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ENVIRONMENTAL RESTORATION PROGRAM

Groundwater Quality Monitoring Well Installation for Waste Area Grouping 3 at Oak Ridge National Laboratory, Oak Ridge, Tennessee

J. A. Mortimore
M. L. Ebers

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ORNL/ER-70

Environmental Restoration Division
ORNL Environmental Restoration Program

Groundwater Quality Monitoring Well Installation for Waste Area Grouping 3 at Oak Ridge National Laboratory, Oak Ridge, Tennessee

J. A. Mortimore
M. L. Ebers

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EXECUTIVE SUMMARY

This report documents the drilling and installation of 15 groundwater quality monitoring (GQM) wells on the perimeter of Waste Area Grouping (WAG) 3. WAG 3 is located in Melton Valley, approximately 3000 ft west of the west gate of Oak Ridge National Laboratory, and consists of an estimated 22 acres. The subject site contains three solid waste management units: the Contractors' Landfill, the Closed Scrap Metal Area, and Solid Waste Storage Area 3. The wells at WAG 3 were drilled and developed between September 1987 and August 1990. These wells were installed to characterize and assess the WAG in accordance with applicable Department of Energy, state, and Environmental Protection Agency regulatory requirements.

Well design and placement were performed by Martin Marietta Energy Systems, Inc. (Energy Systems) geologic staff and their subcontractors. The wells were drilled, installed, and developed by two drilling subcontractors (A. L. Clark Drilling Services and Geotek Engineering, Inc.) under contract with Energy Systems. The contract was administered by the Energy Systems Engineering Division for the Environmental Restoration (ER) Program. Hydrogeologic support was provided by an environmental subcontractor [ERC Environmental and Energy Services, Inc. (ERCE)] under contract with Energy Systems. (As of January 1, 1992, ERCE started operating under the name of Ogden Environmental and Energy Services Co., Inc.) This contract was administered by ER Division staff. Radiation protection and industrial hygiene support for the drilling program were provided by Energy Systems staff or their subcontractors.

The wells at WAG 3 were drilled with auger or air rotary rigs. Depending upon the hydrogeologic conditions present at each proposed well location, one of four basic installation methods was utilized. Detailed procedures for well construction were specified by the Engineering Division to ensure that the wells would provide water samples representative of the aquifer. To ensure conformance with the specifications, Energy Systems Construction Engineering and ERCE provided continuous oversight of field activities.

The purpose of the well installation program was to install GQM wells for groundwater characterization at WAG 3. Data packages produced during installation activities by the ERCE hydrogeologists are an important product of the program. These packages document the well drilling, installation, and development activities and provide valuable data for well sampling and WAG characterization. The forms contained in the packages include predrilling and postdrilling checklists, drilling and construction logs, development and hydraulic conductivity records, and quality control-related documents.

1. INTRODUCTION

The purpose of this report is to document the drilling and installation of the groundwater quality monitoring (GQM) wells on the perimeter of Waste Area Grouping (WAG) 3. Installation of GQM wells was required at Oak Ridge National Laboratory (ORNL) for regulatory compliance. Data obtained from these wells will be used to characterize and assess groundwater quality at the perimeter of each WAG in accordance with applicable Department of Energy, state, and Environmental Protection Agency regulatory requirements. The first eight wells installed in WAG 3 were drilled by A.L. Clark Drilling Services from September 1987 to January 1988. Five additional wells were drilled by Geotek Engineering Company in November 1989. These 13 wells were developed from April to May 1990. Two additional monitoring wells were drilled by Geotek in May 1990 and developed in August 1990.

1.1 THE WAG CONCEPT

At ORNL, the solid waste management units (SWMUs) include solid waste storage areas (SWSAs), pipelines, spill sites, buildings, ponds, and experimental test sites that are considered to be potential sources of contamination. The SWMUs are further grouped into WAGs, the boundaries of which are defined by watersheds that contain contaminants derived from similar assemblages of operating facilities and SWMUs. Basically, the wells are located on or near these boundaries to determine whether contaminants have been released from the WAGs.

1.2 DESCRIPTION OF WAG 3

WAG 3 is located in Melton Valley, approximately 3000 ft west of the west gate of ORNL, and consists of an estimated 22 acres [Fig. 1, map pocket (MMES map #C3E20004A082, Rev. C)]. The subject site contains three SWMUs, the Contractors' Landfill, the Closed Scrap Metal Area, and SWSA 3. Fifteen monitoring wells were drilled around the perimeter of WAG 3 (Fig. 1, map pocket).

The Contractor's Landfill is located about 130 ft west of SWSA 3 and consists of about 7 acres. This SWMU has been in operation since 1975 and continues to be used for the disposal of construction debris.

The Closed Scrap Metal Area consists of approximately 4 acres of graded fill maintained in grass. Its general location is southeast of SWSA 3, although its exact boundaries are not known. This SWMU opened in the early 1950s as a contractors' landfill and was operated as such for an estimated 15 years; then the fill area was reportedly used for storage of scrap metal. SWSA 3 consists of approximately 7 acres; it appears in plan view as two offset rectangles with a triangular protrusion on the southeastern side. This SWMU is located northeast of the Closed Scrap Metal Area and is currently planted in grass and enclosed by

a chain-link fence. SWSA 3 was used for the disposal of contaminated trash and laboratory equipment and was operational from 1946 to 1951.

2. INSTALLATION METHODS

Four basic types of well construction were used during the GQM installation program at ORNL. Schematic diagrams of these four well types are shown on Fig. 2. These four types (A, B, C, and D) were all used at WAG 3, and they are described in Sects. 4.1 through 4.4. The specific details of each well installation are included in the monitoring well narratives (Appendix A). The specifications for drilling and well installation were provided in *Construction Specifications for Monitoring Wells Installation Construction Project*, K-4491G-G1.[1] The proposed well design criteria for the WAG 3 wells can be found in the report *Preliminary Geohydrologic Site Characterization and Proposed Water Quality Well Locations for WAG 4, 5, 3, and SWSA 1*, ORNL/RAP/Sub-86/72139/1.[2] Actual completion data for WAG 3 are listed in Table 1.

2.1 TYPE A WELL

The type A well boring is drilled to total depth with solid-stem augers. On completion, the boring is bailed with a steel bailer to remove drill cuttings. The well is completed with 2-in.-diam stainless steel screen, casing, and a silt trap. Stainless steel centralizers are positioned at the top of the screen and every 20 ft along the casing. A sandpack is poured into the annular space from total depth to 1 ft above the screen. Pelleted bentonite is poured into the annular space to create a 2-ft seal above the sandpack. The top of the bentonite seal is measured with a stainless steel weighted tape. The annular space above the bentonite seal is then grouted to the surface through a tremie pipe.

2.2 TYPE B WELL

The first step in drilling the type B well is to auger a boring from the surface to a depth of 4 ft. A steel diverter casing is installed, and the annulus is grouted to the surface. The boring is then deepened with a tricone air rotary bit to a minimum depth of 10 ft total and 2 ft into bedrock. Next, a steel surface casing is installed and grouted into place. The air rotary method is used to drill the boring to the required depth. The well is completed with 4-in.-diam stainless steel screen and casing. A sandpack, a bentonite seal, and grout are installed in the annular space by the same procedures as used for the type A well.

2.3 TYPE C WELL

A 14-in.-diam boring is augered, and a 10-in.-diam steel casing is set in the same manner as in type B wells. The boring is deepened with an 8-in.-diam tricone air rotary bit to a predetermined depth. Four-in.-diam open-ended stainless steel casing is set from the drilled depth to the surface and grouted into place with a tremie pipe. Below the casing, an open-hole interval is drilled with a 3-7/8-in.-diam tricone air rotary bit. This section of the boring is left open to serve as the sample interval.

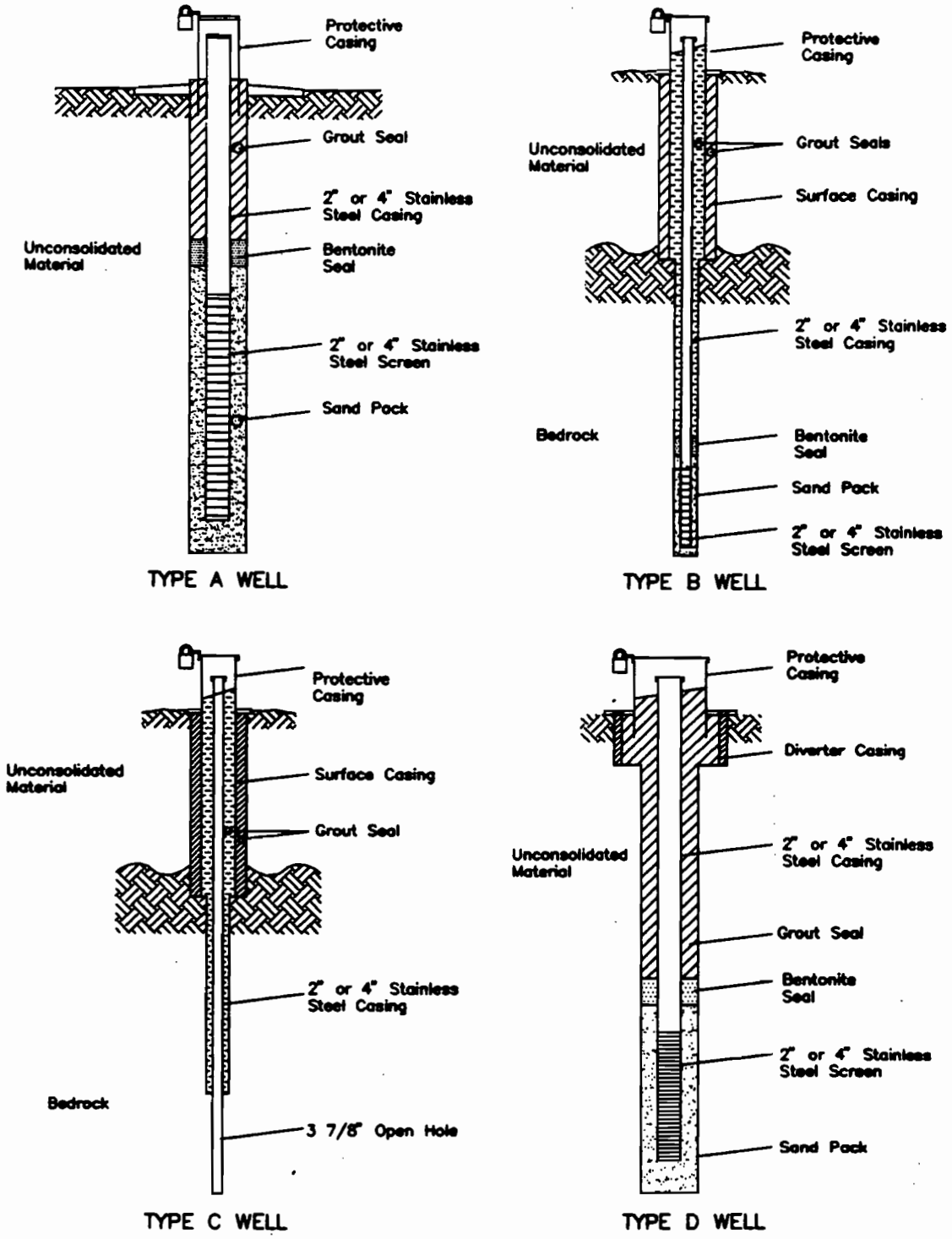


Fig. 2. The four types of well construction used during the Groundwater Quality Monitoring Well Installation Program at Oak Ridge National Laboratory.

2.3 TYPE D WELL

A type D well is a type A well with a diverter casing. If the auger encounters refusal before reaching total depth on a type A well, the boring is reamed with a larger auger to refusal and a steel diverter casing is installed. The annulus is grouted up to surface level. The boring is deepened with a tricone air rotary bit to total depth, and the well is completed with 2-in.-diam stainless steel screen and casing. A sandpack, a bentonite seal, and grout are installed in the annular space by the same procedures as those used for the type A well.

Table 1. Actual completion data for WAG 3

Well	Depth clean to (ft)[a]	SST casing diam (in.)	Well type	Screened interval (ft)	Water level (ft)[b]
985	35.0	2	D	20.0–35.0	-6.9
986	62.0	4	B	41.1–61.7	-9.2
987	48.2	4	B	27.1–47.9	-23.5
988	46.0	2	D	30.8–45.8	-23.6
990	40.8	4	B	25.5–40.5	-29.0
991	85.0	4	B	70.0–85.0	-45.6
992	52.0	2	A	33.0–48.0	-36.0
993	45.0	4	B	23.9–44.7	-21.6
994	80.5	4	C	59.1–80.5	-22.0
995	47.84	2	D	32.84–47.84	-21.5
996	61.76	4	B	41.13–61.49	-14.6
997	33.0	2	D	13.82–29.68	-6.5
998	20.0	2	A	4.7–19.7	+0.2
1247	22.7	2	D	7.5–22.5	-18.2
1248	72.5	4	B	52.3–72.3	-34.2

[a]Total drilled depth may vary from clean-out depth. See data packages (Appendix A).

[b]Predevelopment water level; depth measured from ground surface. (Negative is below surface; positive, above surface.)

3. ENVIRONMENTAL, HEALTH, AND SAFETY REQUIREMENTS

All well drilling at WAG 3 was conducted in accordance with procedures outlined in *Health, Safety, and Environmental Protection Procedures for Excavating Operations*, ORNL/M-116/R1[3]. Among the procedures set forth by this document is a system for rating proposed well locations according to the degree of probability that contamination will be encountered. This rating determined the level of personnel training required and health and safety coverage to be used during drilling.

The Superfund Amendment Reauthorization Act required still more stringent health and safety measures for personnel working in waste areas. These workers were required to have 40 h of training for hazardous duty through an ORNL-approved course, 8 h of refresher training each year, 8 h of supervisor's training for field supervisors, a whole-body count, baseline urinalysis, respirator testing and fitting, and medical monitoring. Personnel were also required to take a construction-worker training course covering the fundamentals of radioactivity and other types of contamination as well as the other hazards that could be encountered at ORNL. The workers were taught the proper procedures to follow in the event of an on-site emergency.

Special procedures were used during drilling. The ground surface at all drill sites was covered with polyethylene sheeting to prevent contact between the tools and the ground. The sheeting would also have protected the environment in the event of a hydraulic fluid release. Containment was required for all drill cuttings produced. During augering, a metal pan was used to hold cuttings until a health physicist (HP) could determine their proper disposition. During air rotary drilling, cuttings were diverted from the borehole to a special containment box designed by Martin Marietta Energy Systems, Inc. (Energy Systems). The box is a 500-gal, trailer-mounted tank with demister elements and high-efficiency particulate air filters at the air exhaust. In order that appropriate methods of disposal could be determined, the tank contents were checked by the HP for radioactive contamination and by the site hydrogeologist for volatile organics. The operating instructions that were followed for determining disposition of the cuttings and water produced during drilling and development are included in Appendix B.

4. FIELD SUPPORT

The construction contractor Geotek Engineering Company, whose contract began in May 1989, installed the GQM wells in WAG 3 during the period from September 1987 to August 1990. ORNL Engineering administered the drilling contract through Energy Systems Procurement. The management organization chart for the project can be found in the report *Task Management Plan for Groundwater Quality Monitoring Well Installation*, ORNL/RAP/LTR-88/28.[4]

The hydrogeologic support and installation record keeping were supplied through a contract with ERC Environmental and Energy Services Company (ERCE), formerly EDGe/MCI. An ERCE representative was present during all activities that affected the quality of the wells and advised Energy Systems on well construction. ORNL personnel or their subcontractors provided HP and industrial hygiene support.

Construction engineering support was supplied by Energy Systems personnel. Drawings, excavation permits, well placement in the field, and as-built surveying and calculations were done by the Energy Systems Civil and Architectural Department or by their subcontractor, Adams Craft Herz Walker Engineering Company. The as-built survey coordinates and elevations are on the well installation/completion form for each well (Appendix A). The as-built coordinates are also summarized in a table on the well location map (Fig. 1).

5. DRILLING RECORDS

A complete data package has been compiled for each of the 15 GQM wells drilled in WAG 3. These data packages are presented in numerical order in Appendix A. All original records are retained in the Environmental Restoration (ER) Division Records Control Data Base. The forms included in each well data package are listed here in the order in which they appear in the package:

1. monitor well narrative,
2. predrilling checklist for monitoring wells,
3. decontamination checklist for drilling equipment,
4. well log,
5. well installation/completion form,
6. monitoring well materials certification,
7. post-well completion checklist,
8. monitoring well development form,
9. monitoring well development progress,
10. hydraulic conductivity calculation,
11. nonconformance report (if necessary), and
12. chain of custody forms.

Three additional forms used in the field by the site hydrogeologist but not included in the published data packages are the monitoring well progress form, the hydraulic conductivity test field sheet, and the containment box checklist. These forms are kept in the ER Division Records Control Data Base.

6. WELL DEVELOPMENT

Wells were developed by pumping. Wells with high initial turbidities were surged beforehand with a workover rig and a stainless steel surge block to facilitate removal of the sediment from the wells. The contents of the wells were then pumped out using Geoguard airlift pumps and oilless air compressors. Development of a well was considered complete when at least three well volumes had been removed and the turbidity was measured at 5 NTUs or less. Several wells had turbidity ratings higher than 5 NTUs even after extensive pumping, but, in order to prevent the pulling in of groundwater from too far away, a maximum limit of 30 to 35 well volumes was determined by Energy Systems hydrogeologists to be the upper limit that should be removed. The contents of the wells were pumped out using Geoguard development pumps. The two-stage Geoguard pumps were converted to dedicated bladder pumps for sampling after development was complete. All development water was contained and disposed of according to the operating instructions in Appendix B.

Of the 15 wells in WAG 3, 11 had turbidity ratings of less than or equal to 5 NTUs. The number of well volumes removed ranged from 9.0 to 34.4, with an average of 22.0 for the 13 monitor wells numbered 985 through 988 and 990 through 998. The remaining two GQM wells, 1247 and 1248, each yielded less than 10 gal during development. The procedure for measuring turbidity described in ORNL/RAP/LTR-88/28[4] was replaced with a more accurate method. While the previously used method depended on a visual comparison of the sample with prepared standards, the new method employs the Cole-Parmer turbidimeter, which measures NTUs by passing a lens-focused light beam through a test tube filled with a water sample. A photosensor detects the intensity of the exiting light beam, and an analog scale on the instrument displays the turbidity of the sample.

7. SAMPLING DURING INSTALLATION

The ERCE hydrogeologist took samples of soil, rock, and drilling water during well installation and submitted them to the ORNL Analytical Chemistry Division for chemical analyses. Soil and rock samples were taken from the unsaturated and saturated zones. Samples of drilling water were collected from the water pump discharge on the drill rig during drilling with the air rotary. All samples were transferred using chain-of-custody forms, which are included in the data packages. The sampling procedures are explained in ORNL/RAP/LTR-88/28.[4] Soil samples were collected from each single well and from one well of each well pair. A drilling-water sample was collected from each air-rotary-drilled boring.

Analyses for 31 chemical elements, gross alpha, gross beta, and ^{40}K were routinely performed on the soil and water samples. The results from these analyses are contained in the ER Division Records Control Data Base.

8. SPECIAL NOTES ON INSTALLATION AND DEVELOPMENT

The following special events took place during the drilling of the GQM wells in WAG 3.

8.1 CONTAMINATION DETECTED

- An alcohol odor was detected during the drilling and completion of well 996.
- A sulfur smell was detected during the development of well 997, but it disappeared after a couple of days.

8.2 DEVIATIONS FROM THE SPECIFICATIONS

- Well 988 was drilled to 100 ft and then plugged back to 47.5 ft before the well was completed.
- Well 989 was a dry hole. It was drilled to a total depth of 100 ft and was plugged and abandoned by grouting the borehole from a depth of 100 feet up to the surface.
- Two nonconformities were documented during the installation of well 991. The first nonconformity was the installation of too many centralizers. The second nonconformity was a bentonite bridge in the annular space at 35 ft and the resulting open zone in the annulus from 35 to 60 ft.

8.3 HYDRAULIC FLUID SPILLS

A hydraulic hose break occurred at well 995. No wellbore contamination occurred, and all hydraulic fluid was cleaned from the equipment before drilling continued.

REFERENCES

1. Engineering Division, *Construction Specifications for Monitoring Wells Installation Construction Project*, K-4491G-G1 (Rev. 2), Martin Marietta Energy Systems, Inc., Oak Ridge National Laboratory, Oak Ridge, Tenn., August 1988.

2. MCI Consulting Engineers, Inc., *Preliminary Geohydrologic Site Characterization and Proposed Water Quality Well Locations for WAG 4, 5, 3, and SWSA 1*, ORNL/RAP/Sub-86/72139/1, Martin Marietta Energy Systems, Inc., Oak Ridge National Laboratory, Oak Ridge, Tenn., February 1987.

3. Environmental Compliance and Health Protection Division, *Health, Safety, and Environmental Protection Procedures for Excavating Operations*, ORNL/M-116/R1, Martin Marietta Energy Systems, Inc., Oak Ridge National Laboratory, Oak Ridge, Tenn., March 3, 1988.

4. J. A. Mortimore, *Task Management Plan for Groundwater Quality Monitoring Well Installation*, ORNL/RAP/LTR-88/28, Martin Marietta Energy Systems, Inc., Oak Ridge National Laboratory, Oak Ridge, Tenn., February 1988.

Appendix A

Data Packages

1.0 General Information

1.1 Well Location

Monitoring well number 985 is located in WAG 3. It is in the northeast corner of WAG 3. The location is shown on ORNL drawing number C3E20004 A075. Survey coordinates for this well are N 21,833.8123, E 26,675.6115 (X-10 grid) or latitude 35°-55'-10.22" and longitude 84°-19'-43.65". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 985 was drilled by Geotek Engineering Company. An Ingersoll-Rand Air Rotary rig was used to drill this boring for monitor well installation under operation of Larry Ledbetter with the assistance of Fred Dixon. Drilling commenced on 11-20-89 and was finished on 11-29-89. Paragraph 2.4.1 includes a detailed discussion of the well installation and a well schematic is included on the well installation/completion form. A synopsis of the drilling activity

follows. This information was typed directly from field notes and was edited only when necessary for clarification.

11-20-89 The Ingersoll-Rand was decontaminated along with the equipment and mobilized to the site. Plastic was layed down and the equipment set up. A 14.0" boring was augered to 7.0' and a 10.0-inch diverter casing was installed and grouted in place.

11-27-89 The Ingersoll-Rand and equipment were decontaminated.

11-28-89 All drilling equipment was mobilized to the site and set up. An 8.0-inch boring was then advanced to 20.0' with a tricone bit. The boring was cleaned and after a 30 minute recharge no water was found in the borehole. A water sample and an air sample was taken at 20.0'. The boring was advanced to 30.5', cleaned, and after a 45 minute recharge period, the water level was at 28.5'. The boring was then drilled to a depth of 35.0', and after a 45 minute recharge period the water level was at 31.5'. The rods were removed and the 2-inch stainless steel screen and casing were installed to a depth of 35.0'. The sand was tremied and a bentonite seal poured.

11-29-89 The remaining annulus was tremie grouted.

This well was logged by ERC Environmental and Energy Services Co., Inc., hydrogeologist C. Allison Bailey. All well construction materials and supplies were from Martin Marietta Energy Systems approved batches. The batch origin of individual items is shown on the included Monitoring Well Materials Certification form.

2.0 Technical Information

2.1 Decontamination Procedures

The drilling rig, down hole tools, surface casing, stainless steel screen, stainless steel casing, centralizers, and stainless steel silt trap underwent the cleaning decontam-ination procedures outlined in the drilling specifications (Release Specific Technical Directions for Regulatory Compliance Monitoring Wells Phase 1, Oak Ridge National Laboratory, Oak Ridge, W.O. K-4147, April 1987, pgs. 2-4). A checklist of the cleaned materials is included with this data package.

2.2 Geology

WAG 3 is located in Melton Valley which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 3 is underlain by limestone, siltstone and shale of the Middle Ordovician Chickamauga Group. The Chickamauga Group consists of eight units, designated by letters "A" to "H" (Stockdale, 1951). WAG 3 is underlain by units E, F, G and H. These units consist of thin bedded nodular limestone with clay and shale partings. A portion of unit H and unit

F consists of calcareous siltstone alternating with beds of olive gray to maroon shale. Strike and dip varies from N 45° E to N 55° E and 25° to 35° southeast, respectively.

2.3 Sample Collection

A drill water sample was collected from the water pump on the drill rig on 11-28-89. Analytical results for this sample described above can be obtained from the Remedial Action Program data base at ORNL.

The Ingersoll-Rand Air Rotary Rig's compressed air was sampled with a cloth filter inserted between drill rods on 11-28-89. The sample was examined with an ultraviolet light for the presence of hydrocarbons. The filter indicated no detectable evidence of hydrocarbons.

2.4 Installation and Development

2.4.1 Installation

This was a "Type D" well. The air rotary method was required to complete the boring to the specified total well depth. Therefore, a 14.0-inch diameter boring was augered from ground surface to 7.0 feet and a 10.0-inch diameter diverter casing was installed and grouted. An 8-inch diameter boring was then drilled with an air rotary tricone roller bit from 7.0 to 35.0 feet. A 2-inch diameter stainless steel screen with welded bottom cap was installed from 35.0 to 20.0 feet. A 2-inch diameter stainless steel casing was

installed above the screen at 20.0 feet and extended 1.93 feet above ground surface. A sandpack was then tremied into the annular space from 35.0 to 16.55 feet, with a 2.68-foot bentonite pellet seal poured into the annular space above the sandpack from 16.55 to 13.87 feet. The annular space from the top of the bentonite seal to the surface was tremie-grouted with a cement/bentonite slurry. A detail of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 985 was developed to remove drill cuttings, silt, and other fines. The monitoring well was developed using a Geoguard pump with an air compressor. All pumps were cleaned prior to use according to specified cleaning procedures (see Paragraph 2.1). The well was developed until a measured total of 100 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was 2.0 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on 4-17-90 at a depth of 33.4 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 985 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity of the well screen. This was accomplished by instantaneously adding a known quantity of water to the monitoring well and measuring the recovery of the water level over time. The changing water levels were measured using a Druck 15 psig pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 1.01×10^{-5} cm/second (shown as permeability on the hydraulic conductivity calculations printout attached) was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 985

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

PRE-DRILLING TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. EXCAVTION PERMIT OBTAINED	11-20-89	CAB
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	11-20-89	CAB
3a. SCREEN AND CASING HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	N/A	
3b. PRE-PACKAGED SCREENS, CASING AND CENTRALIZERS WERE USED.	11-28-89	CAB
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	11-20-89	CAB
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	11-20-89	CAB
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	11-28-89	CAB
7. AIR ROTARY COMPRESSED AIR SAMPLED.	11-28-89	CAB

RESULTS: No hydrocarbons detected on filter under ultraviolet light.

ADDITIONAL NOTES/OBSERVATIONS:

OBSERVER SIGNATURE/DATE C. Allison Bailey 11/20/89
C. Allison Bailey

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 985

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

EQUIPMENT	SCRAPE	STEAM CLEAN	STEAM RINSE	ISOPROPYL ALCOHOL RINSE	DEIONIZED WATER RINSE
RIG	X	X	X	N/A	N/A
AUGERS	X	X	X	X	X
BITS	X	X	X	X	X
RODS	X	X	X	X	X
SAMPLERS	X	X	X	X	X
PIPES	X	X	X	X	X
WORK TOOLS	X	X	X	X	X
AUGER PINS	X	X	X	X	X

OBSERVER SIGNATURE/DATE C. Allison Bailey 11/20/90
C. Allison Bailey

ERC / EDGE Environmental and Energy Services Co.

WELL No. 985

ORNL MONITORING WELL LOG

LOCATION: WAG-3
DRILLER: Larry Ledbetter
HELPER: Fred Dixon
DRILL: Ingersoll Rand T-4

DATE: START: 11-20-89
FINISH: 11-29-89
LOGGED BY: C. Allison Bailey
HEALTH PHYSICIST: W.H. Shinpaugh

TYPE DRILLING: Augering, Air Rotary
LUBRICANT TYPE: Green stuff
No. SAMPLES TAKEN: None
TYPE:
CONTAINMENT TYPE: Plastic, Auger Pan, Containment Box

THICKNESS OF SOIL (REFUSAL DEPTH): 9.5
DEPTH DRILLED IN ROCK: 25.5'
TOTAL DEPTH OF WELL: 35.0'

DRILLING FLUID SAMPLES:
TYPE: Water
DATE: 11-28-89

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
0.0	1.0			Gravel, fill material with clay, light brown and roots.
1.0	7.0			Clay, dark green gray to olive gray, with chert fragments, contains dark mineral, hard, moist.
7.0	9.5			*Fast, smooth, easy drilling.
9.5	35.0			Hard, slow, rough drilling, rock - limestone.
	35.0			Total Depth
				* No detailed lithologic log could be provided due to use of containment box.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 985

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: C. Allison Bailey
PROOFED BY: Michael L. Ebers

DRILLING COMPANY: Geotek

DRILLER: Larry Ledbetter HELPER: Fred Dixon

LOCATION WAG-3
ORNL GRID COORDINATES
N 21,833.8123
E 26,675.6115
ELEV. GROUND 829.97
ELEV. TOP STAINLESS STEEL CASING 831.90

DRILLING DATES:
STARTED: 11-20-89
FINISHED: 11-29-89

EQUIPMENT
- ☒ 14.0 INCH AUGER 7.0 L.F.
- ☐ _____ INCH AUGER _____ L.F.
- ☒ 8.0 INCH ROTARY 28.0 L.F.

MATERIALS USED

EST. VOL.	USED VOL.	
15.0		FEET OF 2.0 IN. S.S. SCREEN
22.5		FEET OF 2.0 IN. S.S. CASING
6.2	6.0	SACKS OF SAND
50	50.0	POUNDS OF BENTONITE PELLETS
2.2	2.25	SACKS OF CEMENT
12.0		POUNDS OF POWDERED BENTONITE
12.50		GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES
Irregular boring diameter.

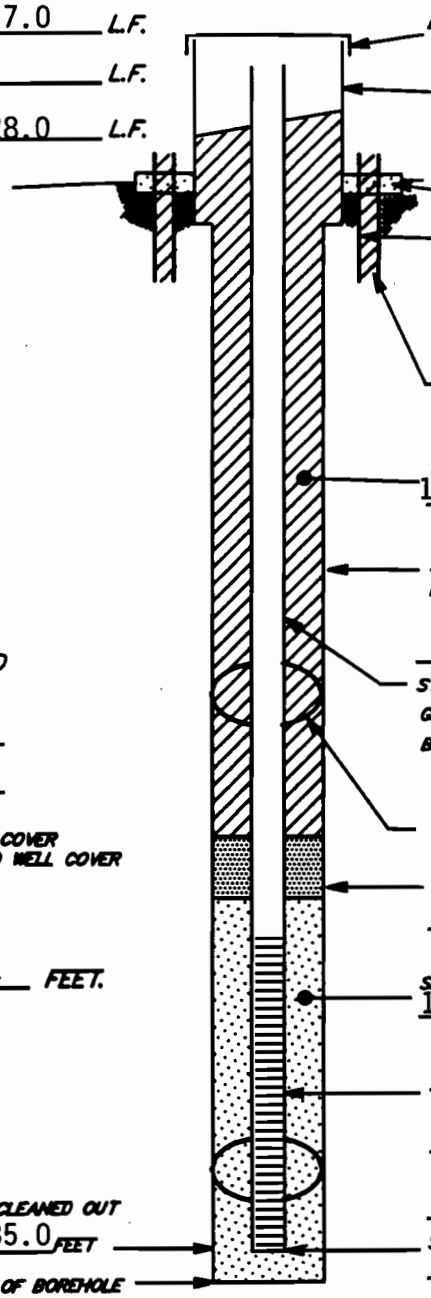
WELL COVER USED
- ☒ LOCKING STEEL COVER
- ☐ FLUSH MOUNTED WELL COVER
- ☐ OTHER

SILT TRAP USED YES ☐ NO ☒

MONITORING WELL PUMP BASE SET AT 33.4 FEET.

CENTRALIZERS AT 15.0 FEET.
35.0 FEET.
_____ FEET.

NOTE:
ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:



LOCKING STEEL COVER

8 INCH DIAMETER STEEL PROTECTIVE CASING 2.84 FT. ABOVE GROUND TO 2.0 FT. BELOW GROUND SURFACE

CONCRETE PAD

10.0 INCH DIVERTER CASING 1.0 FT. ABOVE GROUND SURFACE TO 7.0 FT. BELOW GROUND SURFACE

14.0 INCH BOREHOLE 0.0 TO 7.0 FEET

GROUT SEAL 0.0 TO 13.87 FEET

8.0 INCH DIAMETER BOREHOLE

2.0 INCH DIAMETER STAINLESS STEEL CASING 1.93 FT. ABOVE GROUND SURFACE TO 20.0 FT. BELOW GROUND SURFACE

CENTRALIZER (TYP.)

BENTONITE PELLET SEAL 13.87 TO 16.55 FEET

SAND PACK 16.55 TO 35.0 FEET

2.0 INCH DIAMETER STAINLESS STEEL 0.010 SLOTTED SCREEN 20.0 TO 35.0 FEET

N/A INCH DIAMETER STAINLESS STEEL SILT TRAP/CAP N/A TO N/A FEET

HOLE CLEANED OUT TO 35.0 FEET

BOTTOM OF BOREHOLE 35.0 FEET

TYPE D WELL

NOT TO SCALE

ERC / EDGE Environmental and Energy Services Co.

WELL No. 985

DATE: 11-28-89

MONITORING WELL MATERIALS CERTIFICATION

ITEM/MATERIAL		DATE USED	BATCH NUMBER
SAND		11-28-89	1
BENTONITE		11-28-89	Stores*
STAINLESS STEEL SCREEN	(PREPACKAGED ■ YES ☐ NO)	11-28-89	Stores*
STAINLESS STEEL CASING	(PREPACKAGED ■ YES ☐ NO)	11-28-89	Stores*
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ■ YES ☐ NO)	11-28-89	Stores*
STAINLESS STEEL CAPS	(PREPACKAGED ■ YES ☐ NO)	11-28-89	Stores*
MONITORING WELL PUMP	(PREPACKAGED ■ YES ☐ NO)	4-17-89	5
GROUT		11-29-89	3
WELL COVERS		11-28-89	Stores*
SURFACE CASING		N/A	N/A

COMMENTS:

* Surplus well completion supplies that were purchased but not used in the first monitor well drilling and installation phase (1987-1988).

OBSERVER SIGNATURE/DATE C. Allison Bailey 11-29-89
C. Allison Bailey

ERC / EDGE Environmental and Energy Services Co.

WELL No. 985

POST-WELL COMPLETION CHECKLIST

POST-WELL COMPLETION TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	11-20-89	CAB
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	11-20-89	CAB
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	4-17-90	DCL
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	11-28-89	CAB

* RELEASE SPECIFIC TECHNICAL DIRECTIONS FOR REGULATORY COMPLIANCE MONITORING WELLS PHASE I, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, W.O. K-4147, APRIL 1987.

OBSERVER SIGNATURE/DATE C. Allison Bailey 11-28-89
C. Allison Bailey

D. Charles Lytle 4-17-90
D. Charles Lytle

ERCE
Environmental and Energy Services Co.

WELL No. 985

LOCATION: WAG-3

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF DEVELOPMENT: Surging and Pumping

DEVELOPMENT BEGAN DATE: 4/04/90 TIME:

DEVELOPMENT ENDING DATE: 4/17/90

DEVELOPMENT OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 11.8 GALLONS

TOTAL GALLONS PUMPED: 100 TOTAL WELL VOLUMES PUMPED: 8.5

INITIAL pH: 7.4 FINAL pH: 7.4

INITIAL CONDUCTIVITY (µS/cm): 076 FINAL CONDUCTIVITY (µS/cm): 069

DESCRIPTION OF INITIAL TURBIDITY: Slightly Cloudy

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 2.0 NTU's

WELL APPROVED BY: R. C. Williams MMES

ODOR OF WATER:

WATER DISCHARGED TO:
- ■ GROUND SURFACE
- ☐ STORM SEWERS
- ☐ DRUMS
- ☐ TANK TRUCK
- ☐ STORAGE TANKS
- ☐ OTHER

INITIAL PRE-DEVELOPMENT WATER DEPTH: 6.9 feet from ground surface.

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 4/17/90

D. Charles Lytle

ERCE
Environmental and Energy Services Co.

WELL NO. 985
LOCATION: WAG-3
DATE: 4/04/90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 11.8 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (µS/cm)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
4-04-90	1100	41	Slightly Cloudy	--	7.4	76	41		
4-17-90	1430	59	Clear	2.0	7.4	69	100		
RESULTS AT END OF DEVELOPMENT			Clear	2.0	7.4	100	8.5		

COMMENTS Nice producer, remained clean even after surging. Passed and moved to another hole.

OBSERVER SIGNATURE/DATE D. Charles Lytle 4-17-90
D. Charles Lytle

MWFORM05.DWG

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

(1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967 (ARTICLE IN VOL.3, NO.1 OF WRR ENTITLED "RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER.")

(2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN VOL. 12, NO.3 OF WRR ENTITLED "A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS")

WELL NO.: 985 DATE OF TEST: 6/6/90

PROJECT NO.: E221-001 CLIENT: MMES

SITE LOCATION: X-10

EDGE, INC. FIELD INVESTIGATOR: BRUCE McMASTER

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 8.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 15.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 20.40 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 15.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = 1.00 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .30
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 32

HO WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED VALUES FOR HO (FEET)
3.2050
3.2181

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SECOND)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	4.970	3.970
20.00	4.500	3.500
30.00	4.330	3.330
40.00	4.260	3.260
50.00	4.210	3.210
60.00	4.170	3.170
75.00	4.120	3.120
90.00	4.080	3.080
105.00	4.050	3.050
120.00	4.010	3.010
150.00	3.950	2.950
180.00	3.890	2.890
240.00	3.780	2.780
300.00	3.680	2.680
360.00	3.610	2.610
420.00	3.530	2.530
480.00	3.460	2.460
540.00	3.370	2.370
600.00	3.340	2.340
720.00	3.190	2.190
840.00	3.070	2.070
960.00	2.990	1.990
1080.00	2.880	1.880
1200.00	2.780	1.780
1320.00	2.700	1.700
1440.00	2.610	1.610
1560.00	2.560	1.560
1680.00	2.510	1.510
1800.00	2.440	1.440
1920.00	2.410	1.410
2040.00	2.370	1.370
2160.00	2.320	1.320

****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

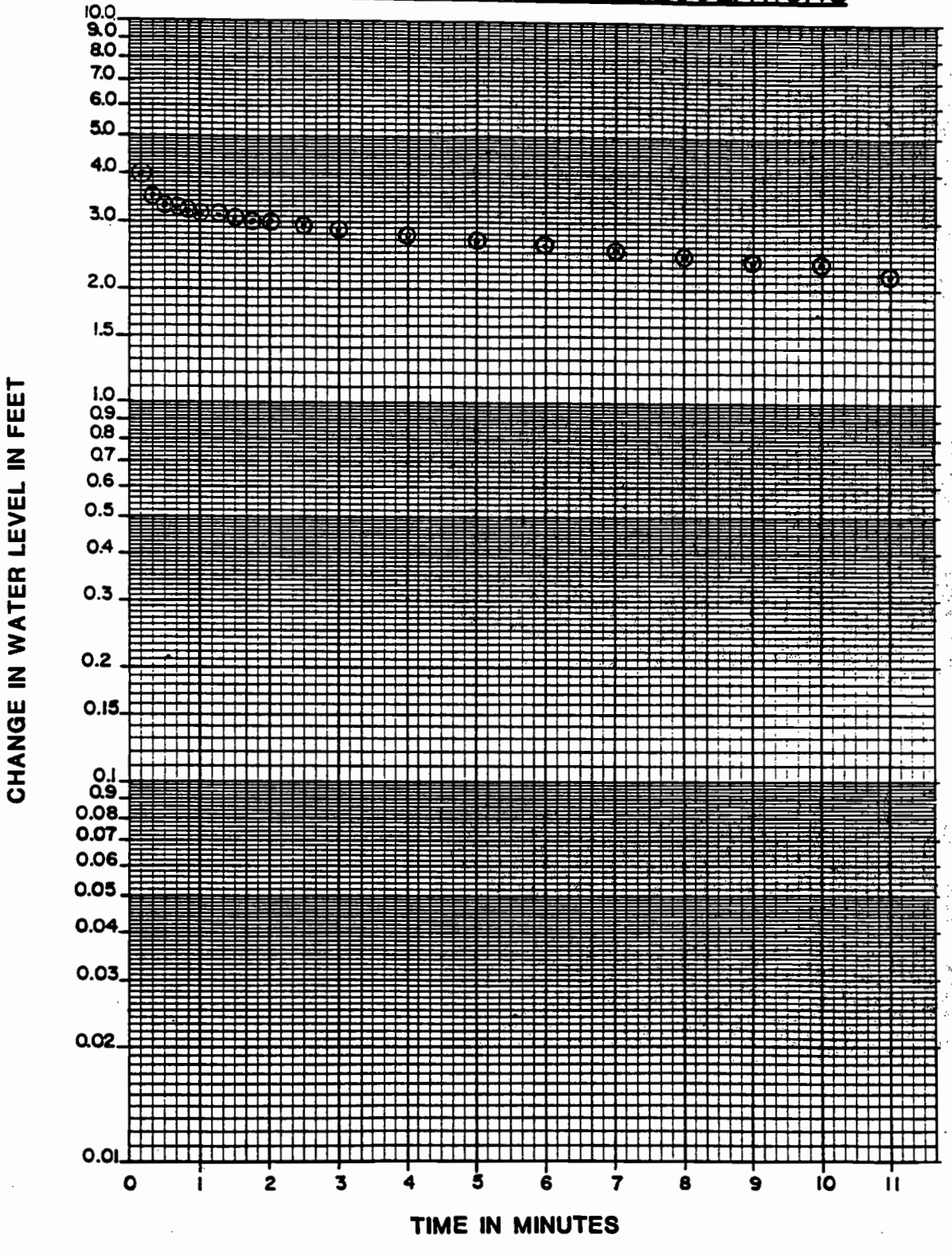
PERMEABILITY = 3.31E-07 FT/SECOND = 1.01E-05 CM/SEC

TRANSMISSIVITY = 4.97E-06 FT**2/SECOND

ERC / EDGE Environmental and Energy Services Co.

WELL No. 985

HYDRAULIC CONDUCTIVITY CALCULATIONS



EDGe Engineering, Design & Geosciences Group, Inc.
725 Pellissippi Parkway
P.O. Box 23010 Knoxville, Tn 37933-1010

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 985WW

WELL NO.	LOCATION:	TYPE:
985	WAG-3	Drill water

SAMPLER:	SAMPLE INTERVAL:	DATE:	TIME:
C. Allison Bailey (SIGNATURE)	N/A	11-28-89	1040

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECEIVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
C. Allison Bailey	01-15-90	1500	EDGE	[illegible]	1-15-90	1500	[illegible]

TYPE OF SAMPLE: ☐ SPLIT SPOON CORES–SOIL ☐ AUGER CUTTINGS–SOIL ☐ AUGER CUTTINGS–ROCK
☐ AIR ROTARY CUTTINGS–ROCK ■ DRILL WATER (NO AIR IN SAMPLE) ☐ OTHER _____

ALL SAMPLES ARE IMMEDIATELY PLACED IN I-CHEM SPECIALTY CLEANED CONTAINERS AND SEALED.

REMARKS: _____

1.0 General Information

1.1 Well Location

Monitoring well number 986 is located in WAG 3. It is along the eastern perimeter of WAG 3. The location is shown on ORNL drawing number C3E20004 A075. Survey coordinates for this well are N 21,813.1583, E 26,674.6725 (X-10 grid) or latitude 35°-55'-10.04" and longitude 84°-19'-43.52". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 986 was drilled by Geotek Engineering Company. An Ingersoll-Rand T-4 Air Rotary rig was used to drill this boring for monitor well installation under operation of Larry Ledbetter with the assistance of Fred Dixon. Drilling commenced on 11-9-89 and was finished on 11-20-89. Paragraph 2.4.1 includes a detailed discussion of the well installation and a well schematic is included on the well installation/completion form. A synopsis of the

drilling activity follows. This information was typed directly from field notes and was edited only when necessary for clarification.

11-9-89 The Ingersoll-Rand T-4 and tools were decontaminated.

11-10-89 The equipment was loaded and all drilling equipment was mobilized to the site. Plastic was layed down and the rig and equipment were set up. An 8-inch boring was split-spooned and augered to a refusal depth of 11.0'. Split spoon sample 986S01 and a bulk density sample were taken. A 22.0" borehole was augered to a completion depth of 7.0' and a 15 1/4" diverter casing set.

11-13-89 The Ingersoll-Rand and equipment were deconed.

11-14-89 The equipment was loaded and all drilling equipment mobilized to the site. The equipment was rigged up and a 14.0" tricone was used to extend the borehole to 14.0'. A 10-inch surface casing was installed, a bentonite seal poured and the annulus grouted.

11-16-89 The Ingersoll-Rand and equipment were cleaned, mobilized to the site and set up. The borehole was advanced to 18.5' with an 8-inch tricone bit; the borehole was cleaned.

11-17-89 The borehole was advanced to 40.0'. The borehole was cleaned. After 30 minutes recharge, the water level was at 37.0'.

The boring was then advanced to 50.0' and after a 15 minute wait, the water level was at 46.5', and after 30 minutes, the water level was at 42.5'. The boring was then advanced to 62.5'. A drill water sample was taken at 51.0' and an air sample taken at 60.0'. After a 5 minute wait the water level was at 47.5'.

11-20-89 The 4-inch stainless steel casing and screen was installed. The sand was tremied into place with water and a bentonite seal poured. The annulus of the boring was then grouted through 1-inch tremie.

This well was logged by ERC Environmental and Energy Services Co., Inc., hydrogeologist C. Allison Bailey. All well construction materials and supplies were from Martin Marietta Energy Systems approved batches. The batch origin of individual items is shown on the included Monitoring Well Materials Certification form.

2.0 Technical Information

2.1 Decontamination Procedures

The drilling rig, down hole tools, surface casing, stainless steel screen, stainless steel casing, centralizers, and stainless steel silt trap underwent the cleaning decontamination procedures outlined in the drilling specifications (Release Specific Technical Directions for Regulatory Compliance Monitoring Wells Phase 1, Oak Ridge National Laboratory, Oak Ridge, W.O. K-4147, April 1987,

pgs. 2-4). A checklist of the cleaned materials is included with this data package.

2.2 Geology

WAG 3 is located in Melton Valley which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 3 is underlain by limestone, siltstone and shale of the Middle Ordovician Chickamauga Group. The Chickamauga Group consists of eight units, designated by letters "A" to "H" (Stockdale, 1951). WAG 3 is underlain by units E, F, G and H. These units consist of thin bedded nodular limestone with clay and shale partings. A portion of unit H and unit F consists of calcareous siltstone alternating with beds of olive gray to maroon shale. Strike and dip varies from N 45° E to N 55° E and 25° to 35° southeast, respectively.

2.3 Sample Collection

One soil sample was collected during drilling, placed in an I-CHEM specialty cleaned glass container, sealed and submitted to Sample Receiving, Analytical Chemistry Division, Bldg. 4500S, ORNL. A chain of custody form for this sample is included with this data package. Soil sample 986S01 was collected in the split spoon interval from 9.0' to 11.0' on 11-10-89.

A drill water sample was collected from the water pump on the drill rig on 11-17-89. Analytical results for the soil and drill water samples described above can

be obtained from the Remedial Action Program data base at ORNL.

A bulk density soil sample was collected from the split spoon sample interval from 5.2' to 5.5'. The sample was measured and weighed, and a bulk density of 2.17 grams/cm^3 was calculated.

The Ingersoll-Rand T-4's compressed air was sampled with a cloth filter inserted between drill rods on 11-17-89. The sample was examined with an ultraviolet light for the presence of hydrocarbons. The filter showed no detectable evidence of hydrocarbons.

