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**ENVIRONMENTAL
RESTORATION
PROGRAM**

**Groundwater Quality Monitoring Well
Installation for Waste Area
Groupings 8 and 9 at
Oak Ridge National Laboratory,
Oak Ridge, Tennessee**

**J. A. Mortimore
M. L. Ebers**

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

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Environmental Restoration Division
ORNL Environmental Restoration Program

**Groundwater Quality Monitoring Well Installation for
Waste Area Groupings 8 and 9 at Oak Ridge
National Laboratory, Oak Ridge, Tennessee**

**J. A. Mortimore
M. L. Ebers**

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CONTENTS

EXECUTIVE SUMMARY	v
1. INTRODUCTION	1
1.1 THE WAG CONCEPT	1
1.2 DESCRIPTION OF WAGS 8 AND 9	1
2. INSTALLATION METHODS	2
2.1 TYPE A WELL	2
2.2 TYPE B WELL	2
2.3 TYPE D WELL	2
3. ENVIRONMENTAL, HEALTH, AND SAFETY REQUIREMENTS	5
4. FIELD SUPPORT	6
5. DRILLING RECORDS	7
6. WELL DEVELOPMENT	8
7. SAMPLING DURING INSTALLATION	9
8. SPECIAL NOTES ON INSTALLATION AND DEVELOPMENT	10
REFERENCES	11
Appendix A—Data Packages	A-1
Appendix B—Operating Instructions for Handling Water and Cuttings from Well Drilling and Development of Groundwater Quality Monitoring Wells	B-1

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EXECUTIVE SUMMARY

This report documents the drilling and installation of nine groundwater quality monitoring (GQM) wells on the perimeter of Waste Area Grouping (WAG) 8 and two GQM wells on the perimeter of WAG 9. WAG 8 encompasses approximately 34 acres, most of which are located in Melton Valley. Irregular in shape, the site has two sinuous extensions from its northern end that contain the low-level radioactive waste (LLW) transfer lines. WAG 8 contains 22 solid waste management units (SWMUs) that can be divided into 4 groups. These groups include the High Flux Isotope Reactor/Transuranium Processing Facility waste collection basins, the LLW line leak sites, and the active LLW tanks. WAG 9 encompasses about 3 acres and is located west of the main portion of WAG 8 and south of Melton Valley Drive. WAG 9 contains four SWMUs. The wells in WAGs 8 and 9 were drilled and developed from June 1989 to March 1990. Monitoring wells were installed to characterize and assess the WAGs 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 a drilling subcontractor (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 WAGs 8 and 9 were drilled with auger or air rotary rigs. Depending on 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 WAGs 8 and 9. 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 Groupings (WAGs) 8 and 9. 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 wells in WAGs 8 and 9 were drilled and developed from June 1989 to March 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 WAGS 8 AND 9

WAG 8 encompasses approximately 34 acres, most of which is located in Melton Valley. Irregular in shape, the site has two sinuous extensions from its northern end that contain the low-level radioactive waste (LLW) transfer lines [Fig. 1, map pocket, (MMES map #C3E20004A085, Rev. B)]. The site is bordered to the east by two draws that contain tributaries of Melton Branch. The floodplain of Melton Branch borders the site to the south. On its western side, WAG 8 is flanked by a low southwesterly trending knoll. Portions of the two aforementioned tributaries and the floodplain of Melton Branch constitute the upper reaches of WAG 2. Nine groundwater monitoring wells were installed along the perimeter of WAG 8 (Fig. 1, map pocket).

WAG 8 contains 20 SWMUs that can be divided into 4 groups: (1) the High Flux Isotope Reactor/Transuranium Processing Facility waste collection basins, (2) LLW line leak sites, (3) active LLW tanks, and (4) other miscellaneous facilities.

WAG 9 encompasses about 3 acres and is located west of the main portion of WAG 8 and south of Melton Valley Drive. WAG 9 was the site of the Homogeneous Reactor Experiment (HRE) 1 and the Homogeneous Reactor Test (HRT). HRE 1 operated intermittently from 1951 through 1954 and was subsequently decommissioned and decontaminated. HRT operated from 1957 to 1961 and was shut down. The site contains four SWMUs: (1) the HRE pond, (2, 3) LLW Collection and Storage Tanks 7560 and 7562 and (4) the Nuclear Safety Pilot Plant Septic Tank. Two groundwater monitoring wells were installed along the eastern perimeter of WAG 9 (Fig. 1, map pocket).

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. Three of the four types were used at WAGs 8 and 9. These types are described in Sects. 2.1 through 2.3. 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 WAGs 8 and 9 wells can be found in the report *Preliminary Geohydrologic Site Characterization and Proposed Water Quality Well Locations for WAG 7, WAG 8, and WAG 9*, ORNL/RAP/Sub/86-72139/2.² Actual completion data for WAGs 8 and 9 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 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.

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

Table 1. Actual completion data for WAGs 8 and 9

Well	Depth clean to (ft) ^a	SST casing diam (in.)	Well type	Screened interval (ft)	Water level (ft) ^b
1087	22.72	2	A	12.15–22.48	–3.8
1088	34.49	2	A	19.25–34.25	–13.3
1089	30.18	2	A	14.01–29.94	–6.7
1090	73.1	4	B	57.4–72.8	+1.5
1091	22.65	2	D	12.41–22.41	–4.3
1092	86.86	4	B	71.59–86.57	–5.0
1093	48.25	2	D	28.0–48.0	–17.4
1094	70.3	4	B	55.0–70.0	+1.3
1095	23.10	2	D	12.22–22.86	–2.1
1096	23.2	2	D	12.3–22.3	–3.2
1097	17.5	2	A	7.3–17.3	–8.5

^aTotal drilled depth may vary from clean-out depth. See data packages (Appendix A).

^bPredevelopment water level; depth measured from ground surface. (Negative is below surface; positive, above surface.)

3. ENVIRONMENTAL, HEALTH, AND SAFETY REQUIREMENTS

All well drilling at WAGs 8 and 9 was conducted in accordance with procedures outlined in *Health, Safety, and Environmental Protection Procedures for Excavating Operations*, ORNL/M-116/R1³. 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. Ratings obtained by this system were used to determine 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 WAGS 8 and 9. ORNL Engineering administered the drilling contract through Energy Systems Procurement. The management organization chart for the project can be found in *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 GQM wells drilled in WAGs 8 and 9. 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 also 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 11 wells in WAGs 8 and 9, 7 wells had turbidities less than or equal to 5 NTUs. The number of well volumes removed ranged from 5.2 to 48.8, with an average of 29.2. The procedure for measuring turbidity described in ORNL/RAP/LTR-88/28⁴ 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 analysis. 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 air rotary drilling. All samples were transferred using chain-of-custody forms, which are included in the data packages. The sampling procedures are explained in the report 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 ⁴⁰K 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

During the drilling of the GQM wells in WAGs 8 and 9, three events occurred in which contamination was detected.

- Apparent contamination was detected with the OVA (Organic Vapor Analyzer) in well 1087, with readings of 560 ppm in the interval from 9.0 to 11.0 ft; therefore, all cuttings were contained in drums.
- The compressed air filter sample exhibited a dull fluorescence under ultraviolet light in well 1090.
- Well 1092 was capable of producing only 0.5 to 1 gal/h.

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 7, WAG 8, and WAG 9*, ORNL/RAP/Sub-86/72139/2, Martin Marietta Energy Systems, Inc., Oak Ridge National Laboratory, Oak Ridge, Tenn., September 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 1087 is located in WAG 8. It is located near the intersection of Melton Valley Drive and Lagoon Road. The location is shown on ORNL drawing number C3E20004 A075. Survey coordinates for this well are N 19,935.3118, E 29,497.7322 (X-10 grid) or latitude 35°-55'-10.14" and longitude 84°-19'-02.30". 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 1087 was drilled by Geotek Engineering Company. A Mobile B-50 auger rig was used to drill this boring for monitor well installation under the operation of Rick Herron with the assistance of James Shelton. Drilling commenced on 9-21-89 and was finished on 9-21-89. 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.

9-20-89: The auger rig, augers, pan, tools and sampling equipment were decontaminated with liquinox, alcohol and deionized water.

9-21-89: The equipment was mobiled to the site, plastic was layed down and the rig set-up. R.C. Williams checked the rig to see if it was level and passed it to drill. Split spooning began at 3.0', through the 6.0" hollow stem augers, and ended at 15.0'. One soil samples and a bulk density were taken. Contamination was detected in the split spoon taken from the 9.0' to 11.0' interval. A fiberous decayed organic material (looked like part of a tree) was abundant from 10.0' to 11.0' and appeared to be the contaminant. A reading of .2 mR was detected. The material was taken and counted at which time 560 ppm were detected. All material out of the boring from 9.0' to total depth was required to be contained in 55 gallon drums. Although split spoon refusal was not met, no spoons were pushed after 15.0' to reduce contact with contamination and limit the amount of deconing. At 17.0' .4 mR was detected. Bentonite was placed around the boring on the ground to prevent the water and saturated mud that was encountered at 19.5' from running out onto the ground. After reaching a total depth of 23.0' the augers

were removed and layed on plastic to dry sto the mud could be scraped off. The augers and equipment were smeared and counted. This time no readings were detected. C.E. Stooksbury stated that it is the volume of material that causes the instruments to have a high reading. Work will still continue as if the area is contaminated. All equipment, however, will be deconed using normal procedures. The water level was found to be 4.0' below ground surface. A 2.0 inch screen and stainless steel casing were installed to a total depth of 22.72'. The sand was tremied in to a level of 8.6'. Bentonite was poured to a level of 6.8'. The well was covered and the site cleaned.

9-22-89: The annulus was grouted under the supervision of C. Allison Hodges.

This well was logged by ERC Environmental and Energy Services Co., Inc., hydrogeologist C. Allison Hodges. 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 8 encompasses approximately 34 acres, the majority of which is located in Melton Valley. Irregular in shape, the site has two sinuous extensions from its northern end. One of the extensions extends northwest and crosses Haw Ridge, the other runs parallel to Melton Valley Drive. WAG 8 is underlain by three geologic units. Traversing the site from south to north are the Conasauga Group, the Rome Formation, and the Chickamauga Limestone. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strikes and dips. The regional strike is 56° northeast and the beds dip about 30° to the southeast.

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 1087S01 was collected in the split spoon interval from 7.7 to 9.0 feet on 9-21-89. Analytical results for the soil sample 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 7.2 to 7.5 feet. The sample was measured and weighed, and a bulk density of 2.3 grams/cm³ 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 23.0 feet. A 2-inch diameter stainless steel screen silt trap was installed from 22.48 to 22.72 feet. Above the silt trap a 2-inch diameter stainless steel screen was installed from 12.15 to 22.48 feet. A 2-inch diameter stainless steel casing was installed above the screen from 12.15 to 2.05 feet above ground surface. A sandpack was then tremied into the annular space from 8.60 to 23.0 feet, with a 1.80-foot bentonite pellet seal poured into the annular space above the sandpack from 6.80 to 8.60 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 1087 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 373 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 greater than 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 07-02-90 at a depth of 21.2 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 1087 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 5.39×10^{-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

1221-A.DWG

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MONITORING WELL PROGRAM
WELL DATA NARRATIVE
WELL No. 1087

package.

PRE-DRILLING CHECKLIST FOR
MONITORING WELLS

<u>PRE-DRILLING TASKS</u>	<u>COMPLIANCE</u>	
	<u>DATE</u>	<u>INITIALS</u>
1. EXCAVATION PERMIT OBTAINED	<u>9-21-89</u>	<u>CAH</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>9-21-89</u>	<u>CAH</u>
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.	<u>N/A</u>	<u>CAH</u>
3b. PRE-PACKAGED SCREENS, CASING AND CENTRALIZERS WERE USED.	<u>9-21-89</u>	<u>CAH</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>9-21-89</u>	<u>CAH</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>9-21-89</u>	<u>CAH</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>9-21-89</u>	<u>CAH</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u> </u>	<u> </u>

RESULTS: _____

ADDITIONAL NOTES/OBSERVATIONS: _____

OBSERVER SIGNATURE/DATE C. Allison Hodges 9/21/89
C. Allison Hodges

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

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

OBSERVER SIGNATURE/DATE C. Allison Hodges 9/21/89
C. Allison Hodges

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WELL No. 1087

ORNL MONITORING WELL LOG

PAGE 1 OF 2

LOCATION: WAG-8
DRILLER: Rick Herron
HELPER: James Shelton
DRILL: Mobile B-50 Auger Rig

DATE: START: 9-21-89
FINISH: 9-21-89
LOGGED BY: C. Allison Hodges
HEALTH PHYSICIST: Carl Stooksbury

TYPE DRILLING: Split Spoon/Auger LUBRICANT TYPE: Green stuff
No. SAMPLES TAKEN: 1 TYPE: Soil
CONTAINMENT TYPE: Plastic, Pan, Barrels

THICKNESS OF SOIL (REFUSAL DEPTH): 23.0'
DEPTH DRILLED IN ROCK: N/A
TOTAL DEPTH OF WELL: 23.0'

DRILLING FLUID SAMPLES:
TYPE: N/A DATE: N/A

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
0.0	3.0			Gravel (Pad/fill material) augered.
3.0	5.0		10%	Clay, mottled, moderate yellowish brown, light brown, dark yellowish orange, and light olive gray. The clay is silty and contains some shale, brittle, light olive gray and some calcareous silt stone (fizzes with acid). Sample also contains large gravel. Dry.
5.0	7.0		0%	No recovery.
7.0	7.2		65%	Clay, mottled, light brown and light olive gray. Contain gravel fragments throughout. Also contains a piece of cloth fibrous material.
7.2	7.7			Clay, mottled, moderate brown, light brown, dark yellowish orange and light olive gray (speckled), silty with mica and some shale, light olive gray. *Bulk density. @ 7.2 to 7.5 feet = 2.3 grams/cm ³
7.7	9.0	1087S01		Clay, mottled, olive gray and moderate brown with very pale green streaks. Contains large fragments of bedded shale, brittle, moderate brown.
		7.7-9.0

ORNL MONITORING WELL LOG

PAGE 2 OF 2

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
9.0	9.5		100%	Clay, mottled, light brown, dark yellowish orange and maroon. The clay is silty and micaceous, very pale green. Slightly damp.
9.5	11.0			Clay, light olive gray and moderate olive brown, dull in appearance. The clay is sandy moist, but damp from 10.5' to 11.0'. Throughout the sample (especially 10.0' to 11.0') there are fibrous organic pieces (rotted wood - from trees) that are grayish black in color. *The HP detected .2 mR readings from this material from 10.0' to 11.0'.
11.0	12.0		50%	Clay, mottled, light olive gray, light olive brown and dusky yellowish brown. The clay is silty and shaley. Moist.
12.0	13.0			Clay, light olive gray. Sandy and very moist. No contamination readings.
13.0	15.0			*The outside of the splitspoon was coated with a saturated mud that was dark yellowish brown to moderate olive brown, contains sand. The split spoon was not opened as per HP recommendation because the material was contaminated.
15.0	23.0			Clay, dark yellowish brown to moderate olive brown, sandy. Saturated. *This interval was not split spooned due to the contamination. It was decided to auger to reduce contact. At 17.0' readings of .4 mR. At 19.0' water out of borehole.
	23.0			Total Depth.

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WELL No. 1087

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

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

DRILLING COMPANY: Geotek

DRILLER: Rick Herron HELPER: James Shelton

EQUIPMENT ☒ 6.0 INCH AUGER 23.0 L.F.

☐ _____ INCH AUGER _____ L.F.

MATERIALS USED

EST. USED
VOL. VOL.

10.33 FEET OF 2.0 IN. S.S. SCREEN

15.0 FEET OF 2.0 IN. S.S. CASING

1.9 20 SACKS OF SAND

25 25.0 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

WELL COVER USED

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

SILT TRAP USED

YES ☒ NO ☐

MONITORING WELL PUMP BASE SET AT 21.2 FEET.

CENTRALIZERS AT 5.0 FEET.

20.0 FEET.

_____ FEET.

NOTE:

ALL DEPTHS ARE MEASURED
FROM GROUND SURFACE
UNLESS OTHERWISE NOTED:

HOLE CLEANED OUT
TO 22.72 FEET

BOTTOM OF BOREHOLE
23.0 FEET

LOCATION WAG-8

ORNL GRID COORDINATES

N 19,935.3118

E 29,497.7322

ELEV. GROUND 779.48

ELEV. TOP STAINLESS

STEEL CASING 781.53

DRILLING DATES:

STARTED: 9-21-89

FINISHED: 9-22-89

LOCKING STEEL COVER

8 INCH DIAMETER

STEEL PROTECTIVE CASING

3.18 FT. ABOVE GROUND

TO 2.0 FT. BELOW

GROUND SURFACE

CONCRETE PAD

GROUT SEAL 0.0 TO

6.8 FEET

6.0 INCH DIAMETER

BOREHOLE

2.0 INCH DIAMETER STAINLESS

STEEL CASING 2.05 FT. ABOVE

GROUND SURFACE TO 12.15 FT.

BELOW GROUND SURFACE

CENTRALIZER (TYP.)

BENTONITE PELLET SEAL

6.8 TO 8.6 FEET

SAND PACK

8.6 TO 23.0 FEET

2.0 INCH DIAMETER

STAINLESS STEEL .010

SLOTTED SCREEN

12.15 TO 22.48 FEET

2.0 INCH DIAMETER STAINLESS

STEEL SILT TRAP/CAP

22.48 TO 22.72 FEET

NOT TO SCALE

TYPE A WELL

ERC / EDGE
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and Energy
Services Co.

WELL No. 1087

DATE: 9-21-89

MONITORING WELL MATERIALS
CERTIFICATION

<u>ITEM/MATERIAL</u>	<u>DATE USED</u>	<u>BATCH NUMBER</u>
SAND	9-21-89	MMES Stores
BENTONITE	9-21-89	MMES Stores
STAINLESS STEEL SCREEN (PREPACKAGED ☒ YES ☐ NO)	9-21-89	MMES Stores
STAINLESS STEEL CASING (PREPACKAGED ☒ YES ☐ NO)	9-21-89	MMES Stores
STAINLESS STEEL CENTRALIZERS (PREPACKAGED ☒ YES ☐ NO)	9-21-89	MMES Stores
STAINLESS STEEL CAPS (PREPACKAGED ☒ YES ☐ NO)	9-21-89	MMES Stores
MONITORING WELL PUMP (PREPACKAGED ☒ YES ☐ NO)	7-02-90	6
GROUT	9-22-89	MMES Stores
WELL COVERS	9-21-89	MMES Stores
SURFACE CASING	N/A	N/A

COMMENTS:

OBSERVER SIGNATURE/DATE C. Allison Hodges 9/22/89
C. Allison Hodges

POST-WELL COMPLETION
CHECKLIST

POST-WELL COMPLETION TASKS

COMPLIANCE
DATE INITIALS

1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	<u>9-21-89</u>	<u>CAH</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>9-21-89</u>	<u>CAH</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>7-02-90</u>	<u>DCL</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>9-22-89</u>	<u>CAH</u>

* 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 Hodges 9/22/89
C. Allison Hodges

D. Charles Lytle 7/02/90
D. Charles Lytle

ERCE
Environmental
and Energy
Services Co.

WELL No. 1087
LOCATION: WAG-4

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and Pumping

DEVELOPMENT
BEGAN DATE: 6/12/90

TIME: _____

DEVELOPMENT
ENDING DATE: 7/02/90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 9.0 GALLONS

TOTAL GALLONS PUMPED: 373 TOTAL WELL VOLUMES PUMPED: 41.4

INITIAL pH: 8.5 FINAL pH: 7.6

INITIAL CONDUCTIVITY ($\mu S/cm$): 259 FINAL CONDUCTIVITY ($\mu S/cm$): 324

DESCRIPTION OF INITIAL TURBIDITY: Very Cloudy

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: 3.8 feet from ground surface.

DEVELOPMENT OBSERVATIONS

We tried to develop this well with workover rig twice a day. Water
remains muddy and will not clear up. A very poor producer, well would dry
up in about an hour with less than 30 gallons.

