRESSURE TESTS				ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
					LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES							
Box 1				35.8									Thinly interbedded shale and thin calcareous sandstone, olive green with minor maroon beds. Moderately hard, with bedding dipping at 65°. Dominant fracture pattern of ~N60°W-20°W.	
	5.3	5.0	94%					954.2	40					
				41.1										
Box 2	10.0	6.5	65%					944.2	45					
				51.1										
Box 2	8.9	4.9	55%						55					
4-inch Tricone				60.0				934.2	60				Overreamed to 62.0' with 4-inch tricone.	
								932.2					Bottom of hole 62.0' Installed observation and sampling well with open interval 37.5-60.3'.	

SS = SPLIT SPOON; ST = SHELBY TUBE;
O = DENNISON; P = PITCHER; Q = OTHER

SITE

BURIAL GROUND B-NORTHERN AREA

HOLE NO.

GW-35

BECHTEL

GEOLOGIC DRILL LOG										PROJECT ENVIRONMENTAL FIELD STUDIES		JOB NO. 16218	SHEET NO. 2 OF 2	HOLE NO. GW-36
SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS "N"	PERCENT CORE RECOVERY	WATER PRESSURE TESTS			ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.	
					LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES							
6-inch hollow stem auger												Possibly into fresh shale @ 35 feet.	Large (coarse sand size) cuttings in hole; unable to wash them out.	
								925.8				Bottom of hole 39.1' Installed observation and sampling well, open from 8.5 to 39.1'.		

SS = SPLIT SPOON; ST = SHELBY TUBE;
D = DENNISON; P = PITCHER; O = OTHER

SITE
NORTH OF BURIAL GROUND B

HOLE NO.
GW-36

GEOLOGIC DRILL LOG										PROJECT		JOB NO.	SHEET NO.	HOLE NO.
										ENVIRONMENTAL FIELD STUDIES		16218	1 OF 2	GW-37
SITE					COORDINATES					ANGLE FROM HORIZ.		BEARING		
NORTHEAST OF BURIAL GROUND B					N 30,695 E 43,342					90°				
BEGUN	COMPLETED	DRILLER			DRILL MAKE AND MODEL		HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH				
10/24/83	10/28/83	Ron Tatum/Geotek			Mobile 61		6"/4"	Weath. Rock 39'	31'	70'				
CORE RECOVERY (FT./%)		CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER		DEPTH/EL. TOP OF ROCK						
23.4/49%		2	6	1005.6	1002.3	43.45'/958.85		39'/963.3						
SAMPLE HAMMER WEIGHT/FALL				CASING LEFT IN HOLE: DIA./LENGTH			LOGGED BY:							
300 lb./30- inch				2-inch Stainless Steel Observation Well			E. M. Fanelli							
SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLER RECOVERY CORE RECOVERY	SAMPLER BLOWS "N"	PERCENT CORE RECOVERY	WATER PRESSURE TESTS				ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
					LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES							
3-inch split spoon	1.5	1.5	11/100%						1000.8				0 - 1.5' SILT: Pale yellowish orange (10 YR 8/6) to greyish orange (10 YR 7/4) soft, organic-rich, clayey silt containing few olive (10 YR 6/2) shale fragments.	Drilled using 3" diameter split spoons and 6" diameter augers to 21.5 feet, then cored with NQ wireline. 6' to 21' had over 100 PPM toxic gas in the hole.
	1.5	1.5	15/100%									1.5 - 39' WEATHERED SHALE: Grayish red purple (5 RP 4/2) to medium light grey (N6) and light olive (10 Y 6/2) shale with some moderate reddish brown (10 R 4/6) and dark yellowish orange (10 YR 6/6) oxidation, shows relict, steeply dipping (~60°) bedding. Fissile, clayey, soft to moderately hard, soapy texture and micaceous sheen on most bedding surfaces, dry, interbedded with thin glauconitic sandstone.		
	1.5	1.0	21/67%									8.3' distinctive, friable to loose dusty yellowish green (10 GY 3/2) glauconitic sand, noncalcareous. Shale becomes less weathered, less stained, harder but fractured with depth.		
	1.5	0.9	40/60%											
	1.5	1.0	90/67%											
6-inch hollow stem auger									992.3	10				@ 21.5' auger refusal.
									982.3	20				
NQ Wireline Core														
	7.0	1.9	27%											
									972.3	30				
	5.0	2.8	56%		.34	5	5							
					1.4	10	19							
					1.1*	5	3							

*Apparently fractured the rock

SS = SPLIT SPOON; ST = SHELBY TUBE; O = DENNISON; P = PITCHER; Q = OTHER	SITE NORTHEAST OF BURIAL GROUND B	HOLE NO. GW-37
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BECHTEL