2.4 Installation and Development

2.4.1 Installation

This was a "Type B" well. An 8-inch boring was point split spooned and augered from 0.0' to a refusal depth of 11.0'. A 22.0-inch diameter boring was augered from ground surface to 7.0 feet. A 15 1/4-inch diverter casing was installed from surface to 7.0 feet below ground surface and grouted in place. The boring was then extended past the refusal depth with a 14.0-inch air rotary tricone roller bit from 7.0 feet to 14.0 feet. A 10.0-inch diameter string of decontaminated steel surface casing was installed from 0.0 feet to 14.0 feet, sealed with a 2.0-foot bentonite pellet layer from 12.0 feet to 14.0 feet, and tremie grouted in place. The surface casing minimizes potential cross contamination between the regolith and bedrock water bearing zones. After the

surface casing was installed, the air rotary method was used to drill an 8-inch diameter boring to a total depth of 62.5 feet. A 4-inch diameter stainless steel screen with a silt trap was installed from 62.0 feet to 41.70 feet. A 4-inch diameter stainless steel casing was installed from the top of the screen at 41.70 feet and extended 1.87 feet above ground surface. A sandpack was then tremied into the annular space from 62.0 to 39.15 feet, with a 2.44-foot bentonite pellet seal poured into the annular space above the sandpack from 39.15 to 36.71 feet. The annular space from the top of the bentonite seal to the surface was tremie grouted with a cement/bentonite slurry. A detailed schematic of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 986 was developed to remove drill cuttings, silt, and other fines. The monitoring well was developed using a Geoguard pump with an air compressor. All pumps were cleaned prior to use according to specified cleaning procedures (see Paragraph 2.1). The well was developed until a measured total of 653 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was 2.0 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on 5-17-90 at a depth of 61.3 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 986 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity of the well screen. This was accomplished by instantaneously adding a known quantity of water to the monitoring well and measuring the recovery of the water level over time. The changing water levels were measured using a Druck 15 psig pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 1.40×10^{-5} cm/second (shown as permeability on the hydraulic conductivity calculations printout attached), was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 986

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

PRE-DRILLING TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. EXCAVTION PERMIT OBTAINED	11-10-89	CAB
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	11-09-89	CAB
3a. SCREEN AND CASING HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	N/A	
3b. PRE-PACKAGED SCREENS, CASING AND CENTRALIZERS WERE USED.	11-20-89	CAB
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	11-10-89	CAB
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	11-10-89	CAB
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	11-10-89	CAB
7. AIR ROTARY COMPRESSED AIR SAMPLED.	11-17-89	CAB

RESULTS: No hydrocarbons detected under ultraviolet light.

ADDITIONAL NOTES/OBSERVATIONS:

OBSERVER SIGNATURE/DATE C. Allison Bailey 11-20-89
C. Allison Bailey

ERC / EDGE Environmental and Energy Services Co.

WELL No. 986

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

EQUIPMENT	SCRAPE	STEAM CLEAN	STEAM RINSE	ISOPROPYL ALCOHOL RINSE	DEIONIZED WATER RINSE
RIG	X	X	X	N/A	N/A
AUGERS	X	X	X	X	X
BITS	X	X	X	X	X
RODS	X	X	X	X	X
SAMPLERS	X	X	X	X	X
PIPES	X	X	X	X	X
WORK TOOLS	X	X	X	X	X
AUGER PINS	X	X	X	X	X

OBSERVER SIGNATURE/DATE C. Allison Bailey 11/10/89
C. Allison Bailey

ERC / EDGE Environmental and Energy Services Co.

WELL No. 986

ORNL MONITORING WELL LOG

LOCATION: WAG-3

DRILLER: Larry Ledbetter

HELPER: Fred Dixon

DRILL: Ingersoll Rand T-4

DATE: START: 11-10-89

FINISH: 11-20-89

LOGGED BY: C. Allison Bailey

HEALTH PHYSICIST: W. H. Shinpaugh

TYPE DRILLING: Split spoon, Auger, Air Rotary

LUBRICANT TYPE: Green stuff

No. SAMPLES TAKEN: One (986-S01)

TYPE: Soil

CONTAINMENT TYPE: Plastic, Pan, Containment Box

THICKNESS OF SOIL (REFUSAL DEPTH): 11.0

DEPTH DRILLED IN ROCK: 51.5

TOTAL DEPTH OF WELL: 67.5

DRILLING FLUID SAMPLES:

TYPE: Drill Water DATE: 11-17-89

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
0.0	1.4		50%	Clay, light brown, with roots, gravel and chert.
				Chert is white, brittle, and has iron stains.
				Clay is moist.
1.4	2.0			Clay, dark green gray to olive gray. Contains
				some chert fragments. Clay is firm and
				moist.
2.0	3.0		90%	Clay, dark gray to dark greenish gray. Clay
				is firm to crumbly and damp. Contains some
				roots and decayed organic material.
3.0	4.0			Clay, dark yellowish brown to brownish gray,
				firm to crumbly, damp, consolidated.
				Contains some roots.
4.0	6.0		80%	Clay, mottled, light brown and olive gray with
				dark mineral specks. Clay is hard, firm and
				cold. Bulk density taken from 5.2 to 5.5' =
				2.2 grams/cm^3.
6.0	7.0		100%	Clay, mottled, light brown, olive gray and
				medium gray, speckled with dark mineral
				(grayish black). Hard, firm and damp.
7.0	7.8		100%	Clay, mottled, light brown, olive gray and
				medium gray, speckled with dark mineral

ERC / EDGE Environmental and Energy Services Co.

WELL No. 986

ORNL MONITORING WELL LOG

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
7.0	7.8		100%	(continued from page 1) (grayish black).
				Hard, firm and damp.
7.8	9.0		100%	Clay, light brown, dark yellowish brown, and
				medium gray. Hard, firm, slightly damp.
				Clay is filled with alluvial/collovial
				material, pebbles, chips of rock, sand and
				silt. Pebbles are a sandy siltstone, pale
				red to maroon, brittle and weathered,
				medium to fine grained. Rock fragments are
				chert, milky, iron stained. Some of the
				chert is sandy, light brownish gray and
				weathered. The sand is pale yellowish orange.
9.0	9.8	986S01	70%	Clay, mottled, light brown, olive gray and
				medium gray, speckled with dark mineral
				(grayish black). Hard, firm and damp.
				Contains some alluvial/colluvial material.
				Siltstone, chert, sand and silt.
9.8	10.8			Clay, mottled, light gray, medium gray, dark
				greenish gray, dark yellowish orange with
				grayish black, mineral specks. Contains some
				siltstone, maroon. Clay is hard and firm.
10.8	11.0			Clay, olive gray, with dark yellowish orange to
				light brown and greenish gray streaks.
				Contains black mineral specks. Firm and
				moist. In the bottom of the split spoon,
				there are limestone fragments and a coating
				of crushed, powdered limestone forming a
				paste like substance. Wet.
	11.0			Split spoon refusal.
11.0	14.0			* Fairly hard drilling.
14.0	62.5			Hard, slow, rough drilling.
	62.5			Total Depth

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 986

ORNL MONITORING WELL LOG

DEPTH (FEET) FROM	DEPTH (FEET) TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
				(continued from page 2)
				* No detailed lithologic log could be provided from 11.0 to 62.5' due to use of containment box.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 986

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: C. Allison Bailey

PROOFED BY: Michael L. Ebers

DRILLING COMPANY: Geotek

DRILLER: Larry Ledbetter HELPER: Fred Dixon

DRILLING METHOD:
- ☒ 22.0 INCH AUGER 7.0 L.F.
- ☐ ____ INCH AUGER ____ L.F.
- ☒ 14.0 INCH ROTARY 7.0 L.F.
- ☒ 8.0 INCH ROTARY 48.5 L.F.

LOCATION WAG-3

ORNL GRID COORDINATES
N 21,813.1583
E 26,674.6725

ELEV. GROUND 830.56

ELEV. TOP STAINLESS STEEL CASING 832.43

DRILLING DATES:
STARTED: 11-09-89
FINISHED: 11-20-89

MATERIALS USED

EST. VOL.	USED VOL.	
	50.0	POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
	15.0	FT. OF 10.0 IN. SURFACE CASING
4.5	6.0	SACKS OF CEMENT (SURFACE CASING)
	30.0	POUNDS OF POWERED BENTONITE (SURFACE CASING)
	35.0	GALLONS OF WATER (SURFACE CASING)
	45.0	FT. OF 4.0 IN. DIA. STAINLESS STEEL CASING
	20.0	FT. OF 4.0 IN. DIA. STAINLESS STEEL SCREEN
5.0	5.25	SACKS OF SAND
500	50.0	POUNDS OF BENTONITE PELLETS
5.5	6.0	SACKS OF CEMENT (WELL CASING)
	18.0	POUNDS OF POWERED BENTONITE (WELL CASING)
	36.0	GALLONS OF WATER (WELL CASING)
	____	FT. OF ____ IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES
Irregular boring diameter.

SURFACE CASING TREMIE GROUTED YES ☒ NO ☐

STAINLESS STEEL CASING TREMIE GROUTED YES ☒ NO ☐

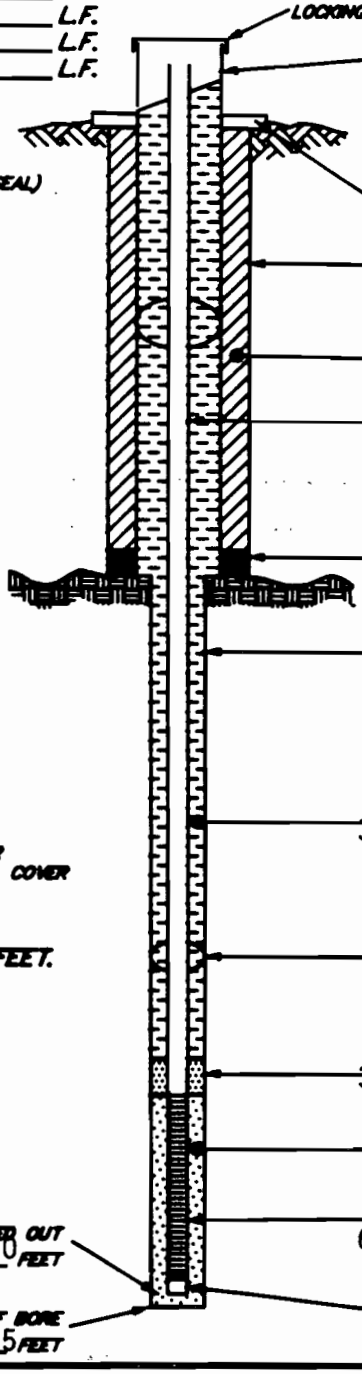
WELL COVER USED
- ☒ LOCKING STEEL COVER
- ☐ FLUSH MOUNTED WELL COVER
- ☐ OTHER

SILT TRAP USED YES ☒ NO ☐

MONITORING WELL PUMP BASE SET AT 61.3 FEET.

CENTRALIZERS AT 15.0 FEET.
40.0 FEET.
61.5 FEET.

NOTE:
ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:



TYPE B WELL

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 986

DATE: 11-10-89

MONITORING WELL MATERIALS CERTIFICATION

ITEM/MATERIAL		DATE USED	BATCH NUMBER
SAND		11-20-89	1
BENTONITE		11-14-89	1
		11-20-89	Stores*
STAINLESS STEEL SCREEN	(PREPACKAGED ■ YES □ NO)	11-20-89	Stores*
STAINLESS STEEL CASING	(PREPACKAGED ■ YES □ NO)	11-20-89	Stores*
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ■ YES □ NO)	11-20-89	Stores*
STAINLESS STEEL CAPS	(PREPACKAGED ■ YES □ NO)	11-20-89	Stores*
MONITORING WELL PUMP	(PREPACKAGED ■ YES □ NO)	5-17-90	5
GROUT		11-14-89	3
		11-20-89	3
WELL COVERS		11-20-89	Stores*
SURFACE CASING		11-14-89	3

COMMENTS:

* Surplus well completion supplies that were purchased but not used in the first monitor well drilling and installation phase (1987-1988).

OBSERVER SIGNATURE/DATE C. Allison Bailey 11-20-89
C. Allison Bailey

ERC / EDGE Environmental and Energy Services Co.

WELL No. 986

POST-WELL COMPLETION CHECKLIST

POST-WELL COMPLETION TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	11-10-89	CAB
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	11-10-89	CAB
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	5-17-90	DCL
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	11-20-89	CAB

* RELEASE SPECIFIC TECHNICAL DIRECTIONS FOR REGULATORY COMPLIANCE MONITORING WELLS PHASE I, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, W.O. K-4147, APRIL 1987.

OBSERVER SIGNATURE/DATE C. Allison Bailey 11-20-89
C. Allison Bailey

D. Charles Lytle 5-17-90
D. Charles Lytle

ERCE
Environmental and Energy Services Co.

WELL No. 986
LOCATION: WAG-3

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF DEVELOPMENT: Surging and Pumping

DEVELOPMENT BEGAN DATE: 5/07/90 TIME:

DEVELOPMENT ENDING DATE: 5/17/90

DEVELOPMENT OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 50.0 GALLONS

TOTAL GALLONS PUMPED: 653 TOTAL WELL VOLUMES PUMPED: 13.1

INITIAL pH: 7.5 FINAL pH: 7.7

INITIAL CONDUCTIVITY (µS/cm): 209 FINAL CONDUCTIVITY (µS/cm): 169

DESCRIPTION OF INITIAL TURBIDITY: Milky

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 2.0 NTU's

WELL APPROVED BY: R. C. Williams MMES

ODOR OF WATER: None

WATER DISCHARGED TO:
- ■ GROUND SURFACE
- ☐ STORM SEWERS
- ☐ DRUMS
- ☐ TANK TRUCK
- ☐ STORAGE TANKS
- ☐ OTHER

INITIAL PRE-DEVELOPMENT WATER DEPTH: 9.2 feet from ground surface.

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 5/17/90
D. Charles Lytle

NVTBFTBRHLDVG

ERCE
Environmental and Energy Services Co.

WELL NO. 986
LOCATION: WAG-3
DATE: 5/17/90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 50.0 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (µS/cm)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
5-07-90	1100	156	Milky	--	7.5	209	156	3.1	
5-07-90	1300	14	Slightly Cloudy	--	7.6	243	170	3.4	
5-08-90	1300	65	Milky	--	7.5	234	235	4.7	
5-11-90	0900	164	Cloudy	--	7.9	211	399	8.0	
5-15-90	0900	116	Slightly Cloudy	--	7.6	179	515	10.3	
5-15-90	1100	26	Slightly Cloudy	--	7.4	181	541	11.0	
5-15-90	1400	18	Slightly Cloudy	--	7.5	182	559	11.2	
5-16-90	1400	62	Slightly Cloudy	--	7.2	219	621	12.4	
5-17-90	0900	32	Clear	2.0	7.7	169	653	13.1	
RESULTS AT END OF DEVELOPMENT			Clear	2.0	7.7	169	653	13.1	

COMMENTS Nice producer, water finally cleared, passed with 2.0 NTU's and moved to another hole.

OBSERVER SIGNATURE/DATE D. Charles Lytle 5/17/90
D. Charles Lytle

MWFORM05.DWG

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

(1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967 (ARTICLE IN VOL.3, NO.1 OF WRR ENTITLED "RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER")

(2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN VOL. 12, NO.3 OF WRR ENTITLED "A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS")

WELL NO.: 986 DATE OF TEST: 6/6/90

PROJECT NO.: E221-001 CLIENT: MMES

SITE LOCATION: X-10

EDGE, INC. FIELD INVESTIGATOR: BRUCE McMASTER

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 8.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 20.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 45.30 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 20.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = .84 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .30
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 31

HO WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED
VALUES FOR HO
(FEET)

1.4453
1.4530

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 986

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SECONDS)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	2.940	2.100
20.00	2.600	1.760
30.00	2.420	1.580
40.00	2.340	1.500
50.00	2.290	1.450
60.00	2.210	1.370
75.00	2.200	1.360
90.00	2.160	1.320
105.00	2.130	1.290
120.00	2.110	1.270
150.00	2.080	1.240
180.00	2.040	1.200
240.00	1.990	1.150
300.00	1.940	1.100
360.00	1.900	1.060
420.00	1.830	.990
480.00	1.780	.940
540.00	1.730	.890
600.00	1.730	.890
720.00	1.620	.780
840.00	1.560	.720
960.00	1.580	.740
1080.00	1.450	.610
1200.00	1.390	.550
1320.00	1.390	.550
1440.00	1.370	.530
1560.00	1.290	.450
1680.00	1.330	.490
1800.00	1.310	.470
1920.00	1.210	.370
2040.00	1.220	.380

****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

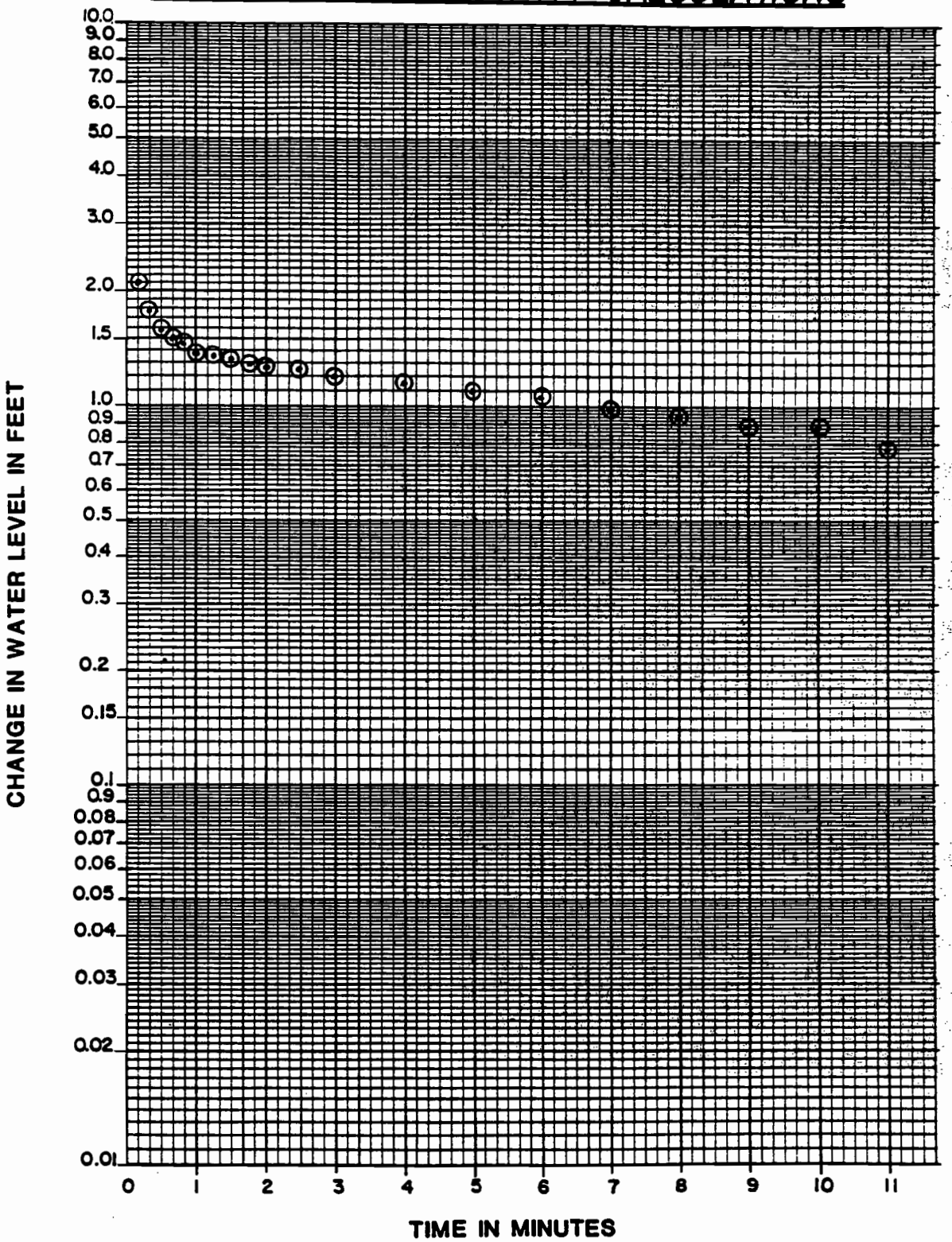
PERMEABILITY = 4.60E-07 FT/SECONDS = 1.40E-05 CM/SEC

TRANSMISSIVITY = 9.20E-06 FT**2/SECONDS

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 986

HYDRAULIC CONDUCTIVITY CALCULATIONS



EDGe Engineering, Design & Geosciences Group, Inc.
725 Pellissippi Parkway
P.O. Box 23010 Knoxville, Tn 37933-1010

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 986WO

WELL NO.	LOCATION:	TYPE:	
986	WAG-3	Drill Water	
SAMPLER: C. Allison Baily (SIGNATURE)	SAMPLE INTERVAL: N/A	DATE: 11-17-89	TIME: 1430

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECEIVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
C. Allison Baily	11-15-90	1500	EDGe	J. C. Pruie	11-15-90	1500	M.M.

TYPE OF SAMPLE: ☐ SPLIT SPOON CORES-SOIL ☐ AUGER CUTTINGS-SOIL ☐ AUGER CUTTINGS-ROCK
☐ AIR ROTARY CUTTINGS-ROCK ■ DRILL WATER (NO AIR IN SAMPLE) ☐ OTHER _____

ALL SAMPLES ARE IMMEDIATELY PLACED IN I-CHEM SPECIALTY CLEANED CONTAINERS AND SEALED.

REMARKS: _____

EDGe Engineering, Design & Geosciences Group, Inc.
726 Pellissippi Parkway
P.O. Box 23010 Knoxville, Tn 37933-1010

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 781-S

WELL NO.	LOCATION:	TYPE:	
986	WAG-3	Soil	
SAMPLER: C. Allison Rady (SIGNATURE)	SAMPLE INTERVAL: 9.0 - 11.0	DATE: 11-10-89	TIME: 0913

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECEIVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
C. Allison Rady	11-15-90	1500	EDGe	[illegible]	1-15-90	1520	[illegible]

TYPE OF SAMPLE: ■ SPLIT SPOON CORES–SOIL ☐ AUGER CUTTINGS–SOIL ☐ AUGER CUTTINGS–ROCK
☐ AIR ROTARY CUTTINGS–ROCK ☐ DRILL WATER (NO AIR IN SAMPLE) ☐ OTHER _____

ALL SAMPLES ARE IMMEDIATELY PLACED IN I–CHEM SPECIALTY CLEANED CONTAINERS AND SEALED.

REMARKS: _____

1.0 General Information

1.1 Well Location

Monitoring well number 987 is located in WAG 3. It is approximately 250 feet west of the SWSA 3 perimeter fence. The location is shown on ORNL drawing number C3E20004 A075. Survey coordinates for this well are N 21,650.1399, E 25,857,8905 (X-10 grid) or latitude 35°-55'-04.21" and longitude 84°-19'-50.67". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 987 was drilled by A. L. Clark Drilling Services, Inc. A Gus Pech and a Schramm rig were used to drill this boring for monitor well installation under operation of A. L. Clark, II and A. L. Clark, III with the assistance of Leo Johnson. Drilling commenced on 11-3-87 and was finished on 11-18-87. Paragraph 2.4.1 includes a detailed discussion of the well installation and a well schematic is included on the well installation/completion form. A synopsis of the drilling activity follows. This information was

typed directly from field notes and was edited only when necessary for clarification.

11-3-87-11-4-87 The Gus Pech was steamcleaned.

11-5-87 The drill rig was mobilized to the staked location and set up. The boring was drilled from 0.0' to 1.4' with 14" augers. The boring was split spooned from 1.4 feet to 9.4 feet.

11-6-87 The boring was split spooned from 9.4 to 13.3 feet, and augered to 14.3 feet with 14" augers.

11-9-87 Ten-inch surface casing was set from the surface to 14.3 feet and the casing grouted.

11-11-87 The Schramm air rotary was steamcleaned and the boring advanced to a total depth of 48.2 feet.

11-17-87 The well was set with 4-inch stainless steel screen and casing. The sand pack and bentonite seal were installed.

11-18-87 The annular space was tremie grouted.

This well was logged by ERC Environmental and Energy Services Co., Inc., hydrogeologists Michael L. Ebers and Bryn D. Howze. All well construction materials and supplies were from Martin Marietta Energy Systems approved batches. The batch origin of individual items is shown on the included Monitoring Well Materials Certification form.

2.0 Technical Information

2.1 Decontamination Procedures

The drilling rig, down hole tools, surface casing, stainless steel screen, stainless steel casing, centralizers, and stainless steel silt trap underwent the cleaning decontamination procedures outlined in the drilling specifications (Release Specific Technical Directions for Regulatory Compliance Monitoring Wells Phase 1, Oak Ridge National Laboratory, Oak Ridge, W.O. K-4147, April 1987, pgs. 2-4). A checklist of the cleaned materials is included with this data package.

2.2 Geology

WAG 3 is located in Melton Valley which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 3 is underlain by limestone, siltstone and shale of the Middle Ordovician Chickamauga Group. The Chickamauga Group consists of eight units, designated by letters "A" to "H" (Stockdale, 1951). WAG 3 is underlain by units E, F, G and H. These units consist of thin bedded nodular limestone with clay and shale partings. A portion of unit H and unit F consists of calcareous siltstone alternating with beds of olive gray to maroon shale. Strike and dip varies from N 45° E to N 55° E and 25° to 35° southeast, respectively.

2.3 Sample Collection

One soil sample and one drill water sample were collected during drilling, placed in an I-CHEM specialty cleaned glass container, sealed and submitted to Sample Receiving, Analytical Chemistry Division, Bldg. 4500S, ORNL. Chain of custody forms for these samples are included with this data package. Soil sample 987S01 was collected in the split spoon interval from 2.1 feet to 2.2 feet on 11-5-87.

A drill water sample was collected from the water pump on the drill rig on 11-11-87. Analytical results for the soil and water samples described above can be obtained from the Remedial Action Program data base at ORNL.

2.4 Installation and Development

2.4.1 Installation

This was a "Type B" well. A 14-inch diameter boring was augered from ground surface to bedrock (14.3 feet). A 10-inch diameter string of decontaminated steel surface casing was installed and tremie grouted in place. The surface casing minimizes potential cross contamination between the regolith and bedrock water bearing zones. The air rotary method was then used to drill an 8-inch diameter boring to a total depth of 48.2 feet. A 4-inch diameter stainless steel silt trap was installed from 47.9 to 48.2 feet. Above

the silt trap, a 4-inch diameter stainless steel screen was installed from 27.1 feet and extending 2.12 feet above ground surface. A sandpack was then poured into the annular space from 25.4 to 48.2 feet, with a 2.3-foot bentonite seal poured into the annular space above the sandpack from 23.1 to 25.4 feet. The annular space from the top of the bentonite seal to the surface was tremie grouted with a cement/bentonite slurry. A detailed schematic of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 987 was developed to remove drill cuttings, silt, and other fines. The monitoring well was developed using a Geoguard pump with an air compressor. All pumps were cleaned prior to use according to specified cleaning procedures (see Paragraph 2.1). The well was developed until a measured total of 404 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was >100 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed

on 5-4-90 at a depth of 45.7 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 987 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity of the well screen. This was accomplished by instantaneously adding a known quantity of water to the monitoring well and measuring the recovery of the water level over time. The changing water levels were measured using a Druck 15 psig pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 4.97×10^{-5} cm/second (shown as permeability on the hydraulic conductivity calculations printout attached) was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 987

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

PRE-DRILLING TASKS		COMPLIANCE DATE	COMPLIANCE INITIALS
1.	EXCAVATION PERMIT OBTAINED.	11-05-87	MLE
2.	ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	11-05-87	MLE
3a.	SCREEN AND CASINGS HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	N/A	
3b.	PRE-PACKAGED SCREENS, CASINGS AND CENTRALIZERS WERE USED.	11-17-87	BDH
4.	WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	11-06-87	MLE
5.	CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON-HAND.	11-05-87	MLE
6.	POLYETHYLENE COVER IN PLACE OVER HOLE.	11-05-87	MLE

ADDITIONAL NOTES/OBSERVATIONS:

OBSERVER SIGNATURE/DATE Michael L. Ebers 11/05/87

Bryn D. Howze 11/17/87

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 987

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

EQUIPMENT	SCRAPE	STEAM CLEAN	STEAM RINSE	ISOPROPYL ALCOHOL RINSE	DEIONIZED WATER RINSE
RIG	X	X	X	N/A	N/A
AUGERS	X	X	X	X	X
BITS	X	X	X	X	X
RODS	X	X	X	X	X
SAMPLERS	X	X	X	X	X
PIPES	X	X	X	X	X
WORK TOOLS	X	X	X	X	X
AUGER PINS	X	X	X	X	X

OBSERVER SIGNATURE/DATE _____ 11/05/87
Michael L. Ebers

ERC / EDGE Environmental and Energy Services Co.

WELL No. 987

ORNL MONITORING WELL LOG

LOCATION: SWSA 3

DRILLER: A.L. Clark, III/A.L. Clark, II

HELPER: Danny Julian/Leo Johnson

DRILL: Gus Pech and Schramm Air Rotary

DATE: START: 11-05-87

FINISH: 11/18/87

LOGGED BY: Bryn D. Howze/ Michael L. Ebers

HEALTH PHYSICIST: N/A

TYPE DRILLING: Auger and Air Rotary

LUBRICANT TYPE: Green stuff

No. SAMPLES TAKEN: 2 (two)

TYPE: 1 soil/1 water

CONTAINMENT TYPE: Auger Pan, Plastic, Containment Box

THICKNESS OF SOIL (REFUSAL DEPTH): 13.3'

DEPTH DRILLED IN ROCK: 34.9'

TOTAL DEPTH OF WELL: 48.2'

DRILLING FLUID SAMPLES:

TYPE: Water DATE: 11/11/87

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
0.0	0.2		14" Auger	Gravels
0.2	1.4		14" Auger	Clay, light to moderate brown, slightly silty,
				medium dense, damp, medium soft-plastic,
				abundant tree roots.
1.4	2.1		100%	Clay, moderate reddish brown, silty, few roots
				and fine chert gravels, damp.
2.1	9.4	0987S01	100%	Clay, distinctly mottled, moderate reddish
		@2.1-2.2'		brown and yellowish orange, fine silty,
				medium stiff, slightly damp, few roots.
9.4	9.8		100%	Clay, silty, reddish brown, mottled, orange,
				yellow, black, minor roots, stiff.
9.8	11.4		100%	Silt, clayey, highly weathered shaley limestone,
				light brown, mottled orange, black, greenish
				gray, firm to stiff.
11.4	13.3		100%	Silt, slightly clayey, highly weathered shaley
				limestone, light brown, mottled orange black,
				greenish gray, with relict bedding, damp,
				stiff.
				Split spoon refusal at 13.3'.
13.3	14.3			Limestone, weathered, light gray.
14.3	48.2			No detailed lithologic description available

ERC / EDGE Environmental and Energy Services Co.

WELL No. 987

ORNL MONITORING WELL LOG

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
14.3	48.2			(continued from page 1) from 14.3' to 48.2'
				due to use of containment box.
	48.2			Total Depth.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 987

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: Michael L. Ebers/ Bryn Howze

PROOFED BY: Michael L. Ebers

DRILLING COMPANY: A. L. Clark

DRILLER: Avery L. Clark, III HELPER: Leo Johnson

DRILLING METHOD:
- ☒ 14 INCH AUGER 14.3 L.F.
- ☐ INCH AUGER L.F.
- ☒ 8 5/8 INCH ROTARY 33.9 L.F.
- ☐ INCH ROTARY L.F.

LOCATION SWSA 3

ORNL GRID COORDINATES
N 21,650.1399
E 25,857.8905

ELEV. GROUND 857.11

ELEV. TOP STAINLESS STEEL CASING 859.23

DRILLING DATES:
STARTED: 11-05-87
FINISHED: 11-18-87

MATERIALS USED

EST. VOL.	USED VOL.	
	50	POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
	16	FT. OF 10 IN. SURFACE CASING
4	6	SACKS OF CEMENT (SURFACE CASING)
	11	POUNDS OF POWERED BENTONITE (SURFACE CASING)
	36	GALLONS OF WATER (SURFACE CASING)
	30.0	FT. OF 4 IN. DIA. STAINLESS STEEL CASING
	20.8	FT. OF 4 IN. DIA. STAINLESS STEEL SCREEN
7.4	8	SACKS OF SAND
50	200	POUNDS OF BENTONITE PELLETS
7.3	14	SACKS OF CEMENT (WELL CASING)
	26	POUNDS OF POWERED BENTONITE (WELL CASING)
	84	GALLONS OF WATER (WELL CASING)
	2	FT. OF 10 IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES
Cavities and fractures.

SURFACE CASING TREMIE GROUTED YES ☒ NO ☐

STAINLESS STEEL CASING TREMIE GROUTED YES ☒ NO ☐

WELL COVER USED
- ☒ LOCKING STEEL COVER
- ☐ FLUSH MOUNTED WELL COVER
- ☐ OTHER

SILT TRAP USED YES ☒ NO ☐

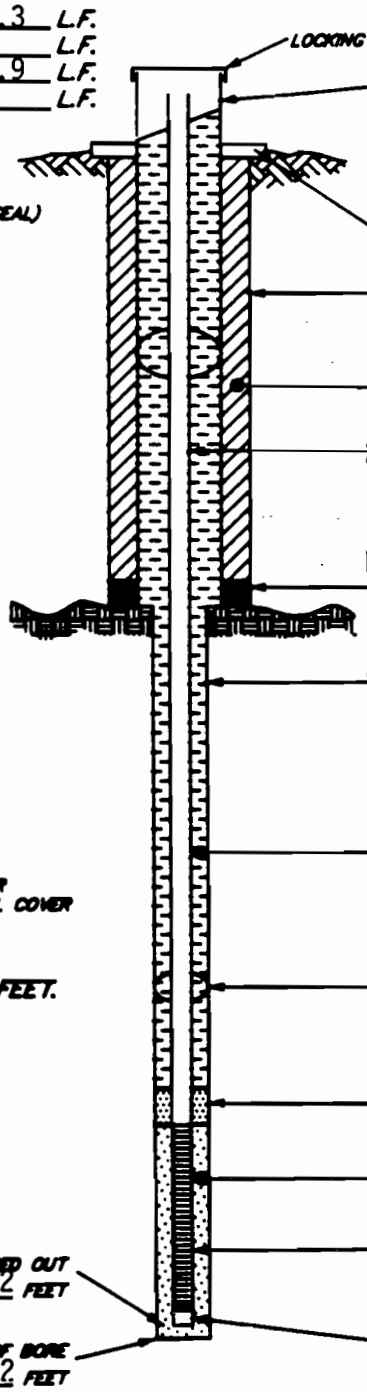
MONITORING WELL PUMP BASE SET AT 45.7 FEET.

CENTRALIZERS AT 3.0 FEET.
12.0 FEET.
27.0 FEET.
48.0 FEET

NOTE:
ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:

HOLE CLEANED OUT TO 48.2 FEET

BOTTOM OF BORE HOLE 48.2 FEET



TYPE B WELL

ERC / EDGE Environmental and Energy Services Co.

WELL No. 987

DATE: 11/17/87

MONITORING WELL MATERIALS CERTIFICATION

ITEM/MATERIAL		DATE USED	BATCH NUMBER
SAND		11-09-87	2
		11-17-87	3
BENTONITE		11-09-87	3
		11-17-87	3
STAINLESS STEEL SCREEN	(PREPACKAGED ■ YES ☐ NO)	11-17-87	5
STAINLESS STEEL CASING	(PREPACKAGED ■ YES ☐ NO)	11-17-87	5
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ■ YES ☐ NO)	11-17-87	5
STAINLESS STEEL CAPS	(PREPACKAGED ■ YES ☐ NO)	11-17-87	5
MONITORING WELL PUMP	(PREPACKAGED ■ YES ☐ NO)	5-04-90	5
GROUT		11-09-87	14
		11-18-87	14
WELL COVERS			
SURFACE CASING		11-09-87	2

COMMENTS:

OBSERVER SIGNATURE/DATE Bryn D. Howze 11-17-87
Bryn D. Howze

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 987

POST-WELL COMPLETION CHECKLIST

POST-WELL COMPLETION TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	11/18/87	BDH
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	11/18/87	BDH
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	5/04/90	DCL
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	11/18/87	BDH

* RELEASE SPECIFIC TECHNICAL DIRECTIONS FOR REGULATORY COMPLIANCE MONITORING WELLS PHASE I, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, W.O. K-4147, APRIL 1987.

OBSERVER SIGNATURE/DATE Bryn D. Howze 11/18/87
Bryn D. Howze

D. Charles Lytle 5/04/90
D. Charles Lytle

ERCE
Environmental and Energy Services Co.

WELL No. 987

LOCATION: WAG-3

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF DEVELOPMENT: Surging and Pumping

DEVELOPMENT BEGAN DATE: 4/27/90 TIME:

DEVELOPMENT ENDING DATE: 5/04/90

DEVELOPMENT OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 13.0 GALLONS

TOTAL GALLONS PUMPED: 404 TOTAL WELL VOLUMES PUMPED: 31.1

INITIAL pH: 7.7 FINAL pH: 7.6

INITIAL CONDUCTIVITY (µS/cm): 674 FINAL CONDUCTIVITY (µS/cm): 651

DESCRIPTION OF INITIAL TURBIDITY: Cloudy

DESCRIPTION OF FINAL TURBIDITY: Milky

FINAL MEASURED TURBIDITY: Greater than 100 NTU's

WELL APPROVED BY: R. C. Williams MMES

ODOR OF WATER: None

WATER DISCHARGED TO:
- ☒ GROUND SURFACE
- ☐ STORM SEWERS
- ☐ DRUMS
- ☐ TANK TRUCK
- ☐ STORAGE TANKS
- ☐ OTHER

INITIAL PRE-DEVELOPMENT WATER DEPTH: 23.5 feet from ground surface.

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 5/04/90

D. Charles Lytle

MVDFORM.DVG

ERCE
Environmental and Energy Services Co.

WELL NO. 987
LOCATION: WAG-3
DATE: 4-27-90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 13.0 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (µS/cm)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
5-01-90	1400	175	Cloudy	--	7.7	674	175	13.5	
5-02-90	0930	72	Muddy	--	7.8	447	247	19.0	
5-03-90	0900	56	Muddy	--	7.4	574	303	23.3	
5-03-90	1100	20	Semi-Muddy	--	7.7	597	323	24.8	
5-03-90	1330	10	Milky	--	7.6	664	333	25.6	
5-04-90	0900	25	Milky	--	7.6	627	358	27.5	
5-04-90	1330	46	Milky	*	7.6	651	404	31.1	
RESULTS AT END OF DEVELOPMENT			Milky	*	7.6	651	404	31.1	

COMMENTS Good producer, water would not clean up at all, remained cloudy.
Passed because of the 31.1 well volumes and moved to another hole.
* Greater than 100 NTU's.

OBSERVER SIGNATURE/DATE D. Charles Lytle 5/04/90
D. Charles Lytle

MWFORM05.DWG

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

(1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967 (ARTICLE IN VOL.3, NO.1 OF WRR ENTITLED "RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER")

(2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN VOL. 12, N0.3 OF WRR ENTITLED "A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS")

WELL NO.: 0987 DATE OF TEST: 5/16/90

PROJECT NO.: E221-002 CLIENT: MMES

SITE LOCATION: WAG-3

EDGE, INC. FIELD INVESTIGATOR: Bruce McMaster

INPUT DATA ARE:

INNER CASING DIAMETER = 4.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 4.00 INCHES
DIAMETER OF DRILLED HOLE = 8.63 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 20.50 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 19.60 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 20.50 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = .00 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .20
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 32

H0 WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED
VALUES FOR H0
(FEET)

1.7612
1.7741

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	1.930	1.930
20.00	1.810	1.810
30.00	1.780	1.780
40.00	1.780	1.780
50.00	1.770	1.770
60.00	1.760	1.760
75.00	1.750	1.750
90.00	1.720	1.720
105.00	1.700	1.700
120.00	1.690	1.690
150.00	1.640	1.640
180.00	1.580	1.580
240.00	1.440	1.440
300.00	1.330	1.330
360.00	1.240	1.240
420.00	1.170	1.170
480.00	1.160	1.160
540.00	1.080	1.080
600.00	1.010	1.010
720.00	.900	.900
840.00	.820	.820
960.00	.730	.730
1080.00	.680	.680
1200.00	.620	.620
1320.00	.580	.580
1440.00	.550	.550
1560.00	.480	.480
1680.00	.450	.450
1800.00	.430	.430
1920.00	.400	.400
2040.00	.400	.400
2160.00	.370	.370

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

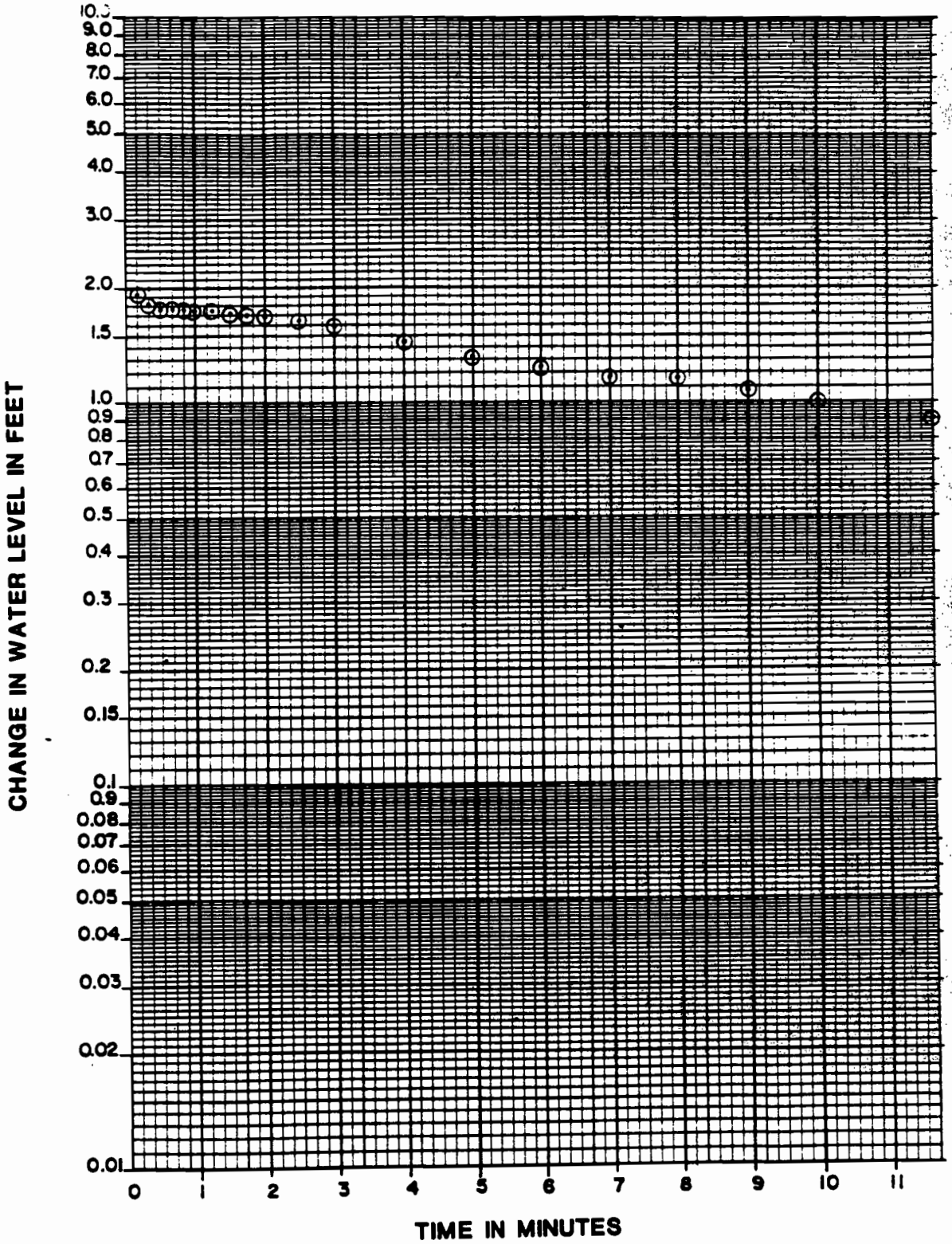
PERMEABILITY = 1.63E-06 FT/SEC = 4.97E-05 CM/SEC

TRANSMISSIVITY = 3.34E-05 FT**2/SEC

ERC / EDGE Environmental and Energy Services Co.

WELL No. 987

HYDRAULIC CONDUCTIVITY CALCULATIONS



MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0987 51

WELL NO.: 987

LOCATION: SWSA 3 2.1'-2.2'

TYPE: Soil

SAMPLER: Bryan House (SIGNATURE)

DATE: 11/5/87

TIME: 4:26 PM

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
Bryan House	12/14/87	9:17AM	MCI	Nancy Owen	12-14-87	9:17	ORNL

REMARKS:

MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0987 W1

WELL NO.: 987

LOCATION: SWSA 3

TYPE: Drilling water

SAMPLER: Bryan Howze (SIGNATURE)

DATE: 11/11/87

TIME: 1:15 PM

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
Bryan Howze	12/14/87	9:17AM	MCI	Nancy Owen	12-14-87	9:17	ORNL

REMARKS:

1.0 General Information

1.1 Well Location

Monitoring well number 988 is located in WAG 3. It is located in the southeastern corner of the contractors landfill. The location is shown on ORNL drawing number C3E20004 A075. Survey coordinates for this well are N 21,075.7290, E 25,471.2850 (X-10 grid) or latitude 35°-54'-57.37" and longitude 84°-19'-50.69". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 988 was drilled by A. L. Clark Drilling Services, Inc. A Gus Pech rig was used to drill this boring for monitor well installation under operation of A. L. Clark III with the assistance of Leo Johnson. Drilling commenced on 9-28-87 and was finished on 11-2-87. Paragraph 2.4.1 includes a detailed discussion of the well installation and a well schematic is included on the well installation/completion form. A synopsis of the drilling activity

follows. This information was typed directly from field notes and was edited only when necessary for clarification.

9-28-87 Set up and started drilling - split spoons, then augering.

9-29-87 Augering.

9-30-87 Augered to 39.0' and started bailing.

10-1-87 Drilled/augered to 46.6' with 6 3/4" augers and started bailing.

10-2-87 Bailing.

10-5-87 Bailing.

10-6-87 Decision made by Martin Marietta to convert hole from A to D.

10-7-87 Augered to 20.0' with 14" auger.

10-8-87 Set 8" surface casing to 20.0'.

10-9-87-10-20-87 Modifying fittings to Gus Pech and containment boxes, moving to new staging area.

10-20-87-10-21-87 Steam cleaning rods, bit, tooling for air rotary (at SWSA 5 shed); took tooling to Gus Pech.

10-22-87 Took head off rig to check seals.

10-23-87 Replaced seals, put head back on rig.

10-26-87 Drilled w/air to 60.0', checked recovery.

10-27-87 Drilled w/air to 80.0', checked recovery.

10-28-87 Drilled w/air to 100.0', checked recovery.

10-29-87 Grouted from 100.0' to 53'.

10-30-87 Circulated hole w/water to clean out any possible grout in screened interval, added bentonite 47.5' in afternoon, pulled rig off, cleaned up.

11-2-87	Added 1/2 bag sand onto top of bentonite - filled up to 46', could not set well due to lack of bottom cap.
11/5/87	Set well and put sand into well, brought sand up to ^30.0'.
11-6-87	Put sand and bentonite in well.
11-9-87	Grouted up to surface.

This well was logged by ERC Environmental and Energy Services Co., Inc., hydrogeologist Bryn D. Howze. All well construction materials and supplies were from Martin Marietta Energy Systems approved batches. The batch origin of individual items is shown on the included Monitoring Well Materials Certification form.

2.0 Technical Information

2.1 Decontamination Procedures

The drilling rig, down hole tools, surface casing, stainless steel screen, stainless steel casing, centralizers, and stainless steel silt trap underwent the cleaning decontamination procedures outlined in the drilling specifications (Release Specific Technical Directions for Regulatory Compliance Monitoring Wells Phase 1, Oak Ridge National Laboratory, Oak Ridge, W.O. K-4147, April 1987, pgs. 2-4). A checklist of the cleaned materials is included with this data package.

2.2 Geology

WAG 3 is located in Melton Valley which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 3 is underlain by limestone, siltstone and shale of the Middle Ordovician Chickamauga Group. The Chickamauga Group consists of eight units, designated by letters "A" to "H" (Stockdale, 1951). WAG 3 is underlain by units E, F, G and H. These units consist of thin bedded nodular limestone with clay and shale partings. A portion of unit H and unit F consists of calcareous siltstone alternating with beds of olive gray to maroon shale. Strike and dip varies from N 45° E to N 55° E and 25° to 35° southeast, respectively.

2.3 Sample Collection

One soil and two rock samples were collected during drilling, placed in I-CHEM specialty cleaned glass containers, sealed and submitted to Sample Receiving, Analytical Chemistry Division, Bldg. 4500S, ORNL. Chain of custody forms for these samples are included with this data package. Soil sample 988S01 was collected in the split spoon interval from 0.3 feet to 0.5 feet on 9/28/87, and rock sample 988R1 was collected in the augered interval from 15.2 feet to 15.5 feet on 9/28/87 and rock sample 988R2 was collected in the drilled interval at 45.0 feet.

Analytical results for the three samples described above can be obtained from the Remedial Action Program data base at ORNL.