OBSERVER SIGNATURE/DATE D. Charles Lytle 7/02/90
D. Charles Lytle

ERCE
Environmental
and Energy
Services Co.

WELL NO. 1087

LOCATION: WAG- 4

DATE: 6/12/90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 9.0 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCT- IVITY (uS/cm)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
6-12-90	1040	10	Very Cloudy	--	8.5	259	10	1.1	
6-21-90	0930	32	Very Cloudy	--	8.4	370	42	4.7	
6-22-90	0845	23	Very Cloudy	--	7.9	313	65	7.2	
6-25-90	1000	20	Muddy	--	8.4	295	85	9.4	
6-26-90	1400	12	Muddy	--	8.4	337	97	10.7	
6-28-90	1200	35	Muddy	--	7.9	376	132	14.6	
6-29-90	0930	3	Muddy	--	7.6	386	135	15.0	
6-29-90	1400	25	Muddy	--	7.4	326	160	17.7	
7-02-90	0830	5	Muddy	--	7.9	311	165	18.3	
7-02-90	0930	45	Muddy	*	7.6	324	210	23.3	
7-02-90		163	WORK	OVER	R	TG	373	41.4	
RESULTS AT END OF DEVELOPMENT			Muddy	*	7.6	324	373	41.4	

COMMENTS We tried to develop this well with the workover rig twice a day.
Water remains muddy and will not clear up. A very poor producer,
it would dry up within one hour with less than 30 gallons.
* Greater than 100 NTU's.

OBSERVER SIGNATURE/DATE D. Charles Lytle 7/02/90
D. Charles Lytle

MYFORMOS.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.: 1087

DATE OF TEST: 9/4/90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: WAG-8

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 = 6.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 10.33 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 15.81 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 10.33 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)

.7901
.8352
.8937
.9284

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (sec)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	4.140	3.140
20.00	3.550	2.550
30.00	3.140	2.140
40.00	2.840	1.840
50.00	2.600	1.600
60.00	2.410	1.410
75.00	2.240	1.240
90.00	2.020	1.020
105.00	1.870	.870
120.00	1.770	.770
150.00	1.630	.630
180.00	1.560	.560
240.00	1.380	.380
300.00	1.240	.240
360.00	1.190	.190
420.00	1.160	.160
480.00	1.150	.150
540.00	1.110	.110
600.00	1.170	.170
720.00	1.090	.090
840.00	1.130	.130
960.00	1.130	.130
1080.00	1.160	.160
1200.00	1.140	.140
1320.00	1.130	.130
1440.00	1.140	.140
1560.00	1.090	.090
1680.00	1.090	.090
1800.00	1.080	.080
1920.00	1.090	.090
2040.00	1.200	.200
2160.00	1.180	.180

HYDRAULIC CONDUCTIVITY CALCULATIONS

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $1.77\text{E-}06$ FT/sec = $5.39\text{E-}05$ CM/sec

TRANSMISSIVITY = $1.83\text{E-}05$ FT**2/sec

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $2.31\text{E-}06$ FT/sec = $7.04\text{E-}05$ CM/sec

TRANSMISSIVITY = $2.39\text{E-}05$ FT**2/sec

HYDRAULIC CONDUCTIVITY CALCULATIONS

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

WELL NO.

1081

LOCATION:

W11 - 6

TYPE:

Soil

SAMPLER:

C. M. Hodge

(SIGNATURE)

SAMPLE INTERVAL:

7.7 - 9.0

DATE:

9-21-89

TIME:

1106

RELINQUISHED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

RECEIVED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

C. M. Hodge

10-3-89

EDGE

J. P. H.

10-3-89

1530

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 1088 is located in WAG 8. It is located approximately 100' southwest of the corner of Melton Valley Drive and the entrance of WAG 5. The location is shown on ORNL drawing number C3E20004 A075. Survey coordinates for this well are N 19,155.7157, E 30,367.6390 (X-10 grid) or latitude 35°-55'-08.52" and longitude 84°-18'48.24". 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 1088 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 01-02-90 and was finished on 01-05-90. 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.

01-02-90: The Ingersoll-Rand T-4 and equipment were decontaminated, mobilized to the site and set up. A 6 inch boring was then split spooned and augered to a split spoon refusal depth of 19.0'. Soil samples 1088S01 and a bulk density sample were taken. The boring was augered to a total depth of 35.0'. At 34.5' saturated mud came out of the boring.

01-03-90: The augers were removed from the annulus and the two-inch stainless steel screen and casing were installed to 34.49. Note that the boring was very muddy at 32.5'. A tremie line was washed into the boring through the thick mud and 4 bags of sand were tremied to a depth of 16.18'. A bentonite seal was poured to a depth of 13.05'.

01-05-90: The remaining annulus was grouted using 2 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 8 encompasses approximately 34 acres, the majority of which is located in Melton Valley. Irregular in shape, the site has two sinuous extensions from its northern end. One of the extensions extends northwest and crosses Haw Ridge, the other runs parallel to Melton Valley Drive. WAG 8 is underlain by three geologic units. Traversing the site from south to north are the Conasauga Group, the Rome Formation, and the Chickamauga Limestone. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strikes and dips. The regional strike is 56° northeast and the beds dip about 30° to the southeast.

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 1088S01 was collected in the split spoon interval from 14.0' to 14.5' on 01-02-90.

A bulk density soil sample was collected from the split spoon sample interval from 2.3' to 2.65'. The sample was measured and weighed, and a bulk density of 1.99 grams/cm³ 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 35.0 feet. A 2-inch diameter stainless steel screen with threaded bottom cap was installed from 34.49 to 19.25 feet. A 2-inch diameter stainless steel casing was installed above the screen from 19.25 to 2.3 feet above ground surface. A sandpack was then tremied into the annular space from 34.49 to 16.18 feet, with a 3.13-foot bentonite pellet seal poured into the annular space above the sandpack from 16.18 to 13.05 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 1088 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 348 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 greater than 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 05-23-90 at a depth of 30.2 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 1088 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

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MONITORING WELL PROGRAM
WELL DATA NARRATIVE
WELL No. 1088

Datapod II data recorder. The hydraulic conductivity value of 3.09×10^{-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.

PRE-DRILLING CHECKLIST FOR
MONITORING WELLS

<u>PRE-DRILLING TASKS</u>	<u>COMPLIANCE</u>	
	<u>DATE</u>	<u>INITIALS</u>
1. EXCAVATION PERMIT OBTAINED	<u>1-02-90</u>	<u>CAB</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>1-02-90</u>	<u>CAB</u>
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.	<u>N/A</u>	<u>N/A</u>
3b. PRE-PACKAGED SCREENS, CASING AND CENTRALIZERS WERE USED.	<u>1-03-90</u>	<u>CAB</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>1-02-90</u>	<u>CAB</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>1-02-90</u>	<u>CAB</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>1-02-90</u>	<u>CAB</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u>N/A</u>	<u>N/A</u>

RESULTS: _____

ADDITIONAL NOTES/OBSERVATIONS: _____

OBSERVER SIGNATURE/DATE C. Allison Bailey 1/03/90
C. Allison Bailey

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and Energy
Services Co.

WELL No. 1088

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

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

OBSERVER SIGNATURE/DATE

C. Allison Bailey 1/02/90
C. Allison Bailey

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1088

ORNL MONITORING WELL LOG

PAGE 1 OF 3

LOCATION: WAG-8
DRILLER: Larry Ledbetter
HELPER: Fred Dixon
DRILL: Ingersoll-Rand T-4

DATE: START: 1-02-90
FINISH: 1-03-90
LOGGED BY: C. Allison Bailey
HEALTH PHYSICIST: L. O. Johnson

TYPE DRILLING: Split Spoon, Auger LUBRICANT TYPE: Green stuff
No. SAMPLES TAKEN: (1) 1088S01 TYPE: Soil
CONTAINMENT TYPE: Plastic, Pan

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

DRILLING FLUID SAMPLES:
TYPE: N/A DATE: N/A
N/A

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
0.0	0.4			Gravel (fill material) and roots.
0.4	2.0		100%	Clay, light brown and moderate brown, slightly shaley and silty. Slightly crumbly, dry to damp.
2.0	4.0	Bulk Density	100%	Shale, clayey, highly weathered, grayish red and light brown, thinly bedded with salt and sand lenses, light olive, moderate yellow and dusky brown. Hard, crumbly, dry. Dip is at 50°.
		2.3 - 2.65		
		= 1.99		
		grams/cm ³		
4.0	5.0		50%	Shale, very weathered, pale yellowish brown and pale red. Not competent, contains some mica. Dry.
5.0	5.5		100%	Clay, light brown with organic black mineral specks. Moist. Firm.
5.5	6.6		100%	Shale, slightly weathered, grayish red, pale red and pale brown. Thinly bedded with mica lenses. Crumbly. Dry. Dip is at 45°.
6.6	7.0		100%	Shale, pale olive and light olive. Thinly layered with large sand lenses, bright green. Also contain thin clay beds (ash beds - bentonite) light gray. Sample is very hard.
7.0	8.2		100%	Shale, very weathered, dark brown and pale

ORNL MONITORING WELL LOG

PAGE 2 OF 3

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
7.0	8.2			(continued from page 1) olive with clay, mottled moderate yellowish brown pale red and light brown. Thinly layered with sand lenses and thin clay beds.
8.2	8.5		100%	Shale, greenish gray, sandy and silty with mica. Very hard.
8.5	9.0		100%	Shale, very weathered, dark brown and pale olive with clay, mottled moderate yellowish brown, pale red and light brown. Thinly layered with sand lenses and thin clay beds. Dry.
9.0	9.8		100%	Shale, very weathered, dark brown and pale olive with clay, mottled moderate yellowish brown, pale red and light brown. Thinly layered with bright green and greenish gray sand and clay lenses. Dry and crumbly.
9.8	11.0		100%	Shale, blackish red, pale red and grayish red. Contains some light gray clay lenses with dark iron stained layers. Hard, dry, breaks clean at 45°.
11.0	12.0		100%	Shale, blackish red, pale red, grayish red and light brown, contains some light gray clay lenses with dark iron stained layers. Hard, dry. Breaks clean at 45°.
12.0	14.0		100%	Shale, blackish red, pale red, grayish red and light brown. Soft. Crumbly. No layers. Iron stained. Hard. Dry.
14.0	14.5	1088S01	100%	Shale, blackish red, pale red, grayish red and light brown. Soft. Crumbly. No layers. Iron stained. Hard. Dry.
		14.0-14.5		
14.5	16.5		100%	Shale, blackish red, pale red, grayish red and light brown. Thinly bedded. Sand and mica lenses with some clay lenses, moderate brown

1927-1928

PAGE 3 OF 3

PAGE 11 OF 21.

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

EQUIPMENT ☒ 6.0 INCH AUGER 35.0 L.F.
☐ INCH AUGER L.F.

LOCATION WAG-8
ORNL GRID COORDINATES
N 19 155 7157
E 30 367 6390
ELEV. GROUND 820.66
ELEV. TOP STAINLESS
STEEL CASING 822.94
DRILLING DATES:
STARTED: 1-02-90
FINISHED: 1-05-90

MATERIALS USED

EST. USED
VOL. VOL.

15.0 FEET OF 2.0 IN. S.S. SCREEN
21.4 FEET OF 2.0 IN. S.S. CASING
2.5 4.0 SACKS OF SAND
50.0 50.0 POUNDS OF BENTONITE PELLETS
1.0 1.5 SACKS OF CEMENT
5.0 POUNDS OF POWDERED BENTONITE
8.0 GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

Irregular boring diameter and
spillage.

WELL COVER USED ☒ LOCKING STEEL COVER
☐ FLUSH MOUNTED WELL COVER
☐ OTHER
SILT TRAP USED YES ☒ NO ☐

MONITORING WELL PUMP BASE SET AT 30.2 FEET.

CENTRALIZERS AT 13.5 FEET.
33.5 FEET.
FEET.

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

HOLE CLEANED OUT
TO 34.49 FEET

BOTTOM OF BOREHOLE
35.0 FEET

NOT TO SCALE

TYPE A WELL

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1088

DATE: 1/03/90

MONITORING WELL MATERIALS
CERTIFICATION

<u>ITEM/MATERIAL</u>	<u>DATE USED</u>	<u>BATCH NUMBER</u>
SAND	1-03-90	2
BENTONITE	1-03-90	1
STAINLESS STEEL SCREEN (PREPACKAGED ☒ YES ☐ NO)	1-03-90	2
STAINLESS STEEL CASING (PREPACKAGED ☒ YES ☐ NO)	1-03-90	2
STAINLESS STEEL CENTRALIZERS (PREPACKAGED ☒ YES ☐ NO)	1-03-90	2
STAINLESS STEEL CAPS (PREPACKAGED ☒ YES ☐ NO)	1-03-90	2
MONITORING WELL PUMP (PREPACKAGED ☒ YES ☐ NO)	5-23-90	6
GROUT	1-05-90	3
WELL COVERS		
SURFACE CASING		

COMMENTS:

OBSERVER SIGNATURE/DATE C. Allison Bailey 1/05/90
C. Allison Bailey

POST-WELL COMPLETION
CHECKLIST

<u>POST-WELL COMPLETION TASKS</u>	<u>COMPLIANCE</u>	
	<u>DATE</u>	<u>INITIALS</u>
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	<u>1-02-90</u>	<u>CAB</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>1-02-90</u>	<u>CAB</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>5-23-90</u>	<u>DCL</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>1-03-90</u>	<u>CAB</u>

* 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 1-03-90
C. Allison Bailey

D. Charles Lytle 5-23-90
D. Charles Lytle

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and Pumping

DEVELOPMENT
BEGAN DATE: 5/15/90

TIME: _____

DEVELOPMENT
ENDING DATE: 5/23/90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 10.7 GALLONS

TOTAL GALLONS PUMPED: 348 TOTAL WELL VOLUMES PUMPED: 32.5

INITIAL pH: 7.8 FINAL pH: 7.5

INITIAL CONDUCTIVITY ($\mu S/cm$): 436 FINAL CONDUCTIVITY ($\mu S/cm$): 273

DESCRIPTION OF INITIAL TURBIDITY: Nasty

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: 13.3 feet below ground surface.

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 5/23/90
D. Charles Lytle

DATE: 5/15/90

ONE WELL VOLUME = 10.7 GALLONS

COMMENTS	Okay producer. Water remains cloudy and will not clear up, had to pass on account of 32.5 well volumes.
	* Greater than 100 NTU's.

OBSERVER SIGNATURE/DATE

D. Charles Lytle 5/23/90
D. Charles Lytle

MWF00M05.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.: 1088

DATE OF TEST: 9/4/90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: WAG-8

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 = 6.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 15.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 23.23 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 = .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)

8.3045

8.4545

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	11.040	10.040
20.00	10.730	9.730
30.00	10.460	9.460
40.00	10.210	9.210
50.00	9.970	8.970
60.00	9.770	8.770
75.00	9.460	8.460
90.00	9.180	8.180
105.00	8.920	7.920
120.00	8.630	7.630
150.00	8.220	7.220
180.00	7.820	6.820
240.00	7.010	6.010
300.00	6.350	5.350
360.00	5.770	4.770
420.00	5.260	4.260
480.00	4.890	3.890
540.00	4.560	3.560
600.00	4.250	3.250
720.00	3.730	2.730
840.00	3.380	2.380
960.00	3.000	2.000
1080.00	2.740	1.740
1200.00	2.560	1.560
1320.00	2.400	1.400
1440.00	2.270	1.270
1560.00	2.150	1.150
1680.00	2.060	1.060
1800.00	1.980	.980
1920.00	1.890	.890
2040.00	1.840	.840
2160.00	1.860	.860

HYDRAULIC CONDUCTIVITY CALCULATIONS

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = 1.01E-06 FT/SEC = 3.09E-05 CM/SEC

TRANSMISSIVITY = 1.52E-05 FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = 1.29E-06 FT/SEC = 3.92E-05 CM/SEC

TRANSMISSIVITY = 1.93E-05 FT**2/SEC

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

1088

WELL NO. 1088		LOCATION: WAG-8		TYPE: Soil			
SAMPLER: <i>C. Sullivan</i> (SIGNATURE)		SAMPLE INTERVAL: 14.0-14.5		DATE: 1-15-90		TIME: 15:45	
RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECEIVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
<i>C. Sullivan</i>	01-15-90	15:45	1088	<i>J. P. ...</i>	1-15-90	15:45	1088

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 1089 is located in WAG 8. It is approximately 300' north of Melton Valley Drive across the street from Bldg. 7500. The location is shown on ORNL drawing number C3E20004 A075. Survey coordinates for this well are N 19,159.1560, E 31,431.7630 (X-10 grid) or latitude 35°-55'-14.40" and longitude 84°-18'-37.51". 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 1089 was drilled by Geotek Engineering Company. A Mobile B-50 rig was used to drill this boring for monitor well installation under operation of Rick Herron with the assistance of Fred Dixon. Drilling commenced on 10-11-89 and was finished on 10-12-89. 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.

10-11-89: The B-50 auger rig was steamcleaned and mobilied to the staked location and set-up. The boring was split spooned from 0.0' to 10.8' and augered with 6" augers from 10.8' to 30.18'.

10-12-89: The boring had 11.5' of water overnight. Two-inch stainless steel casing, screen, sand and bentonite were installed and the annulus grouted to the surface.

This well was logged by ERC Environmental and Energy Services Co., Inc., hydrogeologist 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 8 encompasses approximately 34 acres, the majority of which is located in Melton Valley. Irregular in shape, the site has two sinuous extensions from its northern end. One of the extensions extends northwest and crosses Haw Ridge, the other runs parallel to Melton Valley Drive. WAG 8 is underlain by three geologic units. Traversing the site from south to north are the Conasauga Group, the Rome Formation, and the Chickamauga Limestone. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strikes and dips. The regional strike is 56° northeast and the beds dip about 30° to the southeast.

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 1089S01 was collected in the augered interval from 28.0 to 30.0 feet on 10-11-89.

A bulk density soil sample was collected from the split spoon sample interval from 10.3 to 10.6 feet. The sample was measured and weighed, and a bulk density of 2.2 grams/cm³ 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 29.94 to 30.18 feet. Above the silt trap a 2-inch diameter stainless steel screen was installed from 14.01 to 29.94 feet. A 2-inch diameter stainless steel casing was installed above the screen from 14.01 feet to 1.70 feet above ground surface. A sandpack was then poured into the annular space from 11.7 to 30.18 feet, with a 2.2-foot bentonite pellet seal poured into the annular space above the sandpack from 9.5 to 11.7 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 1089 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 372 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 greater than 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 05-15-90 at a depth of 28.9 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 1089 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 1.16×10^{-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.