GEOLOGIC DRILL LOG				PROJECT		JOB NO.	SHEET NO.	HOLE NO.					
				ENVIRONMENTAL FIELD STUDIES		16218	1 OF 2	GW-38					
SITE			COORDINATES			ANGLE FROM HORIZ.		BEARING					
SOUTHEAST BURIAL GROUND B			N 30,543 E 43,371			90°							
BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL		HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH					
10/20/83	10/21/83	T. Huffaker, Jr. /Geotek	Mobile 53		6"	+Weath. Rock 52.5'		52.5'					
CORE RECOVERY (FT./%)		CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER		DEPTH/EL. TOP OF ROCK					
			8	1007.2	1004.5	Dry on 11/7/83							
SAMPLE HAMMER WEIGHT/FALL			CASING LEFT IN HOLE: DIA./LENGTH			LOGGED BY:							
300 lb./ 30-inch			2-inch Stainless Steel Observation Well			B. L. Turner							
SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLER RECOVERY CORE RECOVERY	SAMPLER BLOWS "N"	PERCENT CORE RECOVERY	WATER PRESSURE TESTS			ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
					LOSS IN Q.P.M.	PRESSURE P.S.I.	TIME IN MINUTES						
3-inch split spoon	1.5	1.5		8/100Z								0.0 - 3.7' <u>FILL</u> : Clayey gravel moderate yellowish brown (10 YR 5/4); gravel is angular small, (less than 2-in.) shale fragments, loose to medium dense, roots, moist.	
	1.5	1.5		6/100Z									
	1.5	1.5		4/100Z				1000.8				3.7 - 7.5' <u>HIGHLY WEATHERED SHALE AND SANDSTONE</u> : Light brown (10 YR 5/6) to moderate reddish brown (10 R 4/6), slightly mottled clayey, relict bedding 35° to vertical, soft to medium stiff sandstone beds are thin, dusky yellowish brown (10 YR 2/2), loose, moist.	
	1.5	1.2		14/80Z					5				
	1.5	1.5		36/100Z				997.0					
	1.5	1.5		45/100Z				994.5	10			7.5 - 52.5' <u>WEATHERED SHALE AND SANDSTONE</u> : Shale is light olive grey (5 YR 5/2) to dusky yellow (5 YR 6/4) sandstone varies from white to dusky yellowish brown (10 YR 2/2), loose. Both shale and sandstone have light brown (5 YR 5/6) clay coatings on partings and fractures. Thin bedded, fissile with bedding at 30-35° to vertical.	
	1.5	1.5		81/100Z								9'-sample includes part of a small fold.	
	1.5	1.5		96/100Z								11'-prominent joint @ 80° to vertical and 45° to bedding, black (MnO ₂) staining on surface.	
6-inch Hollow Stem Auger								984.5	20			24'-cutting are dark yellowish (10 YR 6/6) to dusky yellow (5 YR 6/4), getting harder	
									25				
								974.5	30			18'-grading harder, darker brown, sandstone. Cuttings are cemented, very fine grained.	
									35				

SS = SPLIT SPOON; ST = SHELBY TUBE;
D = DENNISON; P = PITCHER; O = OTHER

SITE
SOUTHEAST OF BURIAL GROUND B

HOLE NO.
GW-38

GEOLOGIC DRILL LOG										PROJECT		JOB NO.	SHEET NO.	HOLE NO.
										ENVIRONMENTAL FIELD STUDIES		1621R	2 OF 2	GW-38
SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLER RECOVERY CORE RECOVERY	SAMPLE BLOWS "N"	PERCENT CORE RECOVERY	WATER PRESSURE TESTS			ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.	
					LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES							
6-inch hollow stem auger								964.5	40			7.5 - 52.5' WEATHERED SANDSTONE AND SHALE (Cont'd)		
								954.5	50					
								952.0				Bottom of hole 52.5'. Installed 2" observation and sampling well with open interval 38.9 - 52.4'.	More than 10' of cave in bottom each time augers are pulled. Since caved material is principally broken rock, wash well assembly in to bottom, using high water pressure through 1-1/4" pvc pipe placed in hole. This worked well, but when water tank overflowed, some oil went in hole; probably was washed out by subsequent pumping, and is unlikely to have reached monitored zone.	

SS = SPLIT SPOON; ST = SHELBY TUBE;
O = DENNISON; P = PITCHER; Q = OTHER

SITE
SOUTHEAST OF BURIAL BOUND B

HOLE NO.
GW-38

BECHTEL

GEOLOGIC DRILL LOG										PROJECT ENVIRONMENTAL FIELD STUDIES		JOB NO. 16218	SHEET NO. 1 OF 1	HOLE NO. GW-39
SITE BURIAL GROUND A - EAST OF SMALL OIL POND				COORDINATES N 30,359 E 44,584				ANGLE FROM HORIZ. 90°		BEARING				
REQ'D 10/12/83	COMPLETED 10/13/83	DRILLER R. Gossage/Geotek		DRILL MAKE AND MODEL Mobile 53		HOLE SIZE 6"	OVERBURDEN (FT.) +Weath. Rock 22.5'	ROCK (FT.)	TOTAL DEPTH 22.5'					
CORE RECOVERY (FT./%)		CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER		DEPTH/EL. TOP OF ROCK						
			11	958.4	955.7	11.4'/944.3								
SAMPLE HAMMER WEIGHT/FALL 300lb./30-inch			CASING LEFT IN HOLE: DIA./LENGTH 2-inch Stainless Steel Observation well			LOGGED BY: E. M. Fanelli								
SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS "N"	PERCENT CORE RECOVERY	WATER PRESSURE TESTS			ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.	
					LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES							
3-inch split spoon sampler	1.5	1.3	15/87Z									<p>0 - 2.0' <u>SILT</u>: Greyish orange (10 YR 7/4), clayey silt, contains some roots, few pebbles to coarse sand size inclusions and some reddish-brown iron oxide concretions, non-calcareous, moderately dense.</p> <p>2.0 - 22.5' <u>WEATHERED SHALE</u>: Pale olive (10 YR 6/2), soft, clayey, and moderate reddish brown (10 R 4/6), moderately, hard, silty, weathered shale. Material shows relict bedding, steeply dipping 55° to 60°; soft clayey shale fragments have a soapy texture, micaceous sheen, friable where dry, fissile where moist, semi-plastic when reworked; moderately hard shale fragments have oxidation stains on bedding surfaces (predominantly dusky yellow brown (10 YR 2/2) and are fractured. Scattered light grey (N7) to light bluish gray (5B7/1) thin (~.25") clay seams. Material is non calcareous. Possibly into good rock at 20', material becomes harder, less clayey with depth.</p>	<p>Drilled using 3" diameter split spoon and 6" diameter auger.</p> <p>11.4' 11/7/83</p> <p>Split spoon refusal @ 16.5'.</p> <p>Auger refusal at 22.5'.</p>	
	1.5	1.3	19/87Z											
	1.5	1.2	28/80Z											
	1.5	1.0	35/67Z											
	1.5	1.3	42/87Z											
	1.5	1.2	37/80Z											
	1.5	1.0	30/67Z											
	1.5	1.0	45/67Z											
	1.5	.7	54/47Z											
	1.5	1.2	40/80Z											
6-inch hollow stem auger														
	1.5	1.5	101/100Z											
								970.6				Bottom of hole 22.5 feet Installed observation and sampling well open 6.0 to 21.1'.		