2.4 Installation and Development

2.4.1 Installation

This was a "Type D" well. A 14-inch diameter boring was augered from ground surface to bedrock (20.0 feet). An 8-inch diameter string of decontaminated steel surface casing was installed and tremie grouted in place. The surface casing minimizes potential cross contamination between the regolith and bedrock water bearing zones. The air rotary method was then used to drill a 6-inch diameter boring to a total depth of 98.3 feet. The boring was grouted from 53.0 feet to 98.3 feet, bentonite pellets were poured in the boring up to 47.5' and sand was poured in up to 46.0 feet. A 2-inch diameter stainless steel silt trap was installed from 45.8 to 46.0 feet. Above the silt trap, 2-inch diameter stainless steel screen was installed from 30.8 feet to 45.8 feet. A 2-inch diameter stainless steel casing was installed above the screen at 30.8 feet and extended 2.09 feet above ground surface. A sandpack was then poured into the annular space from 27.7 to 46.0 feet, with a 2.7-foot bentonite seal poured into the annular space above the sandpack from 25.0 to 27.7 feet. The annular space from the top of the bentonite seal to the surface was tremie grouted with a cement/bentonite slurry. A detailed schematic of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 988 was developed to remove drill cuttings, silt, and other fines. The monitoring well was developed using a Geoguard pump with an air compressor. All pumps were cleaned prior to use according to specified cleaning procedures (see Paragraph 2.1). The well was developed until a measured total of 328 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was 3.0 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on 5-17-90 at a depth of 42.5 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 988 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity of the well screen. This was accomplished by instantaneously adding a known quantity of water to the monitoring well and measuring the recovery of the water level over time. The changing water levels were

measured using a Druck 15 psig pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 4.95 x 10^{-6} cm/second (shown as permeability on the hydraulic conductivity calculations printout attached)was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 988

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

PRE-DRILLING TASKS		COMPLIANCE DATE	COMPLIANCE INITIALS
1.	EXCAVATION PERMIT OBTAINED.	9-28-87	BDH
2.	ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	9-28-87	BDH
3a.	SCREEN AND CASINGS HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	N/A	
3b.	PRE-PACKAGED SCREENS, CASINGS AND CENTRALIZERS WERE USED.	11-05-87	BDH
4.	WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	9-28-87	BDH
5.	CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON-HAND.	9-28-87	BDH
6.	POLYETHYLENE COVER IN PLACE OVER HOLE.	9-28-87	BDH

ADDITIONAL NOTES/OBSERVATIONS:

OBSERVER SIGNATURE/DATE Bryn D. Howze 9-28-87

Bryn D. Howze

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 988

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

EQUIPMENT	SCRAPE	STEAM CLEAN	STEAM RINSE	ISOPROPYL ALCOHOL RINSE	DEIONIZED WATER RINSE
RIG	X	X	X	N/A	N/A
AUGERS	X	X	X	X	X
BITS	X	X	X	X	X
RODS	X	X	X	X	X
SAMPLERS	X	X	X	X	X
PIPES	X	X	X	X	X
WORK TOOLS	X	X	X	X	X
AUGER PINS	X	X	X	X	X

OBSERVER SIGNATURE/DATE Bryn D. Howze 9/28/87
Bryn D. Howze

ERC / EDGE Environmental and Energy Services Co.

WELL No. 988

ORNL MONITORING WELL LOG

LOCATION: SWSA 3
DRILLER: Avery L. Clark III
HELPER: Leo Johnson
DRILL: Gus Pech

DATE: START: 9-28-87
FINISH: 11-09-87
LOGGED BY: Bryn Howze
HEALTH PHYSICIST: Paul Eldridge

TYPE DRILLING: Auger, Air Rotary
LUBRICANT TYPE: Molykote 1000/Green stuff
No. SAMPLES TAKEN: 3 (Three)
TYPE: 1 Soil/2 Rock
CONTAINMENT TYPE: Auger Pan, Plastic, Containment Box

THICKNESS OF SOIL (REFUSAL DEPTH): 20.0
DEPTH DRILLED IN ROCK: 26.0
TOTAL DEPTH OF WELL: 46.0

DRILLING FLUID SAMPLES:
TYPE: DATE:

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
0.0	1.2	0988 S1	100%	Silt, slightly clayey, light brown, mottled
		0.3'-0.5'		orange, black, with abundant rock fragments
				(weathered shale, limestone), roots, very
				stiff.
1.2	6.6		100%	Clay, very silty, reddish orange, mottled
				yellow, black, with some rock fragments, some
				roots, very stiff.
6.6	9.7		100%	Silt/highly weathered shaley limestone, light
				brown, mottled greenish gray, black, orange,
				stiff.
9.7	13.0		100%	Silt/highly weathered shaley limestone, maroon
				to greenish gray, moist at 11.0'.
13.0	13.4			Limestone, shaley, weathered, greenish gray
				and maroon gray.
13.4	20.0	0988 R1		Silt/weathered shaley limestone, light brown
		15.2'-15.5'		to olive gray, mottled black, orange, stiff,
				moist to 14.0'.
20.0	46.0	0988 R2		*Limestone, shaley, light gray, fine-grained.
		at 45.0'		21.5' Hard drilling
				33.0' Soft drilling
				34.0' Hard drilling

ERC / EDGE Environmental and Energy Services Co.

WELL No. 988

ORNL MONITORING WELL LOG

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
20.0	46.0			(continued from page 1)
				35.0' Soft drilling
				38.5' Hard drilling
	46.0			Total Depth
				* A detailed lithologic log could not be pro-
				vided from 20.0' to 46.0' due to the use of
				a containment box.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 988

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: Bryn D. Howze

PROOFED BY: Michael L. Ebers

DRILLING COMPANY: A. L. Clark

DRILLER: Avery L. Clark, III HELPER: Leo Johnson

DRILLING METHOD:
- ☒ 14 INCH AUGER 20.8 L.F.
- ☐ INCH AUGER L.F.
- ☒ 6 5/8 INCH ROTARY 26.0 L.F.
- ☐ INCH ROTARY L.F.

LOCATION SWSA-3

ORNL GRID COORDINATES
N 21,075.7290
E 25,471.2850

ELEV. GROUND 910.97

ELEV. TOP STAINLESS STEEL CASING 913.06

DRILLING DATES:
STARTED: 9-28-87
FINISHED: 11-09-87

MATERIALS USED

EST. VOL.	USED VOL.	
		2 bags of sand and
	50	POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
	22	FT. OF 8 IN. SURFACE CASING
9	9	SACKS OF CEMENT (SURFACE CASING)
	17	POUNDS OF POWDERED BENTONITE (SURFACE CASING)
	54	GALLONS OF WATER (SURFACE CASING)
	33	FT. OF 2 IN. DIA. STAINLESS STEEL CASING
	15	FT. OF 2 IN. DIA. STAINLESS STEEL SCREEN
3.5	4	SACKS OF SAND
40	40	POUNDS OF BENTONITE PELLETS
6	6	SACKS OF CEMENT (WELL CASING)
	11	POUNDS OF POWDERED BENTONITE (WELL CASING)
	36	GALLONS OF WATER (WELL CASING)
	2.1	FT. OF 8 IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

SURFACE CASING TREMIE GROUTED YES ☒ NO ☐

STAINLESS STEEL CASING TREMIE GROUTED YES ☒ NO ☐

WELL COVER USED
- ☒ LOCKING STEEL COVER
- ☐ FLUSH MOUNTED WELL COVER
- ☐ OTHER

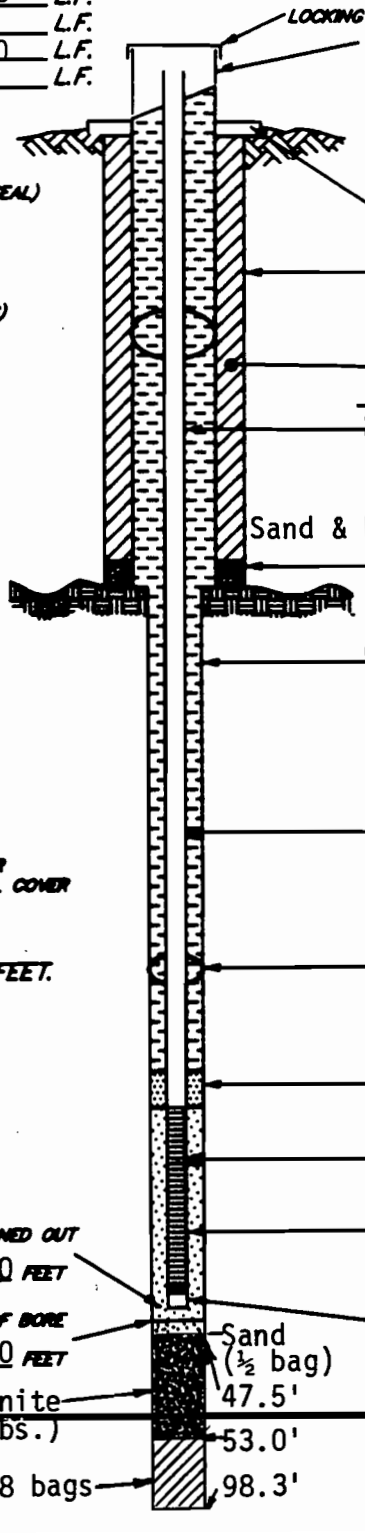
SILT TRAP USED YES ☒ NO ☐

MONITORING WELL PUMP BASE SET AT 42.5 FEET.

CENTRALIZERS AT 2.0 FEET.
10.5 FEET.
30.5 FEET.
45.5 FEET

NOTE:
ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:

TYPE D WELL



ERC / EDGE Environmental and Energy Services Co.

WELL No. 988

DATE: 11-05-87

MONITORING WELL MATERIALS CERTIFICATION

ITEM/MATERIAL		DATE USED	BATCH NUMBER
SAND		10-08-87	2
		11-02/11-05 10-06-87	2
BENTONITE		11-08-87	2
		10-30-87, 11-06-87	2
STAINLESS STEEL SCREEN	(PREPACKAGED ■ YES ☐ NO)	11-05-87	5
STAINLESS STEEL CASING	(PREPACKAGED ■ YES ☐ NO)	11-05-87	5
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ■ YES ☐ NO)	11-05-87	5
STAINLESS STEEL CAPS	(PREPACKAGED ■ YES ☐ NO)	11-05-87	5
MONITORING WELL PUMP	(PREPACKAGED ■ YES ☐ NO)	5-17-90	5
GROUT		10-08-87	11
		10-29-87, 11-09-87	11
WELL COVERS			
SURFACE CASING		10-08-87	2

COMMENTS:

OBSERVER SIGNATURE/DATE Bryn D. Howze 11/09/87
Bryn D. Howze

ERC / EDGE Environmental and Energy Services Co.

WELL No. 988

POST-WELL COMPLETION CHECKLIST

POST-WELL COMPLETION TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	11-09-87	BDH
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	11-09-87	BDH
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	5-17-90	DCL
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	11-09-87	BDH

* RELEASE SPECIFIC TECHNICAL DIRECTIONS FOR REGULATORY COMPLIANCE MONITORING WELLS PHASE I, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, W.O. K-4147, APRIL 1987.

OBSERVER SIGNATURE/DATE Bryn D. Howze 11-09-87
Bryn D. Howze

D. Charles Lytle 5-17-90
D. Charles Lytle

ERCE
Environmental and Energy Services Co.

WELL No. 988

LOCATION: WAG-3

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF DEVELOPMENT: Surging and Pumping

DEVELOPMENT BEGAN DATE: 5-11-90 TIME:

DEVELOPMENT ENDING DATE: 5-17-90

DEVELOPMENT OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 10.7 GALLONS

TOTAL GALLONS PUMPED: 328 TOTAL WELL VOLUMES PUMPED: 30.6

INITIAL pH: 7.8 FINAL pH: 7.8

INITIAL CONDUCTIVITY (µS/cm): 671 FINAL CONDUCTIVITY (µS/cm): 683

DESCRIPTION OF INITIAL TURBIDITY: Cloudy

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 3.0 NTU's

WELL APPROVED BY: R. C. Williams MMES

ODOR OF WATER:

WATER DISCHARGED TO:
- ☒ GROUND SURFACE
- ☐ STORM SEWERS
- ☐ DRUMS
- ☐ TANK TRUCK
- ☐ STORAGE TANKS
- ☐ OTHER

INITIAL PRE-DEVELOPMENT WATER DEPTH: 23.6 feet from ground surface.

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 5/17/90

D. Charles Lytle

ERCE
Environmental and Energy Services Co.

WELL NO. 988
LOCATION: WAG-3
DATE: 5/11/90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 10.7 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (µS/cm)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
5-11-90	1300	165	Cloudy	--	7.8	671	165	15.4	
5-15-90	0900	118	Cloudy	--	8.1	723	253	23.6	
5-15-90	1100	10	Cloudy	--	7.9	779	263	25.0	
5-16-90	1400	45	Cloudy	--	8.1	758	308	28.8	
5-17-90	1300	20	Clear	3.0	7.8	683	328	30.6	
RESULTS AT END OF DEVELOPMENT			Clear	3.0	7.8	683	328	30.6	

COMMENTS Poor producer, slow recharger, water cleared. Passed with 30. NTU's, moved to another hole.

OBSERVER SIGNATURE/DATE D Charles Lytle 5/17/90
D. Charles Lytle

MWFORM05.DWG

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 988

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

(1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967 (ARTICLE IN VOL.3, NO.1 OF WRR ENTITLED "RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER")

(2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN VOL. 12, NO.3 OF WRR ENTITLED "A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS")

WELL NO.: 0988 DATE OF TEST: 5/7/90

PROJECT NO.: E221-002 CLIENT: MMES

SITE LOCATION: WAG-3

EDGE, INC. FIELD INVESTIGATOR: Bruce McCaster

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 6.75 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 15.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 17.30 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 15.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = .00 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .20
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 32

H0 WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED
VALUES FOR H0
(FEET)

3.1567
3.1616

ERC / EDGE Environmental and Energy Services Co.

WELL No. 988

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (sec)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	3.390	3.390
20.00	3.260	3.260
30.00	3.190	3.190
40.00	3.210	3.210
50.00	3.220	3.220
60.00	3.160	3.160
75.00	3.190	3.190
90.00	3.130	3.130
105.00	3.100	3.100
120.00	3.080	3.080
150.00	3.040	3.040
180.00	3.000	3.000
240.00	2.970	2.970
300.00	2.860	2.860
360.00	2.810	2.810
420.00	2.740	2.740
480.00	2.700	2.700
560.00	2.750	2.750
680.00	2.710	2.710
720.00	2.670	2.670
840.00	2.550	2.550
960.00	2.440	2.440
1080.00	2.380	2.380
1200.00	2.380	2.380
1320.00	2.320	2.320
1440.00	2.320	2.320
1560.00	2.280	2.280
1680.00	2.190	2.190
1800.00	2.190	2.190
1920.00	2.120	2.120
2040.00	2.020	2.020
2160.00	2.030	2.030

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

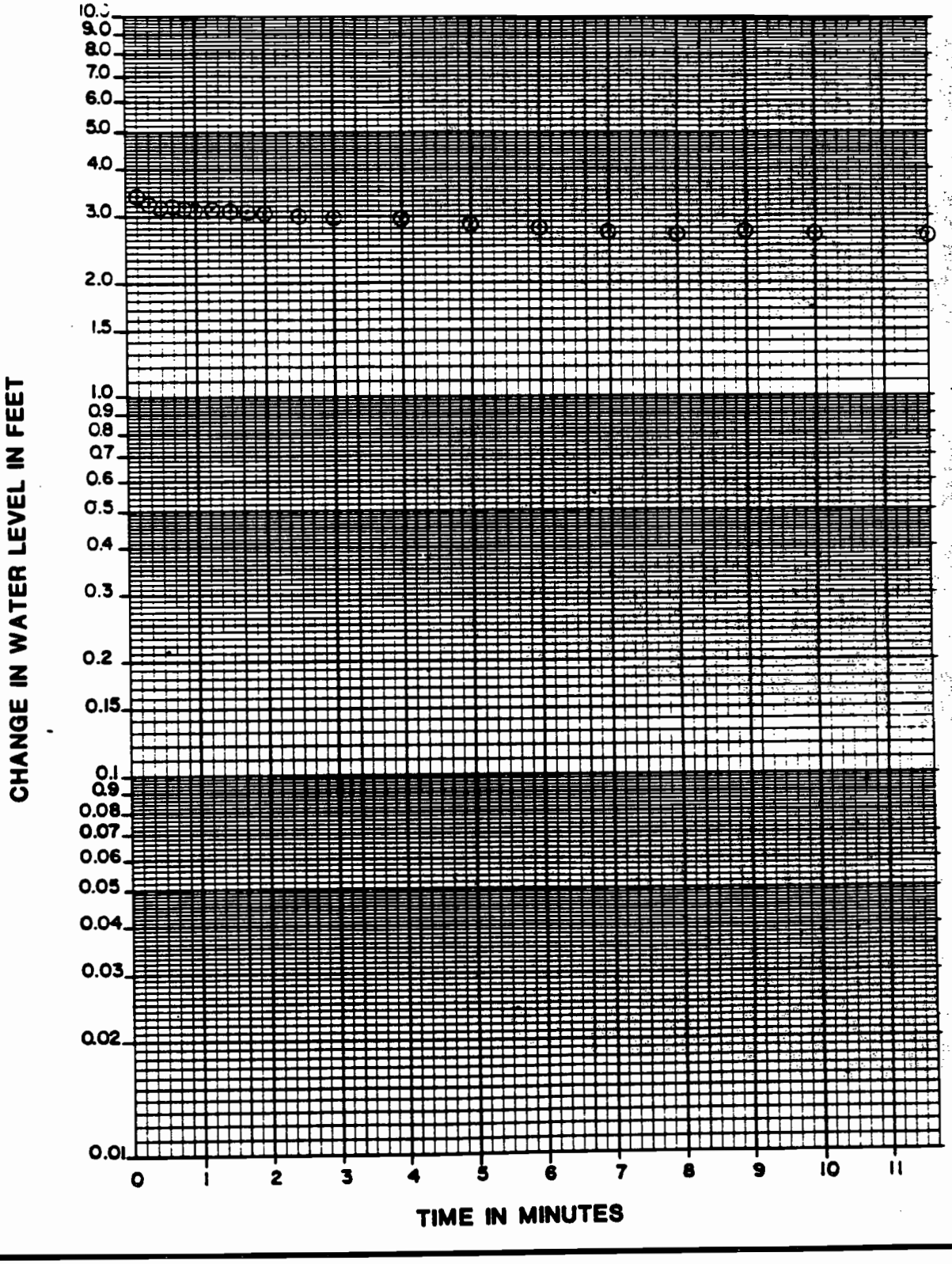
PERMEABILITY = 1.62E-07 FT/sec = 4.95E-06 CM/sec

TRANSMISSIVITY = 2.44E-06 FT**2/sec

ERC / EDGE Environmental and Energy Services Co.

WELL No. 988

HYDRAULIC CONDUCTIVITY CALCULATIONS



MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0988 51

WELL NO.: 988

LOCATION: SWSA 3 0.3'-0.5'

TYPE: Soil

SAMPLER: Bryan Horne (SIGNATURE)

DATE: 9/28/87

TIME: 1:05 PM

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
Bryan Horne	3/14/88	10:37AM	MCI	Nancy Owen	3/14/88	10:37	ORNL

REMARKS:

MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0988 A1

WELL NO.: 988

LOCATION: SWSA 3
15.2' - 15.5'

TYPE: Rock

SAMPLER: Bryn Horne (SIGNATURE)

DATE: 9/28/87

TIME: 1:30 PM

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
Bryn Horne	3/14/88	10:37 AM	MCI	Nancy Owen	3/14/88	10:37	ORNL

REMARKS:

MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0988 R2

WELL NO.: 988

LOCATION: SV 5A 3 at 45.0'

TYPE: Rock

SAMPLER: Bryan Honza (SIGNATURE)

DATE: 10/1/87

TIME: 11:15 AM

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
Bryan Honza	3/14/88	10:37AM	MCI	Nancy Owen	3/14/88	10:37	ORNL

REMARKS:

1.0 General Information

1.1 Well Location

Monitoring well number 990 is located in WAG 3. It is located in the northwest corner of the contractors landfill. The location is shown on ORNL drawing number C3E20004 A075. Survey coordinates for this well are N 21,657.3446, E 24,723.6199 (X-10 grid) or latitude 35°-54'-58.03" and longitude 84°-20'-02.17". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 990 was drilled by A. L. Clark Drilling Services, Inc. A Schramm Rotadrill rig was used to drill this boring for monitor well installation under operation of Rick Pickel with the assistance of Danny Julian. Drilling commenced on 12-10-87 and was finished on 12-31-87. Paragraph 2.4.1 includes a detailed discussion of the well installation and a well schematic is included on the well installation/completion form. A synopsis of the drilling activity

follows. This information was typed directly from field notes and was edited only when necessary for clarification.

12-10-87 The rig was mobilized to the staked location and set up. The boring was split spooned from 0' to 20.8'.

12-11-87 Augered from 0' to 8.0 feet with 14-inch augers.

12-16-87 Augered from 8 feet to 24.2 feet.

12-18-87 Cut and steam cleaned 26.0 feet of surface casing.

12-21-87 Ran in surface casing, had 2.2 feet of stickup. Grouted surface casing with 20 feet of 1-inch tremie pipe.

12-29-87 Drilled with 8 5/8" air rotary tricone and containment from 23.8 feet to 41.0 feet.

12-30-87 Ran in 15 feet of 4-inch stainless steel screen, 27 feet of stainless steel casing, sand pack and pellet bentonite seal.

12-31-87 Grouted annulus from the surface to 22 feet through 20 feet of 1-inch PVC tremie pipe.

This well was logged by ERC Environmental and Energy Services Co., Inc., hydrogeologist Bryn D. Howze and Michael L. Ebers. All well construction materials and supplies were from Martin Marietta Energy Systems approved batches. The batch origin of individual items is shown on the included Monitoring Well Materials Certification form.

2.0 Technical Information

2.1 Decontamination Procedures

The drilling rig, down hole tools, surface casing, stainless steel screen, stainless steel casing, centralizers, and stainless steel silt trap underwent the cleaning decontamination procedures outlined in the drilling specifications (Release Specific Technical Directions for Regulatory Compliance Monitoring Wells Phase 1, Oak Ridge National Laboratory, Oak Ridge, W.O. K-4147, April 1987, pgs. 2-4). A checklist of the cleaned materials is included with this data package.

2.2 Geology

WAG 3 is located in Melton Valley which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 3 is underlain by limestone, siltstone and shale of the Middle Ordovician Chickamauga Group. The Chickamauga Group consists of eight units, designated by letters "A" to "H" (Stockdale, 1951). WAG 3 is underlain by units E, F, G and H. These units consist of thin bedded nodular limestone with clay and shale partings. A portion of unit H and unit F consists of calcareous siltstone alternating with beds of olive gray to maroon shale. Strike and dip varies from N 45° E to N 55° E and 25° to 35° southeast, respectively.

2.3 Sample Collection

Two soil samples were collected during drilling, placed in I-CHEM specialty cleaned glass containers, sealed and submitted to Sample Receiving, Analytical Chemistry Division, Bldg. 4500S, ORNL. Chain of custody forms for these samples are included with this data package. Soil sample 990S01 was collected in the split spoon interval from 0.6 feet to 0.8 feet on 12-10-87 and soil sample 990S02 was collected in the split spoon interval from 15.8 feet to 16.0 feet on 12-10-87.

A drill water sample was collected from the water pump on the drill rig on 12-29-87. Analytical results for the three samples described above can be obtained from the Remedial Action Program data base at ORNL.

2.4 Installation and Development

2.4.1 Installation

This was a "Type B" well. A 14-inch diameter boring was augered from ground surface to bedrock (24.0 feet). A 10-inch diameter string of decontaminated steel surface casing was installed and tremie grouted in place. The surface casing minimizes potential cross contamination between the regolith and bedrock water bearing zones. The air rotary method was then used to drill an 8-inch diameter boring to a total depth of 40.8 feet. A 4-inch diameter stainless steel silt trap was installed from 40.5 to 40.8 feet. Above the silt trap, a 4-inch diameter stainless steel

screen was installed from 25.5 feet to 40.5 feet. A 4-inch diameter stainless steel casing was installed from the top of the screen at 25.5 feet and extending 1.12 feet above ground surface. A sandpack was then poured into the annular space from 24.0 to 40.8 feet, with a 2.0-foot bentonite seal poured into the annular space above the sandpack from 22.0 to 24.0 feet. The annular space from the top of the bentonite seal to the surface was tremie grouted with a cement/bentonite slurry. A detailed schematic of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 990 was developed to remove drill cuttings, silt, and other fines. The monitoring well was developed using a Geoguard pump with an air compressor. All pumps were cleaned prior to use according to specified cleaning procedures (see Paragraph 2.1). The well was developed until a measured total of 440 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was 3.0 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on 5-7-90 at a depth of 39.1 feet below ground

surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 990 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity of the well screen. This was accomplished by instantaneously removing a known quantity of water from the monitoring well and measuring the recovery of the water level over time. The changing water levels were measured using a Druck 15 psig pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 3.57×10^{-5} cm/second (shown as permeability on the hydraulic conductivity calculations printout attached) was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 990

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

PRE-DRILLING TASKS		COMPLIANCE DATE	COMPLIANCE INITIALS
1.	EXCAVATION PERMIT OBTAINED.	12-10-87	MLE
2.	ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	12-10-87	MLE
3a.	SCREEN AND CASINGS HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	N/A	
3b.	PRE-PACKAGED SCREENS, CASINGS AND CENTRALIZERS WERE USED.	12-30-87	MLE
4.	WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	12-10-87	MLE
5.	CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON-HAND.	12-10-87	MLE
6.	POLYETHYLENE COVER IN PLACE OVER HOLE.	12-10-87	MLE

ADDITIONAL NOTES/OBSERVATIONS:

OBSERVER SIGNATURE/DATE Michael L. Ebers 12/10/87

Michael L. Ebers

ERC / EDGE Environmental and Energy Services Co.

WELL No. 990

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

EQUIPMENT	SCRAPE	STEAM CLEAN	STEAM RINSE	ISOPROPYL ALCOHOL RINSE	DEIONIZED WATER RINSE
RIG	X	X	X	N/A	N/A
AUGERS	X	X	X	X	X
BITS	X	X	X	X	X
RODS	X	X	X	X	X
SAMPLERS	X	X	X	X	X
PIPES	X	X	X	X	X
WORK TOOLS	X	X	X	X	X
AUGER PINS	X	X	X	X	X

OBSERVER SIGNATURE/DATE [signature] 12/10/87

Michael L. Ebers

ERC / EDGE Environmental and Energy Services Co.

WELL No. 990

ORNL MONITORING WELL LOG

LOCATION: SWSA 3
DRILLER: A. L. Clark II
HELPER: Rick Pickel/Danny Julian
DRILL: Schramm Rotadrill

DATE: START: 12-10-87
FINISH: 12-30-87
LOGGED BY: Bryn Howze/Michael L. Ebers
HEALTH PHYSICIST: Paul Eldridge

TYPE DRILLING: Split Spoons, Auger, Air Rotary
LUBRICANT TYPE: Molykote 1000
No. SAMPLES TAKEN: Two
TYPE: Soil
CONTAINMENT TYPE: Auger Pan and Plastic

THICKNESS OF SOIL (REFUSAL DEPTH): 20.8'
DEPTH DRILLED IN ROCK: 20.0'
TOTAL DEPTH OF WELL: 40.8'

DRILLING FLUID SAMPLES:
TYPE: DRill Water DATE: 12-29-87

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
0.0	0.4		100%	Clay, slightly silty, reddish orange, with rock fragments, very stiff. (Fill for road.)
0.4	1.5	0990 S1 0.6'-0.8'	100%	Topsoil, silt, medium to dark brown, mottled orange, black, with roots and some rock fragments, stiff.
1.5	4.4		90%	Silt, slightly clayey, orange brown, mottled black, yellow with some roots at top, rock fragments, very stiff to hard.
4.4	7.7		80%	Silt, slightly clayey, reddish brown, mottled yellow, orange, black, with abundant rock fragments, very stiff to hard.
7.7	12.6		100%	Silt, clayey, becoming more clayey downward, reddish brown, mottled yellow, orange, black, very stiff to hard.
12.6	16.4	0990 S2 15.8'-16.0'	100%	Clay, slightly silty, reddish brown, mottled light brown, orange, black, very stiff.
16.4	20.7		100%	Silt, clayey, reddish brown, mottled orange, light brown, black, with a few rock fragments, very stiff, slightly moist at 20.7'.
20.7	20.8		100%	Limestone, weathered, light gray, fine-grained.
	20.8			Split spoon refusal.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 990

ORNL MONITORING WELL LOG

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
20.8	23.5			Clay, reddish brown, silty.
23.5	40.8			Limestone, olive gray, fine grained, massive,
				few very thin shale lenses, hard drilling
				throughout.
	40.8			Total Depth

ERC / EDGE Environmental and Energy Services Co.

WELL No. 990

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: Michael L. Ebers
PROOFED BY: James Caruthers

DRILLING COMPANY: A. L. Clark Drilling Co.

DRILLER: A. L. Clark, II
HELPER: Danny Julian

DRILLING METHOD:
- ☒ 14 INCH AUGER 24.4 L.F.
- ☐ ____ INCH AUGER ____ L.F.
- ☒ 8¼ INCH ROTARY 16.4 L.F.
- ☐ ____ INCH ROTARY ____ L.F.

Total 41.8

LOCATION WAG-3
ORNL GRID COORDINATES
N 21,657.3446
E 24,723.6199
ELEV. GROUND 853.91
ELEV. TOP STAINLESS STEEL CASING 855.03

DRILLING DATES:
STARTED: 12-10-87
FINISHED: 12-31-87

MATERIALS USED

EST. VOL.	USED VOL.	
	50.0	POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
	23.8	FT. OF 10 IN. SURFACE CASING (surface down)
7.2	8.0	SACKS OF CEMENT (SURFACE CASING)
	16.0	POUNDS OF POWERED BENTONITE (SURFACE CASING)
	48.0	GALLONS OF WATER (SURFACE CASING)
	27.1	FT. OF 4 IN. DIA. STAINLESS STEEL CASING
	15.0	FT. OF 4 IN. DIA. STAINLESS STEEL SCREEN
4.5	3.7	SACKS OF SAND
40.0	50.0	POUNDS OF BENTONITE PELLETS
____	7.5	SACKS OF CEMENT (WELL CASING)
	15.0	POUNDS OF POWERED BENTONITE (WELL CASING)
	45.0	GALLONS OF WATER (WELL CASING)
	2.2	FT. OF 10 IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

SURFACE CASING TREMIE GROUTED YES ☒ NO ☐

STAINLESS STEEL CASING TREMIE GROUTED YES ☒ NO ☐

WELL COVER USED
- ☒ LOCKING STEEL COVER
- ☐ FLUSH MOUNTED WELL COVER
- ☐ OTHER

SILT TRAP USED YES ☒ NO ☐

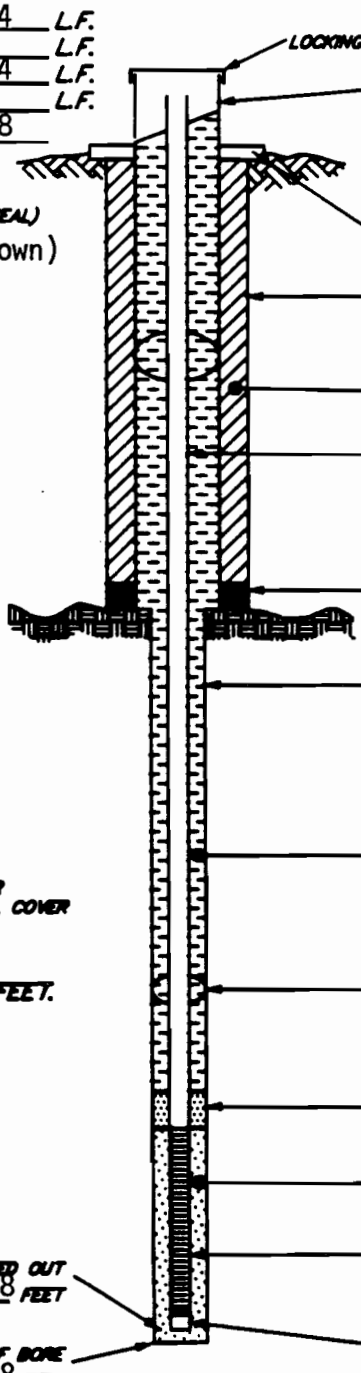
MONITORING WELL PUMP BASE SET AT 39.1 FEET.

CENTRALIZERS AT 3.0 FEET.
25.0 FEET.
40.0 FEET.

NOTE:
ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:

HOLE CLEANED OUT TO 40.8 FEET

BOTTOM OF BORE HOLE 40.8 FEET



LOCKING CAP

10 IN. DIA. SURFACE/PROTECTIVE CASING 1.96 FEET ABOVE GROUND SURFACE TO 23.8 FEET BELOW GROUND SURFACE

CONCRETE PAD

14 IN. DIA. BORE HOLE 0.0 TO 24.4 FEET

GROUT SEAL 0.0 TO 22.5 FEET

4 IN. STAINLESS STEEL CASING 1.12 FEET ABOVE GROUND SURFACE TO 25.5 FEET BELOW GROUND SURFACE

Bentonite SEAL 22.5 TO 24.4 FEET

BEDROCK LEVEL 24.0

8¼ IN. DIA. BORE HOLE

GROUT SEAL 0.0 TO 22.0 FEET

CENTRALIZER

BENTONITE PELLET SEAL 22.0 TO 24.0 FEET

SAND PACK 24.0 TO 40.8 FEET

4 IN. DIA. STAINLESS STEEL SLOTTED SCREEN 25.5 TO 40.5 FEET

4 IN. DIA. STAINLESS STEEL SILT TRAP/CAP 40.5 TO 40.8 FEET

TYPE B WELL

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 990

DATE: 12/21/87

MONITORING WELL MATERIALS CERTIFICATION

ITEM/MATERIAL		DATE USED	BATCH NUMBER
SAND		12-30-87	3
BENTONITE		12-18-87	3
		12-30-87	3
STAINLESS STEEL SCREEN	(PREPACKAGED ■ YES ☐ NO)	12-30-87	5
STAINLESS STEEL CASING	(PREPACKAGED ■ YES ☐ NO)	12-30-87	5
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ■ YES ☐ NO)	12-30-87	5
STAINLESS STEEL CAPS	(PREPACKAGED ■ YES ☐ NO)	12-30-87	5
MONITORING WELL PUMP	(PREPACKAGED ■ YES ☐ NO)	5-07-90	5
GROUT		12-21-87	15
		12-31-87	15
WELL COVERS		12-30-87	1
SURFACE CASING		12-21-87	2

COMMENTS:

OBSERVER SIGNATURE/DATE Michael L. Ebers 12/21/87
Michael L. Ebers

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 990

POST-WELL COMPLETION CHECKLIST

POST-WELL COMPLETION TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	12-31-87	MLE
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	12-31-87	MLE
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	5-07-90	DCL
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	12-31-87	MLE

* RELEASE SPECIFIC TECHNICAL DIRECTIONS FOR REGULATORY COMPLIANCE MONITORING WELLS PHASE I, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, W.O. K-4147, APRIL 1987.

OBSERVER SIGNATURE/DATE Michael L. Ebers 12/31/87
Michael L. Ebers

D. Charles Lytle 5/07/90
D. Charles Lytle

ERCE
Environmental and Energy Services Co.

WELL No. 990

LOCATION: WAG-3

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF DEVELOPMENT: Surging and Pumping

DEVELOPMENT BEGAN DATE: 4-18-90 TIME:

DEVELOPMENT ENDING DATE: 5-07-90

DEVELOPMENT OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 15.8 GALLONS

TOTAL GALLONS PUMPED: 444 TOTAL WELL VOLUMES PUMPED: 28.1

INITIAL pH: 7.5 FINAL pH: 7.9

INITIAL CONDUCTIVITY (µS/cm): 675 FINAL CONDUCTIVITY (µS/cm): 769

DESCRIPTION OF INITIAL TURBIDITY: Slightly Cloudy

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 3.0 NTU's

WELL APPROVED BY: R. C. Williams MMES

ODOR OF WATER: None

WATER DISCHARGED TO:
- ☒ GROUND SURFACE
- ☐ STORM SEWERS
- ☐ DRUMS
- ☐ TANK TRUCK
- ☐ STORAGE TANKS
- ☐ OTHER

INITIAL PRE-DEVELOPMENT WATER DEPTH: 29.0 feet from ground surface.

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 5/07/90

D. Charles Lytle

ERCE
Environmental and Energy Services Co.

WELL NO. 990
LOCATION: WAG-3
DATE: 4/18/90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 15.8 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (µS/cm)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
4-19-90	1330	16	Slightly Cloudy	--	7.5	675	16	1.0	
4-23-90	1430	110	Slightly Cloudy	--	7.6	712	126	8.0	
5-02-90	0930	118	Slightly Cloudy	--	7.9	688	244	15.4	
5-03-90	0900	73	Slightly Cloudy	--	7.8	619	317	20.1	
5-03-90	1100	30	Slightly Cloudy	--	8.2	714	347	22.0	
5-03-90	1330	15	Slightly Cloudy	--	7.8	714	362	23.0	
5-04-90	0900	16	Slightly Cloudy	--	7.9	681	378	24.0	
5-04-90	1330	10	Slightly Cloudy	--	8.1	732	388	24.6	
5-07-90	1100	40	Slightly Cloudy	--	7.8	675	428	27.1	
5-07-90	1300	16	Clear	3.0	7.9	769	444	28.1	
RESULTS AT END OF DEVELOPMENT			Clear	3.0	7.9	769	444	28.1	

COMMENTS

Fair producer. Water cleared, stayed clear even after surging. Passed and moved to another hole.

OBSERVER SIGNATURE/DATE D. Charles Lytle 5/07/90
D. Charles Lytle

MWFORM05.DWG

ERCE
Environmental
and Energy
Services Co.

WELL No. 990

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

(1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967 (ARTICLE IN VOL.3, NO.1 OF WRR ENTITLED "RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER")

(2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN VOL. 12, N0.3 OF WRR ENTITLED "A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS")

WELL NO.: 990 DATE OF TEST: 9/4/90

PROJECT NO.: E221-002 CLIENT: MMES

SITE LOCATION: WAG-3

EDGE, INC. FIELD INVESTIGATOR: JAMES W. CARUTHERS

INPUT DATA ARE:

INNER CASING DIAMETER = 4.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 4.00 INCHES
DIAMETER OF DRILLED HOLE = 8.25 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 15.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 10.73 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 15.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = 11.00 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .20
FALLING-HEAD INDEX = 0 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 32

H0 WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED
VALUES FOR H0
(FEET)

1.1288
1.1337

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	9.560	1.440
20.00	9.690	1.310
30.00	9.760	1.240
40.00	9.790	1.210
50.00	9.830	1.170
60.00	9.850	1.150
75.00	9.870	1.130
90.00	9.890	1.110
105.00	9.910	1.090
120.00	9.920	1.080
150.00	9.930	1.070
180.00	9.960	1.040
240.00	9.980	1.020
300.00	10.000	1.000
360.00	10.030	.970
420.00	10.040	.960
480.00	10.060	.940
540.00	10.070	.930
600.00	10.080	.920
720.00	10.100	.900
840.00	10.120	.880
960.00	10.140	.860
1080.00	10.150	.850
1200.00	10.170	.830
1320.00	10.170	.830
1440.00	10.180	.820
1560.00	10.190	.810
1680.00	10.190	.810
1800.00	10.200	.800
1920.00	10.200	.800
2040.00	10.210	.790
2160.00	10.210	.790

HYDRAULIC CONDUCTIVITY CALCULATIONS

****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = 1.17E-06 FT/SEC = 3.57E-05 CM/SEC

TRANSMISSIVITY = 1.76E-05 FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

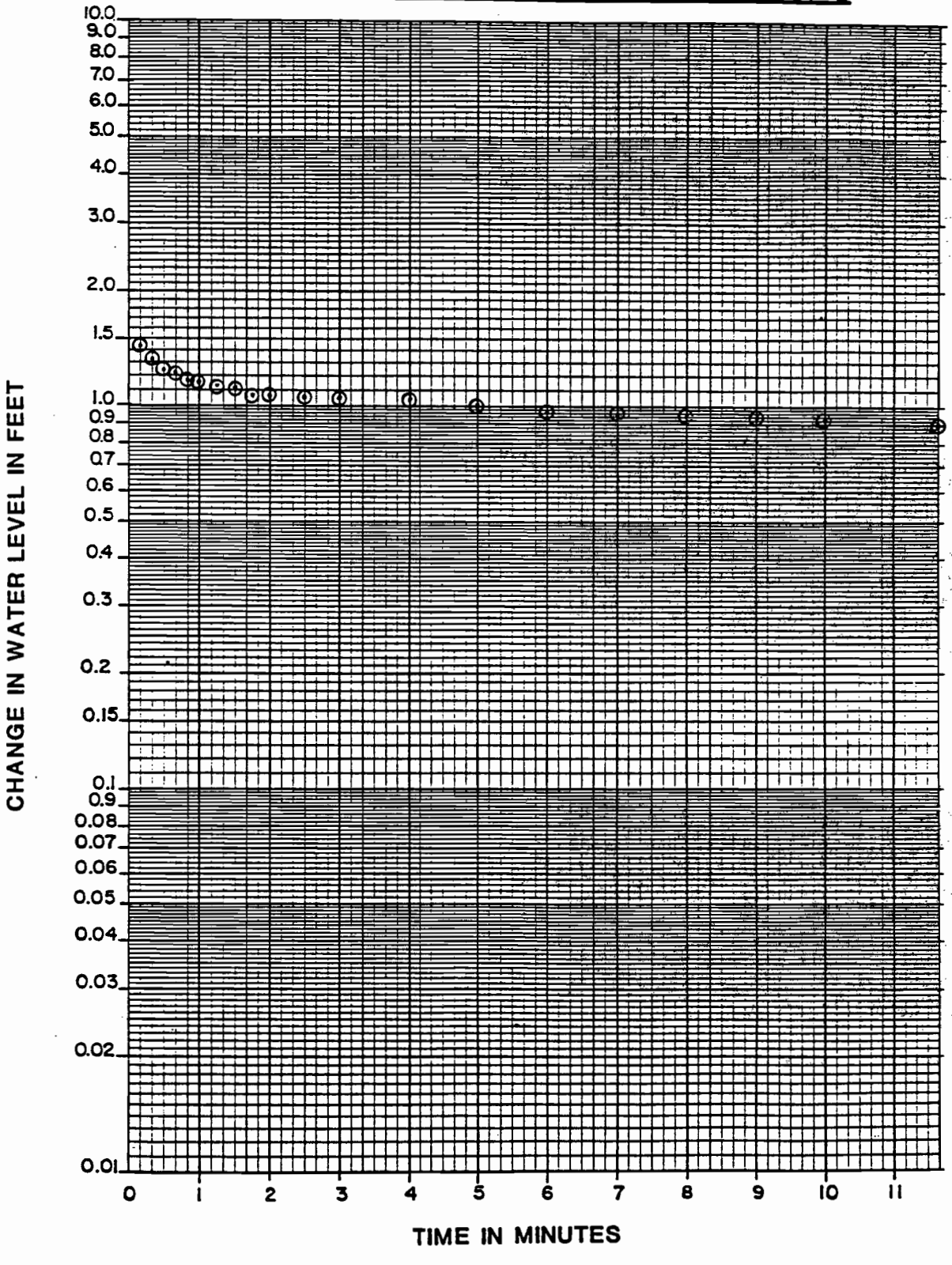
PERMEABILITY = 8.90E-07 FT/SEC = 2.71E-05 CM/SEC

TRANSMISSIVITY = 1.33E-05 FT**2/SEC

ERCE
Environmental
and Energy
Services Co.

WELL No. 990

HYDRAULIC CONDUCTIVITY CALCULATIONS



MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0990 51

WELL NO.: 990

LOCATION: SWSA 3 0.6' – 0.8'

TYPE: Soil

SAMPLER: Bryn Hovge (SIGNATURE)

DATE: 12/10/87

TIME: 3:20 PM

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
Bryn Hovge	12/14/87	9:16AM	MCI	Nancy Owen	12-14-87	9:16	ORNL

REMARKS:

MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0990 52

WELL NO.: 990

LOCATION: SWSA 3 15.8' - 16.0'

TYPE: Soil

SAMPLER: Bryn Horne (SIGNATURE)

DATE: 12/10/87

TIME: 3:40 PM

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
Bryn Horne	12/14/87	9:16 AM	MCI	Nancy Owen	12/14/87	9:16	ORNL

REMARKS:

EDGe Engineering, Design & Geosciences Group, Inc.
725 Pellissippi Parkway
P.O. Box 23010 Knoxville, Tn 37933-1010

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0990 W01

WELL NO. 0990	LOCATION: SWSA-3 CONTRACTORS LANDFILL	TYPE: DRILL WATER
SAMPLER: [signature] (SIGNATURE)	SAMPLE INTERVAL: N/A	DATE: 12/29/87 TIME: 10:40 A.M.

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
[signature]	3/7/88	1:45PM	EDGe	[signature]	3-7-88	1 45	

TYPE OF SAMPLE: ☐ SPLIT SPOON CORES–SOIL ☐ AUGER CUTTINGS–SOIL ☐ AUGER CUTTINGS–ROCK
☐ AIR ROTARY CUTTINGS–ROCK ☒ DRILL WATER (NO AIR IN SAMPLE) ☐ OTHER _____

ALL SAMPLES ARE IMMEDIATELY PLACED IN I-CHEM SPECIALTY CLEANED CONTAINERS AND SEALED.

REMARKS: _____

1.0 General Information

1.1 Well Location

Monitoring well number 991 is located in WAG 3. It is located on the north side of the contractors landfill. The location is shown on ORNL drawing number C3E20004 A075. Survey coordinates for this well are N 21,736.6362, E 25,051.4880 (X-10 grid) or latitude 35°-55'-00.48" and longitude 84°-19'-59.40". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 991 was drilled by A. L. Clark Drilling Services, Inc. A Schramm Rotadrill rig was used to drill this boring for monitor well installation under operation of Rick Pickel with the assistance of Leo Johnson. Drilling commenced on 10-26-87 and was finished on 11-24-87. Paragraph 2.4.1 includes a detailed discussion of the well installation and a well schematic is included on the well installation/completion form. A synopsis of the drilling activity

follows. This information was typed directly from field notes and was edited only when necessary for clarification.

10-26-87 Mobilized drill rig to staked location and set up. Augered from 0.0 feet to 25.3 feet with 14-inch augers.

10-27-87 Ran in 25.3 feet of 10-inch surface casing and grouted.

10-28-87 Rigged up containment box and drilled with 8 5/8- inch tricone from 25.3 feet to 35 feet.

10-29-87 Repairs to diverter head.

10-30-87 Drilled with 8 5/8" tricone from 35.0 feet to 60.5 feet.

11-2-87 Blowing out hole.

11-3-87 Reamed boring from 25.3 feet to 60.0 feet with 9- inch bit.

11-4-87 Ran a 6 5/8-inch steel casing from 0.0 feet to 60.5 feet.

11-11-87 Drilled with 6-inch tricone from 60.5 feet to 85.0 feet.

11-13-87 Completed well with 15 feet of 2-inch stainless steel screen and 70.0 feet of 2-inch stainless steel casing. Poured in sand and pelleted bentonite. Bentonite bridged at 35.0 feet.

11-16-87 Steam cleaning 3/4" iron pipe at SWSA 6. Ran 3/4" pipe into #991 in an attempt to wash out bridged bentonite. Bentonite bridge was located at 35'. Washed pipe through bridge at 35' but most of bentonite still in place at bridge. Taped through

bentonite bridge to top of bentonite pellet seal at 60.5'. Put tremie pipe down to 55' and grouted through with grout - put in 10 bags - pulled pipe, only lower 1' of pipe had grout on it. No visible sign of grout in annulus.

11-19-87 Bryn Houze checked Well #992 for the presence of grout and pH of water. Hand bailer dropped without obstruction to 47.1', pH of water was 8.3.

11-24-87 Steamed cleaned 5 joints (53') of 3/4" iron pipe, rinsed with alcohol and deionized water. Wrapped in plastic and took to Well #991. A.L. Clark ran in four joints of 3/4" tremie pipe. Pipe stopped at bentonite bridge at 35'. Tried to wash pipe through bridge. Disconnected water and made two attempts to push tremie pipe through bridge. Pulled pipe out, loaded it on the water truck and left. A. L. Clark insisted that the tremie pipe was hitting a centralizer and grout at 35'. Bentonite was observed sticking to the end of the tremie pipe. After A. L. Clark left, the hole was taped (bentonite bridge @35) and bentonite with some shale cuttings was observed sticking to the weighted end of the tape.

This well was logged by ERC Environmental and Energy Services Co., Inc., hydrogeologists Michael L. Ebers and John W. Anderson. All well construction materials and

supplies were from Martin Marietta Energy Systems approved batches. The batch origin of individual items is shown on the included Monitoring Well Materials Certification form.

2.0 Technical Information

2.1 Decontamination Procedures

The drilling rig, down hole tools, surface casing, stainless steel screen, stainless steel casing, centralizers, and stainless steel silt trap underwent the cleaning decontamination procedures outlined in the drilling specifications (Release Specific Technical Directions for Regulatory Compliance Monitoring Wells Phase 1, Oak Ridge National Laboratory, Oak Ridge, W.O. K-4147, April 1987, pgs. 2-4). A checklist of the cleaned materials is included with this data package.

2.2 Geology

WAG 3 is located in Melton Valley which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 3 is underlain by limestone, siltstone and shale of the Middle Ordovician Chickamauga Group. The Chickamauga Group consists of eight units, designated by letters "A" to "H" (Stockdale, 1951). WAG 3 is underlain by units E, F, G and H. These units consist of thin bedded nodular limestone with clay and shale partings. A portion of unit H and unit F consists of calcareous siltstone alternating

with beds of olive gray to maroon shale. Strike and dip varies from N 45° E to N 55° E and 25° to 35° southeast, respectively.