PRE-DRILLING CHECKLIST FOR
MONITORING WELLS

<u>PRE-DRILLING TASKS</u>	<u>COMPLIANCE</u>	
	<u>DATE</u>	<u>INITIALS</u>
1. EXCAVATION PERMIT OBTAINED	<u>10-11-89</u>	<u>MLE</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>10-11-89</u>	<u>MLE</u>
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.	<u>N/A</u>	<u></u>
3b. PRE-PACKAGED SCREENS, CASING AND CENTRALIZERS WERE USED.	<u>10-11-89</u>	<u>MLE</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>10-11-89</u>	<u>MLE</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>10-11-89</u>	<u>MLE</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>10-11-89</u>	<u>MLE</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u></u>	<u></u>

RESULTS: _____

ADDITIONAL NOTES/OBSERVATIONS: _____

OBSERVER SIGNATURE/DATE

Michael L. Ebers

10/11/89

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

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

OBSERVER SIGNATURE/DATE

Michael L. Ebers

10/11/89

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1089

ORNL MONITORING WELL LOG

PAGE 1 OF 2

LOCATION: WAG-8
DRILLER: Rick Herron
HELPER: Fred Dixon
DRILL: Mobile B-50

DATE: START: 10-11-89
FINISH: 10-12-89
LOGGED BY: Michael L. Ebers
HEALTH PHYSICIST: Carl Stooksbury

TYPE DRILLING: Split Spoon/Auger LUBRICANT TYPE: Green stuff

No. SAMPLES TAKEN: One TYPE: Soil

CONTAINMENT TYPE: Auger Pan, Plastic

THICKNESS OF SOIL (REFUSAL DEPTH): N/A

DEPTH DRILLED IN ROCK: N/A

TOTAL DEPTH OF WELL: 30.18

DRILLING FLUID SAMPLES:

TYPE: N/A DATE: _____

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
0.0	1.0		Auger	Gravel.
1.0	3.0		50%	Clay, medium brown, silty from 1.0'- 2.0', few maroon shale chips, very damp, loose.
3.0	5.0		60%	Clay, medium brown, slightly silty; few scattered yellowish brown silty shale chips, weathered. Very damp, loose, crumbly.
5.0	6.0		100%	Shale, reddish brown, silty and micaceous, with some clay, brown, interbedded with weathered siltstone, yellowish brown and pea green, locally thinly laminated bedding 15° from horizontal, crumbly, damp.
6.0	7.0		Augered	Shale, reddish brown, damp.
7.0	7.7		30%	Shale, reddish brown, silty, weathered, thinly laminated with siltstone, yellowish brown and bright green, weathered, very crumbly, slightly damp.
7.7	10.0		Augered	Shale, reddish brown, damp.
10.0	10.8		100%	Shale, reddish brown, thinly bedded with silty clay, light greenish gray, bedding 35° to horizontal, weathered, damp. Bulk Density at 10.3'- 10.6' = 2.2 grams/cm ³ .

ORNL MONITORING WELL LOG

PAGE 2 OF 2

[illegible]

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1089

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED

BY: Michael L. Ebers

PROOFED

BY: C. Allison Hodges

DRILLING COMPANY: Geotek

DRILLER: Rick Herron

HELPER: Fred Dixon

EQUIPMENT

☒ 6 INCH AUGER 30.18 L.F.

☐ INCH AUGER L.F.

MATERIALS USED

EST. USED
VOL. VOL.

15.93 FEET OF 2 IN. S.S. SCREEN

14.31 FEET OF 2 IN. S.S. CASING

4.3 5.5 SACKS OF SAND

40 40 POUNDS OF BENTONITE PELLETS

1.5 4.0 SACKS OF CEMENT

20 POUNDS OF POWDERED BENTONITE

24 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 28.9 FEET.

CENTRALIZERS AT 13.0 FEET.

28.0 FEET.

FEET.

NOTE:

ALL DEPTHS ARE MEASURED
FROM GROUND SURFACE
UNLESS OTHERWISE NOTED:

HOLE CLEANED OUT
TO 30.18 FEET

BOTTOM OF BOREHOLE
30.18 FEET

LOCATION WAG-8

ORNL GRID COORDINATES

N 19,159.1560

E 31,431.7630

ELEV. GROUND 855.34

ELEV. TOP STAINLESS

STEEL CASING 857.04

DRILLING DATES:

STARTED: 10/11/89

FINISHED: 10/12/89

LOCKING STEEL COVER

8 INCH DIAMETER

STEEL PROTECTIVE CASING

2.84 FT. ABOVE GROUND

TO 2.0 FT. BELOW

GROUND SURFACE

CONCRETE PAD

GROUT SEAL 0.0 TO

9.5 FEET

6 INCH DIAMETER

BOREHOLE

2 INCH DIAMETER STAINLESS

STEEL CASING 1.70 FT. ABOVE

GROUND SURFACE TO 14.01 FT.

BELOW GROUND SURFACE

CENTRALIZER (TYP.)

BENTONITE PELLET SEAL

9.5 TO 11.7 FEET

SAND BACK
11.7 TO 30.18 FEET

2 INCH DIAMETER

STAINLESS STEEL 0.010

SLOTTED SCREEN

14.01 TO 29.94 FEET

2 INCH DIAMETER STAINLESS

STEEL SILT TRAP/CAP

29.94 TO 30.18 FEET

NOT TO SCALE

TYPE A WELL

MONITORING WELL MATERIALS
CERTIFICATION

ITEM/MATERIAL	DATE USED	BATCH NUMBER
SAND	10/12/89	1
BENTONITE	10/12/89	MMES Stores
STAINLESS STEEL SCREEN (PREPACKAGED ☒ YES ☐ NO)	10/12/89	MMES Stores
STAINLESS STEEL CASING (PREPACKAGED ☒ YES ☐ NO)	10/12/89	MMES Stores
STAINLESS STEEL CENTRALIZERS (PREPACKAGED ☒ YES ☐ NO)	10/12/89	MMES Stores
STAINLESS STEEL CAPS (PREPACKAGED ☒ YES ☐ NO)	10/12/89	MMES Stores
MONITORING WELL PUMP (PREPACKAGED ☒ YES ☐ NO)	5/15/90	6
GROUT	10/12/90	2
WELL COVERS		
SURFACE CASING		

COMMENTS:

OBSERVER SIGNATURE/DATE Michael L. Ebers 10/12/90
Michael L. Ebers

POST-WELL COMPLETION
CHECKLIST

POST-WELL COMPLETION TASKS

		COMPLIANCE	
		DATE	INITIALS
1.	MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	<u>10-12-89</u>	<u>ME</u>
2.	ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>10-12-89</u>	<u>ME</u>
3.	WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>5-15-90</u>	<u>DCL</u>
4.	DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>10-12-89</u>	<u>ME</u>

* 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 10/12/89
Michael L. Ebers

3/15/90
D. Charles Lytle

ERCE
Environmental
and Energy
Services Co.

WELL No. 1089

LOCATION: WAG-8

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and Pumping

DEVELOPMENT
BEGAN DATE: 5/01/90

TIME: _____

DEVELOPMENT
ENDING DATE: 5/15/90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 11.1 GALLONS

TOTAL GALLONS PUMPED: 372 TOTAL WELL VOLUMES PUMPED: 33.5

INITIAL pH: 7.8 FINAL pH: 8.0

INITIAL CONDUCTIVITY ($\mu S/cm$): 750 FINAL CONDUCTIVITY ($\mu S/cm$): 465

DESCRIPTION OF INITIAL TURBIDITY: Muddy

DESCRIPTION OF FINAL TURBIDITY: Slightly 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 ☐ TANK TRUCK
☐ STORM SEWERS ☐ STORAGE TANKS
☐ DRUMS ☐ OTHER _____

INITIAL PRE-DEVELOPMENT
WATER DEPTH: 6.7 feet from ground surface.

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 5/15/90
D. Charles Lytle

WAG-8-1089-10

DATE: 5/01/90

ONE WELL VOLUME = 11.1 GALLONS

COMMENTS	Good producer. Water would not clear up, remains slightly cloudy.
	Had to pass on account of 33.5 well volumes. Passed and moved to another hole.
	* Greater than 100 NTU's.

D. Charles Lytle 5/15/90
D: Charles Lytle

MWF01M03.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.: 1089

DATE OF TEST: 8/22/90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: WAG-8

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 = 6.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 15.93 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 17.71 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 15.93 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)

4.2317
4.2596

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	5.960	4.960
20.00	5.820	4.820
30.00	5.710	4.710
40.00	5.610	4.610
50.00	5.520	4.520
60.00	5.440	4.440
75.00	5.310	4.310
90.00	5.230	4.230
105.00	5.150	4.150
120.00	5.070	4.070
150.00	4.920	3.920
180.00	4.790	3.790
240.00	4.520	3.520
300.00	4.370	3.370
360.00	4.210	3.210
420.00	4.020	3.020
480.00	3.940	2.940
540.00	3.830	2.830
600.00	3.740	2.740
720.00	3.580	2.580
840.00	3.430	2.430
960.00	3.310	2.310
1080.00	3.200	2.200
1200.00	3.110	2.110
1320.00	3.010	2.010
1440.00	2.940	1.940
1560.00	2.870	1.870
1680.00	2.800	1.800
1800.00	2.750	1.750
1920.00	2.700	1.700
2040.00	2.640	1.640
2160.00	2.590	1.590

HYDRAULIC CONDUCTIVITY CALCULATIONS

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $3.82\text{E-}07$ FT/SEC = $1.16\text{E-}05$ CM/SECTRANSMISSIVITY = $6.09\text{E-}06$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $4.89\text{E-}07$ FT/SEC = $1.49\text{E-}05$ CM/SECTRANSMISSIVITY = $7.80\text{E-}06$ FT**2/SEC

HYDRAULIC CONDUCTIVITY CALCULATIONS

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

1089S01

WELL NO.

1089

LOCATION:

WAG 8

TYPE:

SOIL

SAMPLER:

Churchcraft J. Jones
(SIGNATURE)

SAMPLE INTERVAL:

28-30'

DATE:

10/11/89

TIME:

1600

RELINQUISHED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

RECEIVED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

Churchcraft J. Jones

10/16/89

1045

EDGE

J. L. Price

10-16-89

1045

CRM

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 1090 is located in WAG 8. It is approximately 300' north of Melton Valley Drive across the street from Bldg. 7500. The location is shown on ORNL drawing number C3E20004 A075. Survey coordinates for this well are N 19,157.6774, E 31,441.9456 (X-10 grid) or latitude 35°-55'-14.44" and longitude 84°-18'-37.40". 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 1090 was drilled by Geotek Engineering Company. A Mobile B-50 and an Ingersoll Rand T-4 rig were used to drill this boring for monitor well installation under the operation of Rick Herron and Larry Ledbetler with the assistance of James Shelton and Fred Dixon. Drilling commenced on 09-22-89 and was finished on 10-11-89. 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.

9-22-89: The Mobile B-50 auger rig was deconed and mobilized to the site. A 22.0" boring was augered to 7.6' and a 15' ¹/₄" diverter casing was installed and grouted.

10-05-89: The Ingersol Rand T-4 was deconed along with the tools and mobilized to the site. A 14.0" auger was used to drill to 15.0'.

10-06-89: The boring was advanced to 19.1' with the 14.0" auger. A 10.0" surface casing was installed to a depth of 18.0', a bentonite seal installed and the annulus grouted.

10-10-89: The Ingersol Rand T-4 and tools were decontaminated and mobilized to the site. The diverter head, containment box and water truck were rigged up. The boring was extended to a total depth of 73.1 feet with an 8.0-inch tricone bit. After 35 minutes the boring produced 11.0' of water. The 4.0 inch stainless steel screen and casing was installed, sand tremied and bentonite poured into the boring. An air sample and water sample were taken.

10-11-89: The annulus was tremie grouted.

10-16-89: The well was tested with the "Go-No Go" guage and passed by R.C. Williams.

This well was logged by ERC Environmental and Energy Services Co., Inc., hydrogeologist C. Allison Hodges 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 8 encompasses approximately 34 acres, the majority of which is located in Melton Valley. Irregular in shape, the site has two sinuous extensions from its northern end. One of the extensions extends northwest and crosses Haw Ridge, the other runs parallel to Melton Valley Drive. WAG 8 is underlain by three geologic units. Traversing the site from south to north are the Conasauga Group, the Rome Formation, and

the Chickamauga Limestone. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strikes and dips. The regional strike is 56° northeast and the beds dip about 30° to the southeast.

2.3 Sample Collection

One water 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. This drill water sample was collected from the water pump on the drill rig on 10-10-89. Analytical results for sample 1090W01 can be obtained from the Remedial Action Program data base at ORNL.

The Ingersol Rand T-4 compressed air was sampled with a cloth filter inserted between drill rods on 10-10-89. The sample was examined with an ultraviolet light for the presence of hydrocarbons. The filter exhibited a dull fluorescence.

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 7.6 feet. A 15 1/4-inch diverter casing was installed from surface to 7.6 feet below ground surface and grouted in place. A 14.0-inch diameter boring was augered from 7.6 to

19.1 feet (auger refusal). A 10.0-inch diameter string of decontaminated steel surface casing was installed from 0.0 to 18.0 feet, sealed with a 1.4-foot bentonite pellet layer from 16.6 to 18.0 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 73.1 feet. A 4-inch diameter stainless steel silt trap was installed from 72.8 to 73.1 feet. A 4-inch diameter stainless steel screen was installed above the silt trap from 57.4 feet to 72.8 feet. A sandpack was then tremied into the annular space from 55.3 to 73.1 feet, with a 3.3-foot bentonite pellet seal poured into the annular space above the sandpack from 52.0 to 55.3 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 1090 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 316 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 05-08-90 at a depth of 70.9 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 1090 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 1.66×10^{-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.

PRE-DRILLING CHECKLIST FOR
MONITORING WELLS

PRE-DRILLING TASKS

COMPLIANCE

	<u>DATE</u>	<u>INITIALS</u>
1. EXCAVATION PERMIT OBTAINED	<u>9-22-89</u>	<u>CAH</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>9-22-89</u>	<u>CAH</u>
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.	<u>N/A</u>	<u>CAH</u>
3b. PRE-PACKAGED SCREENS, CASING AND CENTRALIZERS WERE USED.	<u>10-10-89</u>	<u>MLE</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>9-22-89</u>	<u>CAH</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>9-22-89</u>	<u>CAH</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>9-22-89</u>	<u>CAH</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u> </u>	<u> </u>

RESULTS: _____

ADDITIONAL NOTES/OBSERVATIONS: _____

Michael L. Ebers

10/10/89

OBSERVER SIGNATURE/DATE

C. Allison Hodges

9/22/89

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

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

OBSERVER SIGNATURE/DATE C. Allison Hodges 9/22/89
C. Allison Hodges

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1090

ORNL MONITORING WELL LOG

PAGE 1 OF 2

LOCATION: WAG-8
DRILLER: Rick Herron/Larry Ledbetter
HELPER: James Shelton/Fred Dixon
DRILL: Mobile B-50/Ingersoll Rand T-4

DATE: START: 09-22-89
FINISH: 10-11-89
LOGGED BY: C. Allison Hodges
Michael I. Ebers
HEALTH PHYSICIST: N/A

TYPE DRILLING: Auger, Air Rotary LUBRICANT TYPE: Green stuff
No. SAMPLES TAKEN: None TYPE: N/A
CONTAINMENT TYPE: Plastic, Pan

THICKNESS OF SOIL (REFUSAL DEPTH): 14.1
DEPTH DRILLED IN ROCK: 54.0
TOTAL DEPTH OF WELL: 73.1

DRILLING FLUID SAMPLES:
TYPE: Water DATE: 10-10-89
(1090W01)

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
0.0	2.5			Gravel fill.
2.5	7.6			Clay, medium brown, moist and shale, weathered.
7.6	13.0			Clay, reddish brown and some yellowish brown and weathered shale, light olive gray, silty and micaceous, damp; locally siltstone, thinly laminated, yellowish brown and brown, jointed with black iron stains.
13.0	16.0			Shale, maroon to medium brown, soft, slightly damp.
16.0	19.1			Shale, maroon, interbedded with siltstone, yellowish brown and greenish gray, locally sandstone, fine grained, light olive gray and yellowish, brown-speckled, slightly damp, slow, hard drilling.
	19.1			Auger refusal.
19.1	33.5			* Soft, smooth drilling.
33.5	41.0			Fairly hard, slow drilling.
41.0	64.0			Soft, easy drilling.
64.0	67.0			Hard drilling with soft streaks.
67.0	73.1			Soft, easy drilling.

WELL No. 1090

PAGE 2 OF 2

PAGE 10 OF 20.

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED C. Allison Hodges/ PROOFED
BY: Michael L. Ebers BY: Michael L. Ebers

DRILLING COMPANY: Geotek

DRILLER: Rick Herron/ James Shelton/
Larry Ledbetter HELPER: Fred Dixon

DRILLING METHOD: ☒ 22 INCH AUGER 7.6 L.F.
☒ 14 INCH AUGER 11.5 L.F.
☒ 8 INCH ROTARY 54.0 L.F.
☐ INCH ROTARY L.F.

MATERIALS USED

EST. VOL. USED VOL.
25.0 POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
20.4 FT. OF 10.0 IN. SURFACE CASING
5.0 7.0 SACKS OF CEMENT (SURFACE CASING)
35.0 POUNDS OF POWDERED BENTONITE (SURFACE CASING)
42.0 GALLONS OF WATER (SURFACE CASING)
60.0 FT. OF 4.0 IN. DIA. STAINLESS STEEL CASING
15.4 FT. OF 4.0 IN. DIA. STAINLESS STEEL SCREEN
4.4 4.2 SACKS OF SAND
66.0 50.0 POUNDS OF BENTONITE PELLETS
10.2 10.0 SACKS OF CEMENT (WELL CASING)
50.0 POUNDS OF POWDERED BENTONITE (WELL CASING)
60.0 GALLONS OF WATER (WELL CASING)
21.2 FT. OF 10 IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

Irregular boring diameter

SURFACE CASING TREME GROUTED YES ☒ NO ☐

STAINLESS STEEL CASING TREME 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 70.9 FEET.

CENTRALIZERS AT 11.0 FEET.
31.0 FEET.
51.0 FEET.
71.0 FEET

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

LOCATION WAG-8
ORNL GRID COORDINATES
N 19.157.6774
E 31.441.9456
ELEV. GROUND 855.22
ELEV. TOP STAINLESS
STEEL CASING 857.34
DRILLING DATES:
STARTED: 09-22-89
FINISHED: 10-11-89

TYPE B WELL

MONITORING WELL MATERIALS
CERTIFICATION

<i>ITEM/MATERIAL</i>	<i>DATE USED</i>	<i>BATCH NUMBER</i>
<i>SAND</i>	10-10-89	1
<i>BENTONITE</i>	10-06-89	MMES Stores
	10-10-89	MMES Stores
<i>STAINLESS STEEL SCREEN</i> (PREPACKAGED ☒ YES ☐ NO)	10-10-89	MMES Stores
<i>STAINLESS STEEL CASING</i> (PREPACKAGED ☒ YES ☐ NO)	10-10-89	MMES Stores
<i>STAINLESS STEEL CENTRALIZERS</i> (PREPACKAGED ☒ YES ☐ NO)	10-10-89	MMES Stores
<i>STAINLESS STEEL CAPS</i> (PREPACKAGED ☒ YES ☐ NO)	10-10-89	MMES Stores
<i>MONITORING WELL PUMP</i> (PREPACKAGED ☒ YES ☐ NO)	5-08-90	6
<i>GROUT</i>	10-06-89	2
	10-11-89	2
<i>WELL COVERS</i>		
<i>SURFACE CASING</i>	10-06-89	MMES Stores

COMMENTS:

OBSERVER SIGNATURE/DATE Michael L. Ebers 10/11/90
Michael L. Ebers

POST-WELL COMPLETION
CHECKLIST

<u>POST-WELL COMPLETION TASKS</u>	<u>COMPLIANCE</u>	
	<u>DATE</u>	<u>INITIALS</u>
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	<u>9-22-89</u>	<u>CAH</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>10-10-89</u>	<u>CAH</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>5-08-90</u>	<u>DCL</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>10-11-89</u>	<u>ME</u>

* 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 Hodges 9/22/89
C. Allison Hodges
Michael L. Ebers 10/11/89
Michael L. Ebers
D. Charles Lytle 5/08/90
D. Charles Lytle

ERCE
Environmental
and Energy
Services Co.