SS = SPLIT SPOON; ST = SHELBY TUBE;
D = DENNISON; P = PITCHER; O = OTHER

SITE

BURIAL GROUND A - EAST OF SMALL OIL POND

HOLE NO.

GW-39

GEOLOGIC DRILL LOG										PROJECT ENVIRONMENTAL FIELD STUDIES		JOB NO. 16218	SHEET NO. 1 OF 1	HOLE NO. GW-40
SITE NORTH OF BURIAL GROUNDS (BACKGROUND HOLE)				COORDINATES N 31.116 E 43.355				ANGLE FROM HORIZ. 90°		BEARING				
BEGUN 9/29/83	COMPLETED 9/30/83	DRILLER R. Gossage/Geotek		DRILL MAKE AND MODEL Mobile 53		HOLE SIZE 6-inch	OVERBURDEN (FT.) +Weathered Rock 22'	ROCK (FT.) 13'	TOTAL DEPTH 35'					
CORE RECOVERY (FT./%)		CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER		DEPTH/EL. TOP OF ROCK						
			9	1008.0	1003.8	16.5'/987.3		22'/981.8						
SAMPLE HAMMER WEIGHT/FALL 300 lb./30-inch			CASING LEFT IN HOLE: DIA./LENGTH 2" stainless steel observation well			LOGGED BY: R. L. Turner								
SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLER RECOVERY CORE RECOVERY	SAMPLER BLOWS "N"	PERCENT CORE RECOVERY	WATER PRESSURE TESTS			ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.	
					LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES							
6-inch hollow stem auger	1.5	1.2	31/80%									0.0 - 22' <u>WEATHERED SHALE AND SANDSTONE:</u> banded along bedding with red, brown, green and black. Shale is clayey, micaceous on bedding surfaces. Sandstone is glauconitic grayish olive green (5 GY 3/2). Thin beds of sandstone alternate with shale. Bedding is 35° to 40° to vertical. Weak, crumbly, dry.	Auger to 0.5 before sampling.	
	1.5	1.5	46/100%											
	1.5	1.5	78/100%											
	1.5	1.2	81/80%											
	1.5	1.3	84/87%											
	1.5	1.3	95/87%											
	1.5	1.3	103/80%											
	1.5	1.2	103/80%											
3-inch split spoon	1.5	1.2	103/80%									~ 12 feet, becoming harder, more dense, less weathered, overall color approx. dark yellowish brown (10 YR 4/2).		
	1.5	1.1	112/73%											
6-inch hollow stem auger												~22 - 35' <u>SHALE AND SANDSTONE:</u> Gray, moderately hard, can be augered.	Water ~23'. Auger to 35' in order to get below the water table, and allow for cave in bottom of hole. Set 2-inch observation and sampling well open from 21 to 29'.	
												Bottom of hole 35.0'		
SS = SPLIT SPOON; ST = SHELBY TUBE; O = DENNISON; P = PITCHER; Q = OTHER										SITE NORTH OF BURIAL GROUNDS (BACKGROUND HOLE)		HOLE NO. GW-40		