2.3 Sample Collection

No samples were collected during drilling.

2.4 Installation and Development

2.4.1 Installation

This was a "Type B" well. A 14-inch diameter boring was augered from ground surface to bedrock (25.3 feet). A 10-inch diameter string of decontaminated steel surface casing was installed and tremie grouted in place. The surface casing minimizes potential cross contamination between the regolith and bedrock water bearing zones. The air rotary method was then used to drill an 8-inch diameter boring to a depth of 60.5 feet. The boring was reamed to 8 5/8" diameter from 25.3 feet to 60.5 feet and a 6 5/8-inch casing was installed from 0.0 feet to 60.5 feet. The boring was deepened to 85.0 feet with a 6-inch tricone bit. A 2-inch diameter stainless steel silt trap was installed from 84.8 to 85.0 feet. Above the silt trap, a 4-inch diameter stainless steel screen was installed from 70.0 feet to 85.0 feet. A 2-inch diameter stainless steel casing was installed from the top of the screen at 70.0 feet and extending 2.44 feet above ground surface. A sandpack was then poured into

the annular space from 62.0 to 85.0 feet, with a 1.5-foot bentonite seal poured into the annular space above the sandpack from 60.5 to 62.0 feet. The annular space from the top of the bentonite seal to the surface was tremie grouted with a cement/bentonite slurry. A detailed schematic of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 991 was developed to remove drill cuttings, silt, and other fines. The monitoring well was developed using a Geoguard pump with an air compressor. All pumps were cleaned prior to use according to specified cleaning procedures (see Paragraph 2.1). The well was developed until a measured total of 225 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was 1.0 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on 4-24-90 at a depth of 81.3 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 991 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity of the well screen. This was accomplished by instantaneously adding a known quantity of water to the monitoring well and measuring the recovery of the water level over time. The changing water levels were measured using a Druck 15 psig pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 6.76×10^{-5} cm/second (shown as permeability on the hydraulic conductivity calculations printout attached) was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

2.6 Nonconformance Reports

Two nonconformance reports have been filed for this well due to improper grouting and centralizer installation. Copies of the two reports are attached.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 991

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

PRE-DRILLING TASKS		COMPLIANCE DATE	COMPLIANCE INITIALS
1.	EXCAVATION PERMIT OBTAINED.	10-26-87	MLE
2.	ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	10-26-87	MLE
3a.	SCREEN AND CASINGS HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	N/A	
3b.	PRE-PACKAGED SCREENS, CASINGS AND CENTRALIZERS WERE USED.	11-12-87	MLE
4.	WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	10-26-87	MLE
5.	CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON-HAND.	10-26-87	MLE
6.	POLYETHYLENE COVER IN PLACE OVER HOLE.	10-26-87	MLE

ADDITIONAL NOTES/OBSERVATIONS:

OBSERVER SIGNATURE/DATE [signature] 11/12/87

Michael L. Ebers

ERC / EDGE Environmental and Energy Services Co.

WELL No. 991

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

EQUIPMENT	SCRAPE	STEAM CLEAN	STEAM RINSE	ISOPROPYL ALCOHOL RINSE	DEIONIZED WATER RINSE
RIG	X	X	X	N/A	N/A
AUGERS	X	X	X	X	X
BITS	X	X	X	X	X
RODS	X	X	X	X	X
SAMPLERS	X	X	X	X	X
PIPES	X	X	X	X	X
WORK TOOLS	X	X	X	X	X
AUGER PINS	X	X	X	X	X

OBSERVER SIGNATURE/DATE [signature] 1/26/87
Michael L. Ebers

ERC / EDGE Environmental and Energy Services Co.

WELL No. 991

ORNL MONITORING WELL LOG

LOCATION: SWSA 3 Contractors Landfill
DRILLER: Rick Pickel
HELPER: Leo Johnson
DRILL: Schramm Rotadrill

DATE: START: 10-26-87
FINISH: 11-11-87
LOGGED BY: John W. Anderson/ Michael L. Ebers
HEALTH PHYSICIST: Paul Eldridge

TYPE DRILLING: Auger, Air Rotary
LUBRICANT TYPE: Molykote 1000
No. SAMPLES TAKEN: None
TYPE: --
CONTAINMENT TYPE: Auger Pan, Plastic, Containment Box

THICKNESS OF SOIL (REFUSAL DEPTH): 25.3
DEPTH DRILLED IN ROCK: 59.7
TOTAL DEPTH OF WELL: 85.0

DRILLING FLUID SAMPLES:
TYPE: DATE:

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
0.0	2.0			Clay, reddish brown with roots.
2.0	9.0			Clay, reddish brown with angular pieces of very fine sandstone.
9.0	25.3			Clay, red mottled with dark red to light brown, with very fine sandstone fragments.
25.3				Auger Refusal.
25.3	28.5			*Limestone, hard.
28.5	29.0			Shale, soft.
29.0	29.1			Limestone, hard.
29.1	32.0			Shale, soft.
32.0	35.5			Limestone, fairly hard with shaly streaks.
35.5	36.0			Cavity - communicating with #992 - compressed air coming out .
36.0	39.5			Limestone, broken, rough drilling.
39.5	42.0			Cavity.
42.0	44.5			Shale, very soft.
44.5	48.3			Limestone, hard, locally thin bedded, rough drilling.
48.3	50.1			Cavity, compressed air and muddy water coming out of #992, shot 6' in air for two minutes.
50.1	56.2			Limestone, massive hard.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 991

ORNL MONITORING WELL LOG

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
56.2	56.7			Limestone, locally shaly.
56.7	60.0			Limestone.
60.0	85.0			Limestone.
	85.0			Total Depth
				*No detailed lithologic description available
				for the interval from 25.3' to 85.0 feet due
				to the use of a containment box.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 991

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: John Anderson
PROOFED BY: Michael L. Ebers

DRILLING COMPANY: A. L. Clark

DRILLER: Rick Pickel
HELPER: A. L. Clark

DRILLING METHOD:
- ☐ 14 INCH AUGER 25.3 L.F.
- ☐ INCH AUGER L.F.
- ☐ 6 INCH ROTARY 60.4-85' L.F.
- ☐ 8 INCH ROTARY 60.4 L.F.

LOCATION SWSA 3
ORNL GRID COORDINATES
N 21,736.6362
E 25,051.4880
ELEV. GROUND 854.79
ELEV. TOP STAINLESS STEEL CASING 857.23

DRILLING DATES:
STARTED: 10-26-87
FINISHED: 11-12-87

MATERIALS USED

EST. VOL.	USED VOL.	
	35	POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
		FT. OF 10 IN. SURFACE CASING
8.0	11.0	SACKS OF CEMENT (SURFACE CASING)
	22.0	POUNDS OF POWERED BENTONITE (SURFACE CASING)
	66.0	GALLONS OF WATER (SURFACE CASING)
		FT. OF 2 IN. DIA. STAINLESS STEEL CASING
	15.0	FT. OF 2 IN. DIA. STAINLESS STEEL SCREEN
3.2	4.5	SACKS OF SAND
42	50	POUNDS OF BENTONITE PELLETS
	10+	SACKS OF CEMENT (WELL CASING)
	20+	POUNDS OF POWERED BENTONITE (WELL CASING)
	60+	GALLONS OF WATER (WELL CASING)
	25.3	FT. OF 10 IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES
Cavities, Voids, Spillage, Etc.

SURFACE CASING TREMIE GROUTED YES ☒ NO ☐

STAINLESS STEEL CASING TREMIE GROUTED YES ☒ NO ☐

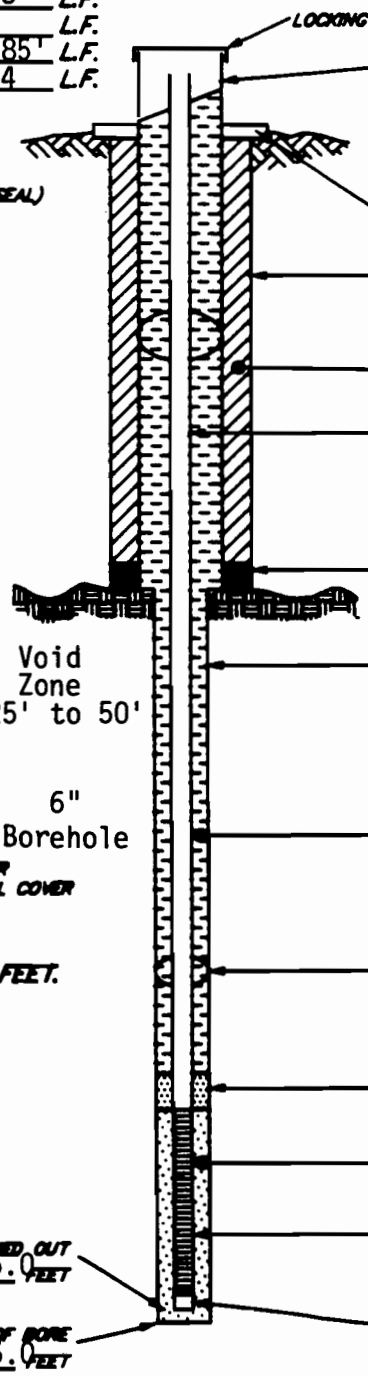
WELL COVER USED
- ☒ LOCKING STEEL COVER
- ☐ FLUSH MOUNTED WELL COVER
- ☐ OTHER

SILT TRAP USED YES ☒ NO ☐

MONITORING WELL PUMP BASE SET AT 81.3 FEET.

CENTRALIZERS AT 15.0 FEET.
35.0 FEET.
45.0 FEET.
75.0 FEET
84.0 FEET

NOTE: ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:



LOCKING CAP
10 IN. DIA. SURFACE/PROTECTIVE CASING 3.43 FEET ABOVE GROUND SURFACE TO 25.3 FEET BELOW GROUND SURFACE
CONCRETE PAD
14 IN. DIA. BORE HOLE 0.0 TO 25.3 FEET
GROUT SEAL 0.0 TO 25.3 FEET
2.0 IN. STAINLESS STEEL CASING 2.44 FEET ABOVE GROUND SURFACE TO 70.0 FEET BELOW GROUND SURFACE
Bentonite SEAL 24.0 TO 25.3 FEET
BEDROCK LEVEL 25.0
8.0 IN. DIA. BORE HOLE
6 5/8" Dia Carbon Steel Casing 0.0 to 60.5' to seal off Void Zone.
GROUT SEAL 0.0 TO 60.5 FEET
CENTRALIZER
BENTONITE PELLET SEAL 60.5 TO 62.0 FEET
SAND PACK 62.0 TO 85.0 FEET
2.0 IN. DIA. STAINLESS STEEL SLOTTED SCREEN 70.0 TO 85.0 FEET
2 IN. DIA. STAINLESS STEEL SILT TRAP/CAP 84.8 TO 85.0 FEET
HOLE CLEANED OUT TO 85.0 FEET
BOTTOM OF BORE HOLE 85.0 FEET

TYPE B WELL

ERC / EDGE Environmental and Energy Services Co.

WELL No. 991

DATE: 10-26-87

MONITORING WELL MATERIALS CERTIFICATION

ITEM/MATERIAL		DATE USED	BATCH NUMBER
SAND		10-27-87	02
		11-12-87	02
BENTONITE		11-10-87	02
		11-12-87	02
STAINLESS STEEL SCREEN	(PREPACKAGED ■ YES ☐ NO)	11-12-87	05
STAINLESS STEEL CASING	(PREPACKAGED ■ YES ☐ NO)	11-12-87	05
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ■ YES ☐ NO)	11-12-87	05
STAINLESS STEEL CAPS	(PREPACKAGED ■ YES ☐ NO)	11-12-87	05
MONITORING WELL PUMP	(PREPACKAGED ■ YES ☐ NO)	4-24-90	05
GROUT		10-27-87	11
		11-10-87	11
WELL COVERS			
SURFACE CASING		10-27-87	02

COMMENTS:

OBSERVER SIGNATURE/DATE [signature] for J.W.A. 11-12-87
John W. Anderson

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 991

POST-WELL COMPLETION CHECKLIST

POST-WELL COMPLETION TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	11/12/87	MLE
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	11/12/87	MLE
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	4/24/90	DCL
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	11/12/87	MLE

* RELEASE SPECIFIC TECHNICAL DIRECTIONS FOR REGULATORY COMPLIANCE MONITORING WELLS PHASE I, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, W.O. K-4147, APRIL 1987.

OBSERVER SIGNATURE/DATE [signature] FOR JWA 11/12/87
John W. Anderson

D. Charles Lytle 4/24/90
D. Charles Lytle

ERCE
Environmental and Energy Services Co.

WELL No. 991
LOCATION: WAG-3

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF DEVELOPMENT: Surging and Pumping

DEVELOPMENT BEGAN DATE: 4/19/90 TIME:

DEVELOPMENT ENDING DATE: 4/24/90

DEVELOPMENT OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 15.4 GALLONS

TOTAL GALLONS PUMPED: 225 TOTAL WELL VOLUMES PUMPED: 14.6

INITIAL pH: 7.6 FINAL pH: 7.8

INITIAL CONDUCTIVITY (µS/cm): 638 FINAL CONDUCTIVITY (µS/cm): 673

DESCRIPTION OF INITIAL TURBIDITY: Slightly Cloudy

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 1.0 NTU's

WELL APPROVED BY: R. C. Williams MMES

ODOR OF WATER: None

WATER DISCHARGED TO:
- ☒ GROUND SURFACE
- ☐ STORM SEWERS
- ☐ DRUMS
- ☐ TANK TRUCK
- ☐ STORAGE TANKS
- ☐ OTHER

INITIAL PRE-DEVELOPMENT WATER DEPTH: 45.6 feet from ground surface.

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 4/24/90
D. Charles Lytle

KV/FTBKLD/VG

ERCE
Environmental and Energy Services Co.

WELL NO. 991
LOCATION: WAG-3
DATE: 4/19/90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 15.4 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (µS/cm)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
4-19-90	1330	115	Slightly Cloudy	--	7.6	638	115	7.5	
4-24-90	1430	110	Clear	1.0	7.8	673	225	14.6	
RESULTS AT END OF DEVELOPMENT			Clear	1.0	7.8	673	225	14.6	

COMMENTS Water cleared rapidly and remained clear even after several cycles after surging. Passed and moved to another hole.

OBSERVER SIGNATURE/DATE D. Charles Lytle 4/24/90
D. Charles Lytle

MWFORM05.DWG

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

(1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967 (ARTICLE IN VOL.3, NO.1 OF WRR ENTITLED "RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER")

(2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN VOL. 12, NØ.3 OF WRR ENTITLED "A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS")

WELL NO.: Ø991 DATE OF TEST: 5/15/90

PROJECT NO.: E221-ØØ2 CLIENT: MMES

SITE LOCATION: WAG-3

EDGE, INC. FIELD INVESTIGATOR: Bruce McMaster

INPUT DATA ARE:

INNER CASING DIAMETER = 2.ØØ INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.ØØ INCHES
DIAMETER OF DRILLED HOLE = 8.63 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 15.ØØ FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 45.6Ø FEET
THICKNESS OF SATURATED AQUIFER ZONE = 15.ØØ FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = .98 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .2Ø
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"Ø" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 32

HØ WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED
VALUES FOR HØ
(FEET)

10.5062
10.5356

ERC / EDGE Environmental and Energy Services Co.

WELL No. 991

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (sec)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	10.010	9.030
20.00	9.610	8.630
30.00	9.390	8.410
40.00	9.210	8.230
50.00	9.050	8.070
60.00	8.910	7.930
75.00	8.680	7.700
90.00	8.450	7.470
105.00	8.230	7.250
120.00	8.010	7.030
150.00	7.590	6.610
180.00	7.170	6.190
240.00	6.420	5.440
300.00	5.750	4.770
360.00	5.150	4.170
420.00	4.630	3.650
480.00	4.180	3.200
540.00	3.760	2.780
600.00	3.400	2.420
720.00	2.800	1.820
840.00	2.340	1.360
960.00	1.990	1.010
1080.00	1.730	.750
1200.00	1.510	.530
1320.00	1.340	.360
1440.00	1.220	.240
1560.00	1.110	.130
1680.00	1.050	.070
1800.00	1.030	.050
1920.00	1.030	.050
2040.00	1.010	.030
2160.00	1.010	.030

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

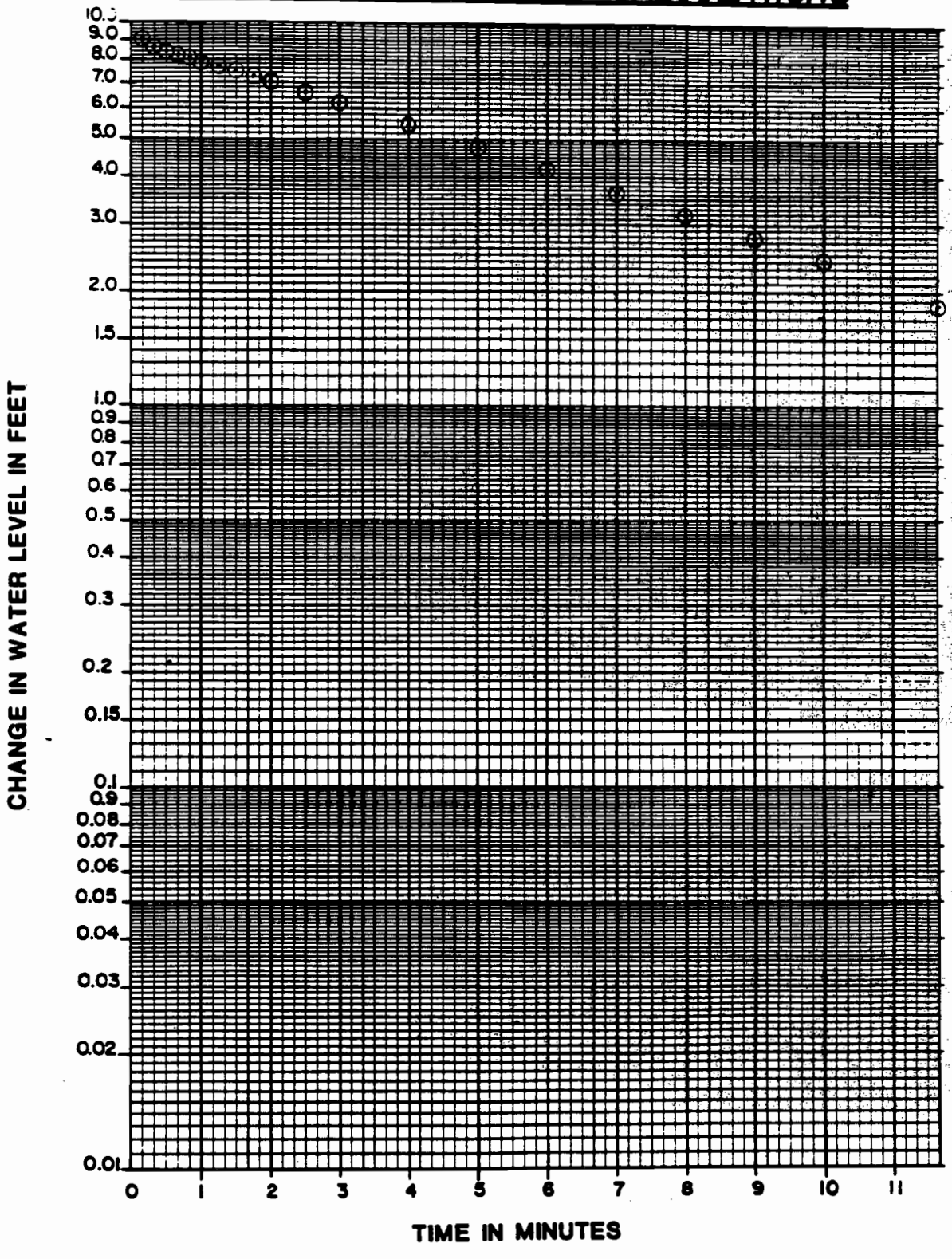
PERMEABILITY = 2.22E-06 FT/sec = 6.76E-05 CM/sec

TRANSMISSIVITY = 3.33E-05 FT**2/sec

ERC / EDGE Environmental and Energy Services Co.

WELL No. 991

HYDRAULIC CONDUCTIVITY CALCULATIONS



EDGe Engineering, Design & Geosciences Group, Inc.
725 Pellissippi Parkway
P.O. Box 23010 Knoxville, Tn 37933-1010 (615)966-9788

WELL No. 991

AREA: SWSA 3

NONCONFORMANCE REPORT

ISSUE DATE: August 10, 1988 DATE OF NONCONFORMANCE: April 1988

DESCRIPTION OF NONCONFORMANCE:

During April, 1988, A. L. Clark Drilling Services, Inc. ran a tremie line in well #991 and grouted the annular space between the 6 5/8" diameter steel casing and the 2" diameter slainless steet casing. Neither A. L. Clark Drilling Services or Construction Engineering informed MCI Consultant Engineers that this was being done. Since MCI was not present when the grouting took place, it cannot confirm whether or not the tremie pipe was placed to the proper depth or how many sacks of grout were used. A. L. Clark III, on April 26, 1988, was unable to recall the length of tremie pipe or the quantity of grout used. The hole had an unwanted 2" bentonite bridge at 35'. If the tremie pipe was not pushed thru this bridge prior to grouting, the annular space (between the 2" s.s. casing and the 6 5/8" diameter steel casing) is still open from 35' down to 60'.

POSSIBLE DETRIMENTAL EFFECTS TO WELL QUALITY:

Possible vertical contamination pathway (Tope of bentonite seal is at 65')

COMMENTS:

OBSERVER OF NONCONFORMANCE:	DATE:
REPORTED BY: Michael L. Ebers	DATE: August 10, 1988
DISTRIBUTION PROJECT MANAGER: Jill Mortimore	DATE SUBMITTED: August 12, 1988
CONSTRUCTION ENGINEER: Steve Laman	DATE SUBMITTED: August 12, 1988

EDGe Engineering, Design & Geosciences Group, Inc.
725 Pellissippi Parkway
P.O. Box 23010 Knoxville, Tn 37933-1010 (615)966-9788

WELL No. 991

AREA: SWSA3

NONCONFORMANCE REPORT

ISSUE DATE: 12/10/87 DATE OF NONCONFORMANCE: 11/13/87

DESCRIPTION OF NONCONFORMANCE:

Installed Centralizers every ten feet above screen-every 20 feet is specified.

POSSIBLE DETRIMENTAL EFFECTS TO WELL QUALITY:

This helped cause the subsequent bridging of the bentonite pellet seal. Numerous attempts were made to remove bridge. Well grouting delayed at least a month, during which time a contaminant pathway existed.

COMMENTS:

OBSERVER OF NONCONFORMANCE: John Anderson	DATE: 12/10/87
REPORTED BY: John Anderson	DATE: 12/10/87
DISTRIBUTION PROJECT MANAGER: Jill Mortimore	DATE SUBMITTED: 12/11/87
CONSTRUCTION ENGINEER: Steve Laman	DATE SUBMITTED: 12/11/87

MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0992 S01

WELL NO.: 0992

LOCATION: SWSA 3 - CONTRACTORS LANDFILL @ 3.0 TO 3.25'

TYPE: SOIL - SPLIT SPOON

SAMPLER: [signature] (SIGNATURE)

DATE: 9/28/87

TIME: 2:11 P.M.

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
[signature]	9/28/87	4:32	MCI	[signature]	9/28/87	4:32 PM	MCI
[signature]	11/25/87	2:40PM	MCI	[signature]	11-25-87	2:40	ORNL

REMARKS:

1.0 General Information

1.1 Well Location

Monitoring well number 992 is located in WAG 3. It is located on the north side of the contractors landfill. The location is shown on ORNL drawing number C3E20004 A075. Survey coordinates for this well are N 21,737.0370, E 25,069.6931 (X-10 grid) or latitude 35°-55'-00.59" and longitude 84°-19'-59.22". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 992 was drilled by A. L. Clark Drilling Services, Inc. A Schramm Rotadrill rig was used to drill this boring for monitor well installation under operation of Rick Pickel with the assistance of Leo Johnson. Drilling commenced on 9-28-87 and was finished on 10-8-87. Paragraph 2.4.1 includes a detailed discussion of the well installation and a well schematic is included on the well installation/completion form. A synopsis of the drilling activity

follows. This information was typed directly from field notes and was edited only when necessary for clarification.

9-28-87 The Schramm Rotadrill was steam cleaned and mobilized to the staked location. The boring was split spooned from 0.0 feet to 11.0 feet and the boring was augered from 0.0 feet to 21.0 feet with 6-inch augers.

9-29-87 The boring was deepened with 6-inch augers from 21 feet to 53.5 feet.

9-30-87 Bailed boring. Dropped auger bit in hole, tried to fish out auger bit.

10-1-87 Bailing hole, dropped bailer, tried to fish out bailer.

10-2-87-10-5-87 Fishing for bailer.

10-6-87 Retrieved bailer, fishing for auger bit.

10-7-87 Bailing well, placed bentonite above lost bit.

10-8-87 Set 2-inch stainless steel screen and casing, sand pack and bentonite.

This well was logged by ERC Environmental and Energy Services Co., Inc., hydrogeologists Dan C. Baughn, Michael L. Ebers and John W. Anderson. All well construction materials and supplies were from Martin Marietta Energy Systems approved batches. The batch origin of individual items is shown on the included Monitoring Well Materials Certification form.

2.0 Technical Information

2.1 Decontamination Procedures

The drilling rig, down hole tools, surface casing, stainless steel screen, stainless steel casing, centralizers, and stainless steel silt trap underwent the cleaning decontamination procedures outlined in the drilling specifications (Release Specific Technical Directions for Regulatory Compliance Monitoring Wells Phase 1, Oak Ridge National Laboratory, Oak Ridge, W.O. K-4147, April 1987, pgs. 2-4). A checklist of the cleaned materials is included with this data package.

2.2 Geology

WAG 3 is located in Melton Valley which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 3 is underlain by limestone, siltstone and shale of the Middle Ordovician Chickamauga Group. The Chickamauga Group consists of eight units, designated by letters "A" to "H" (Stockdale, 1951). WAG 3 is underlain by units E, F, G and H. These units consist of thin bedded nodular limestone with clay and shale partings. A portion of unit H and unit F consists of calcareous siltstone alternating with beds of olive gray to maroon shale. Strike and dip varies from N 45° E to N 55° E and 25° to 35° southeast, respectively.

2.3 Sample Collection

One soil sample was collected during drilling, placed in an I-CHEM specialty cleaned glass container, sealed and submitted to Sample Receiving, Analytical Chemistry Division, Bldg. 4500S, ORNL. A chain of custody form for this sample is included with this data package. Soil sample 992S01 was collected in the split spoon interval from 3.0 feet to 3.25 feet on 9-28-87.

A bulk density soil sample was collected from the split spoon sample interval at 21.0 feet. The sample was measured and weighed, and a bulk density of 2.0 grams/cm^3 was calculated.

2.4 Installation and Development

2.4.1 Installation

This was a "Type A" well. A 2-inch diameter stainless steel silt trap was installed from 48.0 to 52.0 feet. Above the silt trap a 2-inch diameter stainless steel screen was installed from 33.0 to 48.0 feet. A 2-inch diameter stainless steel casing was installed above the screen from 33.0 feet to 2.36 feet above ground surface. A sandpack was then poured into the annular space from 31.0 to 52.0 feet, with a 2-foot bentonite pellet seal poured into the annular space above the sandpack from 29.0 to 31.0 feet. The annular space from the top of the bentonite seal to the surface was

tremie grouted with a cement/bentonite slurry. A detailed schematic of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 992 was developed to remove drill cuttings, silt, and other fines. The monitoring well was developed using a Geoguard pump with an air compressor. All pumps were cleaned prior to use according to specified cleaning procedures (see Paragraph 2.1). The well was developed until a measured total of 320 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was >100 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on 4-23-90 at a depth of 44.9 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 992 was not tested for hydraulic conductivity. The water level in the well was too low

for a falling head test. A stainless steel slug would not pass by a tight spot in the well screen thus prohibiting a rising head test.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 992

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

PRE-DRILLING TASKS		COMPLIANCE DATE	COMPLIANCE INITIALS
1.	EXCAVATION PERMIT OBTAINED.	9/28/87	MLE
2.	ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	9/28/87	MLE
3a.	SCREEN AND CASINGS HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	N/A	
3b.	PRE-PACKAGED SCREENS, CASINGS AND CENTRALIZERS WERE USED.	10/08/87	MLE
4.	WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	9/28/87	MLE
5.	CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON-HAND.	9/28/87	MLE
6.	POLYETHYLENE COVER IN PLACE OVER HOLE.	9/28/87	MLE

ADDITIONAL NOTES/OBSERVATIONS:

OBSERVER SIGNATURE/DATE [signature] 9/28/87

Michael L. Ebers

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 992

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

EQUIPMENT	SCRAPE	STEAM CLEAN	STEAM RINSE	ISOPROPYL ALCOHOL RINSE	DEIONIZED WATER RINSE
RIG	X	X	X	N/A	N/A
AUGERS	X	X	X	X	X
BITS	X	X	X	X	X
RODS	X	X	X	X	X
SAMPLERS	X	X	X	X	X
PIPES	X	X	X	X	X
WORK TOOLS	X	X	X	X	X
AUGER PINS	X	X	X	X	X

OBSERVER SIGNATURE/DATE _____ 9/28/87
Michael L. Ebers

ERC / EDGE Environmental and Energy Services Co.

WELL No. 992

ORNL MONITORING WELL LOG

PAGE 1 OF 2

LOCATION: WAG-3 at N. End of Contractors Landfill

DRILLER: Rick Pickle

HELPER: Leo Johnson

DRILL: Schramm

DATE: START: 9/28/87

FINISH: 10/08/87

LOGGED BY: Daniel C. Baughn/ Michael L. Ebers/ John W. Anderson

HEALTH PHYSICIST: Paul Eldridge

TYPE DRILLING: Split Spoon/Auger

LUBRICANT TYPE: Molykote 1000

No. SAMPLES TAKEN: One

TYPE: Soil

CONTAINMENT TYPE: Auger Pan and Plastic

THICKNESS OF SOIL (REFUSAL DEPTH): 42.0

DEPTH DRILLED IN ROCK: 11.5

TOTAL DEPTH OF WELL: 53.5

DRILLING FLUID SAMPLES:

TYPE: N/A DATE:

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
0.0	2.25		100%	Clay - red to reddish brown with fine root
				channels and roots, isolated nodules of dark
				friable material (possibly an Mn/Fe oxide).
				Slightly silty, negligible moisture.
2.25	4.35	0992S01		Clay - reddish brown with angular pieces of
		@3.0-3.25'		very fine sandstone - friable with cement
				weathered out light tan, predominant with
				some very light red. Nodules at dark
				"oxidized" material still apparent but
				gradually thinning out by 3' interval.
				Slightly silty, negligible moisture.
4.35	6.55		100%	Clay - red, mottled light brown with less
				sandstone and only light tan variety (no
				red ss.). Dark oxized material rare,
				slightly silty, negligible moisture.
				Difficulty obtaining sample - raised rig
				while driving spoons. However, no rock
				debris in base of drive shown.
6.55	8.80		100%	Clay red mottled light brown as above with the
				exception of the reappearance of the dark
				"oxidized" nodules at 8.15'. Decrease in

ERC / EDGE Environmental and Energy Services Co.

WELL No. 992

ORNL MONITORING WELL LOG

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
6.55	8.80			(continued from page 1) silt fraction,
				negligible moisture.
8.8	11.0			Clay, red mottled dark red to light brown,
				with dark "oxidized" nodules and very fine
				sandstone occuring with angular pebble sized
				fragments throughout. Refusal, but in clay -
				very stiff with negligible moisture.
11.0	21.0			Very stiff augering, returns are black frag-
				ments of mottled red and brown clay which
				appears in contorted layers.- possibly reflect
				bedding features?
21.0	26.0			Clay - red and mottled light brown as above
				with slight increase in moisture.
				Bulk Density = 2.0 grams/cm^3.
26.0	26.5			Chert? Cobble.
26.5	42.0			Clay, light brown, plastic, damp to almost
				moist, fairly soft.
42.0	42.5			Limestone, hard.
42.5	43.0			Clay, soft, cavity fill?
43.0	46.5			Limestone, fairly hard.
46.5	52.5			Cavity, filled with mud and water.
52.5	53.5			Limestone.
	53.5			Total Depth
				Note: Lost auger bit in bottom of boring,
				could not recover - put a 2" layer of bento-
				nite pellets in bottom of boring in an effort
				to seal it off. Abundant water while
				bailing.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 992

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: John W. Anderson/ Michael L. Ebers

PROOFED BY: Michael L. Ebers

DRILLING COMPANY: A. L. Clark Drilling Services

DRILLER: Richard Pickel HELPER: Leo Johnson

EQUIPMENT ☒ 7.0 INCH AUGER 53.5 L.F.

☐ _____ INCH AUGER _____ L.F.

LOCATION WAG-3

ORNL GRID COORDINATES

N 21,737.0370

E 25,069.6931

ELEV. GROUND 854.54

ELEV. TOP STAINLESS STEEL CASING 856.90

DRILLING DATES:

STARTED: 9-28-87

FINISHED: 10-08-87

MATERIALS USED

EST. VOL.	USED VOL.	
	15.0	FEET OF 2.0 IN. S.S. SCREEN
	35.0	FEET OF 2.0 IN. S.S. CASING
4	24	SACKS OF SAND
45	45	POUNDS OF BENTONITE PELLETS
3.8	5.5	SACKS OF CEMENT
	11.0	POUNDS OF POWDERED BENTONITE
	33.0	GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

Sand-fill void.

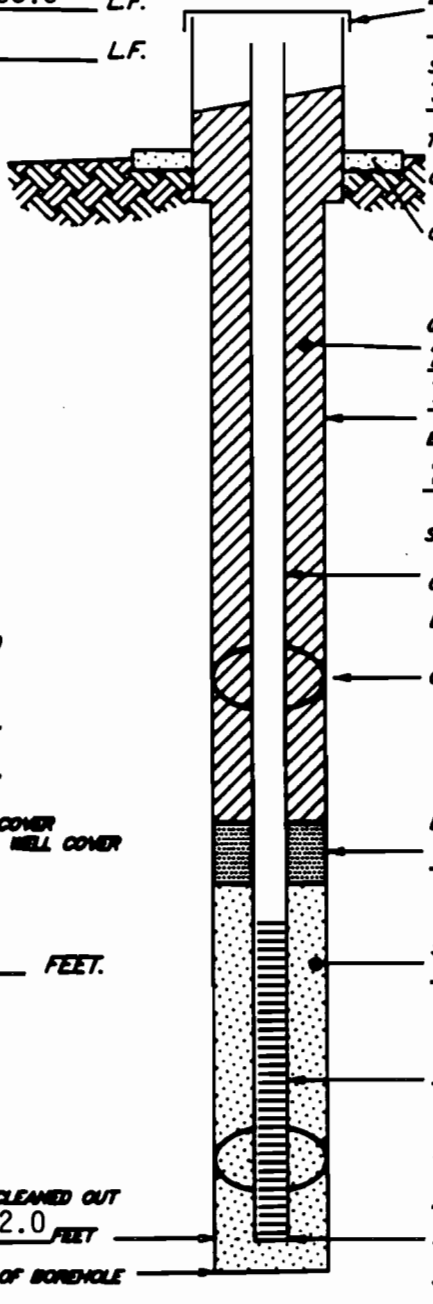
WELL COVER USED ☐ LOCKING STEEL COVER ☐ FLUSH MOUNTED WELL COVER ☐ OTHER

SILT TRAP USED YES ☐ NO ☐

MONITORING WELL PUMP BASE SET AT 44.9 FEET.

CENTRALIZERS AT 15.0 FEET. 34.0 FEET. 40.0 FEET.

NOTE:
ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:



LOCKING STEEL COVER 8 INCH DIAMETER

STEEL PROTECTIVE CASING 3.29 FT. ABOVE GROUND TO 2.0 FT. BELOW GROUND SURFACE

CONCRETE PAD

GROUT SEAL 0.0 TO 29.0 FEET

10.0 INCH DIAMETER BOREHOLE

2.0 INCH DIAMETER STAINLESS STEEL CASING 2.36 FT. ABOVE GROUND SURFACE TO 33.0 FT. BELOW GROUND SURFACE

CENTRALIZER (TYP.)

BENTONITE PELLET SEAL 29.0 TO 31.0 FEET

SAND PACK 31.0 TO 52.0 FEET

2 INCH DIAMETER STAINLESS STEEL 0.010 SLOTTED SCREEN 33.0 TO 48.0 FEET

2.0 INCH DIAMETER STAINLESS STEEL SILT TRAP/CAP 48.0 TO 52.0 FEET

HOLE CLEANED OUT TO 52.0 FEET

BOTTOM OF BOREHOLE 53.5 FEET

TYPE A WELL

NOT TO SCALE

ERC / EDGE Environmental and Energy Services Co.

WELL No. 992

DATE: 9/28/87

MONITORING WELL MATERIALS CERTIFICATION

ITEM/MATERIAL		DATE USED	BATCH NUMBER
SAND		10/08/87	2
BENTONITE		10/08/87	2
STAINLESS STEEL SCREEN	(PREPACKAGED ■ YES ☐ NO)	10/08/87	5
STAINLESS STEEL CASING	(PREPACKAGED ■ YES ☐ NO)	10/08/87	5
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ■ YES ☐ NO)	10/08/87	5
STAINLESS STEEL CAPS	(PREPACKAGED ■ YES ☐ NO)	10/08/87	5
MONITORING WELL PUMP	(PREPACKAGED ■ YES ☐ NO)	4/23/90	5
GROUT		10/09/87	11
WELL COVERS			
SURFACE CASING		10/87	2

COMMENTS:

OBSERVER SIGNATURE/DATE Michael L. Ebers 10/08/87

Michael L. Ebers

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 992

POST-WELL COMPLETION CHECKLIST

POST-WELL COMPLETION TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	10/08/87	MLE
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	10/08/87	MLE
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	4/23/90	DCL
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	10/08/87	MLE

* RELEASE SPECIFIC TECHNICAL DIRECTIONS FOR REGULATORY COMPLIANCE MONITORING WELLS PHASE I, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, W.O. K-4147, APRIL 1987.

OBSERVER SIGNATURE/DATE Michael L. Ebers 10/08/87
Michael L. Ebers

D. Charles Lytle 4/23/90
D. Charles Lytle

ERCE
Environmental and Energy Services Co.

WELL No. 992
LOCATION: WAG-3

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF DEVELOPMENT: Surging and Pumping

DEVELOPMENT BEGAN DATE: 4/03/90 TIME:

DEVELOPMENT ENDING DATE: 4/23/90

DEVELOPMENT OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 10.4 GALLONS

TOTAL GALLONS PUMPED: 320 TOTAL WELL VOLUMES PUMPED: 30.8

INITIAL pH: 7.4 FINAL pH: 7.5

INITIAL CONDUCTIVITY (µS/cm): 923 FINAL CONDUCTIVITY (µS/cm): 951

DESCRIPTION OF INITIAL TURBIDITY: Muddy

DESCRIPTION OF FINAL TURBIDITY: Muddy

FINAL MEASURED TURBIDITY: Greater than 100 NTU's

WELL APPROVED BY: R. C. Williams MMES

ODOR OF WATER: None

WATER DISCHARGED TO:
- ☒ GROUND SURFACE
- ☐ STORM SEWERS
- ☐ DRUMS
- ☐ TANK TRUCK
- ☐ STORAGE TANKS
- ☐ OTHER

INITIAL PRE-DEVELOPMENT WATER DEPTH: 36.0 feet from ground surface.

DEVELOPMENT OBSERVATIONS

Well has bend in stainless steel casing, can only measure to 50.4 feet.

Had to develop with work over rig.

OBSERVER SIGNATURE/DATE D. Charles Lytle 4/23/90

D. Charles Lytle

ERCE
Environmental and Energy Services Co.

WELL NO. 992
LOCATION: WAG-3
DATE: 4/03/90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 10.4 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (µS/cm)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
4-17-90	1430	95	Muddy	--	7.4	923	95	9.1	
4-23-90	1400	225	Muddy	*	7.5	951	320	30.8	
RESULTS AT END OF DEVELOPMENT			Muddy	*	7.5	951	320	30.8	

COMMENTS Well was crooked. Had to develop with work over rig. Poor producer, dried quickly, remained muddy and would not clear. Had to pass on account of 30.8 well volumes and moved to another hole.

* Greater than 100 NTU's.

OBSERVER SIGNATURE/DATE D. Charles Lytle 4/23/90
D. Charles Lytle

MWFORM05.DWG

1.0 General Information

1.1 Well Location

Monitoring well number 993 is located in WAG 3. It is located in the northeastern corner of the contractors landfill. The location is shown on ORNL drawing number C3E20004 A075. Survey coordinates for this well are N 21,884.3521, E 25,619.0831 (X-10 grid) or latitude 35°-55'-04.82" and longitude 84°-19'-54.66". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 993 was drilled by A. L. Clark Drilling Services, Inc. A Gus Pech rig was used to drill this boring for monitor well installation under operation of A. L. Clark, III with the assistance of Leo Johnson. Drilling commenced on 12-2-87 and was finished on 12-9-87. Paragraph 2.4.1 includes a detailed discussion of the well installation and a well schematic is included on the well installation/completion form. A synopsis of the drilling activity

follows. This information was typed directly from field notes and was edited only when necessary for clarification.

12-2-87	The rig was mobilized to the staked location and set up.
12-3-87	The boring was split spooned from 0.0 feet to 10.0 feet and augered from 0.0 feet to 10.8 feet with 14-inch augers.
12-4-87	A 12-foot section of 10-inch surface casing was steam cleaned, set in the boring and grouted.
12-7-87	The boring was deepened with an 8-inch hammer bit.
12-8-87	The boring was set with 4-inch stainless steel casing and screen. A sandpack and bentonite seal were installed.
12-9-87	The annular space was grouted.

This well was logged by ERC Environmental and Energy Services Co., Inc., hydrogeologist Bryn D. Howze. All well construction materials and supplies were from Martin Marietta Energy Systems approved batches. The batch origin of individual items is shown on the included Monitoring Well Materials Certification form.

2.0 Technical Information

2.1 Decontamination Procedures

The drilling rig, down hole tools, surface casing, stainless steel screen, stainless steel casing, centralizers, and stainless steel silt trap underwent

the cleaning decontamination procedures outlined in the drilling specifications (Release Specific Technical Directions for Regulatory Compliance Monitoring Wells Phase 1, Oak Ridge National Laboratory, Oak Ridge, W.O. K-4147, April 1987, pgs. 2-4). A checklist of the cleaned materials is included with this data package.

2.2 Geology

WAG 3 is located in Melton Valley which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 3 is underlain by limestone, siltstone and shale of the Middle Ordovician Chickamauga Group. The Chickamauga Group consists of eight units, designated by letters "A" to "H" (Stockdale, 1951). WAG 3 is underlain by units E, F, G and H. These units consist of thin bedded nodular limestone with clay and shale partings. A portion of unit H and unit F consists of calcareous siltstone alternating with beds of olive gray to maroon shale. Strike and dip varies from N 45° E to N 55° E and 25° to 35° southeast, respectively.

2.3 Sample Collection

Two soil samples were collected during drilling, placed in I-CHEM specialty cleaned glass containers, sealed and submitted to Sample Receiving, Analytical Chemistry Division, Bldg. 4500S, ORNL. Chain of custody forms for these samples are included with this data package. Soil sample 993S1 was collected in the augered/split spoon interval from 0.5 feet to 0.7 feet

on 12-3-87 and soil sample 993S2 was collected in the split spoon interval from 9.6 feet to 9.8 feet on 12-3-87.

A drill water sample was collected from the water pump on the drill rig on 12-7-87. Analytical results for the three samples described above can be obtained from the Remedial Action Program data base at ORNL.

2.4 Installation and Development

2.4.1 Installation

This was a "Type B" well. A 14-inch diameter boring was augered from ground surface to bedrock (10.8 feet). A 10-inch diameter string of decontaminated steel surface casing was installed and tremie grouted in place. The surface casing minimizes potential cross contamination between the regolith and bedrock water bearing zones. The air rotary method was then used to drill an 8-inch diameter boring to a total depth of 45.0 feet. A 4-inch diameter stainless steel silt trap was installed from 44.7 to 45.0 feet. Above the silt trap, a 4-inch diameter stainless steel screen was installed from 23.9 feet to 44.7 feet. A 4-inch diameter stainless steel casing was installed from the top of the screen at 23.9 feet and extending 1.75 feet above ground surface. A sandpack was then poured into the annular space from 21.9 to 45.0 feet, with a 2.4-foot bentonite seal poured into the annular space above the sandpack from 19.5 to 21.9 feet. The annular space from the top of the bentonite seal to the surface was tremie grouted with a cement/bentonite

slurry. A detailed schematic of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 993 was developed to remove drill cuttings, silt, and other fines. The monitoring well was developed using a Geoguard pump with an air compressor. All pumps were cleaned prior to use according to specified cleaning procedures (see Paragraph 2.1). The well was developed until a measured total of 564 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was 2.0 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on 5-7-90 at a depth of 42.6 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 993 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity of the well screen. This was accomplished by

instantaneously adding a known quantity of water to the monitoring well and measuring the recovery of the water level over time. The changing water levels were measured using a Druck 15 psig pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 3.67 x 10^{-4} cm/second (shown as permeability on the hydraulic conductivity calculations printout attached) was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 993

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

PRE-DRILLING TASKS		COMPLIANCE DATE	COMPLIANCE INITIALS
1.	EXCAVATION PERMIT OBTAINED.	12/03/87	BDH
2.	ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	12/03/87	BDH
3a.	SCREEN AND CASINGS HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	N/A	
3b.	PRE-PACKAGED SCREENS, CASINGS AND CENTRALIZERS WERE USED.	12/08/87	BDH
4.	WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	12/03/87	BDH
5.	CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON-HAND.	12/03/87	BDH
6.	POLYETHYLENE COVER IN PLACE OVER HOLE.	12/03/87	BDH

ADDITIONAL NOTES/OBSERVATIONS:

OBSERVER SIGNATURE/DATE Bryn D. Howze 12/03/87

Bryn D. Howze

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 993

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

EQUIPMENT	SCRAPE	STEAM CLEAN	STEAM RINSE	ISOPROPYL ALCOHOL RINSE	DEIONIZED WATER RINSE
RIG	X	X	X	N/A	N/A
AUGERS	X	X	X	X	X
BITS	X	X	X	X	X
RODS	X	X	X	X	X
SAMPLERS	X	X	X	X	X
PIPES	X	X	X	X	X
WORK TOOLS	X	X	X	X	X
AUGER PINS	X	X	X	X	X

OBSERVER SIGNATURE/DATE Bryn D. Howze 12/02/87
Bryn D. Howze

ERC / EDGE Environmental and Energy Services Co.

WELL No. 993

ORNL MONITORING WELL LOG

LOCATION: SWSA 3
DRILLER: Avery L. Clark II
HELPER: Leo Johnson
DRILL: Gus Pech

DATE: START: 12/03/87
FINISH: 12/09/87
LOGGED BY: Bryn D. Howze
HEALTH PHYSICIST: Paul Eldridge

TYPE DRILLING: Auger, Air Rotary
LUBRICANT TYPE: Green Stuff
No. SAMPLES TAKEN: 3
TYPE: 2 Soil/1 Drilling Water
CONTAINMENT TYPE: Plastic, Auger Pan, Containment Box

THICKNESS OF SOIL (REFUSAL DEPTH): 10.0'
DEPTH DRILLED IN ROCK: 35.0'
TOTAL DEPTH OF WELL: 45.0'

DRILLING FLUID SAMPLES:
TYPE: Water DATE: 12/07/87

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
0.0	0.4		100%	Topsoil, silt, medium to dark brown, with roots and rock fragments, firm.
0.4	4.6	0993 S1 0.5-0.7'	100%	Silt, slightly sandy, light brown, mottled black, orange, yellow, with weathered rock fragments, very stiff (more clayey in lower 0.5').
4.6	5.2		100%	Weathered limestone and clay, slightly silty, limestone, light gray (weathered) to greenish gray (fresh) appears as float in clay that is slightly silty, medium brown to orange brown, mottled black, yellow, red, greenish gray, very stiff.
5.2	6.8		100%	Clay, slightly silty, medium brown to orange brown, mottled black, yellow, red, greenish gray, very stiff.
6.8	10.0	0993 S2 9.6-9.8'	100%	Silt, very clayey, medium brown, mottled orange, black, yellow, red, weathered limestone at 10.0', very stiff to hard.
10.0	10.8			Limestone, light gray, weathered. Auger refusal at 10.8'. No detailed lithologic description available from 10.8' to 45.0' due

ERC / EDGE Environmental and Energy Services Co.

WELL No. 993

ORNL MONITORING WELL LOG

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
10.0	10.8			(continued from page 1) to use of containment
				box; used 8" hammer bit with no oil added for
				lubrication.
10.8	15.7			Soft drilling with thin hard streaks.
15.7	28.3			Hard drilling.
28.3	32.0			Soft drilling.
32.0	45.0			Hard drilling with a few thin soft streaks.
	45.0			Total Depth

ERC / EDGE Environmental and Energy Services Co.