WELL No. 1090

LOCATION: WAG-8

**MONITORING WELL
DEVELOPMENT FORM**

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and Pumping

DEVELOPMENT
BEGAN DATE: 5/01/90

TIME: _____

DEVELOPMENT
ENDING DATE: 5/08/90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 60.8 GALLONS

TOTAL GALLONS PUMPED: 316 TOTAL WELL VOLUMES PUMPED: 5.2

INITIAL pH: 7.9 FINAL pH: 7.7

INITIAL CONDUCTIVITY ($\mu S/cm$): 574 FINAL CONDUCTIVITY ($\mu S/cm$): 567

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

INITIAL PRE-DEVELOPMENT
WATER DEPTH: 1.5 feet above ground surface

DEVELOPMENT OBSERVATIONS

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

DATE: 5/14/90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 60.8 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCT- IVITY (uS/cm)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
5-01-90	1400	10	Cloudy	--	7.9	574	10		
5-03-90	1430	48	Slightly Cloudy	--	8.2	536	58		
5-04-90	0900	110	Slightly Cloudy	--	8.2	498	168	2.7	
5-07-90	1300	148	Clear	2.0	7.7	567	316	5.2	
RESULTS AT END OF DEVELOPMENT		148	Clear	2.0	7.7	567	316	5.2	

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

OBSERVER SIGNATURE/DATE D. Charles Lytle 5/08/90
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.: 1090

DATE OF TEST: 8/22/90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: WAG-8

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 = 15.40 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 71.30 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 15.40 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)

2.4074

2.4111

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	3.550	2.550
20.00	3.530	2.530
30.00	3.510	2.510
40.00	3.490	2.490
50.00	3.470	2.470
60.00	3.460	2.460
75.00	3.440	2.440
90.00	3.380	2.380
105.00	3.360	2.360
120.00	3.350	2.350
150.00	3.320	2.320
180.00	3.280	2.280
240.00	3.290	2.290
300.00	3.250	2.250
360.00	3.220	2.220
420.00	3.190	2.190
480.00	3.170	2.170
540.00	3.100	2.100
600.00	3.140	2.140
720.00	3.100	2.100
840.00	3.060	2.060
960.00	3.030	2.030
1080.00	2.950	1.950
1200.00	2.930	1.930
1320.00	2.910	1.910
1440.00	2.940	1.940
1560.00	2.920	1.920
1680.00	2.890	1.890
1800.00	2.870	1.870
1920.00	2.810	1.810
2040.00	2.840	1.840
2160.00	2.790	1.790

HYDRAULIC CONDUCTIVITY CALCULATIONS

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $5.45\text{E-}07$ FT/SEC = $1.66\text{E-}05$ CM/SEC

TRANSMISSIVITY = $8.39\text{E-}06$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $6.32\text{E-}07$ FT/SEC = $1.93\text{E-}05$ CM/SEC

TRANSMISSIVITY = $9.74\text{E-}06$ FT**2/SEC

HYDRAULIC CONDUCTIVITY CALCULATIONS

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
1090W01

WELL NO. 1090	LOCATION: WAG 8	TYPE: DRILL WATER	
SAMPLER: <i>Richard L. Eburn</i> (SIGNATURE)	SAMPLE INTERVAL: N/A	DATE: 10/10/89	TIME: 1450

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECEIVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
<i>Richard L. Eburn</i>	10/16/89	1045	EDGE	<i>J. P. ...</i>	10/16/89	1045	ORIN

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: WATER SAMPLE TAKEN FROM WATER PUMP ON SIDE OF RIG

1.0 General Information

1.1 Well Location

Monitoring well number 1091 is located in WAG 8. It is south of Melton Valley Drive approximately 750' east of Bldg. 7500. The location is shown on ORNL drawing number C3E20004 A075. Survey coordinates for this well are N 18,785.3975, E 32,186.4048 (X-10 grid) or latitude 35°-55'15.48" and longitude 84°-18'-27.36". 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 1091 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 the operation of Larry Ledbetter with the assistance of Fred Dixon. Drilling commenced on 11-29-89 and was finished on 12-12-89. 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.

11-29-89: The Ingersoll Rand and equipment were decontaminated.

11-30-89: The rig and equipment were mobilized to the site, plastic was layed down and the equipment rigged up. An 8-inch boring was augered and split spooned to a depth of 14.5'. A soil sample, 1091S01, was taken but no bulk density could be taken due to the nature of the soil. A 14.0" boring was augered to a depth of 7.0' and a 10 inch diverter was installed.

12-08-89: The Ingersoll Rand and equipment were decontaminated mobilized to the site and set-up. An 8-inch tricone bit was used to advance the boring to 10.5'. The boring was cleaned and after 30 minutes no water was measured. The boring was then advanced to a total depth of 22.65'. An air and a water sample were taken. After the boring was cleaned and 30 minutes of recharge 3.5' of water was measured. After 1 hour of recharge, six feet of water was measured.

12-11-89: The water level was measured at 5.1' below land surface. The boring was cleaned and 10.0' of stainless steel screen and 15.0' of stainless steel casing were installed to

a depth of 22.65'. Sand was poured to a level of 9.14' and a bentonite seal installed to a level of 7.86'.

12-12-89: The annulus was grouted using 1.5 bags of cement.

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 8 encompasses approximately 34 acres, the majority of which is located in Melton Valley. Irregular in shape, the site has two sinuous extensions from its

northern end. One of the extensions extends northwest and crosses Haw Ridge, the other runs parallel to Melton Valley Drive. WAG 8 is underlain by three geologic units. Traversing the site from south to north are the Conasauga Group, the Rome Formation, and the Chickamauga Limestone. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strikes and dips. The regional strike is 56° northeast and the beds dips about 30° to the southeast.

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 1091S01 was collected in the split spoon interval from 7.0 to 7.5 feet on 11-30-89. A drill water sample was collected from the water pump on the drill rig on 12-08-89. Analytical results for the soil and drill water samples described above can be obtained from the Remedial Action Program data base at ORNL.

The Ingersoll Rand T-4's compressed air was sampled with a cloth filter inserted between drill rods on 12-08-89. the sample was examined with an ultraviolet light for the presence of hydrocarbons. No detectable signs of hydrocarbons were visible.

2.4 Installation and Development

2.4.1 Installation

This was a Type D well. A six-inch diameter boring was split spooned and augered from ground surface to auger refusal (14.5 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 22.65 feet. A 2-inch diameter stainless steel screen with a screw on bottom cap was installed from 22.65 to 12.41 feet. A 2-inch diameter stainless steel casing was installed above the screen at 12.41 feet and extended 2.25 feet above ground surface. A sandpack was then tremied into the annular space from 22.65 to 9.14 feet, with a 1.28-foot bentonite pellet seal poured into the annular space above the sandpack from 9.14 to 7.86 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 1091 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 400 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 completions 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 01-19-90 at a depth of 21.0 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 1091 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 4.35×10^{-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

13215-1016

ERC / EDGE
Environmental
and Energy
Services Co.

MONITORING WELL PROGRAM
WELL DATA NARRATIVE
WELL No. 1091

this data package.

PRE-DRILLING CHECKLIST FOR
MONITORING WELLS

<u>PRE-DRILLING TASKS</u>	<u>COMPLIANCE</u>	
	<u>DATE</u>	<u>INITIALS</u>
1. EXCAVATION PERMIT OBTAINED	<u>11-29-89</u>	<u>CAB</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>11-29-89</u>	<u>CAB</u>
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.	<u>N/A</u>	<u> </u>
3b. PRE-PACKAGED SCREENS, CASING AND CENTRALIZERS WERE USED.	<u>12-11-89</u>	<u>CAB</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>11-30-89</u>	<u>CAB</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>11-30-89</u>	<u>CAB</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>11-30-89</u>	<u>CAB</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u>12-08-89</u>	<u>CAB</u>

RESULTS: No hydrocarbons detected under an ultraviolet light.

ADDITIONAL NOTES/OBSERVATIONS: _____

OBSERVER SIGNATURE/DATE C. Allison Bailey 12-11-89
C. Allison Bailey

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1091

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 12-11-89
C. Allison Bailey

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1091

ORNL MONITORING WELL LOG

PAGE 1 OF 2

LOCATION: WAG-8
DRILLER: Larry Ledbetter
HELPER: Fred Dixon
DRILL: Ingersoll Rand T-4

DATE: START: 11-29-89
FINISH: 12-11-89
LOGGED BY: C. Allison Bailey
HEALTH PHYSICIST: Carl Stooksburg

TYPE DRILLING: _____ LUBRICANT TYPE: Green stuff

No. SAMPLES TAKEN: 1091S01 TYPE: Soil

CONTAINMENT TYPE: Plastic, Pan, Containment Box

THICKNESS OF SOIL (REFUSAL DEPTH): 14.5

DRILLING FLUID SAMPLES:

DEPTH DRILLED IN ROCK: 8.15

TYPE: Drill water DATE: 11-08-89

TOTAL DEPTH OF WELL: 22.65

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
0.0	1.5			Gravel - fill material for pad.
1.5	3.5		70%	Clay, mottled, light brown, dark yellowish brown and grayish brown, with gravel and roots. Unconsolidated, firm to crumbly. Damp to moist.
3.5	5.3		65%	Clay, mottled, moderate yellowish brown and dark yellowish orange with shale, highly weathered, laminated, greenish gray, light olive gray and medium bluish gray. Clay is gravel and root filled and loose. Wet from 4.0 to 5.0.
5.3	5.5		65%	Clay, mottled, medium dark gray and greenish gray. Clay is slightly sandy/silty. Contains organic material. Clay is firm.
5.5	6.5		100%	Clay, sandy, mottled, olive gray and light olive gray. Sand is fine to medium grained. Clay contains roots and some shale.
6.5	7.0	1091S01	100%	Clay, slightly sandy, light olive with light brown streaks. Clay is plastic and wet.
		7.0-7.5		
7.5	9.5		100%	Shale, clayey. Shale is dusky brown. Clay is mottled dark yellowish brown and dark

ORNL MONITORING WELL LOG

PAGE 2 OF 2

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
7.5	9.5			(continued from page 1) yellowish orange. Clay is silty/sandy with mica. Sand is dusky yellow orange and very pale green. Mica is very pale green. Dry.
9.5	10.0		100%	Clay, moderate yellowish brown, saturated. Water in spoon at 9.5.
10.0	11.5		100%	Clay, sandy, moderate yellowish brown, with shale, laminated, olive gray and iron stained, very hard. Sand is pale green and light bluish gray.
11.5	12.2		100%	Clay with shale moderate yellowish brown. Shale is hard.
12.2	12.5		100%	Shale, brownish red, layered, breaks at 45° angle. Contains sand and mica, moderate green and dark yellowish green, and some clay, light bluish gray.
12.5	13.5		100%	Shale, clayey, very dusky red purple, has a grayish hue, very weathered, layered, hard, brittle. Contains some sand, silt and mica lenses, brilliant green and grayish green.
13.5	14.5		Augered Interval	Shale, clayey, very dusky red with sand, silt and mica.
	14.5			Auger refusal on hard shale.
14.5	15.0			* Smooth, easy fast drilling.
15.0	22.65			Slightly harder drilling, fast.
	22.65			Total Depth
				*No detailed lithologic log could be provided due to use of containment box.

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

EQUIPMENT
■ 14.0 INCH AUGER 7.0 L.F.
□ INCH AUGER L.F.
■ 8.0 INCH ROTARY 15.65 L.F.

MATERIALS USED

EST. USED VOL. VOL.
10.0 FEET OF 2.0 IN. S.S. SCREEN
15.0 FEET OF 2.0 IN. S.S. CASING
4.6 6.0 SACKS OF SAND
50.0 50.0 POUNDS OF BENTONITE PELLETS
1.2 1.5 SACKS OF CEMENT
7.5 POUNDS OF POWDERED BENTONITE
10.0 GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

Irregular borehole diameter and spillage.

WELL COVER USED
LOCKING STEEL COVER
FLUSH MOUNTED WELL COVER
OTHER
SLT TRAP USED YES NO

MONITORING WELL PUMP BASE SET AT 21.0 FEET.

CENTRALIZERS AT 10.0 FEET.
20.0 FEET.
FEET.

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

HOLE CLEANED OUT
TO 22.65 FEET
BOTTOM OF BOREHOLE
22.65 FEET

LOCATION WAG-8
ORNL GRID COORDINATES
N 18,785.3975
E 32,186.4048
ELEV. GROUND 829.46
ELEV. TOP STAINLESS
STEEL CASING 831.71
DRILLING DATES:
STARTED: 11-29-89
FINISHED: 12-11-89

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

CONCRETE PAD
10.0 INCH DIVERTER
CASING 0.0 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
7.86 FEET

8.0 INCH DIAMETER
BOREHOLE

2.0 INCH DIAMETER STAINLESS
STEEL CASING 2.25 FT. ABOVE
GROUND SURFACE TO 12.41 FT.
BELOW GROUND SURFACE

CENTRALIZER (TYP.)

BENTONITE PELLET SEAL
7.86 TO 9.14 FEET

SAND PACK
9.14 TO 22.65 FEET

2.0 INCH DIAMETER
STAINLESS STEEL 0.010

SLOTTED SCREEN
12.41 TO 22.41 FEET

2.0 INCH DIAMETER STAINLESS
STEEL SLT TRAP/CAP
22.41 TO 22.65 FEET

TYPE D WELL

NOT TO SCALE

MONITORING WELL MATERIALS
CERTIFICATION

<i>ITEM/MATERIAL</i>	<i>DATE USED</i>	<i>BATCH NUMBER</i>
<i>SAND</i>		
	12-11-89	1
<i>BENTONITE</i>		
	12-11-89	1
<i>STAINLESS STEEL SCREEN</i> (PREPACKAGED ☒ YES ☐ NO)	12-11-89	2
<i>STAINLESS STEEL CASING</i> (PREPACKAGED ☒ YES ☐ NO)	12-11-89	2
<i>STAINLESS STEEL CENTRALIZERS</i> (PREPACKAGED ☒ YES ☐ NO)	12-11-89	2
<i>STAINLESS STEEL CAPS</i> (PREPACKAGED ☒ YES ☐ NO)	12-11-89	2
<i>MONITORING WELL PUMP</i> (PREPACKAGED ☒ YES ☐ NO)	6-19-90	6
<i>GROUT</i>		
	12-12-89	4
<i>WELL COVERS</i>	12-11-89	2
<i>SURFACE CASING</i>	N/A	N/A

COMMENTS:

OBSERVER SIGNATURE/DATE

C. Allison Bailey

12/12/89

POST-WELL COMPLETION
CHECKLIST

<u>POST-WELL COMPLETION TASKS</u>	<u>COMPLIANCE</u>	
	<u>DATE</u>	<u>INITIALS</u>
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	<u>11-29-89</u>	<u>CAB</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>11-30-89</u>	<u>CAB</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>6-14-90</u>	<u>DCL</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>12-12-89</u>	<u>CAB</u>

* 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 12-12-89
C. Allison Bailey

D. Charles Lytle 6-19-90
D. Charles Lytle

ERCE
Environmental
and Energy
Services Co.

WELL No. 1091
LOCATION: WAG-8

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and Pumping

DEVELOPMENT
BEGAN DATE: 6/13/90

TIME: _____

DEVELOPMENT
ENDING DATE: 6/19/90

DEVELOPMENT
OBSERVED BY: Nick Norrod and D. Charles Lytle

ONE WELL VOLUME: 8.2 GALLONS

TOTAL GALLONS PUMPED: 400 TOTAL WELL VOLUMES PUMPED: 48.8

INITIAL pH: 8.6 FINAL pH: 8.6

INITIAL CONDUCTIVITY ($\mu S/cm$): 540 FINAL CONDUCTIVITY ($\mu S/cm$): 560

DESCRIPTION OF INITIAL TURBIDITY: Clear

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 5.0 NTU's

WELL APPROVED BY: R. C. Williams MMES

ODOR
OF WATER: None

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

INITIAL PRE-DEVELOPMENT
WATER DEPTH: 4.3 feet from ground surface.

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 6/19/90
D. Charles Lytle

WAG-8-1091

ERCE
Environmental
and Energy
Services Co.

WELL NO. 1091

LOCATION: WAG-8

DATE: 6/13/90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 8.2 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (uS/cm)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
6-13-90	1100	50	Slightly Cloudy	--	8.6	540	50	6.1	
6-13-90	1320	30	Slightly Cloudy	--	8.2	529	80	9.8	
6-14-90	1245	80	Cloudy	--	7.9	567	160	19.6	
6-18-90	0930	170	Cloudy	--	7.9	490	330	40.2	
6-18-90	1130								Resurged
6-18-90	1355	10	Clear	12	8.0	520	340	41.5	
6-19-90	1030	30	Clear	7	8.3	509	370	45.1	
6-19-90	1320	17	Slightly Cloudy	--	8.2	625	387	47.2	
6-19-90	1500	13	Clear	5.0	8.6	560	400	48.8	
RESULTS AT END OF DEVELOPMENT			Clear	5.0	8.6	560	400	48.8	

COMMENTS Good producer, water would not clear at 40.2 well volumes, resurged with work-over rig on 6/18/90 at 11:30 a.m. Water cleared at 48.8 well volumes. Passed with 5.0 NTU's and moved to another hole.

OBSERVER SIGNATURE/DATE D. Charles Lytle 6/19/90
D. Charles Lytle

MMFORM05.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.: 1091

DATE OF TEST: 10-17-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: WAG-8

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 = 10.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 17.35 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 10.00 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)

2.3683
2.4054

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	4.680	3.680
20.00	4.460	3.460
30.00	4.260	3.260
40.00	4.090	3.090
50.00	3.900	2.900
60.00	3.730	2.730
75.00	3.550	2.550
90.00	3.400	2.400
105.00	3.250	2.250
120.00	3.120	2.120
150.00	2.910	1.910
180.00	2.730	1.730
240.00	2.450	1.450
300.00	2.260	1.260
360.00	2.100	1.100
420.00	2.000	1.000
480.00	1.870	.870
540.00	1.780	.780
600.00	1.690	.690
720.00	1.590	.590
840.00	1.510	.510
960.00	1.460	.460
1080.00	1.420	.420
1200.00	1.390	.390
1320.00	1.360	.360
1440.00	1.320	.320
1560.00	1.290	.290
1680.00	1.250	.250
1800.00	1.240	.240
1920.00	1.200	.200
2040.00	1.190	.190
2160.00	1.170	.170

HYDRAULIC CONDUCTIVITY CALCULATIONS

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $1.43\text{E-}06$ FT/SEC = $4.35\text{E-}05$ CM/SECTRANSMISSIVITY = $1.43\text{E-}05$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $2.01\text{E-}06$ FT/SEC = $6.12\text{E-}05$ CM/SECTRANSMISSIVITY = $2.01\text{E-}05$ FT**2/SEC

HYDRAULIC CONDUCTIVITY CALCULATIONS

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
1071501

WELL NO. 1091		LOCATION: WAG-8		TYPE: S-1			
SAMPLER: C. Dillman-Tag (SIGNATURE)		SAMPLE INTERVAL: 7.0-7.5		DATE: 11-20-71		TIME: 11:24	
RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WTH:	RECEIVED BY: (SIGNATURE)	DATE:	TIME:	WTH:
C. Dillman-Tag	01-15-90	1500	EDGE	J. P. Miller	1-15-90	1500	1/4 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: _____

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

1091001

WELL NO.

1091

LOCATION:

WAG-8

TYPE:

Drill Core

SAMPLER:

1001-5000-2000

(SIGNATURE)

SAMPLE INTERVAL:

N/A

DATE:

1-15-89

TIME:

1:20

RELINQUISHED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

RECEIVED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

1001-5000-2000

01-15-90

1500

EDGE

J. K. K.

1-15-90

1500

1/1 1/1

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 1092 is located in WAG 8. It is located south of Melton Valley drive approximately 100' southwest of Bldg. 7547. The location is shown on ORNL drawing number C3E20004 A075. Survey coordinates for this well are N 18,752.7932, E 32,378.9278 (X-10 grid) or latitude 35°-55'-16.27" and longitude 84°-18'-25.19". 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 1092 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 11-08-89 and was finished on 11-16-89. 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.

11-08-89: The Ingersoll Rand T-4 was decontaminated along with the tools. The rig was mobilized to the site, plastic was placed on the ground over the staked location. Split spoons were taken from 0.5 to 18.0 feet. No bulk density samples were taken because of the crumbly nature of the sample. A 22.0" boring was augered from 0.0 to 4.0 feet and a 15 1/4-inch diverter casing was installed and grouted in place.

11-10-89: The Ingersoll Rand T-4 and equipment were deconed, mobilized to the site and set-up. The water truck, diverter head and containment box were hooked up and a 14.0" tricone bit was used to drill to 25.0'.

11-13-89: A 10 3/4" surface casing was deconed and installed to a depth of 24.65'. A bentonite seal was installed and the annulus was grouted four hours later.