GEOLOGIC DRILL LOG										PROJECT		JOB NO.		SHEET NO.		HOLE NO.															
										ENVIRONMENTAL FIELD STUDIES		16218		1 OF 2		GW-41															
SITE					COORDINATES					ANGLE FROM HORIZ.			BEARING																		
BURIAL GROUND - BACKGROUND HOLE					N 31,100 E 43,736					90°																					
BEGIN		COMPLETED		DRILLER		DRILL MAKE AND MODEL		HOLE SIZE		OVERBURDEN (FT.) +weathered rock		ROCK (FT.)		TOTAL DEPTH																	
9/26/83		9/27/83		R. Tatum/Geotek		Mobile 61		6"/41/2"		25.0'		15.0'		40.0'																	
CORE RECOVERY (FT./%)				CORE BOXES		SAMPLES		EL TOP OF CASING		GROUND EL.		DEPTH/EL. GROUND WATER		DEPTH/EL. TOP OF ROCK																	
11.8/47%				2		8		1007.5		1004.3		22.6'/981.7		25.0'/979.3																	
SAMPLE HAMMER WEIGHT/FALL					CASING LEFT IN HOLE: DIA./LENGTH					LOGGED BY:																					
300lb /30-inch					2-inch stainless steel Observation/Sampling Well					THOMAS W. CROSBY/BEVERLY AUSMUS																					
SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLER RECOVERY CORE RECOVERY	SAMPLER BLOWS "N"	PERCENT CORE RECOVERY	WATER PRESSURE TESTS				ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.																	
					LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES																								
3-inch split spoon	1.5	1.5		16/100%					1002.1	5	[Hatched pattern]	[Hatched pattern]	0-2.2' CLAY SOIL: Moderate brown (5YR4/4) mottled with yellow; stiff, moist, clay with rock fragments (colluvium).																		
	1.5	1.5		22/100%									2.2-9.0' WEATHERED SHALE: Moderate brown (5YR3/4) to light brown (5YR6/4), deeply to moderately weathered shale, stiff, moist, micaceous along bedding planes, scattered roots throughout, rust-colored iron staining. 4.5'- dip is ~60'.																		
	1.5	1.3		41/87%									995.3 994.3		10	[Hatched pattern]	[Hatched pattern]	9.0-25.0' SLIGHTLY WEATHERED SHALE AND SILT- STONE AND SANDSTONE: Grayish olive green (5GY3/2) to moderate olive brown, slightly weathered, damp, moderately hard, weathered along fractures, to pale yellowish brown (10YR6/2).													
	1.5	1.3		45/87%														15	[Hatched pattern]	[Hatched pattern]	[Hatched pattern]	Thinly interbedded shade, siltstone, and fine-grained sandstone, bedding dips at 70°.									
	1.5	1.3		47/87%																		20	[Hatched pattern]	[Hatched pattern]	[Hatched pattern]						
	1.5	1.4		32/93%																							25	[Hatched pattern]	[Hatched pattern]	[Hatched pattern]	
	1.0	0.8		81/80%																											
6-inch Auger									984.3	20	[Hatched pattern]	[Hatched pattern]																			
3-in. S.S.	1.5	0.5		41/33%										979.3	25	[Hatched pattern]	[Hatched pattern]														
	Auger			15.0					974.3	30	[Hatched pattern]	[Hatched pattern]																			
NQ Core	10.0	3.9		39%										35	[Hatched pattern]	[Hatched pattern]	[Hatched pattern]														
				25.0					35.0	[Hatched pattern]	[Hatched pattern]	[Hatched pattern]																			
	6.5	3.7		57%															35.0	[Hatched pattern]	[Hatched pattern]	[H									

GEOLOGIC DRILL LOG										PROJECT ENVIRONMENTAL FIELD STUDIES		JOB NO. 16218	SHEET NO. 2 OF 2	WELL NO. GW-41
SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLER RECOVERY CORE RECOVERY	SAMPLER BLOWS "N"	PERCENT CORE RECOVERY	WATER PRESSURE TESTS			ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.	
					LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES							
NQ Core	5.0	2.5		50%								Thinly interbedded shale and fine sandy siltstone with glauconite grains, bedding dips at 65°-70°.		
				40.0				964.3				Bottom of hole 40.0 feet. Installed observation/sampling well open 6.0-40.0 feet.		

SS = SPLIT SPOON; ST = SHELBY TUBE;
 O = DENNISON; P = PITCHER; Q = OTHER

SITE

BURIAL GROUNDS - BACKGROUND HOLE

WELL NO.

GW-41

GEOLOGIC DRILL LOG										PROJECT		JOB NO.		SHEET NO.		HOLE NO.	
										ENVIRONMENTAL FIELD STUDIES		16218		1 OF 1		GW-42	
SITE										COORDINATES				ANGLE FROM HORIZ.			
BURIAL GROUNDS - BACKGROUND HOLE										N 31.142 E 43.935				900			
BEGIN		COMPLETED		DRILLER		DRILL MAKE AND MODEL		HOLE SIZE		OVERBURDEN (FT.)		ROCK (FT.)		TOTAL DEPTH			
9/28/83		9/29/83		R. Tatum/Geotek		Mobile 61		6"		+weathered rock 30.0'				30.0'			
CORE RECOVERY (FT./%)				CORE BOXES		SAMPLES		EL. TOP OF CASING		GROUND EL.		DEPTH/EL. GROUND WATER		DEPTH/EL. TOP OF ROCK			
						11		1003.3		1000.0		18.0'/982.0					
SAMPLE HAMMER WEIGHT/FALL				CASING LEFT IN HOLE: DIA./LENGTH				LOGGED BY:									
300lb./30-inch				2-inch stainless steel Observation Well				THOMAS W. CROSBY									
SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLER RECOVERY CORE RECOVERY	SAMPLER BLOWS "N"	PERCENT CORE RECOVERY	WATER PRESSURE TESTS				ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.			
					LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES										
3-inch Split Spoon and 6-inch Auger	1.5	0.9	14/60Z										0-3.5' SANDY SILT SOIL: Moderate brown (5YR4/4) slightly moist medium stiff, structureless soil, with weathered shale fragments, roots, weathered throughout.	Hole is dry during drilling.			
	1.5	1.1	20/73Z														
	1.5	1.4	20/93Z														
	1.5	1.5	58/100Z										3.5-30' WEATHERED SHALE AND SANDSTONE: Thinly interbedded, light brown (5YR5/6) to pale yellowish orange (10YR8/6), stiff, medium dense, slightly damp, thin beds average 1/4" thick, dip is steep 45°-70°.				
	1.5	1.5	74/100Z														
	1.5	1.4	63/93Z										8-16' Moderately weathered, blocky fractures along bedding and perpendicular to bedding.				
	1.5	1.3	54/87Z														
	1.5	1.3	34/87Z														
	1.5	1.3	68/87Z														
	1.5	1.3	47/87Z														
6-inch Hollow Stem Auger													At 16.5' stopped split spoon sampling due to high blow counts. Augered to 30' to install observation and sampling well.	18.0' 10/3/83			
													Rock becomes harder.				
													27' Slightly weathered, light gray, shale cuttings on auger.				
													Bottom of hole 30.0' Installed observation and sampling well with open interval 13.4-28.2'.				