WELL No. 993

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: Bryn D. Howze

PROOFED BY: Michael L. Ebers

DRILLING COMPANY: A.-L. Clark Drilling Co.

DRILLER: Avery L. Clark, II HELPER: Leo Johnson

DRILLING METHOD:
- ☒ 14 INCH AUGER 10.8 L.F.
- ☐ INCH AUGER L.F.
- ☒ 8 INCH ROTARY 34.2 L.F.
- ☐ INCH ROTARY L.F.

LOCATION SWSA-3

ORNL GRID COORDINATES
N 21,884.3521
E 25,619.0831

ELEV. GROUND 840.39

ELEV. TOP STAINLESS STEEL CASING 842.14

DRILLING DATES:
STARTED: 12-03-87
FINISHED: 12-09-87

MATERIALS USED

EST. VOL.	USED VOL.	
	50	POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
	12.0	FT. OF 10 IN. SURFACE CASING
3.3	4	SACKS OF CEMENT (SURFACE CASING)
	7.5	POUNDS OF POWERED BENTONITE (SURFACE CASING)
	24	GALLONS OF WATER (SURFACE CASING)
	25.0	FT. OF 4 IN. DIA. STAINLESS STEEL CASING
	20.8	FT. OF 4 IN. DIA. STAINLESS STEEL SCREEN
7.5	6	SACKS OF SAND
50	50	POUNDS OF BENTONITE PELLETS
6	8	SACKS OF CEMENT (WELL CASING)
	15	POUNDS OF POWERED BENTONITE (WELL CASING)
	48	GALLONS OF WATER (WELL CASING)
	13.9	FT. OF 10 IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES
Cavities and Spillage.

SURFACE CASING TREMIE GROUTED YES ☒ NO ☐

STAINLESS STEEL CASING TREMIE GROUTED YES ☒ NO ☐

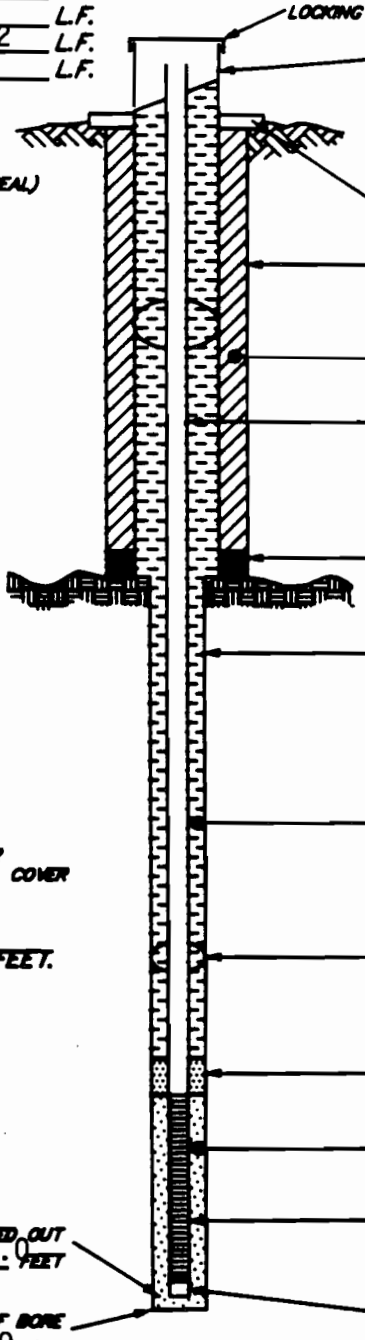
WELL COVER USED
- ☒ LOCKING STEEL COVER
- ☐ FLUSH MOUNTED WELL COVER
- ☐ OTHER

SILT TRAP USED YES ☒ NO ☐

MONITORING WELL PUMP BASE SET AT 42.6 FEET.

CENTRALIZERS AT 3.0 FEET.
23.5 FEET.
45.0 FEET.

NOTE:
ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:



LOCKING CAP

10 IN. DIA. SURFACE/PROTECTIVE CASING 3.03 FEET ABOVE GROUND SURFACE TO 10.8 FEET BELOW GROUND SURFACE

CONCRETE PAD

14 IN. DIA. BORE HOLE 0.0 TO 10.8 FEET

GROUT SEAL 0.0 TO 9.8 FEET

4 IN. STAINLESS STEEL CASING 1.75 FEET ABOVE GROUND SURFACE TO 23.9 FEET BELOW GROUND SURFACE

Bentonite SEAL 9.8 TO 10.8 FEET

BEDROCK LEVEL 10.0

8 IN. DIA. BORE HOLE

GROUT SEAL 0.0 TO 19.5 FEET

CENTRALIZER

BENTONITE PELLET SEAL 19.5 TO 21.9 FEET

SAND PACK 21.9 TO 45.0 FEET

4 IN. DIA. STAINLESS STEEL SLOTTED SCREEN 23.9 TO 44.7 FEET

4 IN. DIA. STAINLESS STEEL SILT TRAP/CAP 44.7 TO 45.0 FEET

HOLE CLEANED OUT TO 45.0 FEET

BOTTOM OF BORE HOLE 45.0 FEET

TYPE B WELL

ERC / EDGE Environmental and Energy Services Co.

WELL No. 993

DATE: 12/09/87

MONITORING WELL MATERIALS CERTIFICATION

ITEM/MATERIAL		DATE USED	BATCH NUMBER
SAND		12/04/87	3
		12/08/87	3
BENTONITE		12/04/87	3
		12/08/87	3
STAINLESS STEEL SCREEN	(PREPACKAGED ■ YES ☐ NO)	12/08/87	5
STAINLESS STEEL CASING	(PREPACKAGED ■ YES ☐ NO)	12/08/87	5
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ■ YES ☐ NO)	12/08/87	5
STAINLESS STEEL CAPS	(PREPACKAGED ■ YES ☐ NO)	12/08/87	5
MONITORING WELL PUMP	(PREPACKAGED ■ YES ☐ NO)	5/07/90	5
GROUT		12/04/87	15
		12/09/87	15
WELL COVERS			
SURFACE CASING		12/04/87	2

COMMENTS:

OBSERVER SIGNATURE/DATE Bryn D. Howze 12/09/87
Bryn D. Howze

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 993

POST-WELL COMPLETION CHECKLIST

POST-WELL COMPLETION TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	12/09/87	BDH
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	12/09/87	BDH
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	5/07/90	DCL
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	12/09/87	BDH

* RELEASE SPECIFIC TECHNICAL DIRECTIONS FOR REGULATORY COMPLIANCE MONITORING WELLS PHASE I, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, W.O. K-4147, APRIL 1987.

OBSERVER SIGNATURE/DATE Bryn D. Howze 12/09/87
Bryn D. Howze

D. Charles Lytle 5/07/90
D. Charles Lytle

ERCE
Environmental and Energy Services Co.

WELL No. 993

LOCATION: WAG-3

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF DEVELOPMENT: Surging and Pumping

DEVELOPMENT BEGAN DATE: 4/06/90 TIME:

DEVELOPMENT ENDING DATE: 5/07/90

DEVELOPMENT OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 31.2 GALLONS

TOTAL GALLONS PUMPED: 564 TOTAL WELL VOLUMES PUMPED: 18.1

INITIAL pH: 7.5 FINAL pH: 7.7

INITIAL CONDUCTIVITY (µS/cm): 769 FINAL CONDUCTIVITY (µS/cm): 549

DESCRIPTION OF INITIAL TURBIDITY: Cloudy

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 2.0 NTU's

WELL APPROVED BY: R. C. Williams MMES

ODOR OF WATER: None

WATER DISCHARGED TO:
- ☒ GROUND SURFACE
- ☐ STORM SEWERS
- ☐ DRUMS
- ☐ TANK TRUCK
- ☐ STORAGE TANKS
- ☐ OTHER

INITIAL PRE-DEVELOPMENT WATER DEPTH: 21.6 feet from ground surface.

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 5/07/90

D. Charles Lytle

ERCE
Environmental and Energy Services Co.

WELL NO. 993
LOCATION: WAG-3
DATE: 4/06/90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 31.2 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (µS/cm)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
4-06-90	1400	12	Cloudy	--	7.5	769	12		
5-01-90	1400	213	Cloudy	--	7.6	811	225	7.2	
5-02-90	0930	81	Slightly Cloudy	--	7.6	475	306	9.8	
5-03-90	0900	75	Slightly Cloudy	--	7.7	497	381	12.2	
5-03-90	1100	48	Slightly Cloudy	--	7.8	584	429	13.7	
5-03-90	1330	15	Cloudy	--	7.9	579	441	14.1	
5-04-90	0900	44	Cloudy	--	7.8	386	485	15.5	
5-04-90	1330	35	Cloudy	--	7.3	503	520	16.6	
5-07-90	1100	34	Slightly Cloudy	--	7.7	509	554	17.7	
5-07-90	1300	10	Clear	2.0	7.7	549	564	18.1	
RESULTS AT END OF DEVELOPMENT			Clear	2.0	7.7	549	564	18.1	

COMMENTS

Nice producer, stays clear after surging. Passed with 2.0 NTU's and moved to another hole.

OBSERVER SIGNATURE/DATE D. Charles Lytle 5/07/90
D. Charles Lytle

MWFORM05.DWG

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

(1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967 (ARTICLE IN VOL.3, NO.1 OF WRR ENTITLED "RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER")

(2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN VOL. 12, NO.3 OF WRR ENTITLED "A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS")

WELL NO.: 993 DATE OF TEST: 5/15/90

PROJECT NO.: E221-001 CLIENT: MMES

SITE LOCATION: X10

EDGE, INC. FIELD INVESTIGATOR: BRUCE McMASTER

INPUT DATA ARE:

INNER CASING DIAMETER = 4.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 4.00 INCHES
DIAMETER OF DRILLED HOLE = 8.63 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 20.80 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 22.80 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 20.80 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = .98 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .30
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 20

HO WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED
VALUES FOR HO
(FEET)

2.3483
2.2432

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 993

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SECOND)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	3.150	2.170
20.00	3.030	2.050
30.00	2.910	1.930
40.00	2.790	1.810
50.00	2.690	1.710
60.00	2.590	1.610
75.00	2.460	1.480
90.00	2.340	1.360
105.00	2.230	1.250
120.00	2.130	1.150
150.00	1.930	.950
180.00	1.750	.770
240.00	1.490	.510
300.00	1.360	.380
360.00	1.250	.270
420.00	1.170	.190
480.00	1.140	.160
540.00	1.100	.120
600.00	1.050	.070
720.00	1.000	.020

****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = 1.20E-05 FT/SECOND = 3.67E-04 CM/SEC

TRANSMISSIVITY = 2.51E-04 FT**2/SECOND

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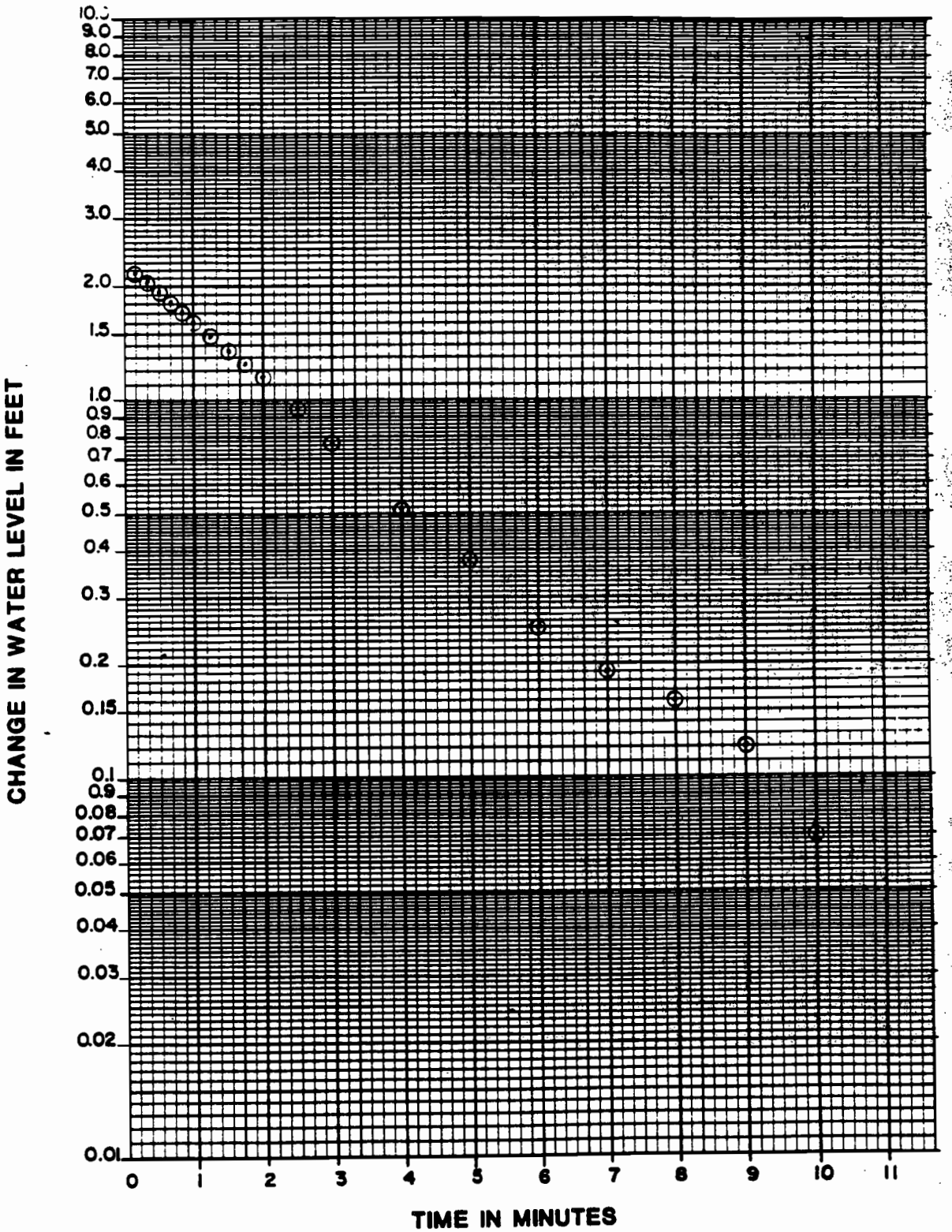
WELL No. 993

HYDRAULIC CONDUCTIVITY CALCULATIONS



MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0993 S1

WELL NO.: 993

LOCATION: SWSA 3

TYPE: Soil

SAMPLER: Bryan House (SIGNATURE)

0.5' - 0.7'

DATE: 12/3/87

TIME: 11:10 AM

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
Bryan House	12/14/87	9:16 AM	MCI	Nancy Owen	12-14-87	9:16	ORNL

REMARKS:

MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0993 52

WELL NO.: 993

LOCATION: SWSA 3 9.6' - 9.8'

TYPE: Soil

SAMPLER: Bryn Horne (SIGNATURE)

DATE: 12/3/87

TIME: 11:40 AM

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
Bryn Horne	12/14/87	9:16 AM	MCI	Nancy Dover	12-14-87	9:16	ORNL

REMARKS:

MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0993 W1

WELL NO.: 993

LOCATION: SWSA 3

TYPE: Drilling Water

SAMPLER: Bryan Horne (SIGNATURE)

DATE: 12/7/87

TIME: 11:30 AM

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
Bryan Horne	12/14/87	9:16AM	McI	Nancy Owen	12-14-87	9:16	ORNL

REMARKS:

1.0 General Information

1.1 Well Location

Monitoring well number 994 is located in WAG 3. It is located in the northeast corner of the contractors landfill. The location is shown on ORNL drawing number C3E20004 A075. Survey coordinates for this well are N 21,895.0273, E 25,639.9173 (X-10 grid) or latitude 35°-55'-05.02" and longitude 84°-19-54.52". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 994 was drilled by A. L. Clark Drilling Services Co. A Gus Pech rig was used to drill this boring for monitor well installation under operation of A. L. Clark III with the assistance of Leo Johnson. Drilling commenced on 12-6-87 and was finished on 1-4-88. Paragraph 2.4.1 includes a detailed discussion of the well installation and a well schematic is included on the well installation/completion form. A synopsis of the drilling activity

follows. This information was typed directly from field notes and was edited only when necessary for clarification.

12-16-87 The Gus Pech drill rig was steam cleaned and mobilized to the staked location and set up. The boring was drilled from 0.0 feet to 16.8 feet with 14-inch augers.

12-17-87 The boring was deepened to 17.6 feet with 14-inch augers.

12-18-87 Set and grouted 19 feet of 10-inch surface casing.

12-21 - 12-22-87 The containment box was cleaned out.

12-28-87 Set 60 feet of 4-inch stainless steel casing and grouted annulus.

12-31-87 Steam cleaned drill rods and bit and drilled from 60.0 feet to 80.5 feet with a 3 7/8" tricone bit.

1-4-88 Checked water level, blew hole dry and pulled rig off site.

This well was logged by ERC Environmental and Energy Services Co., Inc., hydrogeologist Bryn D. Howze. All well construction materials and supplies were from Martin Marietta Energy Systems approved batches. The batch origin of individual items is shown on the included Monitoring Well Materials Certification form.

2.0 Technical Information

2.1 Decontamination Procedures

The drilling rig, down hole tools, surface casing, stainless steel screen, stainless steel casing, centralizers, and stainless steel silt trap underwent the cleaning decontamination procedures outlined in the drilling specifications (Release Specific Technical Directions for Regulatory Compliance Monitoring Wells Phase 1, Oak Ridge National Laboratory, Oak Ridge, W.O. K-4147, April 1987, pgs. 2-4). A checklist of the cleaned materials is included with this data package.

2.2 Geology

WAG 3 is located in Melton Valley which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 3 is underlain by limestone, siltstone and shale of the Middle Ordovician Chickamauga Group. The Chickamauga Group consists of eight units, designated by letters "A" to "H" (Stockdale, 1951). WAG 3 is underlain by units E, F, G and H. These units consist of thin bedded nodular limestone with clay and shale partings. A portion of unit H and unit F consists of calcareous siltstone alternating with beds of olive gray to maroon shale. Strike and dip varies from N 45° E to N 55° E and 25° to 35° southeast, respectively.

2.3 Sample Collection

A drill water sample was collected from the water pump on the drill rig on 12-31-87. Analytical results for the water sample described above can be obtained from the Remedial Action Program data base at ORNL.

2.4 Installation and Development

2.4.1 Installation

This was an open hole or "Type C" well, without a stainless steel screen. A 14-inch diameter boring was augered from ground surface to bedrock (17.6 feet). A 10-inch diameter string of decontaminated steel surface casing was installed and grouted in place. The surface casing minimizes potential cross contamination between the regolith and bedrock water bearing zones. The air rotary method was then used to drill an 8-inch diameter boring to a depth of 60.0 feet. A 4-inch diameter stainless steel casing was installed and a 1.1-foot bentonite seal installed from 58.0 feet to 59.1 feet. The boring was tremie grouted from the top of the bentonite seal at 58.0 feet to ground surface. The air rotary method was then used to drill a 3 7/8-inch diameter boring (open hole interval) from the bottom of the 4-inch diameter stainless steel casing at 60.0 feet to a total depth of 80.5 feet. A detailed schematic of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 994 was developed to remove drill cuttings, silt, and other fines. The monitoring well was developed using a Geoguard pump with an air compressor. All pumps were cleaned prior to use according to specified cleaning procedures (see Paragraph 2.1). The well was developed until a measured total of 340 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was 2.0 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on 4-17-90 at a depth of 78.2 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 994 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity of the well screen. This was accomplished by instantaneously adding a known quantity of water to the monitoring well and measuring the recovery of the water level over time. The changing water levels were

measured using a Druck 15 psig pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 7.01×10^{-5} cm/second (shown as permeability on the hydraulic conductivity calculations printout attached) was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 994

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

PRE-DRILLING TASKS		COMPLIANCE DATE	COMPLIANCE INITIALS
1.	EXCAVATION PERMIT OBTAINED.	12/16/87	BDH
2.	ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	12/16/87	BDH
3a.	SCREEN AND CASINGS HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	N/A	
3b.	PRE-PACKAGED SCREENS, CASINGS AND CENTRALIZERS WERE USED.	12/29/87	BDH
4.	WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	12/16/87	BDH
5.	CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON-HAND.	12/16/87	BDH
6.	POLYETHYLENE COVER IN PLACE OVER HOLE.	12/16/87	BDH

ADDITIONAL NOTES/OBSERVATIONS:

OBSERVER SIGNATURE/DATE Bryn D. Howze 12/16/87

Bryn D. Howze

ERC / EDGE Environmental and Energy Services Co.

WELL No. 994

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

EQUIPMENT	SCRAPE	STEAM CLEAN	STEAM RINSE	ISOPROPYL ALCOHOL RINSE	DEIONIZED WATER RINSE
RIG	X	X	X	N/A	N/A
AUGERS	X	X	X	X	X
BITS	X	X	X	X	X
RODS	X	X	X	X	X
SAMPLERS	X	X	X	X	X
PIPES	X	X	X	X	X
WORK TOOLS	X	X	X	X	X
AUGER PINS	X	X	X	X	X

OBSERVER SIGNATURE/DATE Bryn D. Howze 12/18/87
Bryn D. Howze

ERC / EDGE Environmental and Energy Services Co.

WELL No. 994

ORNL MONITORING WELL LOG

LOCATION: SWSA 3
DRILLER: Avery L. Clark III
HELPER: Leo Johnson
DRILL: Gus Pech

DATE: START: 12/16/87
FINISH: 1/04/88
LOGGED BY: Bryn D. Howze
HEALTH PHYSICIST: Paul Eldridge

TYPE DRILLING: Auger, Air Rotary
LUBRICANT TYPE: Silicon Stopcock Grease
No. SAMPLES TAKEN: 1 (one)
TYPE: Drilling Water
CONTAINMENT TYPE: Plastic, Containment Pan, Containment Box

THICKNESS OF SOIL (REFUSAL DEPTH): 16.8'
DEPTH DRILLED IN ROCK: 63.7'
TOTAL DEPTH OF WELL: 80.5'

DRILLING FLUID SAMPLES:
TYPE: Water
DATE: 12/31/87

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
0.0	0.3			Topsoil, medium to dark brown, with roots and rock fragments, firm.
0.3	4.8			Silt, slightly sandy, light brown, mottled black, orange, yellow, with weathered rock fragments, very stiff.
4.8	6.5			Weathered limestone and clay, slightly silty; limestone, light gray, (weathered) to greenish gray (fresh) appears as float in clay that is medium brown to orange brown, mottled black, yellow, red, greenish gray, stiff.
6.5	16.8			Clay, slightly silty, medium brown to orange brown, mottled black, yellow, red, greenish gray, very stiff.
16.8	17.6			Limestone, weathered, light gray. Auger refusal at 17.6'. No detailed lithologic descriptions available from 17.6' to 80.5' due to use of containment box.
17.6	19.0			Soft drilling.
19.0	24.0			Hard drilling.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 994

ORNL MONITORING WELL LOG

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
24.0	27.0			Soft drilling.
27.0	29.5			Hard Drilling.
29.5	32.0			Soft drilling.
32.0	43.0			Hard drilling.
43.0	51.0			Soft drilling.
51.0	73.0			Hard drilling, returning water was light gray.
73.0	77.0			Moderately hard to soft drilling, returning
				water was maroon.
77.0	80.5			Hard drilling, returning water was light gray.
	80.5			Total Depth

ERC / EDGE Environmental and Energy Services Co.

WELL No. 994

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: Bryn D. Howze

PROOFED BY: Michael L. Ebers

DRILLING COMPANY: A. L. Clark Drilling Service

DRILLER: Avery L. Clark, III HELPER: Leo Johnson

DRILLING METHOD:
- ☒ 14 INCH AUGER 17.6 L.F.
- ☐ INCH AUGER L.F.
- ☒ 8 INCH ROTARY L.F.
- ☒ 3 7/8 INCH ROTARY L.F.

LOCATION SWSA-3

ORNL GRID COORDINATES
N 21,895.0273
E 25,639.9173

ELEV. GROUND 840.41

ELEV. TOP STAINLESS STEEL CASING 842.52

DRILLING DATES:
STARTED: 12-16-87
FINISHED: 1-04-88

MATERIALS USED

EST. VOL.	USED VOL.	
	50	POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
	19	FT. OF 10 IN. SURFACE CASING
5.3	8	SACKS OF CEMENT (SURFACE CASING)
	15	POUNDS OF POWDERED BENTONITE (SURFACE CASING)
	48	GALLONS OF WATER (SURFACE CASING)
	60	FT. OF 4 IN. DIA. STAINLESS STEEL CASING
15.5	30	SACKS OF CEMENT (S.S. CASING)
	60	POUNDS OF POWDERED BENTONITE (S.S. CASING)
	180	GALLONS OF WATER (S.S. CASING)
	50	POUNDS OF BENTONITE PELLETS (STAINLESS STEEL CASING SEAL)

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES
More grout used due to cavity below surface casing.

SURFACE CASING TREMIE GROUTED YES ☒ NO ☐

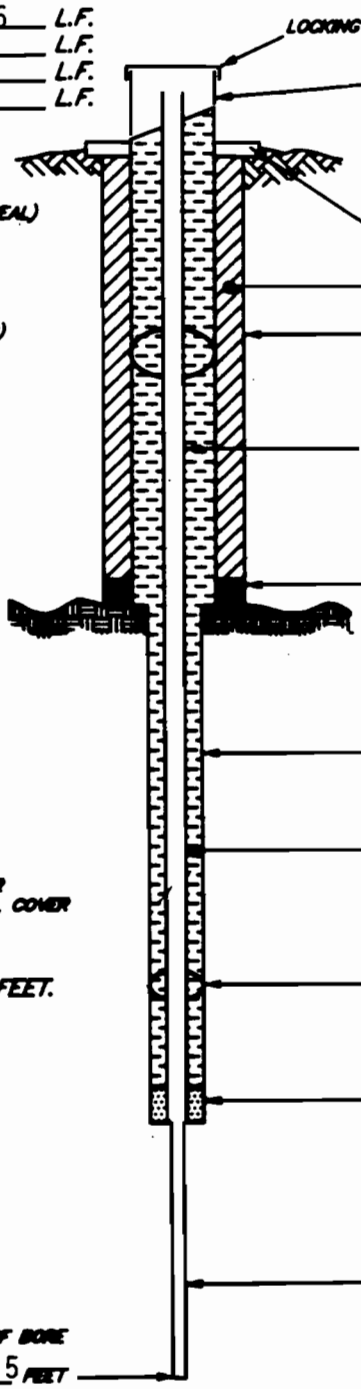
STAINLESS STEEL CASING TREMIE GROUTED YES ☒ NO ☐

WELL COVER USED
- ☒ LOCKING STEEL COVER
- ☐ FLUSH MOUNTED WELL COVER
- ☐ OTHER

MONITORING WELL PUMP BASE SET AT 78.2 FEET.

CENTRALIZERS AT 3.0 FEET.
20.0 FEET.
39.0 FEET.
60.0 FEET

NOTE:
ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:



LOCKING CAP

10 IN. DIA. SURFACE/ PROTECTIVE CASING 3.26 FEET ABOVE GROUND SURFACE TO 17.6 FEET BELOW GROUND SURFACE

CONCRETE PAD

GROUT SEAL 0.0 TO 16.6 FEET

14 IN. DIA. BORE HOLE 0.0 TO 17.6 FEET

4 IN. STAINLESS STEEL CASING 2.11 FEET ABOVE GROUND SURFACE TO 60.0 FEET BELOW GROUND SURFACE

Bentonite SEAL 16.6 TO 17.6 FEET

BEDROCK LEVEL 16.8

8.0 IN. DIA. BORE HOLE

GROUT SEAL 0.0 TO 58.0 FEET

CENTRALIZER (TYP.)

Bentonite SEAL 58.0 TO 59.1 FEET

3 7/8 INCH DIA. OPEN HOLE 59.1 TO 80.5 FEET

BOTTOM OF BORE HOLE 80.5 FEET

TYPE C WELL

NOT TO SCALE

ERC / EDGE Environmental and Energy Services Co.

WELL No. 994

DATE: 12/29/87

MONITORING WELL MATERIALS CERTIFICATION

ITEM/MATERIAL		DATE USED	BATCH NUMBER
SAND		12/18/87	3
		12/29/87	3
BENTONITE		12/18/87	3
		12/29/87	3
STAINLESS STEEL SCREEN	(PREPACKAGED ■ YES ☐ NO)	12/29/87	
STAINLESS STEEL CASING	(PREPACKAGED ■ YES ☐ NO)	12/29/87	5
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ■ YES ☐ NO)	12/29/87	5
STAINLESS STEEL CAPS	(PREPACKAGED ■ YES ☐ NO)	12/29/87	5
MONITORING WELL PUMP	(PREPACKAGED ■ YES ☐ NO)	4/17/90	5
GROUT		12/18/87	15
		12/29/87	15
WELL COVERS			
SURFACE CASING		12/18/87	02

COMMENTS:

OBSERVER SIGNATURE/DATE Bryn D. Howze 12/29/87
Bryn D. Howze

ERC / EDGE Environmental and Energy Services Co.

WELL No. 994

POST-WELL COMPLETION CHECKLIST

POST-WELL COMPLETION TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	1/04/88	BDH
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	1/04/88	BDH
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	4/17/90	DCL
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	1/04/88	BDH

* RELEASE SPECIFIC TECHNICAL DIRECTIONS FOR REGULATORY COMPLIANCE MONITORING WELLS PHASE I, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, W.O. K-4147, APRIL 1987.

OBSERVER SIGNATURE/DATE Bryn D. Howze 1/04/88
Bryn D. Howze

D. Charles Lytle 4/17/90
D. Charles Lytle

ERCE
Environmental and Energy Services Co.

WELL No. 994

LOCATION: WAG-3

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF DEVELOPMENT: Surging and Pumping

DEVELOPMENT BEGAN DATE: 4/04/90 TIME:

DEVELOPMENT ENDING DATE: 4/17/90

DEVELOPMENT OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 38.0 GALLONS

TOTAL GALLONS PUMPED: 340 TOTAL WELL VOLUMES PUMPED: 9.0

INITIAL pH: 7.5 FINAL pH: 7.5

INITIAL CONDUCTIVITY (µS/cm): 774 FINAL CONDUCTIVITY (µS/cm): 834

DESCRIPTION OF INITIAL TURBIDITY: Milky

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 2.0 NTU's

WELL APPROVED BY: R. C. Williams MMES

ODOR OF WATER: None

WATER DISCHARGED TO:
- ☒ GROUND SURFACE
- ☐ STORM SEWERS
- ☐ DRUMS
- ☐ TANK TRUCK
- ☐ STORAGE TANKS
- ☐ OTHER

INITIAL PRE-DEVELOPMENT WATER DEPTH: 22.0 feet from ground surface.

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 4/17/90

D. Charles Lytle

NVDFORLDVG

ERCE
Environmental and Energy Services Co.

WELL NO. 994
LOCATION: WAG-3
DATE: 4/04/90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 38.0 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (µS/cm)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
4/04/90	1100	119	Milky	--	7.5	774	119	3.1	
4/04/90	1300	34	Cloudy	--	7.5	754	153	4.0	
4/04/90	1500	10	Cloudy	--	7.5	736	163	4.3	
4/06/90	1400	12	Cloudy	--	7.7	717	175	4.6	
4/17/90	1430	165	Clear	2.0	7.5	834	340	9.0	
RESULTS AT END OF DEVELOPMENT		165	Clear	2.0	7.5	834	340	9.0	

COMMENTS Steady producer, good recharger. Passed with 2.0 NTU's and moved to another hole.

OBSERVER SIGNATURE/DATE D. Charles Lytle 4/17/90
D. Charles Lytle

MWFORM05.DWG

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

(1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967 (ARTICLE IN VOL.3, NO.1 OF WRR ENTITLED "RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER")

(2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN VOL. 12, NO.3 OF WRR ENTITLED "A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS")

WELL NO.: 994 DATE OF TEST: 5/15/90

PROJECT NO.: E221-001 CLIENT: MMES

SITE LOCATION: X10

EDGE, INC. FIELD INVESTIGATOR: BRUCE McMASTER

INPUT DATA ARE:

INNER CASING DIAMETER = 4.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 4.00 INCHES
DIAMETER OF DRILLED HOLE = 4.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 21.40 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 57.50 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 21.40 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = .89 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .30
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 32

HO WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED
VALUES FOR HO
(FEET)

2.1309
2.1253

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 994

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SECOND)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	3.390	2.500
20.00	3.340	2.450
30.00	3.310	2.420
40.00	3.290	2.400
50.00	3.270	2.380
60.00	3.250	2.360
75.00	3.210	2.320
90.00	3.170	2.280
105.00	3.120	2.230
120.00	3.080	2.190
150.00	3.000	2.110
180.00	2.940	2.050
240.00	2.790	1.900
300.00	2.660	1.770
360.00	2.540	1.650
420.00	2.410	1.520
480.00	2.330	1.440
540.00	2.280	1.390
600.00	2.220	1.330
720.00	2.050	1.160
840.00	1.940	1.050
960.00	1.840	.950
1080.00	1.750	.860
1200.00	1.620	.730
1320.00	1.610	.720
1440.00	1.540	.650
1560.00	1.520	.630
1680.00	1.450	.560
1800.00	1.410	.520
1920.00	1.340	.450
20.00	1.260	.370
2160.00	1.240	.350

****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = 2.30E-06 FT/SECOND = 7.01E-05 CM/SEC

TRANSMISSIVITY = 4.92E-05 FT**2/SECOND

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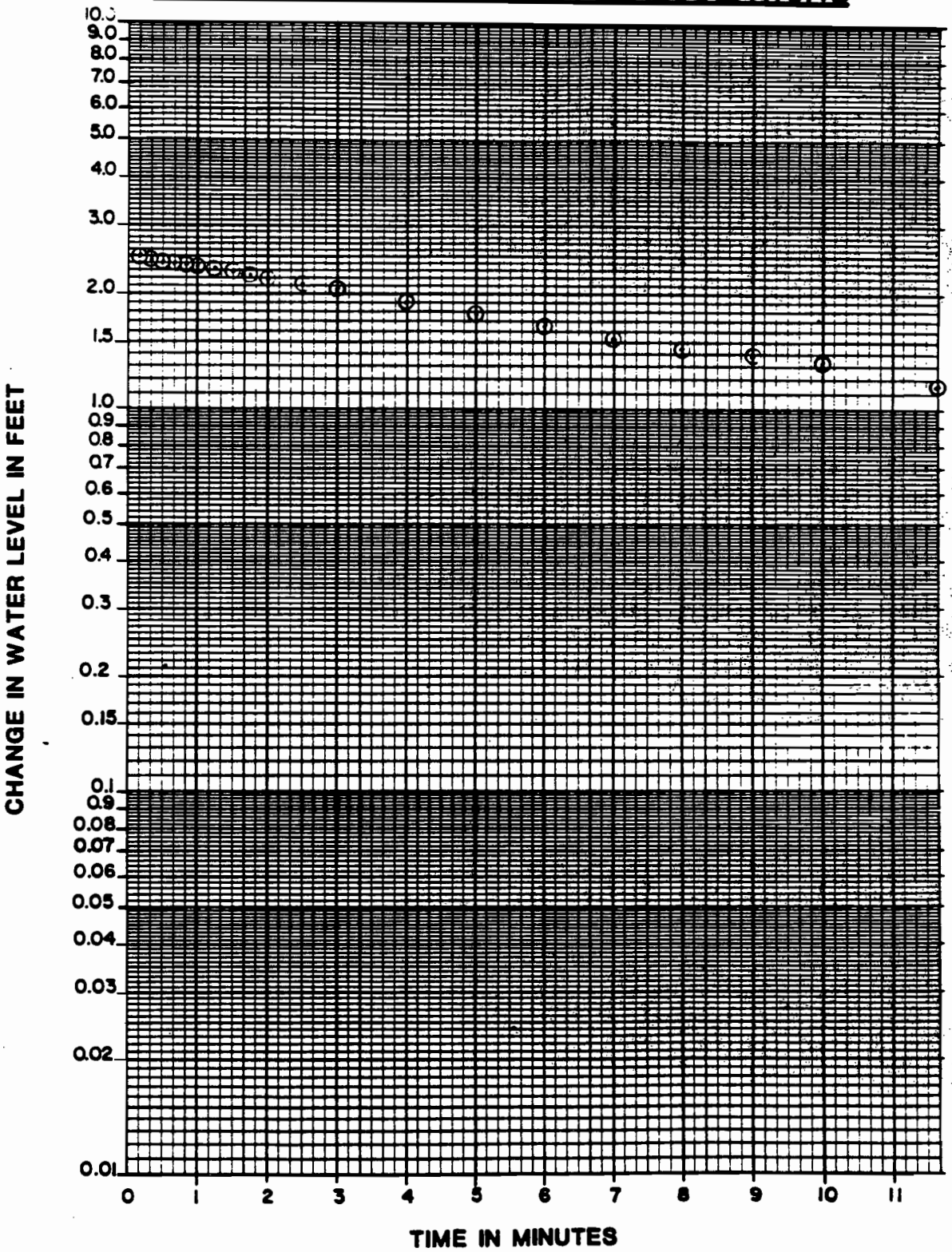
WELL No. 994

HYDRAULIC CONDUCTIVITY CALCULATIONS



MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615)966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0994 W1

WELL NO.: 994

LOCATION: SWSA 3

TYPE: Drilling Water

SAMPLER: Bryn Hovge (SIGNATURE)

DATE: 12/31/87

TIME: 3:30 PM

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
Bryn Hovge	3/14/88	10:38AM	MCI	Nancy Owen	3/14/88	10:38	ORNL

REMARKS:

1.0 General Information

1.1 Well Location

Monitoring well number 995 is located in WAG 3. It is approximately 100' east of the northwest corner of SWSA 3. The location is shown on ORNL drawing number C3E20004 A075. Survey coordinates for this well are N 22,011.4058, E 25,867.5608 (X-10 grid) or latitude 35°-55'-07.23" and longitude 84°-19'-53.01". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 995 was drilled by Geotek Engineering Company. An Ingersoll-Rand Air Rotary rig was used to drill this boring for monitor well installation under operation of Larry Ledbetter with the assistance of Fred Dixon. Drilling commenced on 11-28-89 and was finished on 12-5-89. Paragraph 2.4.1 includes a detailed discussion of the well installation and a well schematic is included on the well installation/completion form. A synopsis of the drilling activity follows. This information was typed directly from

field notes and was edited only when necessary for clarification.

11-28-89 The Ingersoll-Rand and equipment were decontaminated.

11-29-89 The rig and auger equipment were mobilized to the site, plastic was layed down and the equipment was set up. The borehole was split spooned and augered to 14.0'. A bulk density was taken from 4.4 to 4.8'. Soil sample 995S01 was taken from 9.0 to 10.3. A 14.0-inch borehole was then augered to 7.0' and a 10-inch diverter casing set.

11-30-89 The Ingersoll-Rand and equipment were decontaminated and mobilized to the site. A leak was found in the main hydraulic control line. Drilling activities ended until repair could be made.

12-1-89 The equipment was rigged up and an 8-inch bore hole was advanced to 20.0'. After the boring was cleaned, and after 35 minutes of recharge, no water was measured in the borehole. The boring was advanced to 30', cleaned and after waiting for 30 minutes, no water was found. The boring was advanced to 42.5', cleaned and after waiting 15 minutes, no water was found. The boring was then advanced to a total depth of 48.5. An air and a water sample were taken.

12-4-89 After a meeting with Bill Mc Master, it was decided to check the water level then blow the borehole dry and check the water level

at 30 minutes and 1 hour, then drill further if necessary. The initial water level was at 21.0'. The borehole was then blown dry and after 30 minutes, the water level was at 42.5'. It was decided to set the well at this depth. Fifteen feet of screen and 35' of casing was installed to a depth of 47.84'. The sand was tremied to 30.30' and bentonite poured to 27.88'

12-5-89 The annulus was tremie grouted and covered with insulation to protect against freezing.

This well was logged by ERC Environmental and Energy Services Co., Inc., hydrogeologist C. Allison Bailey. All well construction materials and supplies were from Martin Marietta Energy Systems approved batches. The batch origin of individual items is shown on the included Monitoring Well Materials Certification form.

2.0 Technical Information

2.1 Decontamination Procedures

The drilling rig, down hole tools, surface casing, stainless steel screen, stainless steel casing, centralizers, and stainless steel silt trap underwent the cleaning decontamination procedures outlined in the drilling specifications (Release Specific Technical Directions for Regulatory Compliance Monitoring Wells Phase 1, Oak Ridge National

Laboratory, Oak Ridge, W.O. K-4147, April 1987, pgs. 2-4). A checklist of the cleaned materials is included with this data package.

2.2 Geology

WAG 3 is located in Melton Valley which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 3 is underlain by limestone, siltstone and shale of the Middle Ordovician Chickamauga Group. The Chickamauga Group consists of eight units, designated by letters "A" to "H" (Stockdale, 1951). WAG 3 is underlain by units E, F, G and H. These units consist of thin bedded nodular limestone with clay and shale partings. A portion of unit H and unit F consists of calcareous siltstone alternating with beds of olive gray to maroon shale. Strike and dip varies from N 45° E to N 55° E and 25° to 35° southeast, respectively.

2.3 Sample Collection

Two samples were collected during drilling, placed in I-CHEM specialty cleaned glass containers, sealed and submitted to Sample Receiving, Analytical Chemistry Division, Bldg. 4500S, ORNL. Chain of custody forms for these samples are included with this data package. Soil sample 995S01 was collected in the split spoon interval from 9.0 to 10.3 on 11-29-89.

A drill water sample was collected from the water pump on the drill rig on 12-1-89. Analytical results for the soil and drill water samples described above can

be obtained from the Remedial Action Program data base at ORNL.

A bulk density soil sample was collected from the split spoon sample interval from 4.4 to 4.8. The sample was measured and weighed, and a bulk density of 1.82 grams/cm^3 was calculated.

The Ingersoll-Rand T-4's compressed air was sampled with a cloth filter inserted between drill rods on 12-1-89. The sample was examined with an ultraviolet light for the presence of hydrocarbons. The filter showed no evidence of hydrocarbons.

2.4 Installation and Development

2.4.1 Installation

This was a "Type D" well. A 6-inch diameter boring was split spooned and augered from ground surface to auger refusal (14.0 feet). The air rotary method was required to complete the boring to the specified total well depth. Therefore, a 14.0- inch diameter boring was augered from ground surface to 7.0 feet and a 10.0-inch diverter casing was installed and grouted. An 8-inch diameter boring was then drilled with an air rotary tricone roller bit from 7.0 to 48.5 feet. A 2-inch diameter stainless steel screen with welded bottom cap was installed from 47.84 to 32.84 feet. A 2-inch diameter stainless steel casing was installed above the screen at 32.84 feet and extended 1.65 feet above ground surface. A sandpack was then tremied into the annular space from 47.84 to 30.30 feet, with

a 2.42-foot bentonite pellet seal poured into the annular space above the sandpack from 30.30 to 27.88 feet. The annular space from the top of the bentonite seal to the surface was tremie-grouted with a cement/bentonite slurry. A detail of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 995 was developed to remove drill cuttings, silt, and other fines. The monitoring well was developed using a Geoguard pump with an air compressor. All pumps were cleaned prior to use according to specified cleaning procedures (see Paragraph 2.1). The well was developed until a measured total of 203 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was 2.0 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on 5-8-90 at a depth of 45.7 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 995 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity of the well screen. This was accomplished by instantaneously adding a known quantity of water to the monitoring well and measuring the recovery of the water level over time. The changing water levels were measured using a Druck 15 psig pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 3.94×10^{-6} cm/second (shown as permeability on the hydraulic conductivity calculations printout attached) was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

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WELL No. 995

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

PRE-DRILLING TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. EXCAVTION PERMIT OBTAINED	11-28-89	CAB
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	11-28-89	CAB
3a. SCREEN AND CASING HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	N/A	
3b. PRE-PACKAGED SCREENS, CASING AND CENTRALIZERS WERE USED.	12-04-89	CAB
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	11-21-89	CAB
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	11-29-89	CAB
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	11-29-89	CAB
7. AIR ROTARY COMPRESSED AIR SAMPLED.	12-04-89	CAB

RESULTS: No hydrocarbons detected under ultraviolet light.

ADDITIONAL NOTES/OBSERVATIONS:

OBSERVER SIGNATURE/DATE C. Allison Bailey 12-04-89
C. Allison Bailey

ERC / EDGE Environmental and Energy Services Co.

WELL No. 995

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

EQUIPMENT	SCRAPE	STEAM CLEAN	STEAM RINSE	ISOPROPYL ALCOHOL RINSE	DEIONIZED WATER RINSE
RIG	X	X	X	N/A	N/A
AUGERS	X	X	X	X	X
BITS	X	X	X	X	X
RODS	X	X	X	X	X
SAMPLERS	X	X	X	X	X
PIPES	X	X	X	X	X
WORK TOOLS	X	X	X	X	X
AUGER PINS	X	X	X	X	X

OBSERVER SIGNATURE/DATE C. Allison Bailey 11/29/89
C. Allison Bailey

ERC / EDGE Environmental and Energy Services Co.

WELL No. 995

ORNL MONITORING WELL LOG

LOCATION: WAG-3
DRILLER: Larry Ledbetter
HELPER: Fred Dixon
DRILL: Ingersoll Rand T-4

DATE: START: 11-29-89
FINISH: 12-05-89
LOGGED BY: C. Allison Bailey
HEALTH PHYSICIST: C. E. Stooksbury

TYPE DRILLING: Split Spoon, Auger, Air Rotary
LUBRICANT TYPE: Green stuff
No. SAMPLES TAKEN: 995S01 9.0-10.3
TYPE: Soil
CONTAINMENT TYPE: Plastic, Auger Pan and Containment Box

THICKNESS OF SOIL (REFUSAL DEPTH): 14.0
DEPTH DRILLED IN ROCK: 34.5
TOTAL DEPTH OF WELL: 48.5

DRILLING FLUID SAMPLES:
TYPE: Water
DATE: 12-01-89

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
0.0	2.0		0%	No recovery.
0.0	2.0		0%	No recovery.
1.0	3.0		1%	Clay, light moderate brown and moderate brown,
				unconsolidated, with gravel. Fill material.
3.0	5.0		1%	Clay, dark moderate brown, with gravel,
				unconsolidated, fill material.
3.0	3.2		100%	Clay, moderate brown, with gravel, unconsoli-
				dated.
3.2	5.0		100%	Clay, shaley, mottled, moderate brown, dusky
				yellow, light olive brown with black mineral
				streaks, firm, layered, consolidated, hard,
				moist. Bulk density taken at 4.4' to 4.8' =
				1.82 grams/cm^3.
5.0	5.5		90%	Clay, mottled, moderate yellowish brown,
				dusty yellow, light olive brown, dark
				yellowish orange with dusky brown mineral
				specks, moist.
5.5	6.7		90%	Clay, moderate brown (chocolate brown), dark
				yellowish orange, pale olive and dusky yellow,
				slightly shaley, firm, moist.
6.7	7.0		90%	Clay, light olive gray to pale olive. Very

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WELL No. 995

ORNL MONITORING WELL LOG

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
6.7	7.0			(continued from page 1) hard. Dry to damp.
7.0	9.0		30%	Clay, moderate brown (chocolate brown) with
				dusky yellow streaks. Hard, firm, plastic,
				moist. At 7.6' hit a layer of crushed rock,
				calcareous siltstone, light olive gray, fine
				grained, hard (fizzes with acid). Pushed
				spoon to 9.0 but no recovery in spoon after
				7.6'.
9.0	10.0	995S01	100%	Clay, moderate brown (chocolate brown) with
		9.0-10.3		light olive gray and black streaks. Very
				hard and plastic, moist.
10.0	10.3		100%	Siltstone, light olive brown, small fragments
				(crushed) with sand size particles, and
				chert fragments. Highly weathered. The
				crushed rock is intermingled with the clay,
				moderate brown. Moist. Bottom of spoon
				contains a light olive brown and pale olive
				powder. Fizzes with acid.
10.3	12.0		10%	Clay, dark moderate brown, firm, soft, moist.
12.0	13.2		100%	Clay, mottled, dark moderate brown, dark
				yellowish orange and light olive brown, with
				black mineral specks, slightly shaley, firm,
				slightly hard, moist.
13.2	13.6		100%	Siltstone, calcareous, olive gray, large
				fragments, weathered, some in powdered form.
13.6	14.0		100%	Clay, moderate brown (chocolate brown), hard,
				firm, moist.
14.0	15.5			*Hard drilling. Fast.
15.5	16.5			Hard drilling. Slow. Limestone.
16.5	20.0			Hard, rough, irregular drilling. Slow.
20.0	48.0			Hard, slow drilling.
	48.5			Total Depth

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WELL No. 995

ORNL MONITORING WELL LOG

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
				* No detailed lithologic log could be provided due to use of containment box from 14.0' to 48.5".