11-14-89: The rig and equipment were decontaminated and mobilized to the site. The diverter head, containment box and water truck were connected and an 8-inch tricone bit was used to drill to 72.5'. Water and air sample taken at 48.5'. No hydrocarbons detected. No deep water encountered while drilling.

11-15-89: Bill McMaster recommended drilling in 10.0' intervals to a maximum depth of 90.0'. Water encountered between 77.5' and 87.5'. Water level checked after 15 minutes and found to be 72.5' below land surface. Well site has been down graded to RP rating of 1. Fifteen feet of 4 inch stainless steel screen and seventy-five feet of 4 inch casing were installed to a depth of 86.86'. A sandpack was tremied into the annulus and a bentonite seal poured.

11-16-89: The remaining annulus was tremie grouted to within one foot of the surface.

This well was logged by ERC Environmental and Energy Services Co., Inc., hydrogeologist C. Allison Bailey 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 8 encompasses approximately 34 acres, the majority of which is located in Melton Valley. Irregular in shape, the site has two sinuous extensions from its northern end. One of the extensions extends northwest and crosses Haw Ridge, the other runs parallel to Melton Valley Drive. WAG 8 is underlain by three geologic units: Traversing the site from south to north are the Conasauga Group, the Rome Formation, and the Chickamauga Limestone. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strikes and dips. The regional strike is 56° northeast and the beds dip about 30° to the southeast.

2.3 Sample Collection

Soil and drill water 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 1092S01 was collected in the split spoon interval from 15.4' to 15.7' on 11-08-89. A drill water sample was collected from the water pump on

the drill rig on 11-14-89. Analytical results for the two samples described above can be obtained from the Remedial Action Program data base at ORNL.

The Ingersoll Rand T-4's compressed air was sampled with a cloth filter inserted between drill rods on 11-14-89. 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 B well. An 8-inch diameter boring was split spooned and augered from ground surface to a refusal depth 18 feet. A 22.0-inch diameter boring was augered from ground surface to 4.0 feet. A 15 1/4-inch diverter casing was installed from surface to 4.0 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 4.0 to 25.0 feet. A 10 3/4-inch diameter string of decontaminated steel surface casing was installed from 24.65 feet to 1.0 foot above ground surface sealed with a 1.5 foot bentonite pellet layer from 24.65 to 23.15 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 87.5 feet. A 4-inch diameter

stainless steel screen with threaded bottom cap was installed from 86.86 to 71.59 feet. A 4-inch diameter stainless steel casing was installed from the top of the screen at 71.59 feet and extended 2.05 feet above ground surface. A sandpack was then tremied into the annular space from 71.59 to 67.3 feet, with a 2.3-foot bentonite pellet seal poured into the annular space above the sandpack from 67.3 to 65.0 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 1092 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 830 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 completions was 5 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 9/21/90 at a depth of 85.5 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 1092 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 3.34×10^{-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.

WELL No. 1092

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

PRE-DRILLING TASKS

COMPLIANCE

DATE INITIALS

1. EXCAVATION PERMIT OBTAINED	11/08/89	MLE
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	11/08/89	MLE
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.	11/15/89	CAB
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	11/08/89	MLE
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	11/08/89	MLE
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	11/08/89	MLE
7. AIR ROTARY COMPRESSED AIR SAMPLED.		

RESULTS: _____

ADDITIONAL NOTES/OBSERVATIONS: _____

11/08/89

Michael L. Ebers

OBSERVER SIGNATURE/DATE

C. Allison Bailey

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1092

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

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

Michael L. Ebers

11/08/89

OBSERVER SIGNATURE/DATE

C. Allison Bailey

11/14/89

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1092

ORNL MONITORING WELL LOG

PAGE 1 OF 2

LOCATION: WAG-8
DRILLER: Larry Ledbetter
HELPER: Fred Dixon
DRILL: Ingersoll Rand T-4

DATE: START: 11/08/89
FINISH: 11/16/89
LOGGED BY: Michael L. Ebers
Carl Stooksbury/
HEALTH PHYSICIST: W. H. Shinpaugh

TYPE DRILLING: Split Spoon, Auger and Air Rotary LUBRICANT TYPE: Green stuff

No. SAMPLES TAKEN: One TYPE: Soil (1092S01)

CONTAINMENT TYPE: Plastic, Pan, Containment Box

THICKNESS OF SOIL (REFUSAL DEPTH): 18.0'

DEPTH DRILLED IN ROCK: 69.5

TOTAL DEPTH OF WELL: 87.5

DRILLING FLUID SAMPLES:

TYPE: Water DATE: 11/14/89

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
0.0	0.5			Gravel pad.
0.5	4.0		35%	Shale, maroon and greenish gray, weathered and unweathered, loose, dry to slightly damp, fill material.
4.0	8.0		60%	Shale, dark yellowish orange, moderate brown and maroon, very weathered, loose, crumbly, damp.
8.0	10.0		0%	No recovery.
10.0	14.0	1092S01	14.0-16.0 =	Shale, reddish brown and light olive.
		15.4-15.7'	100%	
			16.0-18.0 =	Gray, with thin siltstone lenses, yellowish brown and olive gray, locally glauconitic, crumbly, damp; at 15.2' - 15.4' is a green- ish gray clay, soft, plastic, damp.
@	18.0			Split spoon refusal.
18.0	19.5			* Smooth drilling, shale.
19.5	23.5			Slightly harder drilling, still smooth and even; shale.
23.5	43.0			Hard even drilling; fairly slow.
43.0	52.5			Hard, irregular drilling, slow.
52.5	82.5			Very hard irregular drilling, slow.

PAGE 2 OF 2

PAGE 11 OF 23.

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1092

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

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

DRILLING COMPANY: Geotek

DRILLER: Larry Ledbetter HELPER: Fred Dixon

DRILLING METHOD: ☒ 22.0 INCH AUGER 4.0 L.F.
☐ INCH AUGER L.F.
☒ 14.0 INCH ROTARY 21.0 L.F.
☒ 8.0 INCH ROTARY 66.5 L.F.

MATERIALS USED

EST. VOL.	USED VOL.	
	<u>25.0</u>	POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
	<u>24.65</u> FT. OF	<u>10 3/4</u> IN. SURFACE CASING
<u>6.6</u>	<u>6.0</u>	SACKS OF CEMENT (SURFACE CASING)
	<u>30.0</u>	POUNDS OF POWERED BENTONITE (SURFACE CASING)
	<u>36.0</u>	GALLONS OF WATER (SURFACE CASING)
<u>73.89</u>		FT. OF <u>4.0</u> IN. DIA. STAINLESS STEEL CASING
<u>14.98</u>		FT. OF <u>4.0</u> IN. DIA. STAINLESS STEEL SCREEN
<u>4.5</u>	<u>4.75</u>	SACKS OF SAND
<u>40.0</u>	<u>37.5</u>	POUNDS OF BENTONITE PELLETS
<u>12.7</u>	<u>14.0</u>	SACKS OF CEMENT (WELL CASING)
	<u>70.0</u>	POUNDS OF POWERED BENTONITE (WELL CASING)
	<u>84.0</u>	GALLONS OF WATER (WELL CASING)
	<u>3.04</u> FT. OF	<u>10 3/4</u> IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

Irregular boring diameter.

SURFACE CASING TREME GROUTED YES ☒ NO ☐

STAINLESS STEEL CASING TREME 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 85.5 FEET.

CENTRALIZERS AT 25.5 FEET.
40.0 FEET.
60.0 FEET.
85.0 FEET

NOTE:

ALL DEPTHS ARE MEASURED
FROM GROUND SURFACE
UNLESS OTHERWISE NOTED:

LOCATION WAG-8

ORNL GRID COORDINATES

N 18,752.7932

E 32,378.9278

ELEV. GROUND 838.67

ELEV. TOP STAINLESS

STEEL CASING 840.72

DRILLING DATES:

STARTED 11-08-89

FINISHED 11-14-89

TYPE B WELL

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1092

DATE: 11-13-89

MONITORING WELL MATERIALS
CERTIFICATION

<u>ITEM/MATERIAL</u>	<u>DATE USED</u>	<u>BATCH NUMBER</u>
<u>SAND</u>	11-15-89	1
<u>BENTONITE</u>	11-13-89	Stores
	11-15-89	Stores
<u>STAINLESS STEEL SCREEN</u> (PREPACKAGED ☒ YES ☐ NO)	11-15-89	Stores
<u>STAINLESS STEEL CASING</u> (PREPACKAGED ☒ YES ☐ NO)	11-15-89	Stores
<u>STAINLESS STEEL CENTRALIZERS</u> (PREPACKAGED ☒ YES ☐ NO)	11-15-89	Stores
<u>STAINLESS STEEL CAPS</u> (PREPACKAGED ☒ YES ☐ NO)	11-15-89	Stores
<u>MONITORING WELL PUMP</u> (PREPACKAGED ☒ YES ☐ NO)	9-21-90	6
<u>GROUT</u>	11-13-89	3
	11-15-89	3
<u>WELL COVERS</u>	11-15-89	3
<u>SURFACE CASING</u>	11-13-89	3

COMMENTS:

OBSERVER SIGNATURE/DATE C. Allison Bailey 11-13-89
C. Allison Bailey

POST-WELL COMPLETION
CHECKLIST

<u>POST-WELL COMPLETION TASKS</u>	<u>COMPLIANCE</u>	
	<u>DATE</u>	<u>INITIALS</u>
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	<u>11-08-89</u>	<u>CAB</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>11-10-89</u>	<u>CAB</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>9-21-90</u>	<u>DCZ</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>11-15-89</u>	<u>CAB</u>

* 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 11-15-89
C. Allison Bailey

D. Charles Lytle
D. Charles Lytle

ERCE
Environmental
and Energy
Services Co.

WELL No. 1092

LOCATION: WAG-8

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and Pumping

DEVELOPMENT
BEGAN DATE: 06-01-90

TIME: _____

DEVELOPMENT
ENDING DATE: 09-21-90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 56.3 GALLONS

TOTAL GALLONS PUMPED: 830 TOTAL WELL VOLUMES PUMPED: 14.7

INITIAL pH: 8.2 FINAL pH: 10.1

INITIAL CONDUCTIVITY ($\mu S/cm$): 825 FINAL CONDUCTIVITY ($\mu S/cm$): 815

DESCRIPTION OF INITIAL TURBIDITY: Cloudy

DESCRIPTION OF FINAL TURBIDITY: Clean

FINAL MEASURED TURBIDITY: 5.0 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: 5.0 feet from ground surface.

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE

D. Charles Lytle / 9/21/90
D. Charles Lytle

DATE/TIME

ERCE
Environmental
and Energy
Services Co.

WELL NO. 1092

LOCATION: WAG-8

DATE: 10-01-90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = _____ GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCT- IVITY (uS/cm)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
6-1-90	1430	210	Cloudy	---	8.2	825	210	4.0	
6-7-90	1430	114	Cloudy	---	8.7	906	324	5.8	
6-8-90	1120	35	Cloudy	---	9.8	925	359	6.4	
6-8-90	1415	10	Cloudy	---	9.8	935	369	6.5	
6-11-90	1400	75	Cloudy	---	9.6	899	444	7.9	
6-12-90	1115	60	Cloudy	---	9.6	---	504	9.0	
6-13-90	0930	10	Cloudy	---	9.4	886	514	9.1	
6-14-90	0930	10	Cloudy	---	9.4	872	524	9.3	
6-19-90	0900	15	Cloudy	---	9.8	885	539	9.6	
6-20-90	1100	5	Cloudy	---	9.8	046	544	9.7	
6-21-90	0800	7	Cloudy	---	9.7	944	551	9.8	
6-21-90	1430	5	Cloudy	---	9.7	921	556	9.9	
6-25-90	1300	10	Cloudy	---	9.7	895	566	10.1	
6-26-90	1400	20	Cloudy	---	9.7	911	586	10.4	
6-28-90	1100	---	Muddy	---	9.7	--	--	--	Not enough sample
7-2-90	1400	15	Cloudy	---	9.6	912	601	10.7	
7-3-90	0900	14	Cloudy	---	9.8	892	615	10.9	
RESULTS AT END OF DEVELOPMENT									

COMMENTS

OBSERVER SIGNATURE/DATE

D. Charles Lytle 10/21/90
D. Charles Lytle

INFORMOS.DWG

ONE WELL VOLUME = 56.3 GALLONS

COMMENTS	Poor recharger and producer kept drying up. Tried washing well with D.I. water to clean it up, didn't work. Finally cleaned up and passed with 5.0 NTU's.
----------	---

MYFORMOS.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.: 1092

DATE OF TEST: 10-29-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: WAG-8

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 = 15.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 74.10 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 = .20
FALLING-HEAD INDEX = 1 ("1" IF FALLING, "0" IF RISING)
NUMBER OF DEPTH-TIME DATA POINTS = 30

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

SUCCESSIVE COMPUTED
VALUES FOR H0
(FEET)

7.1066

7.1072

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	8.140	7.140
20.00	8.130	7.130
30.00	8.100	7.100
40.00	8.120	7.120
50.00	8.120	7.120
60.00	8.100	7.100
75.00	8.110	7.110
90.00	8.120	7.120
105.00	8.120	7.120
120.00	8.120	7.120
150.00	8.090	7.090
180.00	8.080	7.080
240.00	8.090	7.090
300.00	8.090	7.090
360.00	8.080	7.080
420.00	8.080	7.080
480.00	8.080	7.080
540.00	8.080	7.080
600.00	8.080	7.080
720.00	8.090	7.090
840.00	8.090	7.090
960.00	8.080	7.080
1080.00	8.080	7.080
1200.00	8.080	7.080
1320.00	8.080	7.080
1440.00	8.080	7.080
1560.00	8.080	7.080
1680.00	8.080	7.080
1800.00	8.080	7.080
1920.00	8.080	7.080

HYDRAULIC CONDUCTIVITY CALCULATIONS

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $1.10\text{E-}08$ FT/SEC = $3.34\text{E-}07$ CM/SEC

TRANSMISSIVITY = $1.64\text{E-}07$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $1.27\text{E-}08$ FT/SEC = $3.88\text{E-}07$ CM/SEC

TRANSMISSIVITY = $1.91\text{E-}07$ FT**2/SEC

HYDRAULIC CONDUCTIVITY CALCULATIONS

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

1092So1

WELL NO.

1092

LOCATION:

WAG 8

TYPE:

SOIL

SAMPLER:

Michael J. Shaw
(SIGNATURE)

SAMPLE INTERVAL:

15.4' to 15.7'

DATE:

11/8/89

TIME:

1500

RELINQUISHED BY:
(SIGNATURE)

Michael J. Shaw

DATE:

11/16/89

TIME:

1100

WITH:

ERC

RECEIVED BY:
(SIGNATURE)

J. P. ...

DATE:

11-16-89

TIME:

1100

WITH:

MA 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**

1092101

WELL NO. 1092			LOCATION: WAG-8			TYPE: Drill water		
SAMPLER: C. Allison Bailey (SIGNATURE)			SAMPLE INTERVAL: N/A			DATE: 11-14-89		TIME: 1420
RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECEIVED BY: (SIGNATURE)	DATE:	TIME:	WITH:	
C. Allison Bailey	01-15-90	1500	EDGE	J. Price	1-15-90	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: _____

1.0 General Information

1.1 Well Location

Monitoring well number 1093 is located in WAG 8. It is located south of Melton Valley drive approximately 100' southwest of Bldg. 7547. The location is shown on ORNL drawing number C3E20004 A075. Survey coordinates for this well are N 18,762.5730, E 32,402.1924 (X-10 grid) or latitude 35°-55'-16.48" and longitude 84°-18'-25.03". 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 1093 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 11-29-89 and was finished on 12-08-89. 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.

- 11-29-89: The Ingersoll Rand T-4 and equipment were decontaminated and mobilized to the site. Plastic was layed down and a 14.0" diameter boring was augered to 5.5'. A 10-inch diameter diverter casing was installed and grouted in place.
- 12-04-89: The Ingersoll Rand and equipment were decontaminated, mobilized to the site and set up.
- 12-05-89: Repairs were necessary after a thermostat for the compressor broke. Repairs were made on site.
- 12-07-89: The equipment was rigged up and an 8 inch boring was advanced to 20.0' with a tricone bit. The boring was cleaned and after 45 minutes of recharge no water was measured. The boring was advanced to 32.5'. An air and a water sample were taken. The boring was cleaned and after 1 hour of recharge the water level was measured at 30.0'. The boring was advanced another 10 feet to 42.5', the boring was cleaned and after 45 minutes the water level was measured at 41.0'. The boring was then drilled to a total maximum depth of 48.25' and allowed to recharge overnight.
- 12-08-89: It was decided that the boring could not be drilled to a greater depth due to the

possible interconnection of water with well 1092. The water level in 1093 was measured at 13.5'. Twenty feet of 2 inch stainless steel screen and thirty feet of air. Stainless steel casing were installed to a depth of 48.25'. Sand was tremied to 25.98 feet and bentonite poured to 23.80'. The remaining annulus was grouted using 5 bags of cement.

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 8 encompasses approximately 34 acres, the majority of which is located in Melton Valley. Irregular in shape, the site has two sinuous extensions from its northern end. One of the extensions extends northwest and crosses Haw Ridge, the other runs parallel to Melton Valley Drive. WAG 8 is underlain by three geologic units: Traversing the site from south to north are the Conasauga Group, the Rome Formation, and the Chickamauga Limestone. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strikes and dips. The regional strike is 56° northeast and the beds dip about 30° to the southeast.

2.3 Sample Collection

A drill water sample was collected from the water pump on the drill rig on 12-07-89. Analytical results for the water sample described above can be obtained from the Remedial Action Program data base at ORNL.

The Ingersoll Rand T-4's compressed air was sampled with a cloth filter inserted between drill rods on 12-07-89. 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 D well. The air rotary method was required to drill the boring to the specified total well depth. A 14.0-inch diameter boring was augered from ground surface to 5.5 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 5.5 to 48.25 feet. A 2-inch diameter stainless steel screen with threaded bottom cap was installed from 48.25 to 28.0 feet. A 2-inch diameter stainless steel casing was installed above the screen at 28.0 feet and extended 1.67 feet above ground surface. A sandpack was then tremied into the annular space from 48.25 to 25.98 feet, with a 2.18-foot bentonite pellet seal poured into the annular space above the sandpack from 25.98 to 23.80 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 1093 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 576 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 06-18-90 at a depth of 46.8 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 1093 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 2.42×10^{-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.

PRE-DRILLING CHECKLIST FOR
MONITORING WELLS

<u>PRE-DRILLING TASKS</u>	<u>COMPLIANCE</u>	
	<u>DATE</u>	<u>INITIALS</u>
1. EXCAVATION PERMIT OBTAINED	<u>11-29-89</u>	<u>CAB</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>11-29-89</u>	<u>CAB</u>
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.	<u>N/A</u>	<u> </u>
3b. PRE-PACKAGED SCREENS, CASING AND CENTRALIZERS WERE USED.	<u>12-08-89</u>	<u>CAB</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>11-29-89</u>	<u>CAB</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>11-29-89</u>	<u>CAB</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>11-29-89</u>	<u>CAB</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u>12-07-89</u>	<u>CAB</u>

RESULTS: No hydrocarbons detected under ultraviolet light.

ADDITIONAL NOTES/OBSERVATIONS: _____

OBSERVER SIGNATURE/DATE

C. Allison Bailey
C. Allison Bailey

12-08-89

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1093

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

ORNL MONITORING WELL LOG

PAGE 1 OF 1

LOCATION: WAG-8

DRILLER: Larry Ledbetter

HELPER: Fred Dixon

DRILL: Ingersoll Rand T-4

DATE: START: 11-29-89
FINISH: 12-08-89
LOGGED BY: C. Allison Bailey
HEALTH PHYSICIST: Carl Stooksbury

TYPE DRILLING: Augering, Air Rotary LUBRICANT TYPE: Green stuff
No. SAMPLES TAKEN: N/A TYPE: N/A
CONTAINMENT TYPE: Plastic, Pan, Containment Box

THICKNESS OF SOIL (REFUSAL DEPTH): 18.0
DEPTH DRILLED IN ROCK: 30.25
TOTAL DEPTH OF WELL: 48.25

DRILLING FLUID SAMPLES:
TYPE: Drill Water DATE: 12-07-89

[illegible]

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

EQUIPMENT ■ 14.0 INCH AUGER 5.5 L.F.