SS = SPLIT SPOON; ST = SHELBY TUBE;
D = DENNISON; P = PITCHER; O = OTHER

SITE

BURIAL GROUNDS - BACKGROUND HOLE

HOLE NO.

GW-42

NOTE:

GW-43 and GW-44 were drilled
in the Oil Landfarm area.

BECHTEL

GEOLOGIC DRILL LOG										PROJECT ENVIRONMENTAL FIELD STUDIES		JOB NO. 16218	SHEET NO. 1 OF 1	HOLE NO. GW-45
SITE SOUTHWEST OF BURIAL GROUND A			COORDINATES N 29,146 E 43,353					ANGLE FROM HORIZ. 90°		BEARING				
BEGIN	COMPLETED	DRILLER	DRILL MAKE AND MODEL		HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH						
10/26/83	10/26/83	T. HUFFAKER JR./GEOTEK	Mobile 53		6"	15.2'		15.2'						
CORE RECOVERY (FT./%)		CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER		DEPTH/EL. TOP OF ROCK						
			10	909.7	907.4	13'/894.4								
SAMPLE HAMMER WEIGHT/FALL 300lbs/30-inch			CASING LEFT IN HOLE: DIA./LENGTH 2-inch stainless steel Observation well			LOGGED BY: B.L. TURNER								
SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLER RECOVERY CORE RECOVERY	SAMPLER BLOWS "N"	PERCENT CORE RECOVERY	WATER PRESSURE TESTS			ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.	
					LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES							
3-inch split spoon and 6-inch hollow stem auger	1.5	1.4	17/93%									0.0-9.0' FILL: Weathered shale clayey, grayish orange (10YR7/4) to dark yellowish orange (10YR6/6) fresher pieces light olive gray (5Y5/2), fissile, roots to ~ 5 ft. Humus in upper 0.2 ft. weak to firm.	Rock looked in-place, but dip angles too variable. Soft fill below confirms this. Clean out with auger after split spoon samples.	
	1.5	1.2	25/80%											
	1.5	1.5	34/100%											
	1.5	1.5	35/100%											
	1.5	0.2	25/13%											
	1.5	0.9	15/60%											
	1.5	0.8	10/53%											
	1.5	0.2	11/13%											
	1.5	1.2	6/80%											
	1.5	1.0	1/67%											
								898.4				9.0-15.2' HIGHLY WEATHERED SHALE AND CLAY: (CH) with shale fragments, light brown (5YR5/6) to dark reddish brown (10R3/4) firm, grading soft below the water table. Fill(?).	~ 15' sampler hit something hard which sounded metallic, stop drilling and set observation well. 13' 11/7/83	
								897.4						
												Bottom of hole 15.2' Installed observation and sampling well open 3.0 to 15.2'.		

 SS = SPLIT SPOON; ST = SHELBY TUBE;
 D = DENNISON; P = PITCHER; O = OTHER

SITE

SOUTHWEST OF BURIAL GROUND A

HOLE NO.
GW-45

BECHTEL

GEOLOGIC DRILL LOG										PROJECT ENVIRONMENTAL FIELD STUDIES		JOB NO. 16218	SHEET NO. 1 OF 1	HOLE NO. GW-46
SITE BURIAL GROUNDS SOUTH OF LARGE OIL POND										COORDINATES N 29,568 E 43,279		ANGLE FROM HORIZ. 90°		BEARING —
BEGUN 10/27/83		COMPLETED 10/27/83		DRILLER R. Gossage/Geotek		DRILL MAKE AND MODEL Mobile 53		HOLE SIZE 6"	OVERBURDEN (FT.) +weathered rock 20.5	ROCK (FT.) —	TOTAL DEPTH 20.5'			
CORE RECOVERY (FT.%) —				CORE BOXES —		SAMPLES 12	EL. TOP OF CASING 919.7	GROUND EL. 917.3	DEPTH/EL. GROUND WATER 6.5'/910.8		DEPTH/EL. TOP OF ROCK —			
SAMPLE HAMMER WEIGHT/FALL 300lb./30-inch				CASING LEFT IN HOLE: DIA./LENGTH 2-inch stainless steel Observation Well				LOGGED BY: B.L. TURNER						
SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLER RECOVERY CORE RECOVERY	SAMPLE BLOWS "N"	PERCENT CORE RECOVERY	WATER PRESSURE TESTS				ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
					LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES							
6-inch hollow stem auger														
3-inch split spoon	1.5	1.0		10/67%					913.0	5			<p>0.0-4.3' <u>FILL</u>: Gravelly silty clay, moderate yellowish brown (10YR5/4) to dark yellowish orange (10YR6/6). Gravel is small shale and sandstone fragments. Firm to stiff, no roots, moist.</p> <p>4.3-7.7' <u>CLAY</u>: Organic silty clay, olive gray (5Y4/1) to light olive gray (5Y5/2), micaceous, oily appearance, hydrocarbon odor. Abundant roots and plant fibers at top, but not many below. Contains round "spots" of green and yellow (sand?). Firm to medium stiff above water table, soft below, moist to wet.</p> <p>7.7-20.5' <u>WEATHERED SHALE AND SANDSTONE</u>: Shale is light olive gray on fresh surfaces, black and orange staining on bedding and fractures, fissile, micaceous, thin bedded, clay coatings on open fractures in upper few feet. Sandstone is moderate brown (5YR4/4), fine grained, friable, weak. Bedding 25° to 45° to vertical.</p>	<p>10/27 6.5'</p> <p>14 ft. driller says there was a void - split spoon dropped.</p>
	1.5	1.2		11/80%					909.6					
	1.5	1.3		10/87%										
	1.5	1.2		8/80%										
	1.5	1.5		7/100%										
	1.5	1.5		41/100%										
	1.5	1.2		63/80%										
	1.5	1.3		100/87%										
	1.5	1.3		101/87%										
	1.5	1.2		23/80%										
6-inch hollow stem auger	1.5	1.3		43/87%						15				
	1.5	0.4		60/27%					897.3	20				
									896.8				<p>Bottom of hole 20.5 ft. Installed observation and sampling well. open from 5.0 to 20.3'.</p>	