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WELL No. 995

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: C. Allison Bailey
PROOFED BY: Michael L. Ebers

DRILLING COMPANY: Geotek

DRILLER: Larry Ledbetter
HELPER: Fred Dixon

LOCATION WAG-3
ORNL GRID COORDINATES
N 22,011.4058
E 25,867.5608
ELEV. GROUND 837.17
ELEV. TOP STAINLESS STEEL CASING 838.82

DRILLING DATES:
STARTED: 11-28-89
FINISHED: 12-05-89

EQUIPMENT
- [x] 14.0 INCH AUGER 7.0 L.F.
- [ ] ____ INCH AUGER ____ L.F.
- [x] 8.0 INCH ROTARY 41.5 L.F.

MATERIALS USED

EST. VOL.	USED VOL.	
	15.0	FEET OF 2.0 IN. S.S. SCREEN
	35.0	FEET OF 2.0 IN. S.S. CASING
5.0	5.5	SACKS OF SAND
50.0	50	POUNDS OF BENTONITE PELLETS
5.6	6.0	SACKS OF CEMENT
	30.0	POUNDS OF POWDERED BENTONITE
	30.0	GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES
Irregular boring diameter and spillage.

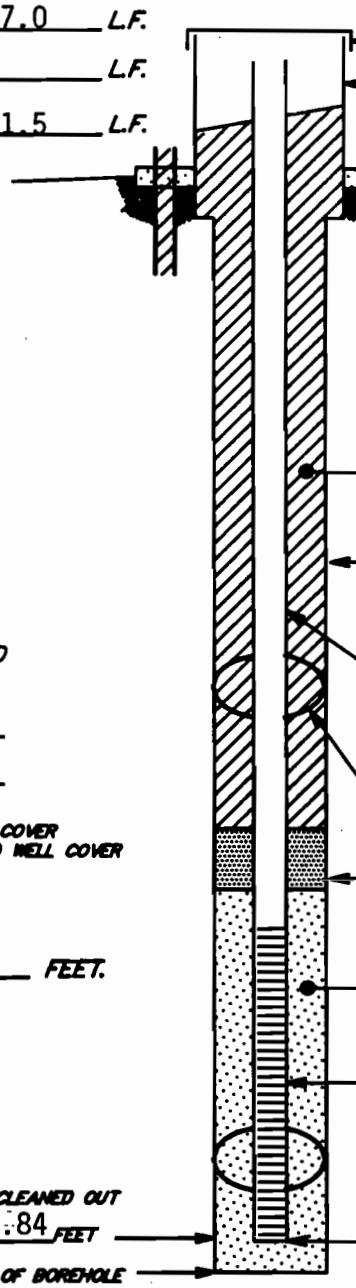
WELL COVER USED
- [x] LOCKING STEEL COVER
- [ ] FLUSH MOUNTED WELL COVER
- [ ] OTHER

SILT TRAP USED YES [ ] NO [x]

MONITORING WELL PUMP BASE SET AT 45.7 FEET.

CENTRALIZERS AT 7.0 FEET.
27.0 FEET.
47.0 FEET.

NOTE:
ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:



LOCKING STEEL COVER
8 INCH DIAMETER STEEL PROTECTIVE CASING 2.96 FT. ABOVE GROUND TO 2.0 FT. BELOW GROUND SURFACE

CONCRETE PAD

10.0 INCH DIVERTER CASING .5 FT. ABOVE GROUND SURFACE TO 7.0 FT. BELOW GROUND SURFACE

14.0 INCH BOREHOLE 0.0 TO 7.0 FEET

GROUT SEAL 0.0 TO 27.88 FEET

8.0 INCH DIAMETER BOREHOLE

2.0 INCH DIAMETER STAINLESS STEEL CASING 1.65 FT. ABOVE GROUND SURFACE TO 32.84 FT. BELOW GROUND SURFACE

CENTRALIZER (TYP.)

BENTONITE PELLET SEAL 27.88 TO 30.30 FEET

SAND PACK 30.3 TO 47.84 FEET

2.0 INCH DIAMETER STAINLESS STEEL 0.010 SLOTTED SCREEN 32.84 TO 47.84 FEET

N/A INCH DIAMETER STAINLESS STEEL SILT TRAP/CAP N/A TO N/A FEET

HOLE CLEANED OUT TO 47.84 FEET

BOTTOM OF BOREHOLE 48.5 FEET

TYPE D WELL

NOT TO SCALE

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WELL No. 995

DATE: 12/-4/89

MONITORING WELL MATERIALS CERTIFICATION

ITEM/MATERIAL		DATE USED	BATCH NUMBER
SAND		12-04-89	1
BENTONITE		12-04-89	1
STAINLESS STEEL SCREEN	(PREPACKAGED ■ YES □ NO)	12-04-89	2
STAINLESS STEEL CASING	(PREPACKAGED ■ YES □ NO)	12-04-89	2
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ■ YES □ NO)	12-04-89	2
STAINLESS STEEL CAPS	(PREPACKAGED ■ YES □ NO)	12-04-89	2
MONITORING WELL PUMP	(PREPACKAGED ■ YES □ NO)	5-08-90	5
GROUT		12-05-89	3
WELL COVERS		12-04-89	2
SURFACE CASING		N/A	N/A

COMMENTS:

OBSERVER SIGNATURE/DATE C. Allison Bailey 12/05/89
C. Allison Bailey

ERC / EDGE Environmental and Energy Services Co.

WELL No. 995

POST-WELL COMPLETION CHECKLIST

POST-WELL COMPLETION TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	11-29-89	CAB
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	11-29-89	CAB
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	5-08-90	DCL
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	12-04-89	CAB

* RELEASE SPECIFIC TECHNICAL DIRECTIONS FOR REGULATORY COMPLIANCE MONITORING WELLS PHASE I, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, W.O. K-4147, APRIL 1987.

OBSERVER SIGNATURE/DATE C. Allison Bailey 12-04-89
C. Allison Bailey

D. Charles Lytle 5-08-90
D. Charles Lytle

ERCE
Environmental and Energy Services Co.

WELL No. 995

LOCATION: WAG-3

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF DEVELOPMENT: Surging and Pumping

DEVELOPMENT BEGAN DATE: 5/03/90 TIME:

DEVELOPMENT ENDING DATE: 5/08/90

DEVELOPMENT OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 10.8 GALLONS

TOTAL GALLONS PUMPED: 203 TOTAL WELL VOLUMES PUMPED: 19.0

INITIAL pH: 8.0 FINAL pH: 7.7

INITIAL CONDUCTIVITY (µS/cm): 635 FINAL CONDUCTIVITY (µS/cm): 699

DESCRIPTION OF INITIAL TURBIDITY: Milky

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 2.0 NTU's

WELL APPROVED BY: R. C. Williams MMES

ODOR OF WATER: None

WATER DISCHARGED TO:
- ☒ GROUND SURFACE
- ☐ STORM SEWERS
- ☐ DRUMS
- ☐ TANK TRUCK
- ☐ STORAGE TANKS
- ☐ OTHER

INITIAL PRE-DEVELOPMENT WATER DEPTH: 21.5 feet from ground surface.

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 5/08/90

D. Charles Lytle

ERCE
Environmental and Energy Services Co.

WELL NO. 995
LOCATION: WAG-3
DATE: 5/03/90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 10.8 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (µS/cm)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
5-03-90	1100	115	Milky	--	8.0	635	115	10.6	
5-03-90	1330	25	Cloudy	--	7.6	688	140	12.9	
5-04-90	1300	8	Cloudy	--	7.6	730	148	13.7	
5-07-90	1300	20	Slightly Cloudy	--	7.8	650	168	15.5	
5-08-90	1300	35	Clear	2.0	7.7	699	203	19.0	
RESULTS AT END OF DEVELOPMENT			Clear	2.0	7.7	699	203	19.0	

COMMENTS Good producer, cleared up fast and moved to another hole. Passed with 2.0 NTU's.

OBSERVER SIGNATURE/DATE D. Charles Lytle 5/08/90
D. Charles Lytle

MWFORM05.DWG

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT, VERSION 4.1. NOV. 1986

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

(1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967 (ARTICLE IN VOL.3, NO.1 OF WRR ENTITLED "RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER")

(2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN VOL. 12, NO.3 OF WRR ENTITLED "A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS")

WELL NO.: 995 DATE OF TEST: 5/16/90

PROJECT NO.: E221-001 CLIENT: MMES

SITE LOCATION: X10

EDGE, INC. FIELD INVESTIGATOR: BRUCE McMASTER

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 8.63 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 15.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 24.10 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 15.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = .96 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .30
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 32

HO WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED
VALUES FOR HO
(FEET)

4.2315
4.2376

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SECOND)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	5.260	4.300
20.00	5.260	4.300
30.00	5.250	4.290
40.00	5.230	4.270
50.00	5.220	4.260
60.00	5.190	4.230
75.00	5.170	4.210
90.00	5.140	4.180
105.00	5.120	4.160
120.00	5.100	4.140
150.00	5.070	4.110
180.00	5.020	4.060
240.00	4.960	4.000
300.00	4.910	3.950
360.00	4.860	3.900
420.00	4.810	3.850
480.00	4.820	3.860
540.00	4.760	3.800
600.00	4.730	3.770
720.00	4.720	3.760
840.00	4.600	3.640
960.00	4.490	3.530
1080.00	4.480	3.520
1200.00	4.360	3.400
1320.00	4.270	3.310
1440.00	4.210	3.250
1560.00	4.160	3.200
1680.00	4.060	3.100
1800.00	4.030	3.070
1920.00	4.010	3.050
2040.00	3.970	3.010
2160.00	3.950	2.990

****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

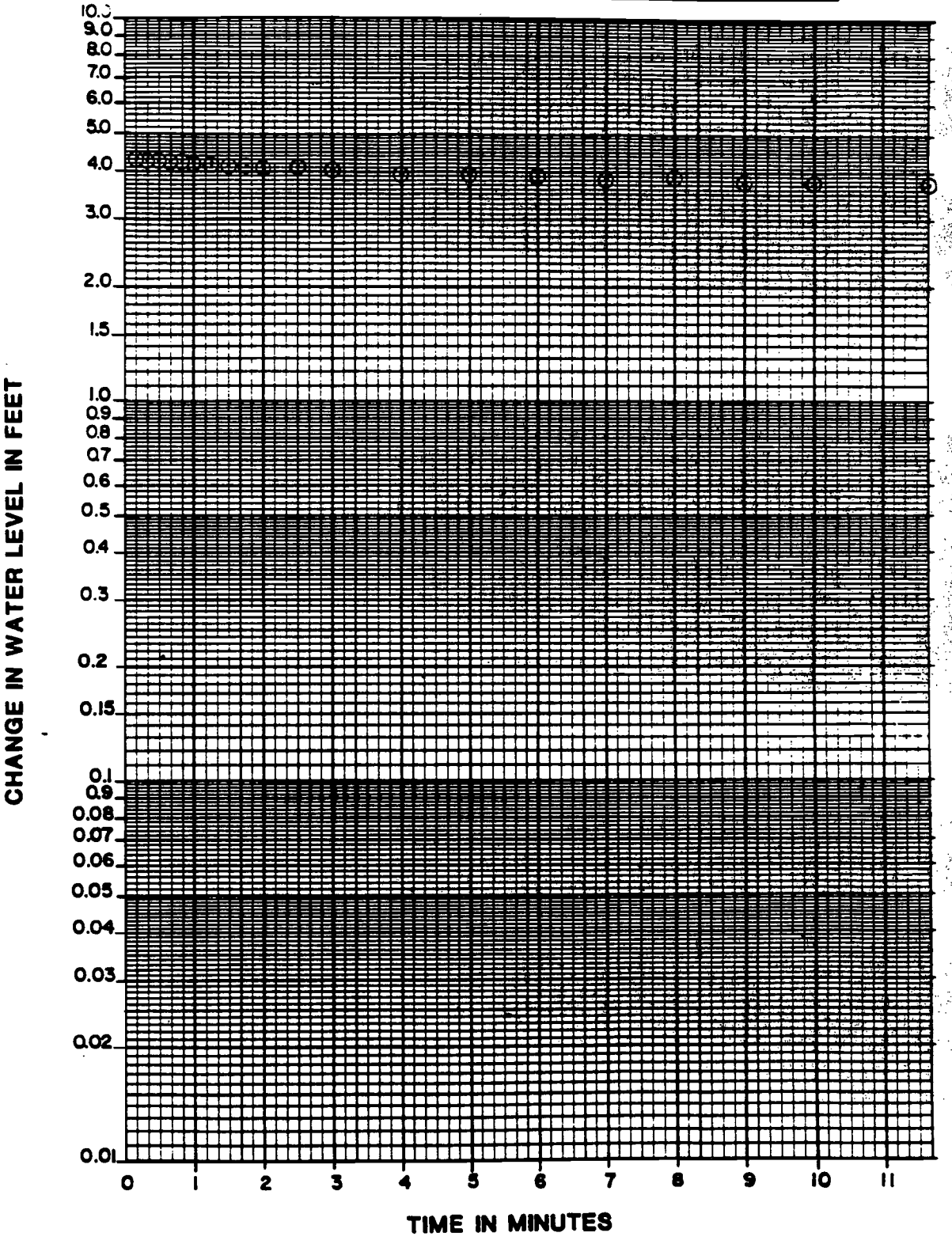
PERMEABILITY = 1.29E-07 FT/SECOND = 3.94E-06 CM/SEC

TRANSMISSIVITY = 1.94E-06 FT**2/SECOND

ERC / EDGE Environmental and Energy Services Co.

WELL No. 995

HYDRAULIC CONDUCTIVITY CALCULATIONS



EDGe Engineering, Design & Geosciences Group, Inc.
726 Pellissippi Parkway
P.O. Box 23010 Knoxville, Tn 37933-1010

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 995

WELL NO.	LOCATION:	TYPE:
995	WAG-3	Soil

SAMPLER: (SIGNATURE)	SAMPLE INTERVAL:	DATE:	TIME:
C. Allison Bailey	9.0 - 10.3	11-29-89	0900

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECEIVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
C. Allison Bailey	11-15-90	1500	EDGe	[illegible]	1-15-90	1500	[illegible]

TYPE OF SAMPLE: ■ SPLIT SPOON CORES–SOIL ☐ AUGER CUTTINGS–SOIL ☐ AUGER CUTTINGS–ROCK
☐ AIR ROTARY CUTTINGS–ROCK ☐ DRILL WATER (NO AIR IN SAMPLE) ☐ OTHER _____

ALL SAMPLES ARE IMMEDIATELY PLACED IN I–CHEM SPECIALTY CLEANED CONTAINERS AND SEALED.

REMARKS: _____

EDGe Engineering, Design & Geosciences Group, Inc.
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CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: MSW

WELL NO.	LOCATION:	TYPE:
975	WAG-3	Drill Water

SAMPLER:	SAMPLE INTERVAL:	DATE:	TIME:
C. Allison Baily (SIGNATURE)	N/A	12-1-89	1241

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECEIVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
C. Allison Baily	01-15-90	1500	EDEC	J. C. Pui	1-15-90	1500	MM

TYPE OF SAMPLE: ☐ SPLIT SPOON CORES-SOIL ☐ AUGER CUTTINGS-SOIL ☐ AUGER CUTTINGS-ROCK
☐ AIR ROTARY CUTTINGS-ROCK ■ DRILL WATER (NO AIR IN SAMPLE) ☐ OTHER _____

ALL SAMPLES ARE IMMEDIATELY PLACED IN I-CHEM SPECIALTY CLEANED CONTAINERS AND SEALED.

REMARKS: _____

1.0 General Information

1.1 Well Location

Monitoring well number 996 is located in WAG 3. It is along the north perimeter fence of SWSA 3. The location is shown on ORNL drawing number C3E20004 A075. Survey coordinates for this well are N 21,920.1708, E 26,458.1823 (X-10 grid) or latitude 35°-55'-09.73" and longitude 84°-19'-46.43". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 996 was drilled by Geotek Engineering Company. An Ingersoll-Rand T-4 Air Rotary rig was used to drill this boring for monitor well installation under operation of Larry Ledbetter with the assistance of Fred Dixon. Drilling commenced on 11-16-89 and was finished on 11-28-89. Paragraph 2.4.1 includes a detailed discussion of the well installation and a well schematic is included on the well installation/completion form. A synopsis of the

drilling activity follows. This information was typed directly from field notes and was edited only when necessary for clarification.

11-16-89 The Ingersoll-Rand and equipment were set up. (The rig was moved over from Well #997 and there was no need to decontaminate the rig). The augers and down hole tools were decontaminated. A 22.0" boring was augered to 7.0' and a 15 1/4" diverter casing was installed and grouted.

11-20-89 The Ingersoll-Rand and tools were decontaminated and mobilized to the site. Plastic was layed down and the equipment unloaded. The rig was set-up along with the containment box and diverter head. A 14.0' borehole was advanced to 32.5'.

11-22-89 An alcohol type odor was noticed when drilling began but quickly dissipated. The boring was advanced to 36.0' and a 10 3/4" surface casing was installed to a depth of 35.70. A bentonite seal was poured to 34.75'. The annulus was tremie grouted to the surface; while grouting the borehole, an alcohol type odor was again noticed. Jill Greene was notified and an Industrial Hygenist was sent to the site with an Organic Vapor Analyzer. No readings were detected at the well site or in the containment boxes.

11-27-89 An 8-inch borehole was drilled with a tricone bit to 48.0'. After a 1 hour recharge, 18 feet of water was measured.

The borehole was cleaned and the water level checked again. A recharge of 1 ft/3 minutes was calculated. The boring was advanced to a total depth of 62.5'. An air and a water sample were taken. The 4-inch stainless steel screen and casing were installed to a total depth of 61.76'. Sand was tremied to 38.96' and bentonite poured to 35.75'.

11-28-89 The annulus was tremie grouted with 9 bags of cement and 5% bentonite.

This well was logged by ERC Environmental and Energy Services Co., Inc., hydrogeologist C. Allison Bailey. All well construction materials and supplies were from Martin Marietta Energy Systems approved batches. The batch origin of individual items is shown on the included Monitoring Well Materials Certification form.

2.0 Technical Information

2.1 Decontamination Procedures

The drilling rig, down hole tools, surface casing, stainless steel screen, stainless steel casing, centralizers, and stainless steel silt trap underwent the cleaning decontamination procedures outlined in the drilling specifications (Release Specific Technical Directions for Regulatory Compliance Monitoring Wells Phase 1, Oak Ridge National Laboratory, Oak Ridge, W.O. K-4147, April 1987, pgs. 2-4). A checklist of the cleaned materials is included with this data package.

2.2 Geology

WAG 3 is located in Melton Valley which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 3 is underlain by limestone, siltstone and shale of the Middle Ordovician Chickamauga Group. The Chickamauga Group consists of eight units, designated by letters "A" to "H" (Stockdale, 1951). WAG 3 is underlain by units E, F, G and H. These units consist of thin bedded nodular limestone with clay and shale partings. A portion of unit H and unit F consists of calcareous siltstone alternating with beds of olive gray to maroon shale. Strike and dip varies from N 45° E to N 55° E and 25° to 35° southeast, respectively.

2.3 Sample Collection

One sample was collected during drilling, placed in an I-CHEM specialty cleaned glass container, sealed and submitted to Sample Receiving, Analytical Chemistry Division, Bldg. 4500S, ORNL. A chain of custody form for this sample is included with this data package.

A drill water sample was collected from the water pump on the drill rig on 11-27-89. Analytical results for the sample 996W01 described above can be obtained from the Remedial Action Program data base at ORNL.

The Ingersoll-Rand Air Rotary's compressed air was sampled with a cloth filter inserted between drill rods on 11-27-89. The sample was examined with an

ultraviolet light for the presence of hydrocarbons. The filter indicated no evidence of hydrocarbons.

2.4 Installation and Development

2.4.1 Installation

This was a "Type B" well. A 22.0-inch diameter boring was augered from ground surface to 7.0 feet. A 15 1/4-inch diverter casing was installed from surface to 7.0 feet below ground surface and grouted in place. The boring was then extended with a 14.5-inch air rotary tricone roller bit from 7.0 feet to 36.0 feet. A 10 3/4-inch diameter string of decontaminated steel surface casing was installed from 0.0 feet to 35.7 feet, sealed with a 1.25-foot bentonite pellet layer from 35.7 feet to 34.75 feet, and tremie grouted in place. The surface casing minimizes potential cross contamination between the regolith and bedrock water bearing zones. After the surface casing was installed, an 8-inch diameter boring was drilled to a total depth of 62.5 feet. A 4-inch diameter stainless steel screen with threaded bottom cap was installed from 61.76 feet to 41.13 feet. A 4-inch diameter stainless steel casing was installed from the top of the screen at 41.13 feet and extended 1.95 feet above ground surface. A sandpack was then tremied into the annular space from 61.76 to 38.96 feet, with a 3.21-foot bentonite pellet seal poured into the annular space above the sandpack from 38.96 to 35.75 feet.

The annular space from the top of the bentonite seal to the surface was tremie grouted with a cement/ bentonite slurry. A detailed schematic of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 996 was developed to remove drill cuttings, silt, and other fines. The monitoring well was developed using a Geoguard pump with an air compressor. All pumps were cleaned prior to use according to specified cleaning procedures (see Paragraph 2.1). The well was developed until a measured total of 413 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was 2.0 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on 4-10-90 at a depth of 27.6 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 996 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity of the well screen. This was accomplished by instantaneously adding a known quantity of water to the monitoring well and measuring the recovery of the water level over time. The changing water levels were measured using a Druck 15 psig pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 6.46×10^{-5} cm/second (shown as permeability on the hydraulic conductivity calculations printout attached) was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 996

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

PRE-DRILLING TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. EXCAVTION PERMIT OBTAINED	11-16-89	CAB
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	11-16-89	CAB
3a. SCREEN AND CASING HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	N/A	
3b. PRE-PACKAGED SCREENS, CASING AND CENTRALIZERS WERE USED.	11-27-89	CAB
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	11-16-89	CAB
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	11-16-89	CAB
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	11-16-89	CAB
7. AIR ROTARY COMPRESSED AIR SAMPLED.	11-27-89	CAB

RESULTS: No hydrocarbons were detected under ultraviolet light.

ADDITIONAL NOTES/OBSERVATIONS:

OBSERVER SIGNATURE/DATE C. Allison Bailey 11/27/89
C. Allison Bailey

ERC / EDGE Environmental and Energy Services Co.

WELL No. 996

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

EQUIPMENT	SCRAPE	STEAM CLEAN	STEAM RINSE	ISOPROPYL ALCOHOL RINSE	DEIONIZED WATER RINSE
RIG	X	X	X	N/A	N/A
AUGERS	X	X	X	X	X
BITS	X	X	X	X	X
RODS	X	X	X	X	X
SAMPLERS	X	X	X	X	X
PIPES	X	X	X	X	X
WORK TOOLS	X	X	X	X	X
AUGER PINS	X	X	X	X	X

OBSERVER SIGNATURE/DATE C. Allison Bailey 11/16/89
C. Allison Bailey

ERC / EDGE Environmental and Energy Services Co.

WELL No. 996

ORNL MONITORING WELL LOG

LOCATION: WAG-3
DRILLER: Larry Ledbetter
HELPER: Fred Dixon
DRILL: Ingersoll Rand T-4

DATE: START: 11-16-89
FINISH: 11-28-89
LOGGED BY: C. Allison Bailey
HEALTH PHYSICIST: Carl Stooksbury/ Bill Shinpaugh

TYPE DRILLING: Auger, Air Rotary
LUBRICANT TYPE: Green stuff
No. SAMPLES TAKEN: One (996 W01)
TYPE: Drill Water
CONTAINMENT TYPE: Plastic, Pan, Containment Box

THICKNESS OF SOIL (REFUSAL DEPTH): 16.0'
DEPTH DRILLED IN ROCK: 46.5
TOTAL DEPTH OF WELL: 62.5

DRILLING FLUID SAMPLES:
TYPE: Water
DATE: 11-27-89

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
0.0	1.5			Gravel fill. (PAD)
1.5	3.0			Clay, light brown, reddish, plastic, damp.
				Contains gravel and chert fragments, weathered
				white.
3.0	7.0			Clay, dark brown, with some chert, slightly
				silty, moist. At 3.0' encountered a large
				oolitic chert boulder.
7.0	16.0			*Smooth easy drilling, clay.
16.0	16.5			Hard drilling, shale/limestone.
16.5	17.5			Hard, rough, irregular drilling, limestone.
17.5	45.0			Very hard, rough, irregular drilling. Slow.
				Limestone.
45.0	46.5			Soft, fast drilling.
46.5	48.0			Easy drilling, slightly hard. Fast.
48.0	57.0			Easy drilling, slightly hard. Shale.
57.0	58.0			Soft drilling, fast.
58.0	61.5			Soft, slightly harder drilling.
61.5	62.5			Hard drilling, slow.
	62.5			Total Depth
				* No detailed lithologic log could be provided
				from 7.0' to 62.5' due to the use of a

ERC / EDGE Environmental and Energy Services Co.

WELL No. 996

ORNL MONITORING WELL LOG

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
				(* continued from page 1) containment box.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 996

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: C. Allison Bailey
PROOFED BY: Michael L. Ebers

DRILLING COMPANY: Geotek

DRILLER: Larry Ledbetter HELPER: Fred Dixon

DRILLING METHOD:
- ☒ 22.0 INCH AUGER 7.0 L.F.
- ☐ ____ INCH AUGER ____ L.F.
- ☒ 14.0 INCH ROTARY 29.0 L.F.
- ☒ 8.0 INCH ROTARY 26.5 L.F.

LOCATION WAG-3
ORNL GRID COORDINATES
N 21,920.1708
E 26,458.1823
ELEV. GROUND 830.31
ELEV. TOP STAINLESS STEEL CASING 832.26

DRILLING DATES:
STARTED: 11-16-89
FINISHED: 11-28-89

MATERIALS USED

EST. VOL.	USED VOL.	
	50.0	POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
	36.0	FT. OF 10 3/8 IN. SURFACE CASING
11.50	12.0	SACKS OF CEMENT (SURFACE CASING)
	50.0	POUNDS OF POWERED BENTONITE (SURFACE CASING)
	85.0	GALLONS OF WATER (SURFACE CASING)
	45.0	FT. OF 4.0 IN. DIA. STAINLESS STEEL CASING
	20.36	FT. OF 4.0 IN. DIA. STAINLESS STEEL SCREEN
5.5	5.5	SACKS OF SAND
40.0	50.0	POUNDS OF BENTONITE PELLETS
8.45	9.0	SACKS OF CEMENT (WELL CASING)
	35.0	POUNDS OF POWERED BENTONITE (WELL CASING)
	54.0	GALLONS OF WATER (WELL CASING)
	____	FT. OF ____ IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES
Spillage.

SURFACE CASING TREMIE GROUTED YES ☐ NO ☐

STAINLESS STEEL CASING TREMIE GROUTED YES ☐ NO ☐

WELL COVER USED
- ☒ LOCKING STEEL COVER
- ☐ FLUSH MOUNTED WELL COVER
- ☐ OTHER

SILT TRAP USED YES ☒ NO ☐

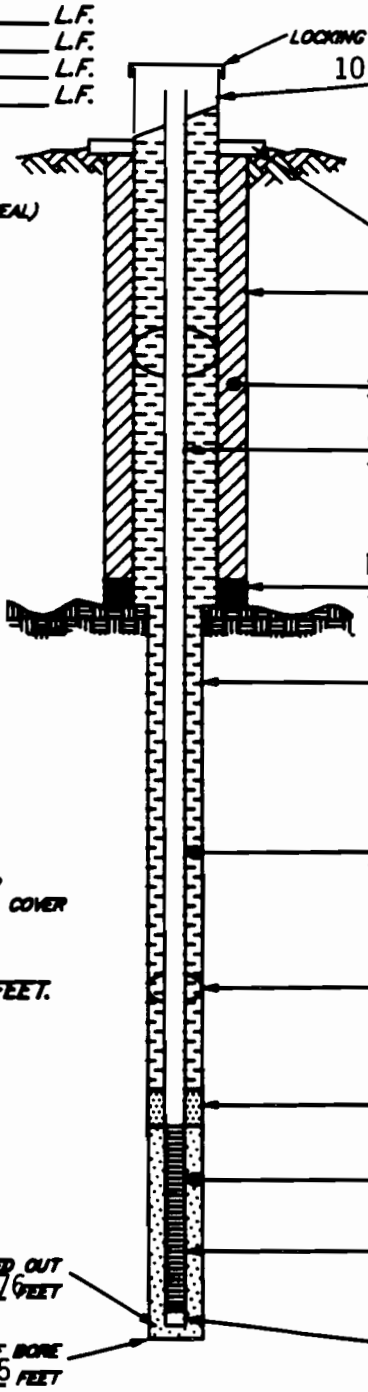
MONITORING WELL PUMP BASE SET AT ____ FEET.

CENTRALIZERS AT 16.0 FEET.
41.0 FEET.
61.0 FEET.

NOTE:
ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:

HOLE CLEANED OUT TO 61.76 FEET

BOTTOM OF BORE HOLE 62.5 FEET



TYPE B WELL

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 996

DATE: 11/16/89

MONITORING WELL MATERIALS CERTIFICATION

ITEM/MATERIAL		DATE USED	BATCH NUMBER
SAND		11-27-89	1
BENTONITE		11-22-89	Stores
		11-27-89	Stores
STAINLESS STEEL SCREEN	(PREPACKAGED ■ YES ☐ NO)	11-27-89	Stores
STAINLESS STEEL CASING	(PREPACKAGED ■ YES ☐ NO)	11-27-89	Stores
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ■ YES ☐ NO)	11-27-89	Stores
STAINLESS STEEL CAPS	(PREPACKAGED ■ YES ☐ NO)	11-27-89	Stores
MONITORING WELL PUMP	(PREPACKAGED ■ YES ☐ NO)	4-10-90	5
GROUT		11-27-89	3
		11-28-89	3
WELL COVERS		11-27-89	Stores
SURFACE CASING		11-22-89	2

COMMENTS:

OBSERVER SIGNATURE/DATE C. Allison Bailey 11/16/89
C. Allison Bailey

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 996

POST-WELL COMPLETION CHECKLIST

POST-WELL COMPLETION TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	11-16-89	CAB
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	11-16-89	CAB
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	4-10-90	DCL
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	11-27-89	CAB

* RELEASE SPECIFIC TECHNICAL DIRECTIONS FOR REGULATORY COMPLIANCE MONITORING WELLS PHASE I, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, W.O. K-4147, APRIL 1987.

OBSERVER SIGNATURE/DATE C. Allison Bailey 11/27/89
C. Allison Bailey

D. Charles Lytle 4/10/90
D. Charles Lytle

ERCE
Environmental and Energy Services Co.

WELL No. 996

LOCATION: WAG-3

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF DEVELOPMENT: Surging and Pumping

DEVELOPMENT BEGAN DATE: 4-02-90 TIME:

DEVELOPMENT ENDING DATE: 4-10-90

DEVELOPMENT OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 12.0 GALLONS

TOTAL GALLONS PUMPED: 413 TOTAL WELL VOLUMES PUMPED: 34.4

INITIAL pH: 7.5 FINAL pH: 7.7

INITIAL CONDUCTIVITY (µS/cm): 878 FINAL CONDUCTIVITY (µS/cm): 880

DESCRIPTION OF INITIAL TURBIDITY: Cloudy

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 2.0 NTU's

WELL APPROVED BY: R. C. Williams MMES

ODOR OF WATER: None

WATER DISCHARGED TO:
- ☒ GROUND SURFACE
- ☐ STORM SEWERS
- ☐ DRUMS
- ☐ TANK TRUCK
- ☐ STORAGE TANKS
- ☐ OTHER

INITIAL PRE-DEVELOPMENT WATER DEPTH: 14.6 feet from ground surface.

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE: D. Charles Lytle 4/10/90

D. Charles Lytle

HVDFDNLDVG

ERCE
Environmental and Energy Services Co.

WELL NO. 996
LOCATION: WAG-3
DATE: 4/02/90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 12.0 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (µS/cm)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
4-02-90	1100	42	Cloudy	--	7.5	878	42	3.5	
4-02-90	1300	10	Cloudy	--	7.4	857	52	4.3	
4-02-90	1500	62	Cloudy	--	7.5	830	114	9.5	
4-03-90	1000	30	Cloudy	--	7.7	785	144	12.0	
4-03-90	1300	12	Slightly Cloudy	--	7.5	791	156	13.0	
4-04-90	1100	55	Slightly Cloudy	--	7.4	834	211	17.6	
4-04-90	1300	14	Slightly Cloudy	--	7.4	827	225	19.0	
4-04-90	1500	49	Slightly Cloudy	--	7.5	836	274	22.8	
4-09-90	1400	84	Slightly Cloudy	--	7.6	811	358	29.8	
4-10-90	1430	24	Clear	2.0	7.7	880	413	34.4	
RESULTS AT END OF DEVELOPMENT			Clear	2.0	7.7	880	413	34.4	

COMMENTS Nice recharger and producer, passed and moved off hole.

OBSERVER SIGNATURE/DATE D. Charles Lytle 4/10/90
D. Charles Lytle

MWFORM05.DWG

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

(1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967 (ARTICLE IN VOL.3, NO.1 OF WRR ENTITLED "RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER")

(2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN VOL. 12, NO.3 OF WRR ENTITLED "A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS")

WELL NO.: 996 DATE OF TEST: 5/21/90

PROJECT NO.: E221-001 CLIENT: MMES

SITE LOCATION: X10

EDGE, INC. FIELD INVESTIGATOR: BRUCE McMASTER

INPUT DATA ARE:

INNER CASING DIAMETER = 4.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 4.00 INCHES
DIAMETER OF DRILLED HOLE = 8.63 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 20.50 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 43.80 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 20.50 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = .00 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .30
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 32

HO WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED
VALUES FOR HO
(FEET)

1.9568
1.9782

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 996

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SECOND)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	2.360	2.360
20.00	2.270	2.270
30.00	2.200	2.200
40.00	2.150	2.150
50.00	2.090	2.090
60.00	2.060	2.060
75.00	1.990	1.990
90.00	1.930	1.930
105.00	1.860	1.860
120.00	1.820	1.820
150.00	1.730	1.730
180.00	1.630	1.630
240.00	1.500	1.500
300.00	1.380	1.380
360.00	1.290	1.290
420.00	1.210	1.210
480.00	1.130	1.130
540.00	1.080	1.080
600.00	1.030	1.030
720.00	.920	.920
840.00	.830	.830
960.00	.770	.770
1080.00	.700	.700
1200.00	.650	.650
1320.00	.600	.600
1440.00	.540	.540
1560.00	.510	.510
1680.00	.480	.480
1800.00	.430	.430
1920.00	.430	.430
2040.00	.400	.400
2160.00	.400	.400

(**********

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

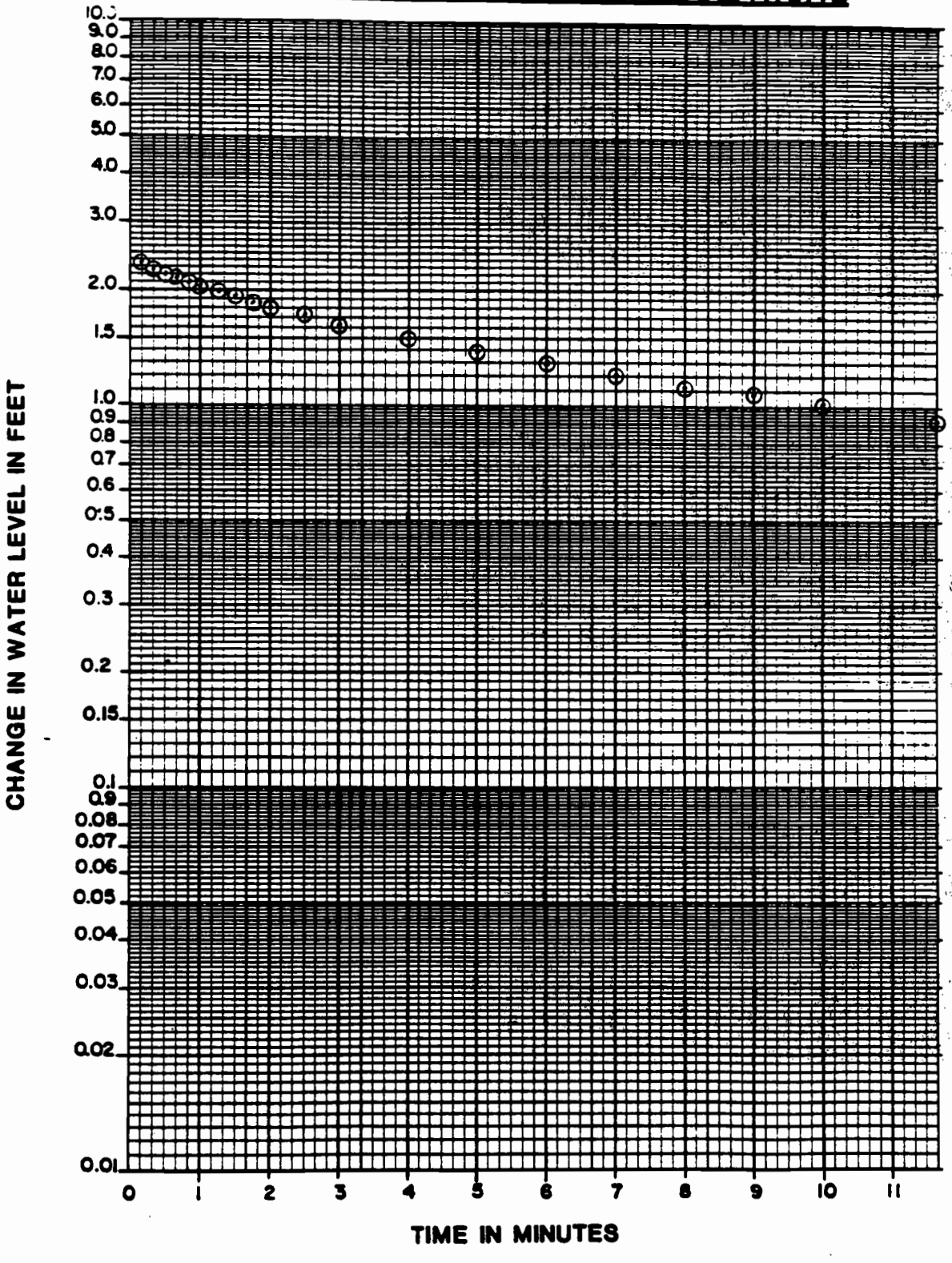
PERMEABILITY = 2.12E-06 FT/SECOND = 6.46E-05 CM/SEC

TRANSMISSIVITY = 4.34E-05 FT**2/SECOND

ERC / EDGE Environmental and Energy Services Co.

WELL No. 996

HYDRAULIC CONDUCTIVITY CALCULATIONS



EDGe Engineering, Design & Geosciences Group, Inc.
725 Pellissippi Parkway
P.O. Box 23010 Knoxville, Tn 37933-1010

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 996W01

WELL NO.	LOCATION:	TYPE:
996	WAG-3	Drill water

SAMPLER:	SAMPLE INTERVAL:	DATE:	TIME:
C. William Bailey (SIGNATURE)	N/A	11-27-89	1024

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECEIVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
C. William Bailey	01-15-90	1500	EDGE	J. Pruit	1-15-90	1500	EDGE

TYPE OF SAMPLE: ☐ SPLIT SPOON CORES–SOIL ☐ AUGER CUTTINGS–SOIL ☐ AUGER CUTTINGS–ROCK
☐ AIR ROTARY CUTTINGS–ROCK ■ DRILL WATER (NO AIR IN SAMPLE) ☐ OTHER _____

ALL SAMPLES ARE IMMEDIATELY PLACED IN I-CHEM SPECIALTY CLEANED CONTAINERS AND SEALED.

REMARKS: _____

1.0 General Information

1.1 Well Location

Monitoring well number 997 is located in SWSA 3. It is along the north perimeter fence of SWSA 3. The location is shown on ORNL drawing number C3E20004 A075. Survey coordinates for this well are N 21,911.0380, E 26,467.4951 (X-10 grid) or latitude 35°-55'-09.71" and longitude 84°-19'-46.27". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 997 was drilled by Geotek Engineering Company. Schramm and Ingersoll-Rand Air Rotary rigs were used to drill this boring for monitor well installation under operation of George Akins and Larry Ledbetter with the assistance of Steve Kirk and Fred Dixon. Drilling commenced on 11-9-89 and was finished on 11-27-89. Paragraph 2.4.1 includes a detailed

discussion of the well installation and a well schematic is included on the well installation/ completion form. A synopsis of the drilling activity follows. This information was typed directly from field notes and was edited only when necessary for clarification.

11-9-89 The Schramm rig was mobilized to the staked location and set up on plastic. Split spoon samples were taken from the surface to 11.6'. The boring was then augered with a 6" auger to refusal at 11.6'. The boring was then augered with a 20" auger to 8.0 feet. Set 7.0 feet of 16" surface casing and grouted with 4 sacks of cement with 5% bentonite. The Schramm rig was moved off the hole.

11-13-89 The rig and equipment were decontaminated and mobilized to the site. The diverter head was connected and a 14" boring was advanced to 15.0' with a tricone bit. A 10 3/4" surface casing was installed to a depth of 14.65' and a bentonite seal was poured into the annulus to 13.25'.

11-14-89 The annulus was tremied grouted to the surface.

11-15-89 The rig and equipment were decontaminated and mobilized to the site.

11-16-89 The Ingersoll-Rand and equipment were set up and the boring was drilled to a total depth of 33.5'. With an 8-inch tricone bit. This was originally to be a deep boring but because water was encountered

between 16.0 and 18.0', it was decided by Bill McMasters to make this the shallow boring. This boring will be completed after the deep boring is set.

11-27-89 The boring caved to 33.0' and sand was added to 30.0' so a 15.0' screen could be utilized to encounter the water zone. A 2.0" stainless steel screen and casing were installed to a depth of 29.92'. The sand was tremie grouted to 11.95' and a bentonite seal poured to 9.64'. No air or water samples were taken because it was thought this would be a deep boring and drilling was completed before samples could be taken.

11-28-89 The annulus was tremie grouted using 2.5 bags of cement with 5% bentonite.

This well was logged by ERC Environmental and Energy Services Co., Inc., hydrogeologists Timothy A. Lee and C. Allison Bailey. All well construction materials and supplies were from Martin Marietta Energy Systems approved batches. The batch origin of individual items is shown on the included Monitoring Well Materials Certification form.

2.0 Technical Information

2.1 Decontamination Procedures

The drilling rig, down hole tools, surface casing, stainless steel screen, stainless steel casing, centralizers, and stainless steel silt trap underwent

the cleaning decontamination procedures outlined in the drilling specifications (Release Specific Technical Directions for Regulatory Compliance Monitoring Wells Phase 1, Oak Ridge National Laboratory, Oak Ridge, W.O. K-4147, April 1987, pgs. 2-4). A checklist of the cleaned materials is included with this data package.

2.2 Geology

WAG 3 is located in Melton Valley which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 3 is underlain by limestone, siltstone and shale of the Middle Ordovician Chickamauga Group. The Chickamauga Group consists of eight units, designated by letters "A" to "H" (Stockdale, 1951). WAG 3 is underlain by units E, F, G and H. These units consist of thin bedded nodular limestone with clay and shale partings. A portion of unit H and unit F consists of calcareous siltstone alternating with beds of olive gray to maroon shale. Strike and dip varies from N 45° E to N 55° E and 25° to 35° southeast, respectively.

2.3 Sample Collection

One soil sample was collected during drilling, placed in an I-CHEM specialty cleaned glass container, sealed and submitted to Sample Receiving, Analytical Chemistry Division, Bldg. 4500S, ORNL. A chain of custody form for this sample is included with this

data package. Soil sample 997S01 was collected in the split spoon interval from 10.7 feet to 11.0 feet on 11-9-89.

A bulk density soil sample was collected from the split spoon sample interval from 6.0 to 6.3 feet. The sample was measured and weighed, and a bulk density of 2.04 grams/cm^3 was calculated.

2.4 Installation and Development

2.4.1 Installation

This was a "Type D" well. A 22.0-inch diameter boring was augered from ground surface to 8.0 feet. A 15 1/4-inch diverter casing was installed from surface to 8.0 feet below ground surface and grouted in place. The boring was then extended with a 14.0-inch air rotary tricone roller bit from 8.0 feet to 15.0 feet. A 10 3/4-inch diameter string of decontaminated steel surface casing was installed from 0.0 feet to 14.65 feet, sealed with a 1.4-foot bentonite pellet layer from 14.65 feet to 13.25 feet, and tremie grouted in place. The surface casing minimizes potential cross contamination between the regolith and bedrock water bearing zones. After the surface casing was installed, the air rotary method was used to drill an 8-inch diameter boring to a total depth of 33.5 feet. A 2-inch diameter stainless steel screen with threaded bottom cap was installed from 29.92 feet to 13.82 feet. A 2-inch diameter stainless steel casing was installed from the top of the screen at 13.82 feet and extended 1.77 feet above ground surface. A sandpack

was then tremied into the annular space from 33.0 to 11.95 feet, with a 2.31-foot bentonite pellet seal poured into the annular space above the sandpack from 11.95 to 9.64 feet. The annular space from the top of the bentonite seal to the surface was tremie grouted with a cement/bentonite slurry. A detailed schematic of the well is included on the well installation/ completion form.

2.4.2 Well Development

Well number 997 was developed to remove drill cuttings, silt, and other fines. The monitoring well was developed using a Geoguard pump with an air compressor. All pumps were cleaned prior to use according to specified cleaning procedures (see Paragraph 2.1). The well was developed until a measured total of 812 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was 5.0 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on 4-24-90 at a depth of 59.4 feet below ground surface.

These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 997 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity of the well screen. This was accomplished by instantaneously adding a known quantity of water to the monitoring well and measuring the recovery of the water level over time. The changing water levels were measured using a Druck 15 psig pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 4.98×10^{-4} cm/second (shown as permeability on the hydraulic conductivity calculations printout attached) was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 997

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

PRE-DRILLING TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. EXCAVTION PERMIT OBTAINED	11-09-89	CAB
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	11-09-89	CAB
3a. SCREEN AND CASING HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	N/A	
3b. PRE-PACKAGED SCREENS, CASING AND CENTRALIZERS WERE USED.	11-27-89	CAB
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	11-09-89	CAB
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	11-09-89	CAB
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	11-09-89	CAB
7. AIR ROTARY COMPRESSED AIR SAMPLED.		

RESULTS: _____

ADDITIONAL NOTES/OBSERVATIONS: _____

Timothy A. Lee 11-09-89

OBSERVER SIGNATURE/DATE C. Allison Bailey 11/27/89

ERC / EDGE Environmental and Energy Services Co.

WELL No. 997

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

EQUIPMENT	SCRAPE	STEAM CLEAN	STEAM RINSE	ISOPROPYL ALCOHOL RINSE	DEIONIZED WATER RINSE
RIG	X	X	X	N/A	N/A
AUGERS	X	X	X	X	X
BITS	X	X	X	X	X
RODS	X	X	X	X	X
SAMPLERS	X	X	X	X	X
PIPES	X	X	X	X	X
WORK TOOLS	X	X	X	X	X
AUGER PINS	X	X	X	X	X

OBSERVER SIGNATURE/DATE C. Allison Bailey 11/09/89
C. Allison Bailey

ERC / EDGE Environmental and Energy Services Co.

WELL No. 997

ORNL MONITORING WELL LOG

LOCATION: WAG-3
DRILLER: George Akins
HELPER: Steve Kirk
DRILL: Schramm

DATE: START: 11-09-89
FINISH: 11-27-89
LOGGED BY: Timothy A. Lee/ C. Allison Bailey
HEALTH PHYSICIST: Bill Shinpaugh

TYPE DRILLING: Split Spoon/Auger
LUBRICANT TYPE: Green stuff
No. SAMPLES TAKEN: 1
TYPE: Soil, Split Spoon
CONTAINMENT TYPE: Plastic and Pan

THICKNESS OF SOIL (REFUSAL DEPTH): 11.6
DEPTH DRILLED IN ROCK: 21.90
TOTAL DEPTH OF WELL: 33.5

DRILLING FLUID SAMPLES:
TYPE: N/A
DATE:

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
0.0	1.5			Gravel fill.
1.5	2.0		85%	Clay, dark yellowish orange, damp, dense,
				plastic, fill? Scattered limestone gravel.
2.0	2.6		85%	Clay, moderate brown, plastic, damp, scattered
				roots.
2.6	3.2		85%	Clay, dark yellowish orange, damp, slightly
				silty, plastic.
3.2	3.6		85%	Clay, dark yellowish orange, damp, plastic;
				scattered sandstone fragments, dark reddish
				brown, medium grained.
3.6	5.6		20%	Clay dark yellowish orange, damp, plastic;
				scattered limestone gravel; fill and gravel?
5.6	7.6	Bulk Density	100%	Clay, dark yellowish orange, damp, dense,
		@6.0'-6-3'		slightly silty; clay, mottled, yellowish grey,
				damp, dense, plastic; scattered sandstone
				fragments, dark reddish brown, medium grained;
				bulk density sample taken from 6.0' to 6.3';
				Bulk Density = 2.04 g/cm^3.
7.6	9.6		100%	Clay, dark yellowish orange, damp, dense,
				plastic; mottled clay, yellowish grey, damp
				dense, slightly silty; scattered dark sheets

ERC / EDGE Environmental and Energy Services Co.