□ INCH AUGER L.F.

■ 8.0 INCH ROTARY 42.75 L.F.

MATERIALS USED

EST. USED
VOL. VOL.

20.0 FEET OF 2.0 IN. S.S. SCREEN

30.0 FEET OF 2.0 IN. S.S. CASING

7.5 7.5 SACKS OF SAND

50.0 50.0 POUNDS OF BENTONITE PELLETS

4.76 5.0 SACKS OF CEMENT

25.0 POUNDS OF POWDERED BENTONITE

30.0 GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED
VOLUMES AND USED VOLUMES

Spillage

WELL COVER USED

■ LOCKING STEEL COVER
□ FLUSH MOUNTED WELL COVER
□ OTHER

SILT TRAP USED

YES ■ NO □

MONITORING WELL PUMP BASE SET AT 46.8 FEET.

CENTRALIZERS AT 25.0 FEET.

48.0 FEET.

 FEET.

NOTE:

ALL DEPTHS ARE MEASURED
FROM GROUND SURFACE
UNLESS OTHERWISE NOTED:

LOCATION WAG-8

ORNL GRID COORDINATES

N 18,762.5730

E 32,402.1924

ELEV. GROUND 839.97

ELEV. TOP STAINLESS

STEEL CASING 841.64

DRILLING DATES:

STARTED: 11-29-89

FINISHED: 12-08-89

TYPE D WELL

NOT TO SCALE

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1093

DATE: 12-08-89

MONITORING WELL MATERIALS
CERTIFICATION

<i>ITEM/MATERIAL</i>	<i>DATE USED</i>	<i>BATCH NUMBER</i>
<i>SAND</i>	12-08-89	1
<i>BENTONITE</i>	12-08-89	2
<i>STAINLESS STEEL SCREEN</i> (PREPACKAGED ☒ YES ☐ NO)	12-08-89	2
<i>STAINLESS STEEL CASING</i> (PREPACKAGED ☒ YES ☐ NO)	12-08-89	2
<i>STAINLESS STEEL CENTRALIZERS</i> (PREPACKAGED ☒ YES ☐ NO)	12-08-89	2
<i>STAINLESS STEEL CAPS</i> (PREPACKAGED ☒ YES ☐ NO)	12-08-89	2
<i>MONITORING WELL PUMP</i> (PREPACKAGED ☒ YES ☐ NO)	6-18-90	6
<i>GROUT</i>	12-08-89	3
<i>WELL COVERS</i>		
<i>SURFACE CASING</i>	N/A	N/A

COMMENTS:

OBSERVER SIGNATURE/DATE C. Allison Bailey 12-08-89
C. Allison Bailey

POST-WELL COMPLETION
CHECKLIST

POST-WELL COMPLETION TASKS

COMPLIANCE
DATE INITIALS

1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	<u>11-29-89</u>	<u>CAB</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>11-29-89</u>	<u>CAB</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>6-18-90</u>	<u>DCS</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>12-08-89</u>	<u>CAB</u>

* 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 12-08-89
C. Allison Bailey

D. Charles Lytle 6-18-90
D. Charles Lytle

ERCE
Environmental
and Energy
Services Co.

WELL No. 1093
LOCATION: WAG-8

**MONITORING WELL
DEVELOPMENT FORM**

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and Pumping

DEVELOPMENT
BEGAN DATE: 6/08/90

TIME: _____

DEVELOPMENT
ENDING DATE: 6/18/90

DEVELOPMENT
OBSERVED BY: Chuck Lytle, Nick Norrad

ONE WELL VOLUME: 14.7 GALLONS

TOTAL GALLONS PUMPED: 576 TOTAL WELL VOLUMES PUMPED: 39.2

INITIAL pH: 8.3 FINAL pH: 8.3

INITIAL CONDUCTIVITY ($\mu S/cm$): 862 FINAL CONDUCTIVITY ($\mu S/cm$): 891

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: None

WATER
DISCHARGED
TO:

☒ GROUND SURFACE
☐ STORM SEWERS
☐ DRUMS

☐ TANK TRUCK
☐ STORAGE TANKS
☐ OTHER _____

INITIAL PRE-DEVELOPMENT
WATER DEPTH: 17.4 feet from ground surface.

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 6/18/90
D. Charles Lytle

ERCE
Environmental
and Energy
Services Co.

WELL NO. 1093
LOCATION: WAG-8
DATE: 6/08/90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 14.7 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCTIVITY (uS/cm)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
6-08-90	1120	42	Cloudy	--	8.3	862	42	2.9	
6-08-90	1413	27	Cloudy	--	8.5	864	69	4.7	
6-11-90	1405	88	Cloudy	--	8.3	870	157	10.7	
6-12-90	1115	43	Cloudy	--	8.3	887	200	13.6	
6-12-90	1500	42	Cloudy	--	8.2	855	242	16.5	
6-13-90	0930	30	Cloudy	--	8.3	885	272	18.5	
6-13-90	1050	15	Slightly Cloudy	--	8.3	907	287	19.5	
6-13-90	1320	10	Slightly Cloudy	--	8.1	868	297	20.2	
6-14-90	0930	65	Slightly Cloudy	--	8.6	898	362	24.6	
6-14-90	1400	15	Clear	6.0	8.3	901	377	25.6	
6-18-90	0930	159	Slightly Cloudy	--	8.3	875	536	36.5	
6-18-90	1130	20	Slightly Cloudy	--	8.6	914	556	37.8	
6-18-90	1355	20	Clear	5.0	8.3	891	576	39.2	
RESULTS AT END OF DEVELOPMENT			Clear	5.0	8.3	891	576	39.2	

COMMENTS Good producer, passed with 39.2 well volumes and 5.0 NTU's, moved
to another hole.

OBSERVER SIGNATURE/DATE

D. Charles Lytle 6/18/90
D. Charles Lytle

MWFORM03.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.: 1093

DATE OF TEST: 10-16-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: WAG-8

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 = 20.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 36.95 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)

3.1761
3.2305

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	5.290	4.290
20.00	5.150	4.150
30.00	4.940	3.940
40.00	4.820	3.820
50.00	4.680	3.680
60.00	4.560	3.560
75.00	4.340	3.340
90.00	4.170	3.170
105.00	4.030	3.030
120.00	3.900	2.900
150.00	3.680	2.680
180.00	3.480	2.480
240.00	3.140	2.140
300.00	2.870	1.870
360.00	2.680	1.680
420.00	2.520	1.520
480.00	2.380	1.380
540.00	2.270	1.270
600.00	2.130	1.130
720.00	1.970	.970
840.00	1.830	.830
960.00	1.740	.740
1080.00	1.620	.620
1200.00	1.590	.590
1320.00	1.530	.530
1440.00	1.470	.470
1560.00	1.440	.440
1680.00	1.400	.400
1800.00	1.380	.380
1920.00	1.350	.350
2040.00	1.330	.330
2160.00	1.310	.310

HYDRAULIC CONDUCTIVITY CALCULATIONS

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $7.94\text{E-}07$ FT/SEC = $2.42\text{E-}05$ CM/SEC

TRANSMISSIVITY = $1.59\text{E-}05$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $1.06\text{E-}06$ FT/SEC = $3.24\text{E-}05$ CM/SEC

TRANSMISSIVITY = $2.12\text{E-}05$ FT**2/SEC

HYDRAULIC CONDUCTIVITY CALCULATIONS

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**

107-200

WELL NO.

1093

LOCATION:

WNG-2

TYPE:

١٢٠

SAMPLER:

000.81-1

(SIGNATURE)

SAMPLE INTERVAL:

1.2/A

DATE:

15.

TIME:

144C

RELINQUISHED BY:
(SIGNATURE)

DATE:

TIME:

. MTH:

RECEIVED BY:
(SIGNATURE)

DATE:

TIME:

WTH:

all so fairly

01-15-90

1500

EDGE

(SIGNATURE)

1-590

1570

My

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 1094 is located in WAG 8. It is south of the southwest corner of WAG 8 approximately 1000' west of the high flux isotope reactor. The location is shown on ORNL drawing number C3E20004 A075. Survey coordinates for this well are N 16,682.8475, E 31,329.1592 (X-10 grid) or latitude 35°-54'-53.48" and longitude 84°-18'21.81". 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 1094 was drilled by Geotek Engineering Company. A Model B-50 and an Ingersoll Rand T-4 rig were used to drill this boring for monitor well installation under operation of Rick Herron and Larry Ledbetter with the assistance of James Shelton and Fred Dixon. Drilling commenced on 09-21-89 and was finished on 10-10-89. 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.

- 09-21-89: Decontaminated the Mobile B-50 auger rigs, augers and tools mobilized to the site and set up. Split spoon samples were taken through 6.0" hollow stem augers to a depth of 4.6' or refusal. One soil sample was taken. The sample was not uniform enough to conduct a bulk density test. A 22.0 inch boring was completed to 4.2' in order to set a 15 1/4 inch diverter casing.
- 09-22-89: The diverter casing was cut and deconed and mobilized to the site. The casing could not be installed because the boring has caved.
- 09-25-89: The auger rig, augers and tools were deconed, mobilized to the site and set up on a new location that was restaked by MMES. A 22.0 inch boring was augered to 5.25' and cleaned out to 4.75'. A diverter casing was installed and grouted.
- 10-02-89: The Ingersoll Rand T-4 was decontaminated along with tools mobilized to the site and set up.
- 10-03-89: The diverter head and containment box were rigged up. A 14.0 inch boring was completed to a depth of 20.5 feet with a tricone bit and a 10.0 inch surface casing was installed, bentonited and grouted.

10-06-89: The Ingersoll Rand T-4 and tools were deconed, mobilized to the site along with the containment box, and set up. The diverter head was rigged up and an eight inch boring was drilled to a total depth of 70.3' with a tricone bit. A 55.0' the boring produced 31.0' of water in 10 minutes. At 70.0' the boring produced 26.0 feet of water in 10 minutes. After removing the diverter, a large stream of water was visibly flowing into the boring at 24.0 feet. An air sample and drill water sample were taken.

10-09-89: The 4.0 inch stainless steel screen and casing were installed as per R.C. Williams. Sand was tremied and bentonite was poured inot the annulus.

10-10-89: The annulus was tremied grouted.

10-16-89: The well was tested with the "Go-No Go" gauge and passed by R. C. Williams.

This well was logged by ERC Environmental and Energy Services Co., Inc., hydrogeologist C. Allison Hodges 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 8 encompasses approximately 34 acres, the majority of which is located in Melton Valley. Irregular in shape, the site has two sinuous extensions from its northern end. One of the extensions extends northwest and crosses Haw Ridge, the other runs parallel to Melton Valley Drive. WAG 8 is underlain by three geologic units: Traversing the site from south to north are the Conasauga Group, the Rome Formation, and the Chickamauga Limestone. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strikes and dips. The regional strike is 56° northeast and the beds dip about 30° to the southeast.

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 1094S01 was collected in the split spoon interval from 3.0 feet to 4.1 feet on 09-21-89. A drill water sample, 1094W01, was collected from the water pump on the drill rig on 10-06-89. Analytical results for the soil and water samples described above can be obtained from the Remedial Action Program data base at ORNL.

The Ingersoll Rand T-4 compressed air was not sampled.

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 5.2 feet. A 15 1/4-inch diverter casing was installed from surface to 5.2 feet below ground surface and grouted in place. The boring was extended with a 14.0-inch air rotary tricone roller bit from 5.2 to 20.5 feet. A 10.0-inch diameter string of decontaminated steel surface casing was installed from 0.0 to 20.5 feet, sealed with a 2.9-foot bentonite pellet layer from 17.6 to 20.5 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 70.3 feet. A 4-inch diameter stainless steel silt trap was installed from 70.3 to 70.0 feet. A 4-inch diameter stainless steel screen was installed above the the silt trap from 70.0 to 55.0 feet. A sandpack was then tremied into the annular space from 52.0 to 70.3 feet, with a 1.8-foot bentonite pellet seal poured into the annular space above the sandpack from 50.2 to 52.0 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 1094 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 606 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 completions 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 06-07-90 at a depth of 60.3 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 1094 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 3.45×10^{-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.

WELL No. 1094

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

COMPLIANCE

INITIALS

CAH

CA#

N/A

10-09-89

11E

9-21-89

Call

9-21-89

с. 14

9-21-89

CAH

RESULTS: _____

ADDITIONAL NOTES/OBSERVATIONS: _____

Michael R. Ebers 10-09-89

OBSERVER SIGNATURE/DATE

C. Allison Hodges 9-21-89
C. Allison Hodges

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

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

OBSERVER SIGNATURE/DATE

C. Allison Hodges 9/21/89
C. Allison Hodges

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1094

ORNL MONITORING WELL LOG

PAGE 1 OF 2

LOCATION: WAG-8
DRILLER: Rick Herron/Larry Ledbetter
HELPER: James Shelton/Fred Dixon
DRILL: Mobile B-50/Ingersoll Rand T-4

DATE: START: 9-21-89
FINISH: 10-10-89
LOGGED BY: C. Allison Hodges/
Michael L. Ebers
HEALTH PHYSICIST: Carl Stooksbury

TYPE DRILLING: Dplit Spoon, Auger, Air Rotary LUBRICANT TYPE: Green stuff

No. SAMPLES TAKEN: One TYPE: Soil

CONTAINMENT TYPE: Plastic, Auger Pan, Containment Box

THICKNESS OF SOIL (REFUSAL DEPTH): 5.2

DEPTH DRILLED IN ROCK: 65.1'

TOTAL DEPTH OF WELL: 70.3'

DRILLING FLUID SAMPLES:

TYPE: Water DATE: 10/09/89

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
0.0	3.0			Gravel - fill material for pad.
3.0	3.6	1094S01	100%	Clay, olive gray, with roots and gravel,
		3.0-4.1'		slightly damp.
3.6	4.1			Clay, shaley, greenish gray and light olive
				brown with interbedded shale, hard, layered,
				dusky brown, damp to moist.
4.1	5.2		100%	Shale, highly weathered, crumbly, brittle, dry,
				bedded, olive gray and light olive gray, dry.
				- Samples not uniform enough to take bulk
				density sample.
	5.2			Auger refusal.
5.2	6.0			* Rough, hard drilling.
6.0	8.5			Smooth, easy drilling.
8.5	10.5			Hard, slow, smooth and soft drilling.
10.5	11.0			Smooth soft drilling.
11.0	12.5			Hard, irregular drilling, bit jumping around.
12.5	15.5			Smooth easy drilling.
15.5	17.5			Hard drilling.
17.5	18.5			Smooth easy drilling.
18.5	19.0			Hard drilling, slow.
19.0	20.0			Very hard drilling.

WELL No. 1094

ORNL MONITORING WELL LOG

PAGE 2 OF 2

* Detailed lithologic logs could not be provided from 5.2 to 70.3 feet due to the use of containment box.

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

LOGGED Allison Hodges/ PROOFED
BY: Michael L. Ebers BY: Michael L. Ebers

DRILLING COMPANY: Geotek
Rick Herron/ James Shelton/
DRILLER: Larry Ledbetter HELPER: Rick Herron

DRILLING METHOD: ☒ 22.0 INCH AUGER 5.2 L.F.
☐ INCH AUGER L.F.
☒ 14.0 INCH ROTARY 14.8 L.F.
☒ 8.0 INCH ROTARY 55.5 L.F.

MATERIALS USED

EST. VOL	USED VOL	
	50	POUNDS OF BENTONITE PELLETS (SURFACE CASING SEAL)
	20.5	FT. OF 10.0 IN. SURFACE CASING
5.3	6.0	SACKS OF CEMENT (SURFACE CASING)
	30.0	POUNDS OF POWDERED BENTONITE (SURFACE CASING)
	36.0	GALLONS OF WATER (SURFACE CASING)
	57.3	FT. OF 4.0 IN. DIA. STAINLESS STEEL CASING
	15.0	FT. OF 4.0 IN. DIA. STAINLESS STEEL SCREEN
4.6	4.5	SACKS OF SAND
36.0	50.0	POUNDS OF BENTONITE PELLETS
11.1	18.0	SACKS OF CEMENT (WELL CASING)
	90.0	POUNDS OF POWDERED BENTONITE (WELL CASING)
	108.0	GALLONS OF WATER (WELL CASING)
	3.3	FT. OF 10.0 IN. STEEL PROTECTIVE CASING

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

Wash out and water zone at ~25'

SURFACE CASING TREME GROUTED YES ☒ NO ☐

STAINLESS STEEL CASING TREME 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 60.3 FEET.

CENTRALIZERS AT 23.0 FEET.
48.0 FEET.
68.0 FEET.

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

TYPE B WELL

LOCATION WAG-8
ORNL GRID COORDINATES
N 16,682.8475
E 31,329.1592
ELEV. GROUND 782.45
ELEV. TOP STAINLESS
STEEL CASING 784.69
DRILLING DATES:
STARTED: 9-21-89
FINISHED: 10-09-89

MONITORING WELL MATERIALS
CERTIFICATION

<i>ITEM/MATERIAL</i>	<i>DATE USED</i>	<i>BATCH NUMBER</i>
<i>SAND</i>	10-09-89	1
<i>BENTONITE</i>	10-09-89	MMES Stores
<i>STAINLESS STEEL SCREEN</i> (PREPACKAGED ☒ YES ☐ NO)	10-09-89	MMES Stores
<i>STAINLESS STEEL CASING</i> (PREPACKAGED ☒ YES ☐ NO)	10-09-89	MMES Stores
<i>STAINLESS STEEL CENTRALIZERS</i> (PREPACKAGED ☒ YES ☐ NO)	10-09-89	MMES Stores
<i>STAINLESS STEEL CAPS</i> (PREPACKAGED ☒ YES ☐ NO)	10-09-89	MMES Stores
<i>MONITORING WELL PUMP</i> (PREPACKAGED ☒ YES ☐ NO)	6-07-90	6
<i>GROUT</i>	10-03-89	1
	10-10-89	2
<i>WELL COVERS</i>	10-09-89	MMES Stores
<i>SURFACE CASING</i>	10-03-89	1

COMMENTS:

OBSERVER SIGNATURE/DATE Michael L. Ebers 10/09/89

POST-WELL COMPLETION
CHECKLIST

POST-WELL COMPLETION TASKS

COMPLIANCE
DATE INITIALS

1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	<u>10-09-89</u>	<u>MLE</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>10-09-89</u>	<u>MLE</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>6-07-90</u>	<u>DCO</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>10-10-89</u>	<u>MLE</u>

* 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 10/09/89
Michael L. Ebers

D. Charles Lytle 6/07/90
D. Charles Lytle

ERCE
Environmental
and Energy
Services Co.

WELL No. 1094

LOCATION: WAG-8

**MONITORING WELL
DEVELOPMENT FORM**

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and Pumping

DEVELOPMENT
BEGAN DATE: 5/25/90

TIME: _____

DEVELOPMENT
ENDING DATE: 6/07/90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 59.1 GALLONS

TOTAL GALLONS PUMPED: 606 TOTAL WELL VOLUMES PUMPED: 10.3

INITIAL pH: 8.3 FINAL pH: 8.4

INITIAL CONDUCTIVITY ($\mu S/cm$): 391 FINAL CONDUCTIVITY ($\mu S/cm$): 444

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: None

WATER
DISCHARGED
TO:

☒ GROUND SURFACE
☐ STORM SEWERS
☐ DRUMS

☐ TANK TRUCK
☐ STORAGE TANKS
☐ OTHER _____

INITIAL PRE-DEVELOPMENT
WATER DEPTH: +1.3 feet above ground surface.

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 6/07/90
D. Charles Lytle

HYDROLOG

ERCE
Environmental
and Energy
Services Co.