H&CF 19-1

BECHTEL

GEOLOGIC DRILL LOG										PROJECT		JOB NO.		SHEET NO.		HOLE NO.	
ENVIRONMENTAL FIELD STUDIES										16218		1 OF 1		GW-48			
SITE SOUTH OF BURIAL GROUND A- NEAR EAST TRIBUTARY TO BEAR CREEK										COORDINATES N 29,390 E 44,236				ANGLE FROM HORIZ. 90°		BEARING	
BEGUN		COMPLETED		DRILLER		DRILL MAKE AND MODEL		HOLE SIZE		OVERBURDEN (FT.)		ROCK (FT.)		TOTAL DEPTH			
10/31/83		10/31/83		R. Gossage/Geotek		Mobile 53		6"		+weathered rock 9.0'				9'			
CORE RECOVERY (FT./%)				CORE BOXES		SAMPLES		EL. TOP OF CASING		GROUND EL.		DEPTH/EL. GROUND WATER		DEPTH/EL. TOP OF ROCK			
						6		918.2		915.0		1.3'/913.7					
SAMPLE HAMMER WEIGHT/FALL				CASING LEFT IN HOLE: DIA./LENGTH				LOGGED BY:									
300lb./30-inch				2-inch stainless steel Observation/Sampling Well				THOMAS W. CROSBY									
SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLER RECOVERY CORE RECOVERED	SAMPLER BLOWS "N"	PERCENT CORE RECOVERY	WATER PRESSURE TESTS				ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.			
					LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES										
3-inch Split Spoon	1.5	1.1	3/73Z						911.5	5			0-3.5' SILTY CLAY: Moderate yellowish brown to dark yellowish orange, fine sandy silty clay, soft, plastic, wet below 1 ft., abundant roots. Uniform character.	1.3' 11/7/83 Gamma meter shows radiation from sample at 2MR/hr.			
	1.5	1.1	8/73Z														
	1.5	1.5	20/100Z					3.5-9.0' WEATHERED SHALE: Moderate yellowish brown to grayish brown (5YR3/2). Highly to moderately weathered shale, oxidized along bedding planes to yellow; soft to stiff, parts along thin bedding, 60° dip.									
	1.5	0.8	12/53Z														
	1.5	0.9	78/60Z														
	1.5	1.2	102/80Z														
								906.0					Bottom of hole 9.0 ft. Installed observation and sampling well open from 2.0'-8.7'.				

 SS = SPLIT SPOON; ST = SHELBY TUBE;
 D = DENNISON; P = PITCHER; O = OTHER

SITE

SOUTH OF BURIAL GROUND A - NEAR EAST TRIBUTARY TO BEAR CREEK

HOLE NO.

GW-48

BECHTEL

GEOLOGIC DRILL LOG										PROJECT ENVIRONMENTAL FIELD STUDIES		JOB NO. 16218	SHEET NO. 1 OF 1	HOLE NO. GW-50
SITE SOUTH OF BURIAL GROUND A - BEAR CREEK AREA					COORDINATES N 29,078 E 44,097					ANGLE FROM HORIZ. 90°		BEARING		
REQ'D 10/28/83	COMPLETED 10/28/83	DRILLER R. Gossage/Geotek			DRILL MAKE AND MODEL Mobile 53			HOLE SIZE 6"	OVERBURDEN (FT.) +weathered rock 15'	ROCK (FT.)	TOTAL DEPTH 15'			
CORE RECOVERY (FT./%)		CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER			DEPTH/EL. TOP OF ROCK					
			10	914.7	912.2	Dry on 11/7/83								
SAMPLE HAMMER WEIGHT/FALL 300lb./30-inch			CASING LEFT IN HOLE: DIA./LENGTH 2-inch Stainless Steel Observation Well			LOGGED BY: E.M. FANELLI								
SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLER RECOVERY CORE RECOVERY	SAMPLER BLOWS "N"	PERCENT CORE RECOVERY	WATER PRESSURE TESTS			ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.	
					LOSS IN O.P.M.	PRESSURE P.S.I.	TIME IN MINUTES							
3-inch split spoon and 6-inch auger	1.5	1.5	12/100Z									0-15' CLAY AND SILT: Moderate yellowish brown (10YR5/4) to dark yellowish orange (10YR6/6) containing manganese, iron oxides, abundant subangular to rounded broken and fractured pebble to granule sized clasts. Clasts generally have secondary calcite coatings and become less abundant with depth. Material is dry becoming moist, and more clayey and plastic with depth. 0.0-3.0' organic-rich ~12' material is more clayey	Advanced using 3" split spoon and 6" auger 6' moved hole over ~3 feet continued sampling. 6' - hit toxic gas 7.5'-80ppm toxic gas in hole 8.0'-210ppm toxic gas in hole 300 ppm	
	1.5	1.0	35/67Z											
	1.5	1.2	51/80Z											
	1.5	1.0	100/67Z											
	1.5	1.2	37/80Z											
	1.5	1.2	34/80Z											
	1.5	1.3	30/87Z											
	1.5	1.2	18/80Z											
	1.5	1.0	17/67Z											
	1.5	1.3	8/87Z											
												Bottom of hole 15 feet Installed observation and sampling well open 6.0 to 14.2'.	15' Auger and split spoon refusal - hard (limestone)?	