WELL No. 997

ORNL MONITORING WELL LOG

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
7.6	9.6			(continued from page 1) of organic material or
				iron stains.
9.6	11.4	0997S01	100%	Clay, dark yellowish orange, damp, dense,
		@10.7'-11.0'		plastic, slightly silty; mottled with clay,
				yellowish gray, damp, dense, plastic. Soil
				sample taken from 10.7' to 11.0'.
11.4	11.6		100%	Limestone, shaley, dark olive gray. Hard.
	11.6			Split spoon refusal.
	11.6			6" auger refusal.
11.6	13.0			* Hard, rough, irregular drilling.
13.0	16.0			Very hard, rough, irregular drilling.
16.0	18.0			Smooth, soft, fast, regular drilling.
18.0	29.0			Hard, rough, slow, regular drilling.
29.0	31.0			Hard, smooth drilling, slightly faster drilling.
31.0	33.5			Hard, rough, irregular drilling. Slow.
	33.5			Total Depth
				* No detailed lithologic log could be provided
				from 11.6 to 33.5' due to use of containment
				box.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 997

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: C. Allison Bailey/ Timothy A. Lee

PROOFED BY: Michael L. Ebers

DRILLING COMPANY: Geotek

DRILLER: George Akins HELPER: Steve Kirk

DRILLING METHOD:
- ☒ 22.0 INCH AUGER 8.0 L.F.
- ☐ INCH AUGER L.F.
- ☒ 14.0 INCH ROTARY 17.0 L.F.
- ☒ 8.0 INCH ROTARY 18.5 L.F.

LOCATION WAG-3

ORNL GRID COORDINATES
N 21,911.0380
E 26,467.4951

ELEV. GROUND 830.24

ELEV. TOP STAINLESS STEEL CASING 832.01

DRILLING DATES:
STARTED: 11-09-89
FINISHED: 11-28-89

MATERIALS USED

EST. VOL.	USED VOL.	
	20.0	POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
	7.0	FT. OF 16 IN. SURFACE CASING
3.5	4.0	SACKS OF CEMENT (SURFACE CASING)
	25.0	POUNDS OF POWDERED BENTONITE (SURFACE CASING)
	32	GALLONS OF WATER (SURFACE CASING)
	18.23	FT. OF 2.0 IN. DIA. STAINLESS STEEL CASING
	15.86	FT. OF 2.0 IN. DIA. STAINLESS STEEL SCREEN
7.0	7.0	SACKS OF SAND
50.0	50.0	POUNDS OF BENTONITE PELLETS
2.5	2.5	SACKS OF CEMENT (WELL CASING)
	30.0	POUNDS OF POWDERED BENTONITE (WELL CASING)
	35.0	GALLONS OF WATER (WELL CASING)
	17.5	FT. OF 8 IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES
Spillage and irregular boring diameter.

SURFACE CASING TREMIE GROUTED YES ☒ NO ☐

STAINLESS STEEL CASING TREMIE GROUTED YES ☒ NO ☐

WELL COVER USED
- ☒ LOCKING STEEL COVER
- ☐ FLUSH MOUNTED WELL COVER
- ☐ OTHER

SILT TRAP USED YES ☒ NO ☐

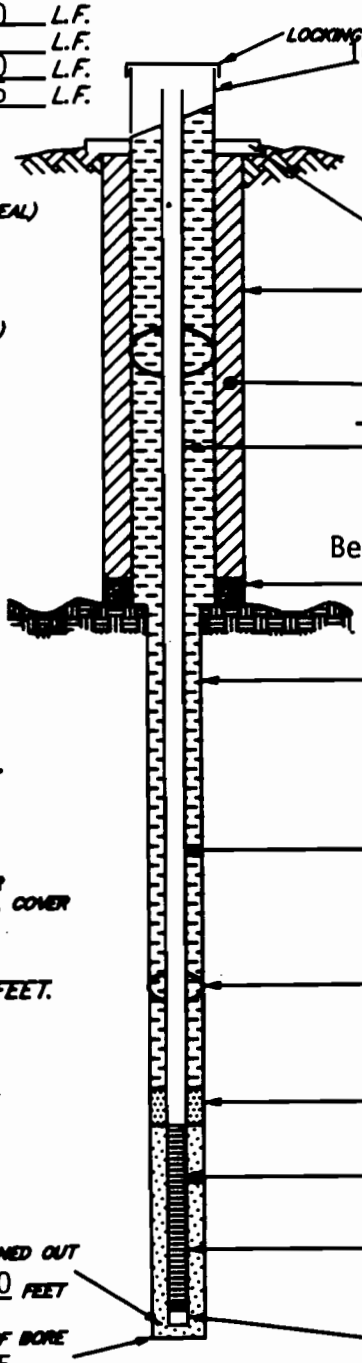
MONITORING WELL PUMP BASE SET AT 59.4 FEET.

CENTRALIZERS AT 15.0 FEET.
29.0 FEET.
FEET.

NOTE:
ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:

HOLE CLEANED OUT TO 33.0 FEET

BOTTOM OF BORE HOLE 33.5 FEET



LOCKING CAP

10 3/4 IN. DIA. SURFACE/PROTECTIVE CASING 2.80 FEET ABOVE GROUND SURFACE TO 14.65 FEET BELOW GROUND SURFACE

CONCRETE PAD

22.0 IN. DIA. BORE HOLE 0.0 TO 8.0 FEET

GROUT SEAL 0.0 TO 8.0 FEET

2.0 IN. STAINLESS STEEL CASING 1.77 FEET ABOVE GROUND SURFACE TO 13.82 FEET BELOW GROUND SURFACE

Bentonite SEAL 13.25 TO 14.65 FEET

BEDROCK LEVEL 11.6

8.0 IN. DIA. BORE HOLE

GROUT SEAL 0.0 TO 9.64 FEET

CENTRALIZER

BENTONITE PELLET SEAL 9.64 TO 11.95 FEET

SAND PACK 11.95 TO 33.0 FEET

2.0 IN. DIA. STAINLESS STEEL SLOTTED SCREEN 13.82 TO 29.68 FEET

2.0 IN. DIA. STAINLESS STEEL SILT TRAP/CAP 29.68 TO 29.92 FEET

TYPE D WELL

ERC / EDGE Environmental and Energy Services Co.

WELL No. 997

DATE: 11/13/89

MONITORING WELL MATERIALS CERTIFICATION

ITEM/MATERIAL		DATE USED	BATCH NUMBER
SAND			
		11-27-89	1
BENTONITE		11-13-89	Stores
		11-27-89	Stores
STAINLESS STEEL SCREEN	(PREPACKAGED ■ YES ☐ NO)	11-27-89	1
STAINLESS STEEL CASING	(PREPACKAGED ■ YES ☐ NO)	11-27-89	1
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ■ YES ☐ NO)	11-27-89	1
STAINLESS STEEL CAPS	(PREPACKAGED ■ YES ☐ NO)	11-27-89	1
MONITORING WELL PUMP	(PREPACKAGED ■ YES ☐ NO)	4-24-90	5
GROUT		11-14-89	3
		11-27-89	3
WELL COVERS		11-27-89	1
SURFACE CASING		11-13-89	2

COMMENTS:

OBSERVER SIGNATURE/DATE C. Allison Bailey 11/27/89
C. Allison Bailey

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 997

POST-WELL COMPLETION CHECKLIST

POST-WELL COMPLETION TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	11-09-89	CAB
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	11-09-89	CAB
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	4-24-90	DCL
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	11-27-89	CAB

* RELEASE SPECIFIC TECHNICAL DIRECTIONS FOR REGULATORY COMPLIANCE MONITORING WELLS PHASE I, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, W.O. K-4147, APRIL 1987.

OBSERVER SIGNATURE/DATE C. Allison Bailey 11/27/89
C. Allison Bailey

Timothy A. Lee 11/09/89
Timothy A. Lee

D. Charles Lytle 4/24/90
D. Charles Lytle

ERCE
Environmental and Energy Services Co.

WELL No. 997

LOCATION: WAG-3

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF DEVELOPMENT: Surging and Pumping

DEVELOPMENT BEGAN DATE: 4-02-90 TIME:

DEVELOPMENT ENDING DATE: 4-24-90

DEVELOPMENT OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 44.7 GALLONS

TOTAL GALLONS PUMPED: 812 TOTAL WELL VOLUMES PUMPED: 18.2

INITIAL pH: 7.6 FINAL pH: 7.5

INITIAL CONDUCTIVITY (µS/cm): 785 FINAL CONDUCTIVITY (µS/cm): 684

DESCRIPTION OF INITIAL TURBIDITY: Cloudy

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 5.0 NTU's

WELL APPROVED BY: R. C. Williams MMES

ODOR OF WATER: Sulfer Smell

WATER DISCHARGED TO:
- ☒ GROUND SURFACE
- ☐ STORM SEWERS
- ☐ DRUMS
- ☐ TANK TRUCK
- ☐ STORAGE TANKS
- ☐ OTHER

INITIAL PRE-DEVELOPMENT WATER DEPTH: 6.5 feet from ground surface.

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 4/24/90

D. Charles Lytle

ERCE
Environmental and Energy Services Co.

WELL NO. 997
LOCATION: WAG-3
DATE: 4/02/90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 44.7 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (µS/cm)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
4-02-90	1300	149	Cloudy	--	7.6	785	149	3.3	
4-02-90	1500	24	Cloudy	--	7.5	798	173	3.9	
4-03-90	1000	35	Cloudy	--	7.6	737	208	4.7	
4-03-90	1300	18	Cloudy	--	7.5	744	226	5.1	
4-04-90	1100	51	Cloudy	--	7.5	804	277	6.2	
4-04-90	1300	24	Cloudy	--	7.5	825	301	6.7	
4-06-90	1400	82	Slightly Cloudy	--	7.5	820	383	8.6	
4-17-90	1430	132	Slightly Cloudy	--	7.6	802	515	11.5	
4-19-90	1330	159	Slightly Cloudy	--	7.4	708	674	15.1	
4-24-90	1430	138	Clear	5.0	7.5	684	812	18.2	
RESULTS AT END OF DEVELOPMENT			Clear	5.0	7.5	684	812	18.2	

COMMENTS Fast recharger and producer. Cleared up fast. Passed and moved to another hole.

* Had a sulfur smell when we first started pumping, after a couple of days the smell disappeared.

OBSERVER SIGNATURE/DATE D. Charles Lytle 4/24/90
D. Charles Lytle

MWFORMOS.DWG

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

(1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967 (ARTICLE IN VOL.3, NO.1 OF WRR ENTITLED "RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER")

(2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN VOL. 12, NO.3 OF WRR ENTITLED "A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS")

WELL NO.: 997 DATE OF TEST: 5/21/90

PROJECT NO.: E221-001 CLIENT: MMES

SITE LOCATION: X10

EDGE, INC. FIELD INVESTIGATOR: BRUCE McMASTER

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 8.63 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 15.80 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 16.20 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 15.80 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = .00 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .30
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 23

HYDRAULIC CONDUCTIVITY CALCULATIONS

HO WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED VALUES FOR HO (FEET)
2.0534
2.1790
2.3441
2.5188
2.7751
3.1184
3.3804
3.6741
3.9283
4.2131
4.5436
4.7671

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SECOND)	DEPTH TO WATER (FEET)	HEAD (FEET)
5.00	4.850	4.850
10.00	3.930	3.930
15.00	3.180	3.180
20.00	2.670	2.670
25.00	2.320	2.320
30.00	2.020	2.020
35.00	1.820	1.820
40.00	1.620	1.620
45.00	1.470	1.470
50.00	1.320	1.320
55.00	1.230	1.230
60.00	1.130	1.130
75.00	.890	.890
90.00	.810	.810
105.00	.710	.710
120.00	.660	.660
150.00	.540	.540
180.00	.470	.470
240.00	.400	.400
300.00	.330	.330
360.00	.270	.270
420.00	.290	.290
480.00	.270	.270

****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

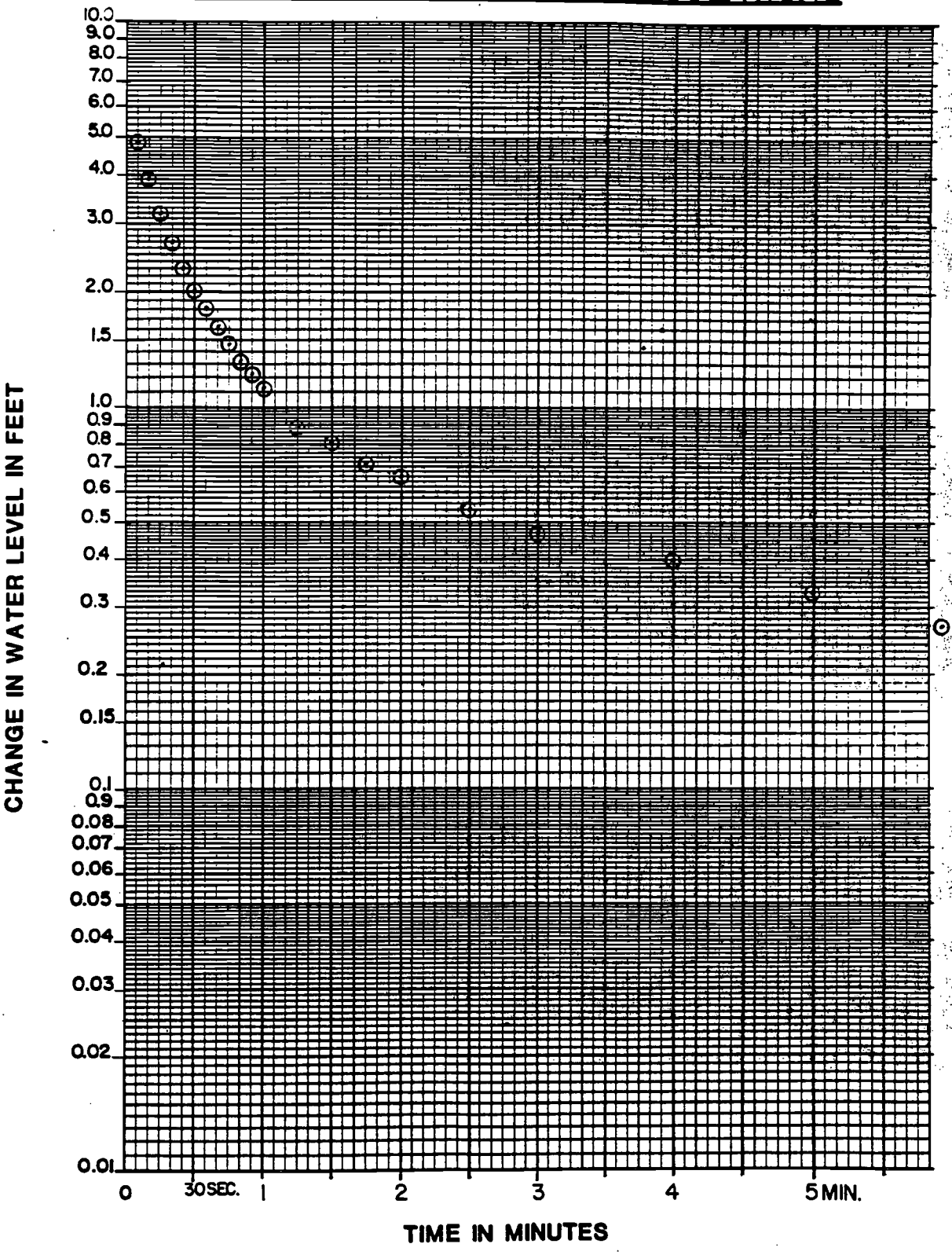
PERMEABILITY = 1.63E-05 FT/SECOND = 4.98E-04 CM/SEC

TRANSMISSIVITY = 2.58E-04 FT**2/SECOND

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 997

HYDRAULIC CONDUCTIVITY CALCULATIONS



EDGe Engineering, Design & Geosciences Group, Inc.
725 Pellissippi Parkway
P.O. Box 23010 Knoxville, Tn 37933-1010

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 049750 1

WELL NO.	LOCATION:	TYPE:
099	WAG 3	Soil

SAMPLER: (SIGNATURE)	SAMPLE INTERVAL:	DATE:	TIME:
Timothy A Gray	@ 10.1' - 11.0'	11-9-89	1000

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECEIVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
Timothy A Gray	1-31-90	1500	ERC	N E Oliver	1/31/90	1500	ORNL

TYPE OF SAMPLE: ☒ SPLIT SPOON CORES–SOIL ☐ AUGER CUTTINGS–SOIL ☐ AUGER CUTTINGS–ROCK
☐ AIR ROTARY CUTTINGS–ROCK ☐ DRILL WATER (NO AIR IN SAMPLE) ☐ OTHER _____

ALL SAMPLES ARE IMMEDIATELY PLACED IN I–CHEM SPECIALTY CLEANED CONTAINERS AND SEALED.

REMARKS: _____

1.0 General Information

1.1 Well Location

Monitoring well number 998 is located in WAG 3. It is located 450 feet south of the SWSA 3 boundary fence. The location is shown on ORNL drawing number C3E20004 A075. Survey coordinates for this well are N 20,984.5939, E26,235.9355 (X-10 grid) or latitude 35°-55'-00.82" and longitude 84°-19'-42.35". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 998 was drilled by A. L. Clark Drilling Services. A Schramm Rotadrill rig was used to drill this boring for monitor well installation under operation of Richard Pickel with the assistance of Leo Johnson. Drilling commenced on 9-23-87 and was finished on 9-25-87. Paragraph 2.4.1 includes a detailed discussion of the well installation and a well schematic is included on the well installation/completion form. A synopsis of the drilling activity

follows. This information was typed directly from field notes and was edited only when necessary for clarification.

9-23-87 The Schramm Rotadrill was steamcleaned and mobilized to the staked location and set up. The boring was split spooned from 0.0 feet to 8.0 feet and augered from 0.0 feet to 12.0 feet with a 6 1/4-inch auger.

9-24-87 Deepened boring from 12.0 feet to 20.0 feet with a 6 1/4-inch auger. Bailed hole, had 10 to 12 feet of water in boring.

9-25-87 Boring was bailed and well was set with 2-inch stainless steel screen and casing. A sandpack and bentonite seal were installed.

This well was logged by ERC Environmental and Energy Services Co., Inc., hydrogeologists Daniel C. Baughn and Michael L. Ebers. All well construction materials and supplies were from Martin Marietta Energy Systems approved batches. The batch origin of individual items is shown on the included Monitoring Well Materials Certification form.

2.0 Technical Information

2.1 Decontamination Procedures

The drilling rig, down hole tools, surface casing, stainless steel screen, stainless steel casing, centralizers, and stainless steel silt trap underwent the cleaning decontamination procedures outlined in

the drilling specifications (Release Specific Technical Directions for Regulatory Compliance Monitoring Wells Phase 1, Oak Ridge National Laboratory, Oak Ridge, W.O. K-4147, April 1987, pgs. 2-4). A checklist of the cleaned materials is included with this data package.

2.2 Geology

WAG 3 is located in Melton Valley which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 3 is underlain by limestone, siltstone and shale of the Middle Ordovician Chickamauga Group. The Chickamauga Group consists of eight units, designated by letters "A" to "H" (Stockdale, 1951). WAG 3 is underlain by units E, F, G and H. These units consist of thin bedded nodular limestone with clay and shale partings. A portion of unit H and unit F consists of calcareous siltstone alternating with beds of olive gray to maroon shale. Strike and dip varies from N 45° E to N 55° E and 25° to 35° southeast, respectively.

2.3 Sample Collection

Two soil samples were collected during drilling, placed in I-CHEM specialty cleaned glass containers, sealed and submitted to Sample Receiving, Analytical Chemistry Division, Bldg. 4500S, ORNL. Chain of custody forms for these samples are included with this data package. Soil sample 998S02 was collected in the split spoon interval from 3.1 feet to 3.2 feet on

9-23-87 and soil sample 0998S02 was collected in the split spoon interval from 7.7 feet to 7.8 feet on 9-23-87.

A bulk density soil sample was collected from the split spoon sample interval from 2.60 feet to 3.06 feet. The sample was measured and weighed, and a bulk density of 2.2 grams/cm^3 was calculated.

2.4 Installation and Development

2.4.1 Installation

This was a "Type A" well. A 6-inch diameter boring was split spooned and augered from ground surface to a total depth of 20.7 feet. A 2-inch diameter stainless steel silt trap was installed from 19.7 to 20.0 feet. Above the silt trap a 2-inch diameter stainless steel screen was installed from 4.7 feet to 19.7 feet. A 2-inch diameter stainless steel casing was installed above the screen from 4.7 feet to 3.16 feet above ground surface. A sandpack was then poured into the annular space from 3.2 to 20.0 feet, with a 2.3-foot bentonite pellet seal poured into the annular space above the sandpack from 0.9 to 3.2 feet. The annular space from the top of the bentonite seal to the surface was tremie grouted with a cement/bentonite slurry. A detailed schematic of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 998 was developed to remove drill cuttings, silt, and other fines. The monitoring well was developed using a Geoguard pump with an air compressor. All pumps were cleaned prior to use according to specified cleaning procedures (see Paragraph 2.1). The well was developed until a measured total of 311 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was 3.0 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on 4-23-90 at a depth of 17.8 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 998 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity of the well screen. This was accomplished by instantaneously adding a known quantity of water to the monitoring well and measuring the recovery of the water level over time. The changing water levels were

measured using a Druck 15 psig pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 9.39 x 10^{-5} cm/second (shown as permeability on the hydraulic conductivity calculations printout attached) was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 998

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

PRE-DRILLING TASKS		COMPLIANCE DATE	COMPLIANCE INITIALS
1.	EXCAVATION PERMIT OBTAINED.	9-23-87	MLE
2.	ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	9-23-87	MLE
3a.	SCREEN AND CASINGS HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	N/A	
3b.	PRE-PACKAGED SCREENS, CASINGS AND CENTRALIZERS WERE USED.	9-25-87	MLE
4.	WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	9-23-87	MLE
5.	CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON-HAND.	9-23-87	MLE
6.	POLYETHYLENE COVER IN PLACE OVER HOLE.	9-23-87	MLE

ADDITIONAL NOTES/OBSERVATIONS:

OBSERVER SIGNATURE/DATE [signature] 9/25/87

Michael L. Ebers

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 998

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

EQUIPMENT	SCRAPE	STEAM CLEAN	STEAM RINSE	ISOPROPYL ALCOHOL RINSE	DEIONIZED WATER RINSE
RIG	X	X	X	N/A	N/A
AUGERS	X	X	X	X	X
BITS	X	X	X	X	X
RODS	X	X	X	X	X
SAMPLERS	X	X	X	X	X
PIPES	X	X	X	X	X
WORK TOOLS	X	X	X	X	X
AUGER PINS	X	X	X	X	X

OBSERVER SIGNATURE/DATE Michael L. Ebers 9/23/87
Michael L. Ebers

ERC / EDGE Environmental and Energy Services Co.

WELL No. 998

ORNL MONITORING WELL LOG

LOCATION: SWSA 3
DRILLER: Rick Pickel
HELPER: Leo Johnson
DRILL: Schramm

DATE: START: 9/23/87
FINISH: 9/25/87
LOGGED BY: M.L. Ebers
HEALTH PHYSICIST: Paul Eldridge

TYPE DRILLING: Split Spoon, 7" Auger
LUBRICANT TYPE: Molykote 1000
No. SAMPLES TAKEN: Two
TYPE: Soil
CONTAINMENT TYPE: Auger Pan and Plastic

THICKNESS OF SOIL (REFUSAL DEPTH): 8.0
DEPTH DRILLED IN ROCK: 12.7
TOTAL DEPTH OF WELL: 20.7

DRILLING FLUID SAMPLES:
TYPE: N/A
DATE:

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
0.0	1.5		100%	Loam, silty, moderate yellowish brown, dry,
				crumbly, few roots in upper o.3'.
1.5	5.8	0998S01	65%	Clay, silty, dark yellowish orange and dark
		@3.1-3.2'		yellowish brown; scattered weathered silt-
				stone fragments to 1/4", pale yellowish
				orange, medium dense, dry.
5.8	7.2		100%	Clay, dark yellowish brown with abundant
				siltstone fragments varying in color from
				light greenish gray, light yellowish orange
				and reddish brown, crumbly, damp.
7.2	7.8	0998S02	100%	Clay, dark yellowish brown, soft plastic, damp
		@7.7-7.8'		
7.8	8.0		100%	Siltstone, light gray, weathered, crumbly, and
				shale, greenish gray, weathered.
	8.0			Split spoon refusal.
				Bulk Density Sample @ 2.6 - 3.05'
				Bulk Density = 2.2 grams/cm^3
8.0	11.0			Clay, dark yellowish brown, damp, soft.
11.0	12.8			Limestone, hard, medium gray.
12.8	13.6			Shale, silty, greenish gray.
13.6	20.7			Shale, calcareous, reddish brown.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 998

ORNL MONITORING WELL LOG

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
	20.7			Total Depth

ERC / EDGE Environmental and Energy Services Co.

WELL No. 998

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: Michael L. Ebers/ Daniel C. Baughn

PROOFED BY: Michael L. Ebers

DRILLING COMPANY: A. L. Clark Drilling Services

DRILLER: Richard Pickel HELPER: Leo Johnson

EQUIPMENT ☒ 7 INCH AUGER 20.7 L.F.

☐ _____ INCH AUGER _____ L.F.

LOCATION WAG-3

ORNL GRID COORDINATES

N 20,984.5939

E 26,235.9355

ELEV. GROUND 872.17

ELEV. TOP STAINLESS STEEL CASING 875.33

DRILLING DATES:

STARTED: 9-23-87

FINISHED: 9-25-87

MATERIALS USED

EST. VOL.	USED VOL.	
	15.0	FEET OF 2.0 IN. S.S. SCREEN
	7.9	FEET OF 2.0 IN. S.S. CASING
3.0	4.0	SACKS OF SAND
30.0	35.0	POUNDS OF BENTONITE PELLETS
1.0	1.0	SACKS OF CEMENT
	1.0	POUNDS OF POWDERED BENTONITE
	6.0	GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

_____

_____

WELL COVER USED ☒ LOCKING STEEL COVER ☐ FLUSH MOUNTED WELL COVER ☐ OTHER

SILT TRAP USED YES ☒ NO ☐

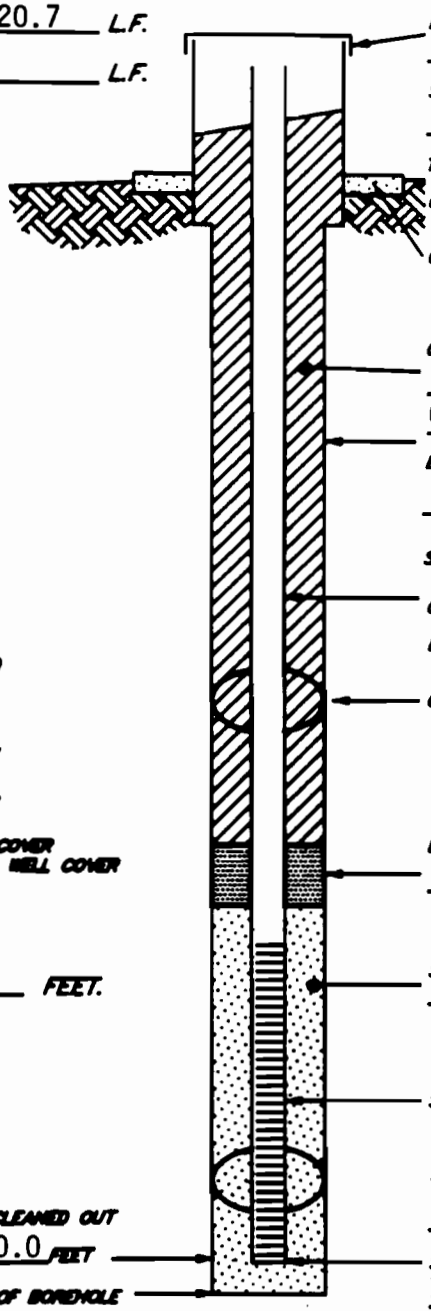
MONITORING WELL PUMP BASE SET AT 17.8 FEET.

CENTRALIZERS AT 4.0 FEET.

20.0 FEET.

_____ FEET.

NOTE:
ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:



LOCKING STEEL COVER 8 INCH DIAMETER

STEEL PROTECTIVE CASING 3.97 FT. ABOVE GROUND TO 2.0 FT. BELOW GROUND SURFACE

CONCRETE PAD

GROUT SEAL 0.0 TO 0.9 FEET

6.25 INCH DIAMETER BOREHOLE

2.0 INCH DIAMETER STAINLESS STEEL CASING 3.16 FT. ABOVE GROUND SURFACE TO 4.7 FT. BELOW GROUND SURFACE

CENTRALIZER (TYP.)

BENTONITE PELLET SEAL 0.9 TO 3.2 FEET

SAND PACK 3.2 TO 20.0 FEET

2.0 INCH DIAMETER STAINLESS STEEL 0.010 SLOTTED SCREEN 4.7 TO 19.7 FEET

2.0 INCH DIAMETER STAINLESS STEEL SILT TRAP/CAP 19.7 TO 20.0 FEET

HOLE CLEANED OUT TO 20.0 FEET

BOTTOM OF BOREHOLE 20.7 FEET

TYPE A WELL

NOT TO SCALE

ERC / EDGE Environmental and Energy Services Co.

WELL No. 998

DATE: 9/25/87

MONITORING WELL MATERIALS CERTIFICATION

ITEM/MATERIAL		DATE USED	BATCH NUMBER
SAND		9/25/87	2
BENTONITE		9/25/87	2
STAINLESS STEEL SCREEN	(PREPACKAGED ■ YES ☐ NO)	9/25/87	5
STAINLESS STEEL CASING	(PREPACKAGED ■ YES ☐ NO)	9/25/87	5
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ■ YES ☐ NO)	9/25/87	5
STAINLESS STEEL CAPS	(PREPACKAGED ■ YES ☐ NO)	9/25/87	5
MONITORING WELL PUMP	(PREPACKAGED ■ YES ☐ NO)	4/23/90	5
GROUT		9/26/87	
		12/87	15
WELL COVERS			1
SURFACE CASING		12/87	2

COMMENTS:

OBSERVER SIGNATURE/DATE Michael L. Ebers 9/26/87

Michael L. Ebers

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 998

POST-WELL COMPLETION CHECKLIST

POST-WELL COMPLETION TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	9/25/87	MLE
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	9/25/87	MLE
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	4/23/90	DCL
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	9/25/87	MLE

* RELEASE SPECIFIC TECHNICAL DIRECTIONS FOR REGULATORY COMPLIANCE MONITORING WELLS PHASE I, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, W.O. K-4147, APRIL 1987.

OBSERVER SIGNATURE/DATE [signature] 9/25/87
Michael L. Ebers

D. Charles Lytle 4/23/90
D. Charles Lytle

ERCE
Environmental and Energy Services Co.

WELL No. 998

LOCATION: WAG-3

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF DEVELOPMENT: Surging and Pumping

DEVELOPMENT BEGAN DATE: 4/19/90 TIME:

DEVELOPMENT ENDING DATE: 4/23/90

DEVELOPMENT OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 10.0 GALLONS

TOTAL GALLONS PUMPED: 311 TOTAL WELL VOLUMES PUMPED: 31.1

INITIAL pH: 7.7 FINAL pH: 7.7

INITIAL CONDUCTIVITY (µS/cm): 498 FINAL CONDUCTIVITY (µS/cm): 536

DESCRIPTION OF INITIAL TURBIDITY: Slightly Cloudy

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 3.0 NTU's

WELL APPROVED BY: R. C. Williams MMES

ODOR OF WATER: None

WATER DISCHARGED TO:
- ☒ GROUND SURFACE
- ☐ STORM SEWERS
- ☐ DRUMS
- ☐ TANK TRUCK
- ☐ STORAGE TANKS
- ☐ OTHER

INITIAL PRE-DEVELOPMENT WATER DEPTH: +.2" above ground surface.

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 4/23/90

D. Charles Lytle

ERCE
Environmental and Energy Services Co.

WELL NO. 998
LOCATION: WAG-3
DATE: 4/19/90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 10.0 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (µS/cm)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
4-19-90	1330	156	Slightly Cloudy	--	7.7	498	156	15.6	
4-23-90	1430	155	Clear	3.0	7.7	536	311	31.1	
RESULTS AT END OF DEVELOPMENT			Clear	3.0	7.7	536	311	31.1	

COMMENTS Nice producer. Cleared fast and remained clear even after several cycles after surging. Passed and moved off of hole.

OBSERVER SIGNATURE/DATE D. Charles Lytle 4/23/90
D. Charles Lytle

MWFORMOS.DWG

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

(1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967 (ARTICLE IN VOL.3, NO.1 OF WRR ENTITLED "RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER")

(2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN VOL. 12, NO.3 OF WRR ENTITLED "A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS")

WELL NO.: 998 DATE OF TEST: 5/16/90

PROJECT NO.: E221-001 CLIENT: MMES

SITE LOCATION: X10

EDGE, INC. FIELD INVESTIGATOR: BRUCE McMASTER

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 6.25 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 15.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 14.20 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 15.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = .89 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .30
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 22

HO WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED
VALUES FOR HO
(FEET)

1.6417
1.7098

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SECOND)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	3.570	2.680
20.00	3.170	2.280
30.00	2.870	1.980
40.00	2.640	1.750
50.00	2.440	1.550
60.00	2.280	1.390
75.00	2.090	1.200
90.00	1.920	1.030
105.00	1.790	.900
120.00	1.680	.790
150.00	1.530	.640
180.00	1.420	.530
240.00	1.290	.400
300.00	1.220	.330
360.00	1.140	.250
420.00	1.120	.230
480.00	1.070	.180
540.00	1.040	.150
600.00	1.040	.150
720.00	.980	.090
840.00	.930	.040
960.00	.930	.040

****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

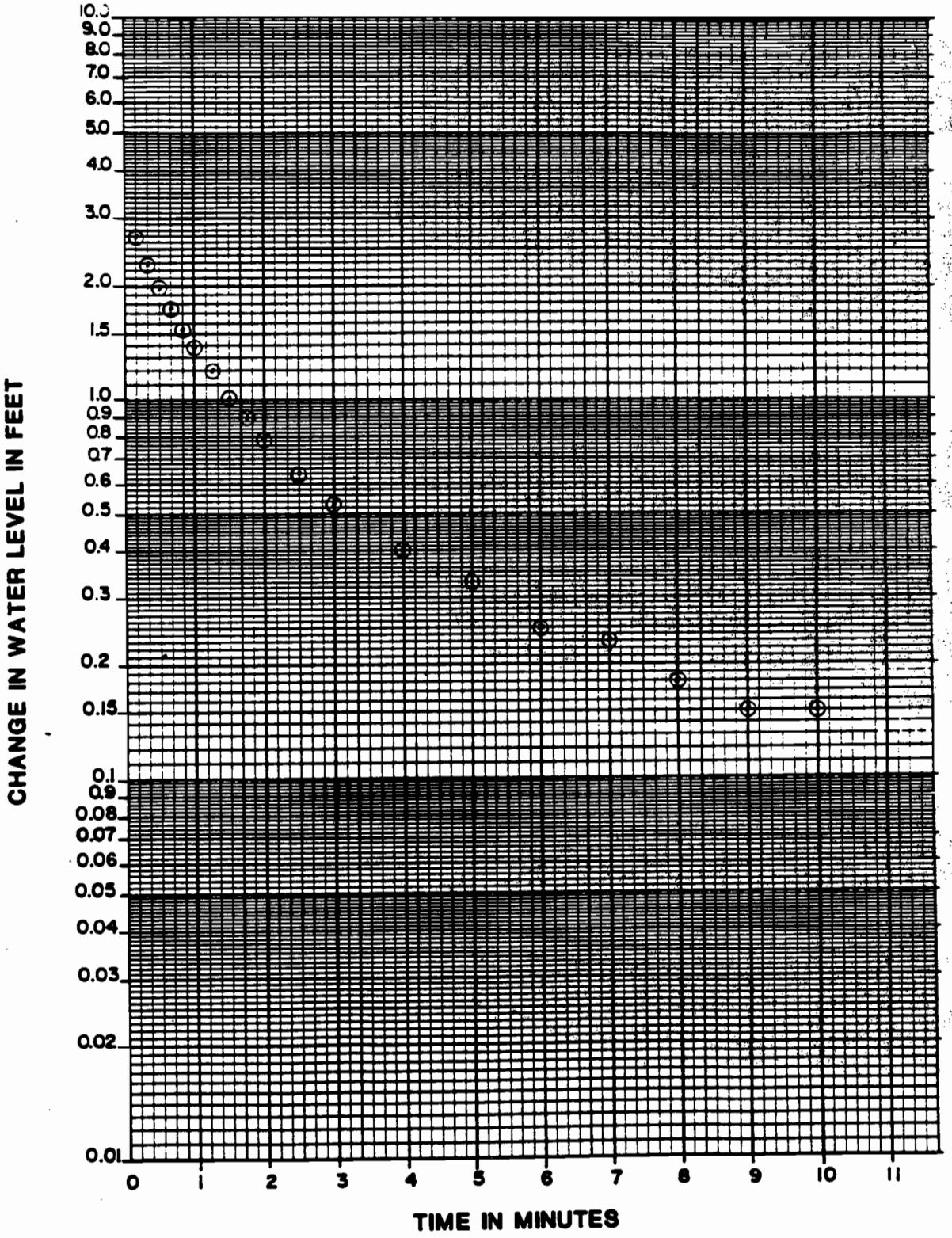
PERMEABILITY = 3.08E-06 FT/SECOND = 9.39E-05 CM/SEC

TRANSMISSIVITY = 4.62E-05 FT**2/SECOND

ERC / EDGE Environmental and Energy Services Co.

WELL No. 998

HYDRAULIC CONDUCTIVITY CALCULATIONS



MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 0998 S01

WELL NO.: 0998

LOCATION: SWSA 3

3.1' TO 3.2'

TYPE: SOIL

SAMPLER: [signature] (SIGNATURE)

DATE: 9/23/87

TIME: 4.30 PM.

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
[signature]	10/20/87	9:45AM	MCI	Nancy Owen	10/20/87	9:45	ORNL

REMARKS:

MCI/CONSULTING ENGINEERS, INC.
NASHVILLE KNOXVILLE HUNTSVILLE LOUISVILLE
(615) 966-9788

CHAIN OF CUSTODY RECORD
FOR
MARTIN MARIETTA ENERGY SYSTEMS
OAK RIDGE NATIONAL LABORATORY

SAMPLE NUMBER: 998 SO2

WELL NO.: 998

LOCATION: SWSA 3
7.7' TO 7.8'

TYPE: SOIL

SAMPLER: (SIGNATURE)

DATE: 9/23/87

TIME: 4:30 P.M.

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECIEVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
	10/20/87	9:45AM	MCI	Nancy Owen	10/20/87	8:85	ORNL

REMARKS:

1.0 General Information

1.1 Well Location

Monitoring well number 1247 is located in WAG 3. It is located on the western boundary of WAG 3 adjacent to Highway 95.

The location is shown on ORNL drawing number C3E20004 A075. Survey coordinates for this well are N 21,357.5769, E 24,659.5516 (X-10 grid) or latitude 35°-54'-55.21" and longitude 84°-20'-00.79". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 1247 was drilled by Geotek Engineering Company. An Ingersoll-Rand rig was used to drill this boring for monitor well installation under operation of Larry Ledbetter with the assistance of Fred Dixon. Drilling commenced on 5-22-90 and was finished on 5-25-90. Paragraph 2.4.1 includes a detailed discussion of the well installation and a well

schematic is included on the well installation/ completion form. A synopsis of the drilling activity follow. This information was typed directly from field notes and was edited only when necessary for clarification.

5-22-90 Moved site to location and set up on plastic sheeting. Augered from surface to 6.0 feet using a 14-inch auger. Set and grouted 10-inch decontaminated steel diverter casing.

5-24-90 Drill to 22.7 feet using an 8-inch air rotary tricone bit into containment box.

5-25-90 Set 2-inch stainless steel screen and casing with sandpack and bentonite seal. Grout annulus with 1.5 sacks cement.

This well was logged by ERC Environmental and Energy Services Co., Inc., hydrogeologist Timothy A. Lee. All well construction materials and supplies were from Martin Marietta Energy Systems approved batches. The batch origin of individual items is shown on the included Monitoring Well Materials Certification form.

2.0 Technical Information

2.1 Decontamination Procedures

The drilling rig, down hole tools, surface casing, stainless steel screen, stainless steel casing, centralizers, and stainless steel silt trap underwent the cleaning decontamination procedures outlined in the drilling specifications (Release Specific

Technical Directions for Regulatory Compliance Monitoring Wells Phase 1, Oak Ridge National Laboratory, Oak Ridge, W.O. K-4147, April 1987, pgs. 2-4). A checklist of the cleaned materials is included with this data package.

2.2 Geology

WAG 3 is located in Melton Valley which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 3 is underlain by limestone, siltstone and shale of the Middle Ordovician Chickamauga Group. The Chickamauga Group consists of eight units, designated by letters "A" to "H" (Stockdale, 1951). WAG 3 is underlain by units E, F, G and H. These units consist of thin bedded nodular limestone with clay and shale partings. A portion of unit H and unit F consists of calcareous siltstone alternating with beds of olive gray to maroon shale. Strike and dip varies from N 45° E to N 55° E and 25° to 35° southeast, respectively.

2.3 Sample Collection

No samples were collected during drilling.

The Ingersoll-Rand T-4 compressed air was sampled with a cloth filter inserted between drill rods on 5-29-90. The sample was examined with an ultraviolet light for the pressure of hydrocarbons. The filter showed no detectable signs of hydrocarbons.

2.4 Installation and Development

2.4.1 Installation

This was a "Type D" well. The air rotary method was required to complete the boring to the specified total well depth. Therefore, a 14.0-inch diameter boring was augered from ground surface to 6.0 feet and a 10-inch diverter casing was installed and grouted. An 8-inch diameter boring was then drilled with an air rotary tricone roller bit from 6.0 to 22.7 feet. A 2-inch diameter stainless steel screen with threaded bottom cap was installed from 7.5 to 22.7 feet. A 2-inch diameter stainless steel casing was installed above the screen at 7.5 feet and extended 2.15 feet above ground surface. A sandpack was then poured/tremied into the annular space from 6.5 to 22.7 feet, with a 1.0-foot bentonite pellet seal poured into the annular space above the sandpack from 5.5 to 6.5 feet. The annular space from the top of the bentonite seal to the surface was tremie-grouted with a cement/bentonite slurry. A detail of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 1247 was developed to remove drill cuttings, silt, and other fines. The monitoring well was developed using a Geoguard pump with an air compressor. All pumps were cleaned prior to use according to specified cleaning procedures (see Paragraph 2.1). The well was developed until a measured total of 8 gallons of water had been

evacuated. Well development was terminated due to the extremely poor well recharge rate. The final turbidity value measured at completion was >100 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on 8-23-90 at a depth of 21.6 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 1247 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity of the well screen. This was accomplished by instantaneously adding a known quantity of water to the monitoring well and measuring the recovery of the water level over time. The changing water levels were measured using a Druck 15 psig pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 5.59×10^{-5} cm/second (shown as permeability on the hydraulic conductivity calculations printout attached) was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 1247

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

PRE-DRILLING TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. EXCAVTION PERMIT OBTAINED	5-22-90	TAL
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	5-22-90	TAL
3a. SCREEN AND CASING HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	N/A	
3b. PRE-PACKAGED SCREENS, CASING AND CENTRALIZERS WERE USED.	5-25-90	TAL
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	5-22-90	TAL
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	5-22-90	TAL
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	5-24-90	TAL
7. AIR ROTARY COMPRESSED AIR SAMPLED.	5-24-90	TAL

RESULTS: Sample showed no detectable signs of hydrocarbons under ultra-violet light.

ADDITIONAL NOTES/OBSERVATIONS:

OBSERVER SIGNATURE/DATE Timothy A. Lee 5/25/90
Timothy A. Lee

ERC / EDGE Environmental and Energy Services Co.

WELL No. 1247

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

EQUIPMENT	SCRAPE	STEAM CLEAN	STEAM RINSE	ISOPROPYL ALCOHOL RINSE	DEIONIZED WATER RINSE
RIG	X	X	X	N/A	N/A
AUGERS	X	X	X	X	X
BITS	X	X	X	X	X
RODS	X	X	X	X	X
SAMPLERS	X	X	X	X	X
PIPES	X	X	X	X	X
WORK TOOLS	X	X	X	X	X
AUGER PINS	X	X	X	X	X

OBSERVER SIGNATURE/DATE Timothy A. Lee 5/25/90
Timothy A. Lee

ERC / EDGE Environmental and Energy Services Co.

WELL No. 1247

ORNL MONITORING WELL LOG

PAGE 1 OF 1

LOCATION: WAG-3
DRILLER: Larry Ledbetter
HELPER: Fred Dixon
DRILL: Ingersoll Rand T-4

DATE: START: 5-22-90
FINISH: 5-25-90
LOGGED BY: Timothy A. Lee
HEALTH PHYSICIST: C.E. Stooksbury

TYPE DRILLING: Auger, Air Rotary
LUBRICANT TYPE: Green stuff
No. SAMPLES TAKEN: None
TYPE: N/A
CONTAINMENT TYPE: Plastic, Pan, Containment Box

THICKNESS OF SOIL (REFUSAL DEPTH): 14.0
DEPTH DRILLED IN ROCK: 8.7
TOTAL DEPTH OF WELL: 22.7

DRILLING FLUID SAMPLES:
TYPE: N/A DATE: N/A

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
0.0	2.0		Augered	Gravel fill.
2.0	5.0		Augered	Clay, mottled dark yellowish orange and grayish orange, silty, moist, plastic.
5.0	6.0		Augered	Clay, dry, mottled dark yellowish orange and moderate reddish brown.
6.0	22.7		Air Rotary	* Limestone, microcrystalline, medium gray, calcite filled fracture fillings, hard drilling.
	22.7			Total Depth
				* No detailed lithologic description available from 7.0 feet to 22.7 feet due to the use of containment box.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 1247

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: Timothy A. Lee

PROOFED BY: Michael L. Ebers

DRILLING COMPANY: Geotck

DRILLER: Larry Ledbetter HELPER: Fred Dixon

LOCATION WAG-3

ORNL GRID COORDINATES
N 21,357.5769
E 24,659.5516

ELEV. GROUND 860.75

ELEV. TOP STAINLESS STEEL CASING 862.90

DRILLING DATES:
STARTED: 5-22-90
FINISHED: 5-24-90

EQUIPMENT

- [x] 14 INCH AUGER 6.0 L.F.
- [ ] ____ INCH AUGER ____ L.F.
- [x] 8 INCH ROTARY 16.7 L.F.

MATERIALS USED

EST. VOL.	USED VOL.	
	15.0	FEET OF 2 IN. S.S. SCREEN
	10.0	FEET OF 2 IN. S.S. CASING
3.2	6.0	SACKS OF SAND
50.0	50.0	POUNDS OF BENTONITE PELLETS
1.0	1.5	SACKS OF CEMENT
	7.5	POUNDS OF POWDERED BENTONITE
	12.0	GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

Fractures and Spillage.

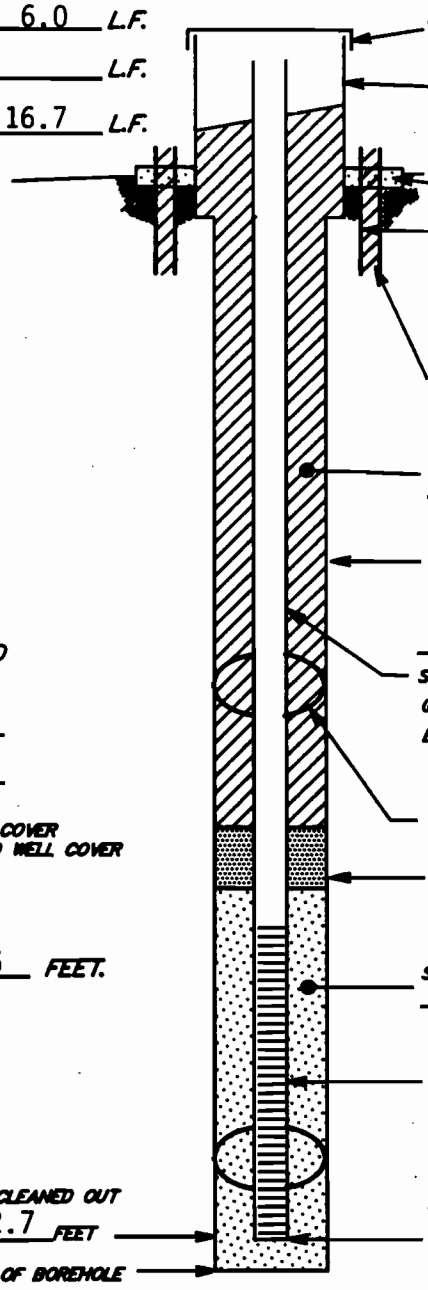
WELL COVER USED
- [x] LOCKING STEEL COVER
- [ ] FLUSH MOUNTED WELL COVER
- [ ] OTHER

SILT TRAP USED YES [x] NO [ ]

MONITORING WELL PUMP BASE SET AT 21.6 FEET.

CENTRALIZERS AT 5.0 FEET.
22.0 FEET.
____ FEET.