WELL NO. 1094
LOCATION: WAG-8
DATE: 5/25/90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 59.1 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCT- IVITY (uS/cm)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
5-29-90	0900	64	Cloudy	--	8.3	391	64	1.1	
5-29-90	1100	30	Cloudy	--	8.6	402	94	1.6	
5-30-90	1300	62	Cloudy	--	8.5	438	156	2.6	
5-31-90	1430	124	Cloudy	--	8.0	443	280	5.0	
6-04-90	1100	42	Slightly Cloudy	--	7.9	486	322	5.4	
6-04-90	1300	61	Slightly Cloudy	--	8.3	401	383	6.5	
6-05-90	1100	63	Slightly Cloudy	--	8.4	420	446	7.5	
6-06-90	1430	110	Slightly Cloudy	--	8.4	458	556	9.4	
6-07-90	1000	50	Clear	3.0	8.4	444	606	10.3	
RESULTS AT END OF DEVELOPMENT			Clear	3.0	8.4	444	606	10.3	

COMMENTS Good producer. Water remained clear after surging. Passed with
3.0 NTU's, moved to another hole.

OBSERVER SIGNATURE/DATE

D. Charles Lytle 6-07-90
D. Charles Lytle

HWFORM05.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
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"A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY
OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY
PENETRATING WELLS")

WELL NO.: 1094

DATE OF TEST: 10-16-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: WAG-8

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 = 15.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 70.40 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 = .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)

1.2234
1.2266

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	2.250	1.250
20.00	2.240	1.240
30.00	2.240	1.240
40.00	2.230	1.230
50.00	2.220	1.220
60.00	2.220	1.220
75.00	2.220	1.220
90.00	2.210	1.210
105.00	2.210	1.210
120.00	2.190	1.190
150.00	2.160	1.160
180.00	2.170	1.170
240.00	2.140	1.140
300.00	2.100	1.100
360.00	2.080	1.080
420.00	2.060	1.060
480.00	2.040	1.040
540.00	2.000	1.000
600.00	1.980	.980
720.00	1.940	.940
840.00	1.910	.910
960.00	1.870	.870
1080.00	1.850	.850
1200.00	1.830	.830
1320.00	1.790	.790
1440.00	1.770	.770
1560.00	1.750	.750
1680.00	1.710	.710
1800.00	1.700	.700
1920.00	1.690	.690
2040.00	1.670	.670
2160.00	1.660	.660

1221-1094

HYDRAULIC CONDUCTIVITY CALCULATIONS

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $1.13\text{E-}06$ FT/SEC = $3.45\text{E-}05$ CM/SEC

TRANSMISSIVITY = $1.70\text{E-}05$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $1.31\text{E-}06$ FT/SEC = $4.00\text{E-}05$ CM/SEC

TRANSMISSIVITY = $1.97\text{E-}05$ FT**2/SEC

HYDRAULIC CONDUCTIVITY CALCULATIONS

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

1014-21

WELL NO.

1014

LOCATION:

WAG-8

TYPE:

Soil

SAMPLER:

C. Collins-Hodges

(SIGNATURE)

SAMPLE INTERVAL:

30-4.1

DATE:

9-21-89

TIME:

RELINQUISHED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

RECEIVED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

C. Collins-Hodges

10-3-89

EDGE

J. Price

10-3-89

1530

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.
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**

1094W01

WELL NO.

1094

LOCATION:

WAG 8

TYPE:

DRILL WATER

SAMPLER:*Michael J. Jones*

(SIGNATURE)

SAMPLE INTERVAL:

N/A

DATE:

10/6/89

TIME:

1500

**RELINQUISHED BY:
(SIGNATURE)****DATE:****TIME:****WITH:****RECEIVED BY:
(SIGNATURE)****DATE:****TIME:****WITH:***Michael J. Jones*

10/16/89

1045

EDGE

J.P. Lee

10/16/89

1045

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: SAMPLE TAKEN FROM WATER PUMP ON SIDE OF RIG

1.0 General Information

1.1 Well Location

Monitoring well number 1095 is located in WAG 8. It is located south of the southwest corner of WAG 8 approximately 1000 feet southwest of the high flux isotope reactor. The location is shown on ORNL drawing number C3E20004 A075. Survey coordinates for this well are N 16,634.4042, E 31,325.2365 (X-10 grid) or latitude 35°-54'-53.06" and longitude 84°-18'-21.52". 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 1095 was drilled by Geotek Engineering Company. A Mobile B-50 and an Ingersoll Rand T-4 rig were used to drill this boring for monitor well installation under operation of Rick Herron and Larry Ledbetter with the assistance of James Shelton and Fred Dixon. Drilling commenced on 09-25-89 and was finished on 10-13-89. 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.

09-25-89: The auger rig, augers, and tools were decontaminated and mobilized to the site and set up. A 14.0-inch boring was augered from ground surface to 3.4'. A 10.0-inch diverter casing was installed and grouted.

10-12-89: The T-4 was decontaminated along with the tools.

10-13-89: The rig was mobilized to the site and set up. The diverter head and containment box were rigged up. An 8-inch boring was completed to a depth of 23.10 feet using a tricone bit. The rods were removed and water was observed seeping through the boring walls between 10.0' and 16.0'. The 2-inch stainless steel screen and casing were installed sand tremined and bentonite poured into the borehole. The annulus was then grouted. An air and a drill water sample were taken.

10-16-89: The well was tested with the "Go-No Go" gauge and passed by R.C. Williams.

This well was logged by ERC Environmental and Energy Services Co., Inc., hydrogeologist C. Allison Hodges 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 8 encompasses approximately 34 acres, the majority of which is located in Melton Valley. Irregular in shape, the site has two sinuous extensions from its northern end. One of the extensions extends northwest and crosses Haw Ridge, the other runs parallel to Melton Valley Drive. WAG 8 is underlain by three geologic units. Traversing the site from south to north are the Conasauga Group, the Rome Formation, and the Chickamauga Limestone. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strikes and dips. The regional strike is 56° northeast and the beds dip about 30° to the southeast.

2.3 Sample Collection

A drill water sample was collected from the water pump on the drill rig on 10-13-89. Analytical results for the water sample (1095W01) can be obtained from the Remedial Action Program data base at ORNL.

The Ingersoll Rand T-4 compressed air was sampled with a cloth filter inserted between drill rods on 10-13-89. The cloth filter was inserted between drill rods on 10-13-89. The cloth filter was examined with an ultraviolet light for the presence of hydrocarbons. The filter exhibited a dull fluorescence.

2.4 Installation and Development

2.4.1 Installation

This was a Type D well. A 14.0-inch diameter boring was augered from ground surface to 3.4 feet and a 10.0-inch diameter diverter was installed from 0.0 to 3.4 feet and grouted. The air rotary method was required to complete the boring to the specified total well depth. An 8-inch diameter boring was then drilled with an air rotary tricone roller bit from 3.4 to 23.1 feet. A 2-inch diameter stainless steel silt trap was installed from 22.86 to 23.10 feet. A 2-inch diameter stainless steel screen was installed above the silt trap from 22.86 feet to 12.22 feet. Above the screen a 2-inch diameter stainless steel casing was installed from 12.22' and extended 2.3' above ground surface. A sandpack was then tremied into the annular space from 23.10 to 10.5 feet, with a 2.8-foot

bentonite pellet seal poured into the annular space above the sandpack from 7.7 to 10.5 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 1095 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 256 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 05-30-90 at a depth of 21.2 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 1095 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 6.79×10^{-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.

PRE-DRILLING CHECKLIST FOR MONITORING WELLS

CALL

PAGE 7 OF 18.

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

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

OBSERVER SIGNATURE/DATE C. Allison Hodges 9/25/89
C. Allison Hodges

**ERC / EDGE
Environmental
and Energy
Services Co.**

WELL No. 1095

ORNL MONITORING WELL LOG

PAGE 1 OF 1

LOCATION: WAG-8
DRILLER: Larry Ledbetter/Rick Herron
HELPER: Fred Dixon/James Shelton
DRILL: Ingersoll Rand T-4/Mobile B-50

DATE: START: 9/25/89
FINISH: 10/13/89
LOGGED BY: C. Allison Hodges/
Michael L. Ebers
HEALTH PHYSICIST: Carl Stooksbury

TYPE DRILLING: Auger, Air Rotary LUBRICANT TYPE: Green stuff

No. SAMPLES TAKEN: None TYPE: N/A

CONTAINMENT TYPE: Auger Pan, Plastic and Containment Box

THICKNESS OF SOIL (REFUSAL DEPTH): 3.4'
DEPTH DRILLED IN ROCK: 19.7'
TOTAL DEPTH OF WELL: 23.1'

DRILLING FLUID SAMPLES:
TYPE: Drill Water DATE: 10/13/89
(109SW01)

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
0.0	2.5			Gravel fill.
2.5	3.4			Clay, olive gray, slightly damp.
3.4	9.0			* Fairly hard, rough drilling.
9.0	11.0			Fairly hard, smooth drilling.
11.0	12.0			Soft drilling.
12.0	12.5			Hard, rough drilling.
12.5	14.0			Soft.
14.0	15.0			Alternating soft and hard drilling.
15.0	16.0			Hard, rough drilling.
16.0	18.5			Soft.
18.5	19.5			Hard.
19.5	23.1			Soft.
	23.1			Total Depth.
				* No detailed lithologic log could be provided
				from 3.4 to 23.1 feet due to the use of a
				containment box.

WELL INSTALLATION/COMPLETION FORM

O.R.N.L. MONITORING WELL PROGRAM

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

DRILLING COMPANY: Geotek
Rick Herron/
DRILLER: Larry Ledbetter HELPER: James Shelton/
Fred Dixon

LOCATION WAG-8
ORNL GRID COORDINATES
N 16,634.4042
E 31,325.2365
ELEV. GROUND 780.02
ELEV. TOP STAINLESS
STEEL CASING 782.31
DRILLING DATES:
STARTED: 9-25-89
FINISHED: 10-13-89

EQUIPMENT
■ 14.0 INCH AUGER 3.4 L.F.
■ 8.0 INCH TRICONE 19.7 L.F.
□ INCH ROTARY L.F.

MATERIALS USED

EST. USED
VOL. VOL.
10.64 FEET OF 2.0 IN. S.S. SCREEN
14.52 FEET OF 2.0 IN. S.S. CASING
3.0 5.0 SACKS OF SAND
60.0 50.0 POUNDS OF BENTONITE PELLETS
1.3 3.0 SACKS OF CEMENT
15.0 POUNDS OF POWDERED BENTONITE
18.0 GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

Irregular boring diameter and
spillage.

WELL COVER USED
☒ LOCKING STEEL COVER
☐ FLUSH MOUNTED WELL COVER
☐ OTHER
SLT TRAP USED YES ☒ NO ☐

MONITORING WELL PUMP BASE SET AT 21.2 FEET.

CENTRALIZERS AT 3.0 FEET.
21.0 FEET.
FEET.

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

HOLE CLEANED OUT
TO 23.10 FEET
BOTTOM OF BOREHOLE
23.10 FEET

LOCKING STEEL COVER
8 INCH DIAMETER
STEEL PROTECTIVE CASING
3.33 FT. ABOVE GROUND
TO 2.0 FT. BELOW
GROUND SURFACE
CONCRETE PAD
10.0 INCH DIVERTER
CASING 0.0 FT. ABOVE
GROUND SURFACE TO
3.4 FT. BELOW GROUND
SURFACE
14.0 INCH BOREHOLE
0.0 TO 3.4 FEET
GROUT SEAL 0.0 TO
7.7 FEET
8.0 INCH DIAMETER
BOREHOLE
2.0 INCH DIAMETER STAINLESS
STEEL CASING 2.3 FT. ABOVE
GROUND SURFACE TO 12.22 FT.
BELOW GROUND SURFACE
CENTRALIZER (TYP.)
BENTONITE PELLET SEAL
7.7 TO 10.5 FEET
SAND PACK
10.5 TO 23.10 FEET
2.0 INCH DIAMETER
STAINLESS STEEL 0.010
SLOTTED SCREEN
12.22 TO 22.86 FEET
2.0 INCH DIAMETER STAINLESS
STEEL SLT TRAP/CAP
22.86 TO 23.10 FEET

TYPE D WELL

NOT TO SCALE

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1095

DATE: 10/13/89

MONITORING WELL MATERIALS
CERTIFICATION

<u>ITEM/MATERIAL</u>	<u>DATE USED</u>	<u>BATCH NUMBER</u>
<u>SAND</u>	10-13-89	1
<u>BENTONITE</u>	10-13-89	MMES Stores
<u>STAINLESS STEEL SCREEN</u> (PREPACKAGED ☒ YES ☐ NO)	10-13-89	MMES Stores
<u>STAINLESS STEEL CASING</u> (PREPACKAGED ☒ YES ☐ NO)	10-13-89	MMES Stores
<u>STAINLESS STEEL CENTRALIZERS</u> (PREPACKAGED ☒ YES ☐ NO)	10-13-89	MMES Stores
<u>STAINLESS STEEL CAPS</u> (PREPACKAGED ☒ YES ☐ NO)	10-13-89	MMES Stores
<u>MONITORING WELL PUMP</u> (PREPACKAGED ☒ YES ☐ NO)	5-30-90	6
<u>GROUT</u>	10-13-89	1
<u>WELL COVERS</u>	10-13-89	MMES Stores
<u>SURFACE CASING</u>		

COMMENTS:

OBSERVER SIGNATURE/DATE

Michael L. Ebers

10/13/89

POST-WELL COMPLETION
CHECKLIST

POST-WELL COMPLETION TASKS

	COMPLIANCE	
	<u>DATE</u>	<u>INITIALS</u>
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	<u>10-13-89</u>	<u>MLE</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>10-13-89</u>	<u>MLE</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>5-30-90</u>	<u>DCL</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>10-13-89</u>	<u>MLE</u>

* 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

10/13/89
Michael L. Ebers

5/30/90
D. Charles Lytle

ERCE
Environmental
and Energy
Services Co.

WELL No. 1095
LOCATION: WAG-8

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and Pumping

DEVELOPMENT
BEGAN DATE: 5/29/90

TIME: _____

DEVELOPMENT
ENDING DATE: 5/30/90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 8.4 GALLONS

TOTAL GALLONS PUMPED: 256 TOTAL WELL VOLUMES PUMPED: 30.5

INITIAL pH: 8.3 FINAL pH: 8.2

INITIAL CONDUCTIVITY ($\mu S/cm$): 446 FINAL CONDUCTIVITY ($\mu S/cm$): 480

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: None

WATER
DISCHARGED
TO:

☒ GROUND SURFACE
☐ STORM SEWERS
☐ DRUMS

☐ TANK TRUCK
☐ STORAGE TANKS
☐ OTHER _____

INITIAL PRE-DEVELOPMENT
WATER DEPTH: 2.1 feet from ground surface.

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE D. Charles Lytle 5/30/90
D. Charles Lytle

DATE: 5/29/90

ONE WELL VOLUME = 8.4 GALLONS

COMMENTS	Excellent producer and recharger, recovered fast. Passed with 2.0 NTU's and 30.5 well volumes. Moved to another hole.
----------	---

OBSERVER SIGNATURE/DATE D. Charles Lytle 5/30/90
D. Charles Lytle

INFORMOS.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.: 1095

DATE OF TEST: 10-16-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: WAG-8

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 = 10.64 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 20.10 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 10.64 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 = 30

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

SUCCESSIVE COMPUTED
VALUES FOR H0
(FEET)

1.0622
1.0509

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	3.620	2.620
20.00	3.070	2.070
30.00	2.740	1.740
40.00	2.480	1.480
50.00	2.290	1.290
60.00	2.130	1.130
75.00	1.970	.970
90.00	1.840	.840
105.00	1.740	.740
120.00	1.660	.660
150.00	1.550	.550
180.00	1.480	.480
240.00	1.390	.390
300.00	1.350	.350
360.00	1.280	.280
420.00	1.270	.270
480.00	1.230	.230
540.00	1.210	.210
600.00	1.170	.170
720.00	1.140	.140
840.00	1.140	.140
960.00	1.130	.130
1080.00	1.080	.080
1200.00	1.080	.080
1320.00	1.080	.080
1440.00	1.050	.050
1560.00	1.040	.040
1680.00	1.020	.020
1800.00	1.020	.020
1920.00	1.010	.010

HYDRAULIC CONDUCTIVITY CALCULATIONS

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $2.23\text{E-}06$ FT/SEC = $6.79\text{E-}05$ CM/SECTRANSMISSIVITY = $2.37\text{E-}05$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $3.11\text{E-}06$ FT/SEC = $9.49\text{E-}05$ CM/SECTRANSMISSIVITY = $3.31\text{E-}05$ FT**2/SEC

HYDRAULIC CONDUCTIVITY CALCULATIONS

1.0 General Information

1.1 Well Location

Monitoring well number 1096 is located in WAG 9. It is located approximately 200 feet east of Building 7500. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 18,657.3102, E 31,549.5391 (X-10 grid) or 35°-55'-10.92" and 84°-18'-32.93". 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 1096 was drilled by Geotek Engineering Company. An Ingersoll Rand R-4 rig was used to drill this boring for monitor well installation under the operation of Larry Ledbetter with the assistance of Fred Dixon, Tom Doonan and Tracy Mitchell. Drilling commenced on 4/26/90, and was finished on 4/27/90. 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.

4/26/90: This location was determined to be Class III. Moved rig to location and set up on 2 sheets plastic. Split spoon samples taken from surface to refusal at 9.0 feet. Auger to refusal at 10.6 feet. (RAD > 50 cpm over background, OVA $\geq$ 0.05 ppm). Reamed hole to 9.0 feet using a 14.0 inch auger. Set 9.0 feet of 10.0 inch decontaminated steel diverter casing with 50.0 lbs. Bentonite pellets. Grout diverter casing annulus with 11.0 sacks cement.

4/27/90: Drill from 9.0 to 23.2 feet using an 8.0 inch air rotary tricone bit into containment box. Set 2.0 inch stainless steel screen and casing with sandpack and bentonite seal. Grout annulus with 3.0 sacks cement.

This well was logged by ERC Environmental and Energy Services Co. (ERC) 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

Based on a recently drafted geologic map (R. Dreier and K. Boedoin - 1987), WAG 9 is underlain by three members of the Conasauga Group. These members dip to the southeast and from youngest to oldest are: The Rogersville Shale, the Rutledge Limestone and the Pumpkin Valley Shale. The contact between the Rogersville Shale and the Rutledge Limestone occurs near the site's southern tip, while the Rutledge Limestone/Pumpkin Valley Shale contact occurs just south of Building 7500. The Rogersville Shale underlies the southernmost portion of WAG 9, the Rutledge Limestone underlies the site's south central portion (including the HRT Pond) and the Pumpkin Valley Shale underlies the site's northern portions.

2.3 Sample Collection

No samples were collected.

A bulk density soil sample was collected from the split spoon sample interval from 7.1 to 7.4 feet. The sample was measured and weighed, and a bulk density of 1.91 grams/cm³ was calculated.

The Ingersoll Rand T-4 compressed air was sampled with a cloth filter inserted between drill rods on 4/27/90. The sample was examined with an ultraviolet light for the presence 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. A 6-inch diameter boring was split spooned and augered from ground surface to auger refusal (10.6 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 9.0 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 9.0 to 23.2 feet. A 2-inch diameter stainless steel screen with threaded bottom cap was installed from 12.3 to 22.5 feet. A 2-inch diameter stainless steel casing was installed above the screen at 12.3 feet and extended 1.69 feet above ground surface. A sandpack was then tremied into the annular space from 23.2 feet up to 9.8, with a 1.4 foot bentonite pellet seal poured into the annular space above the sandpack from 8.4 to 9.8 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 1096 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 287 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 7.0 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 8/24/90 at a depth of 20.9 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 1096 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 psi pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 2.72×10^{-4} cm/second (shown as permeability on the hydraulic

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and Energy
Services Co.

MONITORING WELL PROGRAM
WELL DATA NARRATIVE
WELL No. 1096

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.