 SS = SPLIT SPOON; ST = SHELBY TUBE;
 O = DENNISON; P = PITCHER; Q = OTHER

 SITE
 SOUTH OF BURIAL GROUND A - BEAR CREEK AREA

 HOLE NO.
 GW-50

BECHTEL

GEOLOGIC DRILL LOG										PROJECT		JOB NO.		SHEET NO.		HOLE NO.			
SITE SOUTH OF BURIAL GROUND A-BEAR CREEK AREA										COORDINATES N 29,056 E 43,740		ENVIRONMENTAL FIELD STUDIES		16218		OF		GW-51	
												ANGLE FROM HORIZ.		90°		BEARING		--	
BEGIN		COMPLETED		DRILLER		DRILL MAKE AND MODEL		HOLE SIZE		OVERBURDEN (FT.)		ROCK (FT.)		TOTAL DEPTH					
11-2-83		11-2-83		Ron Gossage/Geotek		Mobile 53		6"		11.2'		--		11.2'					
CORE RECOVERY (FT./%)		CORE BOXES		SAMPLES		EL. TOP OF CASING		GROUND EL.		DEPTH/EL. GROUND WATER		DEPTH/EL. TOP OF ROCK							
--		--		8		910.2		906.6		3.4' / 903.2		Weathered (?) hard rock at 11.2' / 895.4							
SAMPLE HAMMER WEIGHT/FALL				CASING LEFT IN HOLE: DIA./LENGTH				LOGGED BY:											
300 lb/ 30-inch				2-inch Stainless Steel Observation/Sampling Well				Thomas W. Crosby											
SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLER RECOVERY CORE RECOVERY	SAMPLER BLOWS "N"	PERCENT CORE RECOVERY	WATER PRESSURE TESTS			ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.						
					LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES												
3-inch split spoon and 6-inch auger	1.5	1.2	13/80%									0 - 10.7' <u>SILT</u> : Pale yellowish orange (10 YR 8/6) to moderate yellowish brown (10 YR 5/4), clayey silt with variable amounts of subround to subangular limestone and chert pebbles. Silt is dense and stiff, increasingly with depth. No bedding or stratigraphic structure observed.	3.4' 11/7/83 At 11.2' Sudden refusal on very hard material.						
	1.5	1.2	30/80%																
	1.5	1.3	20/87%																
	1.5	1.4	34/93%																
	1.5	0.9	35/60%																
	1.5	1.5	30/100%																
	1.5	1.0	30/67%																
	0.7	0.4	18/57%									10.7 - 11.2' <u>PEAT</u> : Black soft, organic peat with asphaltic odor, moist.							
								896.6	10										
								895.9											
								895.4				Bottom of hole 11.2 ft. On hard limestone bedrock. Installed observation and sampling well open from 2.0 to 11.2'.	Shoe on spoon is bent inward, limestone rock dust is on bent shoe. Directed driller to auger a new hole 11.2' to the west; that hole had refusal at 11.2' as well.						

SS = SPLIT SPOON; ST = SHELBY TUBE;
D = DENNISON; P = PITCHER; O = OTHER

SITE
SOUTH OF BURIAL GROUND A- BEAR CREEK AREA

HOLE NO.
GW-51

BECHTEL

GEOLOGIC DRILL LOG										PROJECT		JOB NO.	SHEET NO.	HOLE NO.
										ENVIRONMENTAL FIELD STUDIES		16218	1 OF 1	GW-52
SITE					COORDINATES					ANGLE FROM HORIZ.		BEARING		
SOUTH OF BURIAL GROUND A-BEAR CREEK AREA					N 29.052 E 43.478					90°				
BEGIN	COMPLETED	DRILLER			DRILL MAKE AND MODEL			HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH			
11/2/83	11/2/83	R. Gossage/Geotek			Mobile 53			6"	19.5'		19.5'			
CORE RECOVERY (FT./%)		CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER			DEPTH/EL. TOP OF ROCK					
			12	905.7	903.4	12.8'/890.6								
SAMPLE HAMMER WEIGHT/FALL				CASING LEFT IN HOLE: DIA./LENGTH				LOGGED BY:						
300lb. /30-inch				2-inch stainless steel Observation/Sampling Well				THOMAS W. CROSBY						
SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLER RECOVERY CORE RECOVERY PERCENT CORE RECOVERY	SAMPLER BLOWS "N"	WATER PRESSURE TESTS			ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.		
				LOSS IN O.P.M.	PRESSURE P.S.I.	TIME IN MINUTES								
3-inch split spoon and 6-inch auger	1.5	1.4	14/93%								0-19.5' PEBBLE SILT : Pale yellowish orange to moderate brown (SYR3/4), stiff, dense, silt with varying abundance of subrounded limestone and chert pebbles. No stratification or bedding structure observed in samples. Organic silt with tree roots to a depth of 4.5'. Gradual change in pebble abundance noted: Rock Fragments: 4.5-6.0' 50% of sample 6.0-9.0' 15-20% 9.0-10.5' 50% 10.5-19.5' 15-30% Silt is dense to a depth of 13.5'. 13.5-19.5' silt is saturated, softer, plastic	12.8' on 11/7/83 Driller reports "boulder" alongside spoon from 18.0'- 19.5'. Lost spoon in hole		
	1.5	1.1	21/73%											
	1.5	1.4	22/93%											
	1.5	1.5	30/100%											
	1.5	1.3	27/87%											
	1.5	1.5	26/100%											
	1.5	1.1	34/73%											
	1.5	1.3	18/87%											
	1.5	1.5	17/100%											
	1.5	1.0	12/67%											
	1.5	0.5	16/33%											
	1.5	6.5	20/100%											
1.5	-0-	24/-0-												
							883.9				Bottom of hole 19.5' Installed observation and sampling well, open interval 4.0-19.5'.			