NOTE:
ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:



LOCKING STEEL COVER

8.0 INCH DIAMETER STEEL PROTECTIVE CASING 3.14 FT. ABOVE GROUND TO 2.0 FT. BELOW GROUND SURFACE

CONCRETE PAD

10 INCH DIVERTER CASING 1.0 FT. ABOVE GROUND SURFACE TO 6.0 FT. BELOW GROUND SURFACE

14 INCH BOREHOLE 0.0 TO 6.0 FEET

GROUT SEAL 0.0 TO 5.5 FEET

8 INCH DIAMETER BOREHOLE

2 INCH DIAMETER STAINLESS STEEL CASING 2.15 FT. ABOVE GROUND SURFACE TO 7.5 FT. BELOW GROUND SURFACE

CENTRALIZER (TYP.)

BENTONITE PELLET SEAL 5.5 TO 6.5 FEET

SAND PACK 6.5 TO 22.7 FEET

2 INCH DIAMETER STAINLESS STEEL 0.010 SLOTTED SCREEN 7.5 TO 22.5 FEET

2 INCH DIAMETER STAINLESS STEEL SILT TRAP/CAP 22.5 TO 22.7 FEET

HOLE CLEANED OUT TO 22.7 FEET

BOTTOM OF BOREHOLE 22.7 FEET

TYPE D WELL

NOT TO SCALE

ERC / EDGE Environmental and Energy Services Co.

WELL No. 1247

DATE: 5/25/90

MONITORING WELL MATERIALS CERTIFICATION

ITEM/MATERIAL		DATE USED	BATCH NUMBER
SAND			
		5/25/90	2
BENTONITE	Powder	5/25/90	1
	Pellets	5/25/90	7
STAINLESS STEEL SCREEN	(PREPACKAGED ■ YES □ NO)	5/25/90	5
STAINLESS STEEL CASING	(PREPACKAGED ■ YES □ NO)	5/25/90	5
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ■ YES □ NO)	5/25/90	5
STAINLESS STEEL CAPS	(PREPACKAGED ■ YES □ NO)	5/25/90	5
MONITORING WELL PUMP	(PREPACKAGED ■ YES □ NO)	8/23/90	8
GROUT			
		5/25/90	9
WELL COVERS			
SURFACE CASING		N/A	N/A

COMMENTS:

OBSERVER SIGNATURE/DATE Timothy A. Lee 5/25/90
Timothy A. Lee

ERC / EDGE Environmental and Energy Services Co.

WELL No. 1247

POST-WELL COMPLETION CHECKLIST

POST-WELL COMPLETION TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	5-22-90	TAL
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	5-22-90	TAL
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	8-23-90	DCL
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	5-25-90	TAL

* RELEASE SPECIFIC TECHNICAL DIRECTIONS FOR REGULATORY COMPLIANCE MONITORING WELLS PHASE I, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, W.O. K-4147, APRIL 1987.

OBSERVER SIGNATURE/DATE Timothy A. Lee 5/25/90
Timothy A. Lee

D. Charles Lytle 8/23/90
D. Charles Lytle

ERCE
Environmental and Energy Services Co.

WELL No. 1247
LOCATION: WAG-3

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF DEVELOPMENT: Surging and Pumping

DEVELOPMENT BEGAN DATE: 8/06/90 TIME: _____

DEVELOPMENT ENDING DATE: 8/23/90

DEVELOPMENT OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 7.3 GALLONS

TOTAL GALLONS PUMPED: 8 TOTAL WELL VOLUMES PUMPED: 1.1

INITIAL pH: -- FINAL pH: --

INITIAL CONDUCTIVITY (µS/cm): -- FINAL CONDUCTIVITY (µS/cm): --

DESCRIPTION OF INITIAL TURBIDITY: Cloudy

DESCRIPTION OF FINAL TURBIDITY: Cloudy

FINAL MEASURED TURBIDITY: Greater than 100 NTU's

WELL APPROVED BY: R. C. Williams MMES

ODOR OF WATER: None

WATER DISCHARGED TO:
- ■ GROUND SURFACE
- ☐ STORM SEWERS
- ☐ DRUMS
- ☐ TANK TRUCK
- ☐ STORAGE TANKS
- ☐ OTHER _____

INITIAL PRE-DEVELOPMENT WATER DEPTH: 18.2 feet from ground surface.

DEVELOPMENT OBSERVATIONS

Very poor producer, pumped dry in a matter of minutes and stayed dry. Didn't get enough water for a test, we washed well with D.I. water and called it finished on 8-23-90.

OBSERVER SIGNATURE/DATE D. Charles Lytle 8/23/90
D. Charles Lytle

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

(1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967 (ARTICLE IN VOL.3, NO.1 OF WRR ENTITLED "RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER")

(2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN VOL. 12, NO.3 OF WRR ENTITLED "A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS")

WELL NO.: 1247 DATE OF TEST: 8/29/90

PROJECT NO.: E221-002 CLIENT: MMES

SITE LOCATION: WAG-3

EDGE, INC. FIELD INVESTIGATOR: JAMES W. CARUTHERS

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DIAMETER OF DRILLED HOLE = 8.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 15.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 5.42 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 15.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = 5.51 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .20
FALLING-HEAD INDEX = 0 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 32

H0 WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED
VALUES FOR H0
(FEET)

.7740
.7814

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	3.850	1.660
20.00	4.150	1.360
30.00	4.370	1.140
40.00	4.540	.970
50.00	4.640	.870
60.00	4.710	.800
75.00	4.760	.750
90.00	4.810	.700
105.00	4.840	.670
120.00	4.850	.660
150.00	4.880	.630
180.00	4.900	.610
240.00	4.930	.580
300.00	4.950	.560
360.00	4.960	.550
420.00	4.970	.540
480.00	4.980	.530
540.00	4.990	.520
600.00	5.000	.510
720.00	5.000	.510
840.00	5.010	.500
960.00	5.020	.490
1080.00	5.030	.480
1200.00	5.030	.480
1320.00	5.030	.480
1440.00	5.040	.470
1560.00	5.040	.470
1680.00	5.050	.460
1800.00	5.050	.460
1920.00	5.050	.460
2040.00	5.060	.450
2160.00	5.050	.460

HYDRAULIC CONDUCTIVITY CALCULATIONS

****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = 1.83E-06 FT/SEC = 5.59E-05 CM/SEC

TRANSMISSIVITY = 2.75E-05 FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

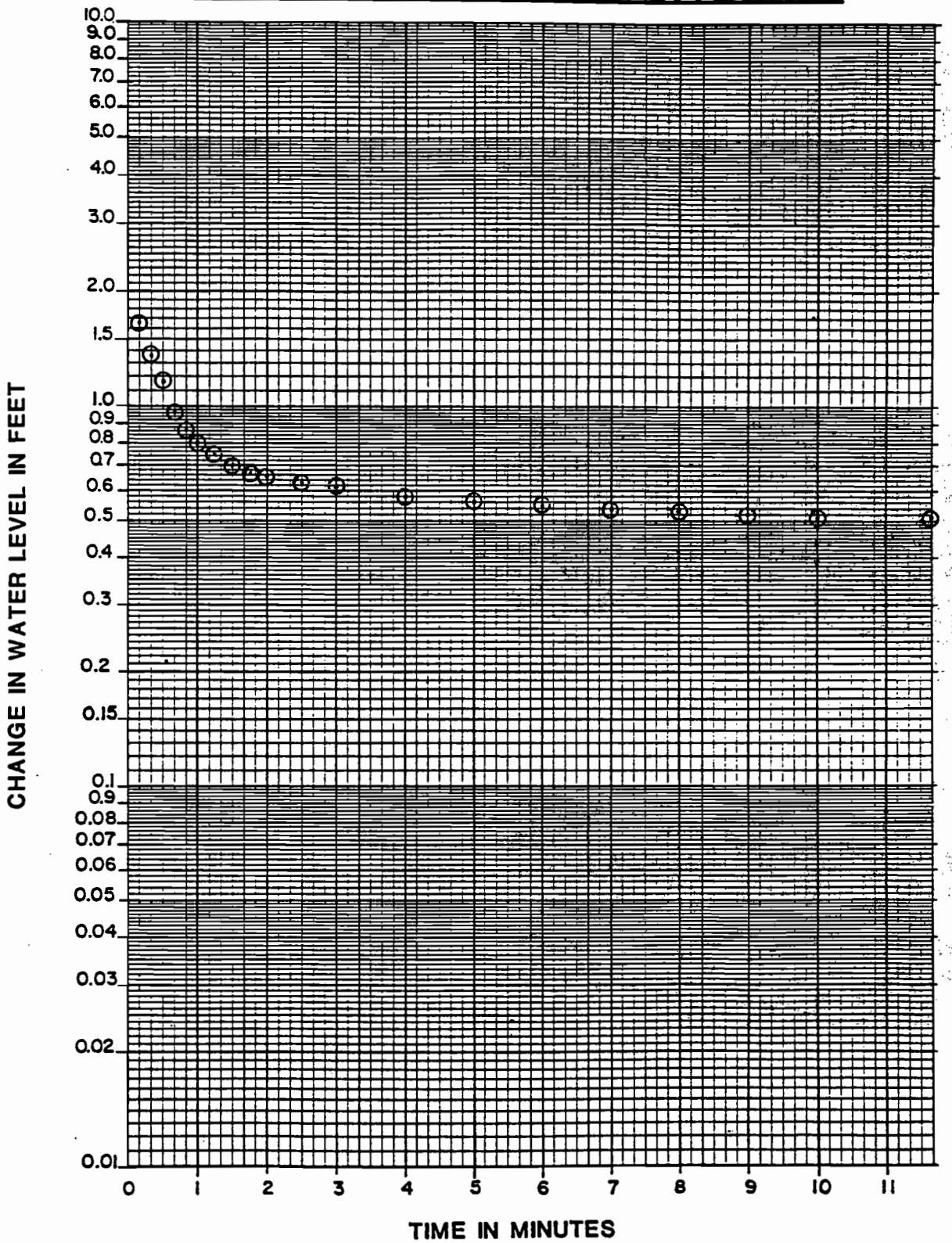
PERMEABILITY = 7.56E-07 FT/SEC = 2.30E-05 CM/SEC

TRANSMISSIVITY = 1.13E-05 FT**2/SEC

ERGE
Environmental
and Energy
Services Co.

WELL No. 1247

HYDRAULIC CONDUCTIVITY CALCULATIONS



1.0 General Information

1.1 Well Location

Monitoring well number 1248 is located in WAG 3. It is located on the western boundary of WAG 3 near Highway 95. The location is shown on ORNL drawing number C3E20004 A075. Survey coordinates for this well are N 21,366.9229, E 24,654.0797 (X-10 grid) or latitude 35°-54'-55.26" and longitude 84°-20'-00.91". Coordinate data were provided by Martin Marietta Energy Systems. The method used for conversion from X-10 grid to Tennessee-Lambert State Plane Coordinates came from the publication "Tennessee Valley Authority Data Services Branch and Mapping Services Branch, Oak Ridge, Tennessee, DOE Plant Control, November 6, 1985, Field Book: ESS-3115, pp. 1-20." The latitude and longitude were calculated by Adams Craft Herz Walker Engineering, Inc., using methods from the U.S. Coast and Geodetic Survey Publication 62-4, "State Plane Coordinates by Automatic Data Processing."

1.2 Drilling Information

Well number 1248 was drilled by Geotek Engineering Company. An Ingersoll-Rand T-4 rig was used to drill this boring for monitor well installation under operation of Larry Ledbetter with the assistance of Fred Dixon. Drilling commenced on 5-15-90 and was finished on 5-29-90. Paragraph 2.4.1 includes a detailed discussion of the well installation and a well schematic is included on the well installation/completion form. A synopsis of the drilling activity

follows. This information was typed directly from field notes and was edited only when necessary for clarification.

5-15-90 The rig was moved to location and set up on plastic. Split spoon samples were taken from surface to 13.0 feet.

5-17-90 Split spoon samples were taken from 13.0 feet to refusal at 14.0 feet. Reamed hole to 8.3 feet using a 22-inch auger and set 8.3 feet of deconta-minated steel diverter casing with 12 sacks of cement.

5-18-90 Drill from 8.3 feet to 20.0 feet using a 14-inch air rotary tricone bit into containment box. Set 20.0 feet decontaminated steel surface casing with 7.0 sacks grout.

5-21-90 Drill from 20.0 feet to 52.5 feet using an 8-inch air rotary tricone bit into containment box.

5-22-90 Drill from 52.5 to 72.5 feet. Not much water.

5-29-90 Decide to set well casing without much water in hole. Set 4-inch stainless steel casing and screen with sandpack and bentonite seal.

5-30-90 Grout annulus with 8 sacks cement.

This well was logged by ERC Environmental and Energy Services Co., Inc., hydrogeologist Timothy A. Lee.

All well construction materials and supplies were from Martin Marietta Energy Systems approved batches. The batch origin of individual items is shown on the included Monitoring Well Materials Certification form.

2.0 Technical Information

2.1 Decontamination Procedures

The drilling rig, down hole tools, surface casing, stainless steel screen, stainless steel casing, centralizers, and stainless steel silt trap underwent the cleaning decontamination procedures outlined in the drilling specifications (Release Specific Technical Directions for Regulatory Compliance Monitoring Wells Phase 1, Oak Ridge National Laboratory, Oak Ridge, W.O. K-4147, April 1987, pgs. 2-4). A checklist of the cleaned materials is included with this data package.

2.2 Geology

WAG 3 is located in Melton Valley which is in the Valley and Ridge Physiographic Province of East Tennessee. WAG 3 is underlain by limestone, siltstone and shale of the Middle Ordovician Chickamauga Group. The Chickamauga Group consists of eight units, designated by letters "A" to "H" (Stockdale, 1951). WAG 3 is underlain by units E, F, G and H. These units consist of thin bedded nodular limestone with clay and shale partings. A portion of unit H and unit F consists of calcareous siltstone alternating with

beds of olive gray to maroon shale. Strike and dip varies from N 45° E to N 55° E and 25° to 35° southeast, respectively.

2.3 Sample Collection

No samples were collected for chemical analysis.

A bulk density soil sample was collected from the split spoon sample interval from 5.4' to 5.7'. The sample was measured and weighed, and a bulk density of 2.28 grams/cm^3 was calculated.

The Ingersoll-Rand T-4 compressed air was sampled with a cloth filter inserted between drill rods on 5-21-90. The sample was examined with an ultraviolet light for the pressure of hydrocarbons. The filter showed no detectable signs of hydrocarbons.

2.4 Installation and Development

2.4.1 Installation

This was a "Type B" well. A 22.0-inch diameter boring was augered from ground surface to 8.3 feet. A 15 1/4-inch diverter casing was installed from surface to 8.3 feet below ground surface and grouted in place. The boring was then extended past the diverter casing depth with a 14.0-inch air rotary tricone roller bit from 8.3 feet to 20.0 feet. A 10.0- inch diameter string of decontaminated steel surface casing was installed from 0.0 feet to 20.0 feet, sealed with a 1.5- foot bentonite pellet layer from 18.5 feet to

20.0 feet, and tremie grouted in place. The surface casing minimizes potential cross contamination between the regolith and bedrock water bearing zones. After the surface casing was installed, the air rotary method was used to drill an 8-inch diameter boring to a total depth of 72.5 feet. A 4-inch diameter stainless steel screen with threaded bottom cap was installed from 52.3 feet to 72.5 feet. A 4-inch diameter stainless steel casing was installed from the top of the screen at 52.3 feet and extended 2.21 feet above ground surface. A sandpack was then tremied into the annular space from 47.9 to 72.5 feet, with a 3.7-foot bentonite pellet seal poured into the annular space above the sandpack from 44.2 to 47.9 feet. The annular space from the top of the bentonite seal to the surface was tremie grouted with a cement/bentonite slurry. A detailed schematic of the well is included on the well installation/completion form.

2.4.2 Well Development

Well number 1248 did not produce sufficient water to develop. Well made less than 1 gallon/day. Well was washed with deionized water and the monitoring well pump installed.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on 8-23-90 at a depth of 68.0 feet below ground surface. These pumps are decontaminated at American Sigma and

are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 1248 was tested for the determination of hydraulic conductivity of the aquifer in the vicinity of the well screen. This was accomplished by instantaneously adding a known quantity of water to the monitoring well and measuring the recovery of the water level over time. The changing water levels were measured using a Druck 15 psig pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 7.55×10^{-7} cm/second (shown as permeability on the hydraulic conductivity calculations printout attached) was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 1248

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

PRE-DRILLING TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. EXCAVTION PERMIT OBTAINED	5-15-90	TAL
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	5-15-90	TAL
3a. SCREEN AND CASING HAVE BEEN WASHED, STEAMED, RINSED WITH DE-IONIZED OR DISTILLED WATER, RINSED WITH ISOPROPYL ALCOHOL, WRAPPED WITH PROTECTIVE COVERING AND STORED OFF THE GROUND.	N/A	
3b. PRE-PACKAGED SCREENS, CASING AND CENTRALIZERS WERE USED.	5-29-90	TAL
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	5-15-90	TAL
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	5-15-90	TAL
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	5-15-90	TAL
7. AIR ROTARY COMPRESSED AIR SAMPLED.	5-21-90	TAL

RESULTS: Sample showed no detectable signs of hydrocarbons under an ultraviolet light.

ADDITIONAL NOTES/OBSERVATIONS:

OBSERVER SIGNATURE/DATE Timothy A. Lee 5/15/90
Timothy A. Lee

ERC / EDGE Environmental and Energy Services Co.

WELL No. 1248

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

EQUIPMENT	SCRAPE	STEAM CLEAN	STEAM RINSE	ISOPROPYL ALCOHOL RINSE	DEIONIZED WATER RINSE
RIG	X	X	X	N/A	N/A
AUGERS	X	X	X	X	X
BITS	X	X	X	X	X
RODS	X	X	X	X	X
SAMPLERS	X	X	X	X	X
PIPES	X	X	X	X	X
WORK TOOLS	X	X	X	X	X
AUGER PINS	X	X	X	X	X

OBSERVER SIGNATURE/DATE Timothy A. Lee 5/15/90
Timothy A. Lee

ERC / EDGE Environmental and Energy Services Co.

WELL No. 1248

ORNL MONITORING WELL LOG

LOCATION: WAG-3
DRILLER: Larry Ledbetter
HELPER: Fred Dixon
DRILL: Ingersoll Rand T-4

DATE: START: 5-15-90
FINISH: 5-29-90
LOGGED BY: Timothy A. Lee
HEALTH PHYSICIST: C.E. Stooksbury

TYPE DRILLING: Split Spoon, Auger, Air Rotary
LUBRICANT TYPE: Green stuff
No. SAMPLES TAKEN: None
TYPE: N/A
CONTAINMENT TYPE: Plastic, Pan, Containment Box

THICKNESS OF SOIL (REFUSAL DEPTH): 14.0
DEPTH DRILLED IN ROCK: 58.5
TOTAL DEPTH OF WELL: 72.5

DRILLING FLUID SAMPLES:
TYPE: N/A
DATE: N/A

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
0.0	1.0		Augered	Gravel fill.
1.0	2.0		25%	Gravel fill.
2.0	3.0		25%	Clay, mottled dark yellowish orange and grayish orange, silty, moist, plastic.
3.0	5.0		25%	Clay, dark yellowish orange, dry; gravel sized limestone, medium crystalline, olive gray, dry.
5.0	7.0		60%	Clay, dry, moderate reddish brown, black streaks; scattered limestone, medium crystalline. Bulk density taken from 5.4' to 5.7' is 2.28 g/cm^3.
7.0	9.0		75%	Clay, dry, mottled dark yellowish orange and moderate reddish brown, black streaks. Cavity at 8.8 to 9.0 feet was dry and dusty.
9.0	11.0		100%	Clay, dry, mottled dark yellowish orange and moderate reddish brown, silty.
11.0	12.0		50%	Clay, dry, silt, mottled dark yellowish orange and moderate reddish brown.
12.0	13.0		50%	Mostly clay, mottled dark yellowish orange and moderate reddish brown, very dry and dusty, scattered limestone fragments, medium

ERC / EDGE Environmental and Energy Services Co.

WELL No. 1248

ORNL MONITORING WELL LOG

DEPTH (FEET) FROM	TO	SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
12.0	13.0		50%	(continued from page 1) crystalline, olive
				gray.
13.0	13.8		80%	Clay, dripping wet (well set for two days in
				rainy weather), mottled dark yellowish
				orange and moderate reddish brown, silty.
13.8	14.0		80%	Limestone, microcrystalline, light gray, dry.
	14.0			Split spoon refusal.
	14.0			6" auger refusal.
14.0	20.0		Air Rotary	* Limestone, microcrystalline, medium gray,
				calcite filled fracture fillings, hard.
20.0	22.0			Limestone, micrite, hard drilling.
22.0	22.5			Drill break, softer drilling.
22.5	32.0			Limestone, micrite, hard drilling.
32.0	32.5			Drill break, softer drilling.
32.5	47.0			Limestone, hard drilling.
47.0	48.0			Drill break, softer.
48.0	72.5			Limestone, hard drilling.
	72.5			Total Depth
				* No detailed lithologic description available
				from 14.0 to 72.5 feet due to the use of
				containment box.

ERC / EDGE Environmental and Energy Services Co.

WELL No. 1248

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED BY: Timothy A. Lee
PROOFED BY: Michael L. Ebers

DRILLING COMPANY: Geotek

DRILLER: Larry Ledbetter HELPER: Fred Dixon

DRILLING METHOD:
- ☒ 22 INCH AUGER 8.3 L.F.
- ☐ INCH AUGER L.F.
- ☒ 14 INCH ROTARY 11.7 L.F.
- ☒ 8 INCH ROTARY 52.5 L.F.

LOCATION WAG-3
ORNL GRID COORDINATES
N 21,366.9229
E 24,654.0797
ELEV. GROUND 860.66
ELEV. TOP STAINLESS STEEL CASING 862.87

DRILLING DATES:
STARTED: 5-15-90
FINISHED: 5-29-90

MATERIALS USED

EST. VOL	USED VOL	
	50.0	POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
	20.0	FT. OF 10 IN. SURFACE CASING
6.7	7.0	SACKS OF CEMENT (SURFACE CASING)
	35.0	POUNDS OF POWERED BENTONITE (SURFACE CASING)
	56.0	GALLONS OF WATER (SURFACE CASING)
	55.0	FT. OF 4 IN. DIA. STAINLESS STEEL CASING
	20.0	FT. OF 4 IN. DIA. STAINLESS STEEL SCREEN
5.0	6.0	SACKS OF SAND
50.0	50.0	POUNDS OF BENTONITE PELLETS
8.0	8.0	SACKS OF CEMENT (WELL CASING)
	45.0	POUNDS OF POWERED BENTONITE (WELL CASING)
	64.0	GALLONS OF WATER (WELL CASING)
	5.0	FT. OF 8 IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES
Fractures and Spillage.

SURFACE CASING TREMIE GROUTED YES ■ NO ☐

STAINLESS STEEL CASING TREMIE GROUTED YES ■ NO ☐

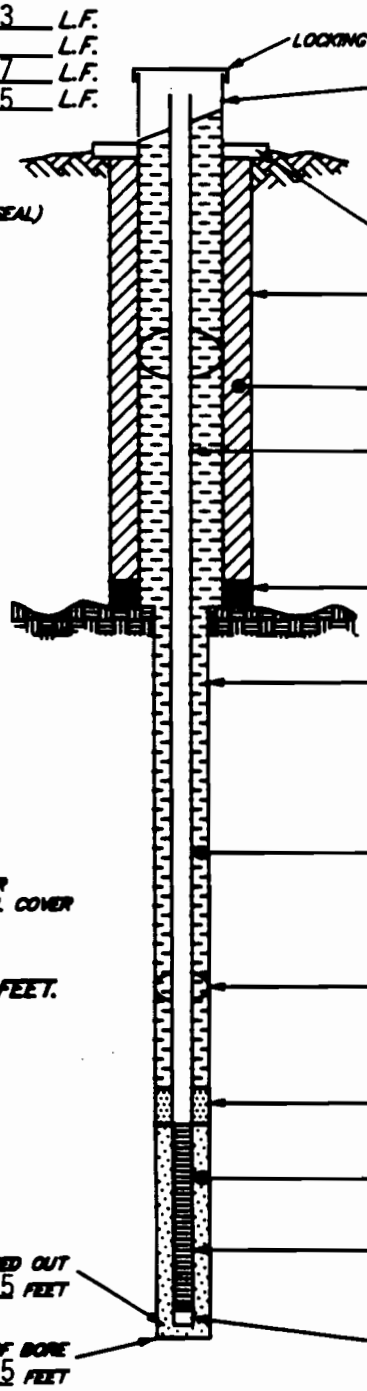
WELL COVER USED
- ■ LOCKING STEEL COVER
- ☐ FLUSH MOUNTED WELL COVER
- ☐ OTHER

SILT TRAP USED YES ■ NO ☐

MONITORING WELL PUMP BASE SET AT 68.0 FEET.

CENTRALIZERS AT 11 FEET.
31 FEET.
51 FEET.
71 FEET.

NOTE:
ALL DEPTHS ARE MEASURED FROM GROUND SURFACE UNLESS OTHERWISE NOTED:



TYPE B WELL

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 1248

DATE: 5/29/90

MONITORING WELL MATERIALS CERTIFICATION

ITEM/MATERIAL		DATE USED	BATCH NUMBER
SAND			
		5-29-90	2
BENTONITE	Powder	5-30-90	1
	Pellets	5-29-90	7
STAINLESS STEEL SCREEN	(PREPACKAGED ■ YES ☐ NO)	5-29-90	5
STAINLESS STEEL CASING	(PREPACKAGED ■ YES ☐ NO)	5-29-90	5
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ■ YES ☐ NO)	5-29-90	5
STAINLESS STEEL CAPS	(PREPACKAGED ■ YES ☐ NO)	5-29-90	5
MONITORING WELL PUMP	(PREPACKAGED ■ YES ☐ NO)	8-23-90	8
GROUT	Surface	5-18-90	9
	Well Casing	5-30-90	9
WELL COVERS			
SURFACE CASING		5-18-90	5

COMMENTS:

OBSERVER SIGNATURE/DATE Timothy A. Lee 5/29/90
Timothy A. Lee

ERC / EDGE
Environmental and Energy Services Co.

WELL No. 1248

POST-WELL COMPLETION CHECKLIST

POST-WELL COMPLETION TASKS	COMPLIANCE DATE	COMPLIANCE INITIALS
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	5-29-90	TAL
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	5-29-90	TAL
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	8-23-90	DCL
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	5-29-90	TAL

* RELEASE SPECIFIC TECHNICAL DIRECTIONS FOR REGULATORY COMPLIANCE MONITORING WELLS PHASE I, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, W.O. K-4147, APRIL 1987.

OBSERVER SIGNATURE/DATE Timothy A. Lee 5/29/90
Timothy A. Lee

D. Charles Lytle 8/23/90
D. Charles Lytle

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WELL No. 1248
LOCATION: WAG-3

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF DEVELOPMENT: Surging and Pumping

DEVELOPMENT BEGAN DATE: 8-07-90 TIME:

DEVELOPMENT ENDING DATE: 8-23-90

DEVELOPMENT OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 44.0 GALLONS

TOTAL GALLONS PUMPED: 1 TOTAL WELL VOLUMES PUMPED: --

INITIAL pH: -- FINAL pH: --

INITIAL CONDUCTIVITY (µS/cm): -- FINAL CONDUCTIVITY (µS/cm): --

DESCRIPTION OF INITIAL TURBIDITY: Cloudy

DESCRIPTION OF FINAL TURBIDITY: Cloudy

FINAL MEASURED TURBIDITY: Greater than 100 NTU's

WELL APPROVED BY: R. C. Williams MMES

ODOR OF WATER: None

WATER DISCHARGED TO:
- ☒ GROUND SURFACE
- ☐ STORM SEWERS
- ☐ DRUMS
- ☐ TANK TRUCK
- ☐ STORAGE TANKS
- ☐ OTHER

INITIAL PRE-DEVELOPMENT WATER DEPTH: 34.2 feet from ground surface.

DEVELOPMENT OBSERVATIONS

Very poor producer, pumped dry in less than a minute and stayed dry with no sign of recharge. Didn't get enough water for sample. Washed with D. I. water and called it finished on 8-23-90.

OBSERVER SIGNATURE/DATE D. Charles Lytle 8/23/90
D. Charles Lytle

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

(1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967 (ARTICLE IN VOL.3, NO.1 OF WRR ENTITLED "RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER")

(2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN VOL. 12, N0.3 OF WRR ENTITLED "A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS")

WELL NO.: 1248 DATE OF TEST: 8/28/90

PROJECT NO.: E221-002 CLIENT: MMES

SITE LOCATION: WAG-3

EDGE, INC. FIELD INVESTIGATOR: JAMES W. CARUTHERS

INPUT DATA ARE:

INNER CASING DIAMETER = 4.00 INCHES
INNER SCREEN OR OPEN-HOLE DIAMETER = 4.00 INCHES
DIAMETER OF DRILLED HOLE = 8.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 20.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 41.25 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 20.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = 1.00 FEET
ESTIMATED POROSITY OF GRAVEL PACK = .20
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 32

H0 WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED
VALUES FOR H0
(FEET)

3.0091
3.0086

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	4.010	3.010
20.00	4.010	3.010
30.00	4.010	3.010
40.00	4.010	3.010
50.00	4.010	3.010
60.00	4.010	3.010
75.00	4.010	3.010
90.00	4.010	3.010
105.00	4.010	3.010
120.00	4.010	3.010
150.00	4.010	3.010
180.00	4.010	3.010
240.00	4.000	3.000
300.00	4.000	3.000
360.00	3.980	2.980
420.00	3.980	2.980
480.00	3.980	2.980
540.00	3.990	2.990
600.00	3.980	2.980
720.00	3.970	2.970
840.00	3.990	2.990
960.00	3.980	2.980
1080.00	3.980	2.980
1200.00	3.980	2.980
1320.00	3.980	2.980
1440.00	3.980	2.980
1560.00	3.970	2.970
1680.00	3.960	2.960
1800.00	3.950	2.950
1920.00	3.950	2.950
2040.00	3.940	2.940
2160.00	3.930	2.930

HYDRAULIC CONDUCTIVITY CALCULATIONS

****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = 2.48E-08 FT/SEC = 7.55E-07 CM/SEC

TRANSMISSIVITY = 4.95E-07 FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = 2.88E-08 FT/SEC = 8.78E-07 CM/SEC

TRANSMISSIVITY = 5.76E-07 FT**2/SEC

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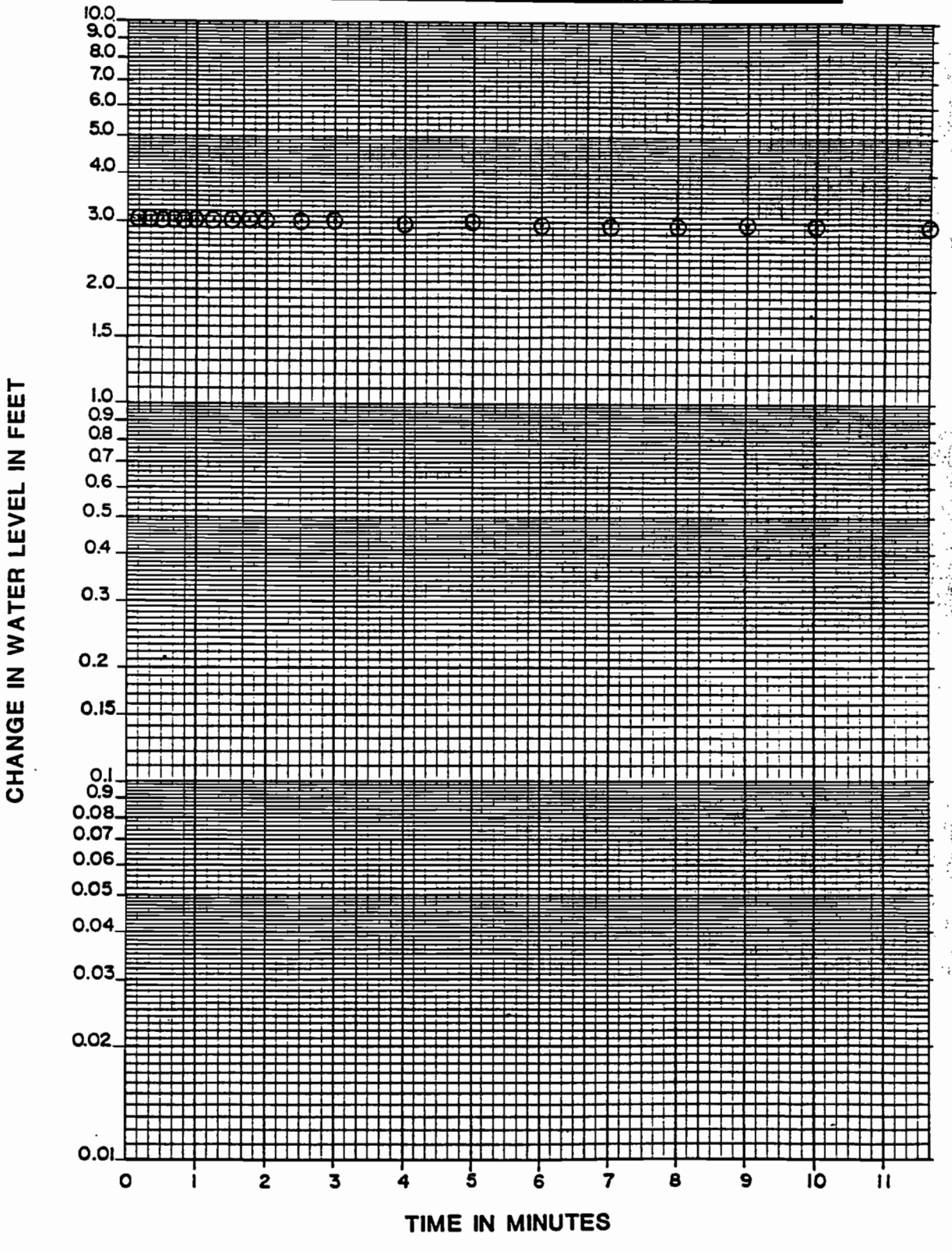
WELL No. 1248

HYDRAULIC CONDUCTIVITY CALCULATIONS



Appendix B

Operating Instructions for Handling Water and Cuttings from Well Drilling and Development of Groundwater Quality Monitoring Wells

OPERATING INSTRUCTIONS FOR HANDLING CUTTINGS AND WATER FROM FROM WELL DRILLING AND DEVELOPMENT OF THE GROUNDWATER QUALITY MONITORING WELLS

Prepared by
J. A. Greene

PROCEDURE REVIEW AND APPROVAL Form

Environmental and Health Protection Division

Procedure Title: Operating Instructions for Handling Cuttings and Water from Well Drilling and Development of the Groundwater Quality Monitoring Wells

Procedure No. _____ Rev. No. 0 Date _____

Author _____

REVIEW AND APPROVAL At a minimum, procedures are approved by the manager of the implementing unit and the next higher level manager. SOPs must be reviewed by QA staff to assure that QA requirements are met and to verify that applicable standards are specified. Signatures of the approvers MUST appear on the first page of each approved procedure. The required approvers and the QA reviewer must sign below.

Approved by: _____ Date _____
Manager, Implementing Unit

_____ Date _____
Higher Level Manager

Reviewed by: Gene F. Bowles Date 1/16/90
Quality Assurance

In the spaces below indicate additional reviews (R) or approvals (A). All reviewers and approvers must sign and date this form before the procedure can be finally approved. If more than one procedure is being reviewed, attach list.

R/A		Name	Date
R	~~Facility Manager~~ MGR Engineering	J.R. Lawson	11/4/89
	Environmental Protection Officer		
R	Safety Officer		
	Office of Operational Safety		
A	Health Physics	J.L. Gray	08-31-89
R	Industrial Hygiene	B.R. Lankford	9/15/89
	Division Director		
	Associate Division Director		
	Section Head		
A	Other Project Manager	J.A. GREENE	11/19/89
A	Other Environmental Compliance	C.E. Nix	10/5/89
R	Other Waste Management	C.B. Scott	11/1/89

Is revision of the SAR/OSR required? _ YES X NO
If yes, by whom: _____

Signature Mark E. Baldwin Date 8-30-89
Procedure Review Officer

Next review dates: 2 yrs. _____ _____ _____

Forward a completed copy of this form to the division QA Office, 4500N, MS-6186.

OPERATING INSTRUCTIONS FOR HANDLING CUTTINGS AND WATER FROM FROM WELL DRILLING AND DEVELOPMENT OF THE GROUNDWATER QUALITY MONITORING WELLS

1.0 PURPOSE

The purpose of this document is to cite the steps that are followed to handle water and soil produced during the installation and development of wells.

2.0 SCOPE

This document applies to well drilling and development associated with the Groundwater Quality Monitoring Wells Installation Program at Oak Ridge National Laboratory.

3.0 REFERENCE

Health, Safety, and Environmental Protection Procedures for Excavating Operations, ORNL/M-116/R1, Oak Ridge National Laboratory, March 3, 1988.

4.0 DEFINITIONS

Well Ratings. Ratings assigned during the excavation permit cycle by Radiation Protection (RP) and Industrial Hygiene (IH) to indicate the probability of encountering radioactive and chemical contamination, respectively. These ratings are based on historical information or from previous drilling or excavation activity. The ratings are marked on the excavation permits. (RP ratings on permits may sometimes be called ''HP'' for ''Health Physics.'' The two designations are interchangeable.) Protective measures required for the three categories are stated in Table 1, ''Excavation-classification categories,'' in ORNL/M-116/R1. The categories for soil handling are stated in Appendix B, ''Radiological Soil Handling Criteria,'' in ORNL/M-116/R1.

RP Category 1. A rating assigned by RP which indicates that the probability of encountering radioactive contamination is low and that intermittent monitoring is required by RP.

IH Category 1. A rating assigned by IH which indicates that the probability of encountering chemical contamination (i.e., organics) is low and that monitoring is not required by IH. An IH and/or Environmental Monitoring and Compliance (EM&C) representative will be called in any time chemical or hazardous contamination is suspected.

RP Category 2. A rating assigned by RP which indicates that the probability of encountering radioactive contamination is moderate and that continuous monitoring is required. The RP representative will determine the necessary level of protective clothing to be worn.

IH Category 2. A rating assigned by IH which indicates that the probability of encountering chemical contamination is moderate and that respirators must be on-site and ready for use by the workers when

indicated by the IH or RP representative on-site. Location will be checked periodically with an IH field instrument, such as a Photovac or Organic Vapor Organizer (OVA).

RP Category 3. A rating assigned by RP which indicates that there is a high probability of encountering radioactive contamination. Therefore, continuous monitoring by an RP representative is required, and protective clothing must be worn. In addition to the training listed above, workers must have successfully completed the Category 3 Driller Training course that is administered by Environmental and Health Protection Division (E&HP) personnel.

IH Category 3. A rating assigned by IH which requires the workers to wear respirators as a minimum. Additional protection deemed appropriate by IH will be designated for each location. Continuous monitoring by IH personnel is required.

Training Requirements. Training requirements for workers include the Basic Radiation Training administered by E&HP personnel and the 40 h of training required by the Superfund Amendment Reauthorization Act (SARA) through a company-approved course. There is an additional training course required for Category 3 drilling.

Air rotary containment box. A box specially designed to contain the cuttings and water that are blown from the borehole during air rotary drilling. The box is equipped with a high-efficiency particulate air (HEPA) filter to prevent particles that possibly contain contaminants from being dispersed into the air. Air rotary drilling is generally used only for drilling into bedrock.

Auger pan. A metal catch pan with a hole cut in the middle. The pan surrounds the borehole and contains soil cuttings as they are augered up.

Proper On-Site Disposal. Disposal of noncontaminated soil and water produced from work on a well at a location near the well that is not openly visible to the public and has no risk of causing erosion or direct discharge into a stream. The construction engineer (CE) will indicate to the drillers which areas are acceptable for on-site disposal. The pH will have been checked and adjusted to the 5-to-9 range before releasing. This precise definition is intended wherever this term is used in this procedure.

Proper Contaminated Waste Disposal. Generally, radioactively contaminated soil will be packaged in drums and tagged by the RP representative for disposal by ORNL Waste Operations. However, Category-2-level soil may be used on site as backfill in remote areas when covered by 1 ft of noncontaminated soil as stipulated in ORNL/M-116/R1. The CE will specify to the drillers when a well location has been approved by EM&C for on-site disposal of contaminated soil. This definition is intended wherever this term is used in this procedure.

Temporary Drilling Equipment Cleaning Facility. An outdoor area located in Melton Valley for steam cleaning of drill rigs and associated equipment, referred to as the steam cleaning area.

Containment Box Holding Pit. A lined pit at the Temporary Drilling Equipment Cleaning Facility. The contents of the pit will be sampled and tested for gross alpha, gross beta, pH, and tritium*, before being released through a silt fence. Contents that have a potential for containing hazardous materials (i.e., IH Category 2 and 3 locations) will have been checked with an IH field instrument before being released into the pit.)

Steam Cleaning Pits. Two lined pits at the Temporary Drilling Equipment Cleaning Facility that collect runoff from the steam cleaning operations. The contents of the pits will be sampled and tested for gross alpha, gross beta, pH, and tritium*, before being released through a silt fence. Contents that have a potential for containing hazardous materials (i.e., IH Category 2 and 3 locations) will have been checked with an IH field instrument before being released into the pit.)

5.0 RESPONSIBILITIES

5.1 Radiation Protection Personnel monitor and determine the presence of detectable radioactive contamination in drill cuttings during well-drilling activities. They provide guidance to ensure that exposures to the workers, public, and environment are kept as low as reasonably achievable. They also provide radiation monitoring during the precursory cleaning by the drillers.

5.2 Well-Drilling Personnel perform well drilling and completion activities. They package soil and water in appropriate containers and transport it, if necessary; perform precursory cleaning of low-level contaminated equipment; and perform cleaning of equipment between the drilling of each well.

5.3 EDGe Hydrogeologists observe all crucial well installation activities and record data for all boreholes drilled. They do a visual inspection of the cuttings produced during augering and note any unusual occurrences and obvious deleterious material encountered during the drilling process. They check the cuttings and water with a Photovac or OVA or similar instrument and check pH of water when necessary.

5.4 Construction Engineer serves as the field contact and provides guidance to the drillers during field activities.

6.0 PROCEDURE

6.1 EXPLANATION OF THE WELL RATING SYSTEM

Each well is assigned a rating by RP and IH before drilling begins. Because additional information is gained during drilling,

well ratings may be changed by RP and IH as the work progresses. A lower RP Category rating will be changed to a Category 3 rating upon encountering radioactive contamination within the Category 3 range defined in ORNL/M-116/R1. Likewise, an IH Category 3 may result if chemical contamination is detected in a well with a lower rating. The RP and/or IH representative on site will notify the on-site personnel when conditions warrant a rating change. Any additional actions or modifications in protective clothing required by the rating change will be executed at that time. The change will be documented immediately by the on-site hydrogeologist in the well data package and as soon as possible by the RP and/or IH representative by a signed written statement stating the well number, the old and new ratings, and the rationale supporting the change. The statement will be sent by the RP and/or IH representative to the Construction Engineer (CE) for filing with the original excavation permit. A copy will be sent to the RAP Well Installation Manager by the CE.

A well category also may be changed from a higher rating to a lower rating. For example, if no contamination is encountered while drilling a Category 2 or 3 well, it may be changed to a lower rating after drilling to a certain depth or for development purposes, depending on the history of the area. The documentation procedure stated above for an increase in rating must also be followed for a decrease in rating.

6.2 CATEGORY 1 WELLS (RP OR IH)

6.2.1 Category 1 Drilling

6.2.1.1 Category 1 Auger Cuttings

a. Auger cuttings will be collected in a catch pan.

b. An RP representative will scan the cuttings intermittently to check for radioactive contamination. Cuttings will be inspected for any unusual discoloration or odor by the hydrogeologist.

c. If there is no contamination detected, proper on-site disposal or disposal at the steam cleaning area will be done.

6.2.1.2 Category 1 Air Rotary Drilling

a. Cuttings will be collected in a containment box.

b. When the containment box is full, one of the following will be done to empty cuttings and/or decant water from the containment box:

(1) proper on-site disposal.

(2) disposal at the containment box holding pit.

6.2.2 Category 1 Well Development

6.2.2.1 Water removed from the well will be contained in drums.

6.2.2.2 The pH of the water will be measured and will be adjusted to be between 5 and 9 by the CE if it is above or below that range.

6.2.2.3 Drums of water will be discarded by proper on-site disposal or disposal at the steam cleaning area will be done.

6.3 CATEGORY 2 WELLS (RP AND IH)

6.3.1 Category 2 Drilling

6.3.1.1 Category 2 Auger Cuttings

a. Auger cuttings will be collected in a catch pan.

b. An RP representative will scan the cuttings continuously to check for radioactive contamination. Cuttings will be inspected for any unusual discoloration or odor and tested with a Photovac or OVA by the hydrogeologist for presence of RCRA materials.

c. If there is no contamination detected, proper on-site disposal or disposal at the steam cleaning area will be done.

d. Cuttings will be contained in drums if contamination is detected. Proper disposal will be arranged by Martin Marietta Energy Systems through Waste Operations.

6.3.1.2 Category 2 Air Rotary Drilling

a. Rock cuttings and drill water will be collected in a containment box.

b. When the containment box becomes full, the RP representative will perform a wet towel smear to detect the presence of radioactive contamination. An inspection for unusual discoloration or odor and tests with an OVA will be conducted for the presence of RCRA materials by the ~~hydro~~geologist.

c. If no contamination is detected, one of the following will be done to empty cuttings and/or decant water from the containment box:

(1) proper on-site disposal.

(2) disposal at the containment box holding pit.

d. If contamination is detected by the tests, arrangements will be made by Martin Marietta Energy Systems through Waste Operations to properly dispose of the water. Further laboratory testing of the box contents may be done.

6.3.2 Category 2 Development

6.3.2.1 Water removed from the well will be contained in drums.

6.3.2.2 When the drums are ready to be emptied, the RP representative will perform a wet towel smear to detect the presence of radioactive contamination. An inspection for unusual discoloration or odor and tests with an OVA will be conducted for presence of RCRA materials by the hydrogeologist. The pH will be adjusted if necessary.

6.3.2.3 If no contamination is detected, the water will be discarded by proper on-site disposal or disposal at the steam cleaning area will be done.

6.3.2.4 If contamination is detected by the tests, arrangements will be made by Martin Marietta Energy Systems to properly dispose of the water. Further laboratory testing may be done.

6.4 CATEGORY 3 WELLS (RP AND IH)

6.4.1 Category 3 Drilling

6.4.1.1 Category 3 Augering

a. When a well is classified as an RP Category 3 or an IH Category 3, continuous monitoring will be required by RP and IH. Wearing of respirators will be required. Cuttings will be inspected for any unusual discoloration or odor. Tests for chemical contamination (i.e., organics) will be performed with IH field instruments by an IH representative for IH Category 3 wells. Specially trained personnel will be required to do the drilling.

b. If no contamination is detected by RP or IH while augering through soil to bedrock, a rating may be changed by RP or IH to a Category 2 depending on the depth, the type of contamination expected, and the history of the area.

c. If contamination is detected during augering, cuttings will be drummed. Proper disposal of all cuttings and water will be arranged by Martin Marietta Energy Systems.

6.4.1.2 Category 3 Air Rotary Drilling

a. Rock cuttings and drill water will be collected in a containment box.

b. When the containment box becomes filled with water and/or cuttings, a sample will be collected by EM&C and will be tested by the Analytical Chemistry Division for gross alpha, gross beta, tritium*, for an RP Category 3. If it is an IH Category 3, the IH representative on-site will determine which (if any) laboratory testing is necessary for chemical contaminants.

c. Proper disposition of the containment box contents will be decided by consensus of E&HP, the IH or RP representative, EM&C, and the CE, based on the results from Analytical Chemistry Division of the above tests.

6.4.2 Category 3 Development

6.4.2.1 Water pumped from Category 3 wells will be contained in drums. Samples will be collected by EM&C and will be tested by Analytical Chemistry Division for gross alpha, gross beta, tritium*, and pH. It will be tested with IH field instruments by IH representatives for the presence of RCRA materials.

6.4.2.2 A decision based on the test results will be made between E&HP and Engineering whether to continue development.

6.5 BOREHOLE CLEANING

When sludge and water have accumulated in the bottoms of boreholes drilled in soil, the boreholes must be cleaned out prior to setting casings. A decision based on the location of the borehole and its rating will be made between the RP and/or IH representatives whether the sludge and water from the borehole must be contained in a drum. Water and sludge from a Category 2 well will be drummed, and a wet towel smear will be done by RP to

determine proper disposal of the drum contents. Laboratory testing of the drum contents for gross alpha, gross beta, tritium*, and pH will be done if recommended by the RP or IH representative. Water and sludge removed from an RP Category 3 well will be drummed, and laboratory testing will be done for gross alpha, gross beta, tritium*, and pH. EM&C will be consulted to determine proper disposal based on the test results. Further laboratory testing to determine actual contaminants will be done if recommended by EM&C.

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*Testing for tritium will be done for wells located in areas where tritium contamination is suspected. This decision will be made between RP and EM&C.

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