 SS = SPLIT SPOON; ST = SHELBY TUBE;
 D = DENNISON; P = PITCHER; O = OTHER

SITE

SOUTH OF BURIAL GROUND A-BEAR CREEK AREA

HOLE NO.

GW-52

GEOLOGIC DRILL LOG										PROJECT		JOB NO.		SHEET NO.		HOLE NO.	
SITE SOUTHWEST OF BURIAL GROUND A Adjacent to Bear Creek										COORDINATES N 29,066 E 43,086				ANGLE FROM HORIZ. 90°		BEARING	
BEGIN		COMPLETED		DRILLER		DRILL MAKE AND MODEL		HOLE SIZE		OVERBURDEN (FT.)		ROCK (FT.)		TOTAL DEPTH			
11/1/83		11/4/83		R. Tatum/Geotek		Mobile 61		6"/4"		+slightly weathered rock 39.7'				39.7'			
CORE RECOVERY (FT./%)				CORE BOXES		SAMPLES		EL. TOP OF CASING		GROUND EL.		DEPTH/EL. GROUND WATER		DEPTH/EL. TOP OF ROCK			
21.3'/69%				2		2		902.8		900.5		7.2/893.3					
SAMPLE HAMMER WEIGHT/FALL				CASING LEFT IN HOLE: DIA./LENGTH				LOGGED BY:									
300lb./30-inch				2-inch stainless steel observation well				B.L. TURNER									
SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLER RECOVERY CORE RECOVERY	SAMPLER BLOWS "N"	PERCENT CORE RECOVERY	WATER PRESSURE TESTS			ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.				
					LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES										
3-inch split spoon	1.5	1.2	5/80Z					896.5				0.0-4.0' <u>SILT</u> : Moderate yellowish brown (10YR5/4) clayey silt, pervious structure, loose to medium dense, rootlets, damp.	Split spoon samples were taken from 1st hole ~25' west of final location. Hole was moved due to refusal on hard rock @ 2.5 ft. Augered new hole to 4.0 ft. before refusal. Set 6 ft. of HW casing and start NQ coring				
6-inch hollow stem auger	1.0	1.0	3/100Z														
NQ	4.0	2.3	58Z				5.4		5			4.0-39.7' <u>LIMESTONE WITH WEATHERED SHALE, SANDSTONE & SILTSTONE INTERBEDS</u> : Limestone is medium gray (5N5) to medium dark gray, (4N4). Partly recrystallized, some beds oolitic. Shale and siltstone are medium dark gray (4N4) to dark gray (3N3), moderately hard. Sandstone beds are medium yellowish brown (10YR5/4), fine-grained, quartzose, washed out of core, so probably uncemented to slightly cemented. Bedding dips at 40° to 50° to vertical, 45° average.	7.2 11/4 Toxic gas ~300 ppm when pulling augers from 4 ft.				
Core																	
Box				8.0					14.7	4	8						
1	6.5	4.4	68Z					890.5	18.0	8	6						
				14.5													
	3.5	3.1	89Z														
				18.0													
	2.0	2.0	100Z						11.7	5	16						
				20.0					16.0	9	6						
	3.0	2.8	93Z						12.7	5	5						
				23.0													
NQ	3.5	2.0	57Z														
Core																	
				26.5													
Box																	
2	3.0	1.0	33Z		0.26	5	9										
				29.5	0.51	12	12										
	2.0	1.7	85Z		0.26	5	5	870.5									
				31.5													
	3.5	1.7	57Z		Note: Hole caved in below 26.5' so test interval not certain (single packer test)												
				35.0													
SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER													SITE SOUTHWEST OF BURIAL GROUND A-ADJACENT TO BEAR CREEK		HOLE NO. GW-53		

BECHTEL

GEOLOGIC DRILL LOG										PROJECT ENVIRONMENTAL FIELD STUDIES		JOB NO. 16218	SHEET NO. 2 OF 2	HOLE NO. GW-53
SAMPLER TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS "N"	PERCENT CORE RECOVERY	WATER PRESSURE TESTS				ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
					LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES							
4-inch tricone					↑			38.0					4.0-39.7' LIMESTONE WITH WEATHERED SHALE, SANDSTONE AND SILTSTONE BEDS: (cont'd)	36.5' soft zone; drill water turning gray. After packer testing, cleaned out hole to 39.7' (before install- ing well).
									860.8				Bottom of hole 39.7' Installed 2-inch observation well with open interval 11.4 to 32.8 ft.	

SS = SPLIT SPOON; ST = SHELBY TUBE;
D = DENNISON; P = PITCHER; O = OTHER

SITE

SOUTHWEST OF BURIAL GROUND A-ADJACENT TO BEAR CREEK

HOLE NO.

GW-53