PRE-DRILLING CHECKLIST FOR
MONITORING WELLS

PRE-DRILLING TASKS

COMPLIANCE

	<u>DATE</u>	<u>INITIALS</u>
1. EXCAVATION PERMIT OBTAINED	<u>4/26/90</u>	<u>TML</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>4/26/90</u>	<u>TML</u>
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.	<u>N/A</u>	<u>N/A</u>
3b. PRE-PACKAGED SCREENS, CASING AND CENTRALIZERS WERE USED.	<u>4/27/90</u>	<u>TML</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>4/26/90</u>	<u>TML</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>4/26/90</u>	<u>TML</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>4/26/90</u>	<u>TML</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u>4/27/90</u>	<u>TML</u>

RESULTS: The air samples showed no detectable hydrocarbons under
ultraviolet light.

ADDITIONAL NOTES/OBSERVATIONS: _____

OBSERVER SIGNATURE/DATE

Timothy A. Lee 4/27/90
Timothy A. Lee

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WELL No. 1096

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
Timothy A. Lee

4/26/90

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and Energy
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WELL No. 1096

ORNL MONITORING WELL LOG

PAGE 1 OF 2

LOCATION: WAG9
DRILLER: Larry Ledbetter
HELPER: Fred Dixon, Tracey Mitchell, Tom Doonan
DRILL: Ingersoll Rand T-4

DATE: START: 4/26/90
FINISH: 4/27/90
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): 10.6'
DEPTH DRILLED IN ROCK: 12.6'
TOTAL DEPTH OF WELL: 23.2'

DRILLING FLUID SAMPLES:
TYPE: N/A DATE: N/A

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
0.0	5.0		Augered	Gravel fill
5.0	7.0		75%	Clay, sandy, dark yellowish brown, wet, iron stains, scattered vegetation, (RAD = 50 cpm over background, OVA < 0.05 ppm)
7.0	8.4		100%	Clay, sandy, dark yellowish brown, dripping wet vegetation, (RAD = 50 cpm over background, OVA < 0.05 ppm) Bulk density taken from 7.1 to 7.4 feet = 1.91 g/cm ³
8.4	8.6		100%	Shale, sandy, weathered, dark yellowish orange iron stains, moist, crumbly, (RAD background, OVA < 0.05 ppm)
8.6	9.0		100%	Shale, grayish brown, iron stains, dry, crumbly
9.0	9.5		100%	Clay, wet, sandy, dark yellowish brown, (RAD = 50 cpm over background, OVA < 0.05 ppm)
9.5	9.9		100%	Clay, mottled dark yellowish orange and pale olive, moist, plastic (RAD background, OVA = < 0.05 ppm)
9.9	10.2		100%	Shale, dark yellowish brown, dry, crumbly (RAD background, OVA = < 0.05 ppm)

PAGE 2 OF 2

PAGE 10 OF 18.

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, Tom Doonan

Tracey Mitchell

EQUIPMENT

■ 14 INCH AUGER 9.0 L.F.

□ INCH AUGER L.F.

■ 8.0 INCH ROTARY 14.2 L.F.

MATERIALS USED

EST. USED
VOL. VOL.

10.0 FEET OF 2.0 IN. S.S. SCREEN

15.0 FEET OF 2.0 IN. S.S. CASING

4.3 5.0 SACKS OF SAND

50.0 50.0 POUNDS OF BENTONITE PELLETS

1.7 3.0 SACKS OF CEMENT

15.0 POUNDS OF POWDERED BENTONITE

24.0 GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED
VOLUMES AND USED VOLUMES

Fractures, irregular boring diameters
and spillage

WELL COVER USED

■ LOCKING STEEL COVER
□ FLUSH MOUNTED WELL COVER
□ OTHER

SILT TRAP USED

YES ■ NO □

MONITORING WELL PUMP BASE SET AT 20.9 FEET.

CENTRALIZERS AT 21.0 FEET.

FEET.

FEET.

NOTE:

ALL DEPTHS ARE MEASURED
FROM GROUND SURFACE
UNLESS OTHERWISE NOTED:

HOLE CLEANED OUT

TO 23.2 FEET

BOTTOM OF BOREHOLE

23.2 FEET

LOCATION WAG9

ORNL GRID COORDINATES

N 18.657 3102

E 31.549 5391

ELEV. GROUND 812.97

ELEV. TOP STAINLESS

STEEL CASING 814.66

DRILLING DATES:

STARTED: 4/26/90

FINISHED: 4/27/90

LOCKING STEEL COVER

8 INCH DIAMETER

STEEL PROTECTIVE CASING

2.90 FT. ABOVE GROUND

TO 2.0 FT. BELOW

GROUND SURFACE

CONCRETE PAD

10.0 INCH DIVERTER

CASING 0.5 FT. ABOVE

GROUND SURFACE TO

9.0 FT. BELOW GROUND

SURFACE

14.0 INCH BOREHOLE

0.0 TO 9.0 FEET

GROUT SEAL 0.0 TO

8.4 FEET

8.0 INCH DIAMETER

BOREHOLE

2.0 INCH DIAMETER STAINLESS

STEEL CASING 1.69 FT. ABOVE

GROUND SURFACE TO 12.3 FT.

BELOW GROUND SURFACE

CENTRALIZER (TYP.)

BENTONITE PELLET SEAL

8.4 TO 9.8 FEET

SAND PACK

9.8 TO 23.2 FEET

2.0 INCH DIAMETER

STAINLESS STEEL 0.010

SLOTTED SCREEN

12.3 TO 22.3 FEET

2.0 INCH DIAMETER STAINLESS

STEEL SILT TRAP/CAP

22.3 TO 22.5 FEET

TYPE D WELL

NOT TO SCALE

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and Energy
Services Co.

WELL No. 1096

DATE: 4/27/90

MONITORING WELL MATERIALS
CERTIFICATION

ITEM/MATERIAL		DATE USED	BATCH NUMBER
SAND			
		4/27/90	2
BENTONITE	Powder	4/27/90	6
	Pellets	4/27/90	1
STAINLESS STEEL SCREEN	(PREPACKAGED ☒ YES ☐ NO)	4/27/90	4
STAINLESS STEEL CASING	(PREPACKAGED ☒ YES ☐ NO)	4/27/90	4
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED ☒ YES ☐ NO)	4/27/90	4
STAINLESS STEEL CAPS	(PREPACKAGED ☒ YES ☐ NO)	4/27/90	4
MONITORING WELL PUMP	(PREPACKAGED ☒ YES ☐ NO)	8/24/90	8
GROUT	Diverter casing	4/26/90	7
	well casing	4/26/90	7
WELL COVERS			
SURFACE CASING		4/26/90	6

COMMENTS:

OBSERVER SIGNATURE/DATE

Timothy A. Lee
Timothy A. Lee

4/27/90

POST-WELL COMPLETION
CHECKLIST

	COMPLIANCE	
	<u>DATE</u>	<u>INITIALS</u>
<u>POST-WELL COMPLETION TASKS</u>		
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	<u>4/27/90</u>	<u>Tms</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>4/27/90</u>	<u>Tms</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>8/24/90</u>	<u>DCC</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>4/27/90</u>	<u>Tms</u>

* 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 4/27/90
Timothy A. Lee

D. Charles Lytle 8/24/90
D. Charles Lytle

ERCE
Environmental
and Energy
Services Co.

WELL No. 1096

LOCATION: WAG9

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Pumping with Geoguard pump

DEVELOPMENT
BEGAN DATE: 8/21/90 TIME: _____

DEVELOPMENT
ENDING DATE: 8/24/90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 8.4 GALLONS

TOTAL GALLONS PUMPED: 287 TOTAL WELL VOLUMES PUMPED: 34.1

INITIAL pH: 8.6 FINAL pH: 8.5

INITIAL CONDUCTIVITY ($\mu S/cm$): 669 FINAL CONDUCTIVITY ($\mu S/cm$): 551

DESCRIPTION OF INITIAL TURBIDITY: Muddy

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 7.0 NTU's

WELL APPROVED BY: R.C. Williams MMES

ODOR

OF WATER: None

WATER

☐ GROUND SURFACE

☐ TANK TRUCK

DISCHARGED

☐ STORM SEWERS

☐ STORAGE TANKS

TO:

☒ DRUMS

☐ OTHER _____

INITIAL PRE-DEVELOPMENT

WATER DEPTH: 3.2 feet from ground surface

DEVELOPMENT OBSERVATIONS

OVA tests were fine, nothing found coming from barrels, breathing zone,
or the well.

OBSERVER SIGNATURE/DATE

D. Charles Lytle 8/24/90

D. Charles Lytle

WATERBURY

DATE: 8/21/90

ONE WELL VOLUME = 8.4 GALLONS

COMMENTS Excellent recharger and producer, made lots of water. OVA tests were fine, nothing found coming from barrels, breathing zone, or well. Passed with 34.1 well volumes.

OBSERVER SIGNATURE/DATE D. Charles Lytle 8/24/90
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.: 1096

DATE OF TEST: 11-1-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: WAG-9

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 = 10.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 19.90 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 10.00 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 = 21

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

SUCCESSIVE COMPUTED VALUES FOR H₀ (FEET)

1.5382
1.6736
1.8600
1.9418

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	4.340	3.340
20.00	3.780	2.780
30.00	3.290	2.290
40.00	2.890	1.890
50.00	2.560	1.560
60.00	2.300	1.300
75.00	2.010	1.010
90.00	1.750	.750
105.00	1.610	.610
120.00	1.470	.470
150.00	1.300	.300
180.00	1.200	.200
240.00	1.120	.120
300.00	1.100	.100
360.00	1.070	.070
420.00	1.060	.060
480.00	1.040	.040
540.00	1.040	.040
600.00	1.020	.020
720.00	1.020	.020
840.00	1.010	.010

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $8.91\text{E-}06$ FT/SEC = $2.72\text{E-}04$ CM/SEC

TRANSMISSIVITY = $8.91\text{E-}05$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $1.25\text{E-}05$ FT/SEC = $3.79\text{E-}04$ CM/SEC

TRANSMISSIVITY = $1.25\text{E-}04$ FT**2/SEC

HYDRAULIC CONDUCTIVITY CALCULATIONS

1.0 General Information

1.1 Well Location

Monitoring well number 1097 is located in WAG 9. It is located approximately 200 feet east of Building 7500. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 18,499.5984, E 31,506.2596 (X-10 grid) or 35°-55'-09.39" and 84°-18'-32.30". 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 1097 was drilled by Geotek Engineering Company. An Ingersoll Rand R-4 rig was used to drill this boring for monitor well installation under the operation of Larry Ledbetter with the assistance of Fred Dixon, Tom Doonan and Tracy Mitchell. Drilling commenced on 4/25/90, and was finished on 4/25/90. 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 follows. This information was typed directly from field notes and was edited only when necessary for clarification.

- 4/24/90: This location was determined to be Class III. Move on staked location and set up on 2 sheets of plastic.
- 4/25/90: Split spoon samples taken from surface to refusal at 14.9 feet. Auger to refusal at 17.8 feet with 6.0-inch augers (RAD = 50 cpm over background, OVA <0.05 ppm). Reamed hole with 12-inch augers to refusal at 17.8 feet. (RAD = about 2MR/hr). Drummed all soil material. Set 2.0-inch stainless steel screen and casing inside 12-inch augers with sandpack and bentonite seal. This location remains Class III due to the radiation encountered.
- 4/26/90: Grout well casing annulus with 2.0 sacks cement.

This well was logged by ERC Environmental and Energy Services Co. (ERC) 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

Based on a recently drafted geologic map (R. Dreier and K. Boedoin - 1987), WAG 9 is underlain by three members of the Conasauga Group. These members dip to the southeast and from youngest to oldest are: The Rogersville Shale, the Rutledge Limestone and the Pumpkin Valley Shale. The contact between the Rogersville Shale and the Rutledge Limestone occurs near the site's southern tip, while the Rutledge Limestone/Pumpkin Valley Shale contact occurs just south of Building 7500. The Rogersville Shale underlies the southernmost portion of WAG 9, the Rutledge Limestone underlies the site's south central portion (including the HRT Pond) and the Pumpkin Valley Shale underlies the site's northern portions.

2.3 Sample Collection

A bulk density soil sample was collected from the split spoon sample interval from 10.0 to 10.3 feet. The sample was measured and weighed, and a bulk density of 2.20 grams/cm³ was calculated.

2.4 Installation and Development

2.4.1 Installation

This was a Type A well. A 12-inch diameter boring was split spooned and augered from ground surface to a total depth of 17.8 feet. A 2-inch diameter stainless steel

screen with threaded bottom cap was installed from 7.3 feet to 17.5 feet. A 2-inch diameter stainless steel casing was installed above the screen from 7.3 feet to 2.7 feet above ground surface. A sandpack was then tremied into the annular space from 17.5 feet up to 5.7 feet, with a 1.5 foot bentonite pellet seal poured into the annular space above the sandpack from 4.2 to 5.7 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 1097 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 195 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 8/31/90 at a depth of 16.9 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 1097 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 psi pressure transducer and an Omnidata Datapod II data recorder. The hydraulic conductivity value of 2.50×10^{-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.

PRE-DRILLING CHECKLIST FOR
MONITORING WELLS

<u>PRE-DRILLING TASKS</u>	<u>COMPLIANCE</u>	
	<u>DATE</u>	<u>INITIALS</u>
1. EXCAVATION PERMIT OBTAINED	<u>4/25/90</u>	<u>TJm</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>4/25/90</u>	<u>TJm</u>
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.	<u>N/A</u>	<u>N/A</u>
3b. PRE-PACKAGED SCREENS, CASING AND CENTRALIZERS WERE USED.	<u>4/25/90</u>	<u>TJm</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>4/25/90</u>	<u>TJm</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>4/25/90</u>	<u>TJm</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>4/25/90</u>	<u>TJm</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u>N/A</u>	<u>N/A</u>

RESULTS: _____

ADDITIONAL NOTES/OBSERVATIONS: _____

OBSERVER SIGNATURE/DATE

Timothy A. Lee
Timothy A. Lee

4/25/90

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1097

DECONTAMINATION CHECKLIST
DRILLING EQUIPMENT

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

OBSERVER SIGNATURE/DATE

Timothy A. Lee

4/23/90

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1097

ORNL MONITORING WELL LOG

PAGE 1 OF 2

LOCATION: WAG9
DRILLER: Larry Ledbetter
HELPER: Fred Dixon, Tom Doonan, Tracey Mitchell
DRILL: Ingersoll Rand T-4

DATE: START: 4/25/90
FINISH: 4/26/90
LOGGED BY: Timothy A. Lee
HEALTH PHYSICIST: C.E. Stooksbury

TYPE DRILLING: Split spoon, auger LUBRICANT TYPE: Green stuff
No. SAMPLES TAKEN: None TYPE: N/A
CONTAINMENT TYPE: Plastic, pan

THICKNESS OF SOIL (REFUSAL DEPTH): 17.8'
DEPTH DRILLED IN ROCK: 0.0'
TOTAL DEPTH OF WELL: 17.8'

DRILLING FLUID SAMPLES:
TYPE: N/A DATE: N/A

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
0.0	5.0		Augered	Gravel fill
5.0	7.0		05%	Clay, dusky yellowish brown, moist, scattered sandstone, medium grained, yellowish brown, scattered vegetation (RAD = 50 cpm over background, OVA < 0.05 ppm)
7.0	9.0		05%	Clay, dusky yellowish brown, dry, scattered sandstone fragments, medium grained, yellowish brown, scattered vegetation (RAD = 50 cpm over background, OVA = < 0.05 ppm)
9.0	9.3		100%	Clay, dusky yellowish brown, dry, scattered fragments of sandstone, medium grained, yellowish brown, (RAD = slightly greater than background, OVA = < 0.1 ppm)
9.3	10.7		100%	Clay, light olive gray, moist, plastic (RAD background, OVA < 0.5 ppm) Bulk density taken from 10.0 to 10.3 feet = 2.20 g/cm ³
10.7	11.0		100%	Clay, mottled dark yellowish orange and pale olive, shaley, iron staining. (RAD background, OVA = < 0.5 ppm)

ORNL MONITORING WELL LOG

PAGE 2 OF 2

PAGE 9 OF 18.

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1097

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, Tom Doonan
Tracey Mitchell

EQUIPMENT ☒ 12.0 INCH AUGER 17.8 L.F.
☐ _____ INCH AUGER _____ L.F.

LOCATION WAG9
ORNL GRID COORDINATES
N 18,499.5984
E 31,506.2596
ELEV. GROUND 810.85
ELEV. TOP STAINLESS
STEEL CASING 812.55
DRILLING DATES:
STARTED: 4/25/90
FINISHED: 4/25/90

MATERIALS USED

EST. USED VOL. VOL.
10.0 FEET OF 2.0 IN. S.S. SCREEN
9.0 FEET OF 2.0 IN. S.S. CASING
7.2 8.0 SACKS OF SAND
50.0 50.0 POUNDS OF BENTONITE PELLETS
1.7 2.0 SACKS OF CEMENT
10.0 POUNDS OF POWDERED BENTONITE
16.0 GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

Fractures and spillage

WELL COVER USED ☒ LOCKING STEEL COVER
☐ FLUSH MOUNTED WELL COVER
☐ OTHER
SILT TRAP USED YES ☒ NO ☐

MONITORING WELL PUMP BASE SET AT 16.9 FEET.

CENTRALIZERS AT 2.0 FEET.
16.0 FEET.
_____ FEET.

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

MOLE CLEANED OUT
TO 17.5 FEET
BOTTOM OF BOREHOLE
17.8 FEET

LOCKING STEEL COVER
8 INCH DIAMETER
STEEL PROTECTIVE CASING
3.15 FT. ABOVE GROUND
TO 2.0 FT. BELOW
GROUND SURFACE
CONCRETE PAD
GROUT SEAL 0.0 TO
4.2 FEET
12.0 INCH DIAMETER
BOREHOLE
2.0 INCH DIAMETER STAINLESS
STEEL CASING 1.70 FT. ABOVE
GROUND SURFACE TO 7.3 FT.
BELOW GROUND SURFACE
CENTRALIZER (TYP.)
BENTONITE PELLET SEAL
4.2 TO 5.7 FEET
SAND PACK
5.7 TO 17.5 FEET
2.0 INCH DIAMETER
STAINLESS STEEL 0.010
SLOTTED SCREEN
7.3 TO 17.3 FEET
2.0 INCH DIAMETER STAINLESS
STEEL SILT TRAP/CAP
17.3 TO 17.5 FEET

TYPE A WELL

NOT TO SCALE

MONITORING WELL MATERIALS
CERTIFICATION

<u>ITEM/MATERIAL</u>	<u>DATE USED</u>	<u>BATCH NUMBER</u>
SAND	4/25/90	2
BENTONITE Powder Pellets	4/26/90	6
	4/25/90	1
STAINLESS STEEL SCREEN (PREPACKAGED ☒ YES ☐ NO)	4/25/90	4
STAINLESS STEEL CASING (PREPACKAGED ☒ YES ☐ NO)	4/25/90	4
STAINLESS STEEL CENTRALIZERS (PREPACKAGED ☒ YES ☐ NO)	4/25/90	4
STAINLESS STEEL CAPS (PREPACKAGED ☒ YES ☐ NO)	4/25/90	4
MONITORING WELL PUMP (PREPACKAGED ☒ YES ☐ NO)	8/31/90	8
GROUT	4/26/90	7
WELL COVERS		
SURFACE CASING	N/A	N/A

COMMENTS:

OBSERVER SIGNATURE/DATE

Timothy A. Lee 4/26/90
Timothy A. Lee

POST-WELL COMPLETION
CHECKLIST

	COMPLIANCE	
	<u>DATE</u>	<u>INITIALS</u>
<u>POST-WELL COMPLETION TASKS</u>		
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	<u>4/25/90</u>	<u>Th</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>4/25/90</u>	<u>Th</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>8/31/90</u>	<u>DCL</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>4/26/90</u>	<u>Th</u>

* 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 4/26/90
Timothy A. Lee

D. Charles Lytle 8/31/90
D. Charles Lytle

ERCE
Environmental
and Energy
Services Co.

WELL No. 1097

LOCATION: WAG9

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Pumping with Geoguard pump

DEVELOPMENT
BEGAN DATE: 8/22/90

TIME: _____

DEVELOPMENT
ENDING DATE: 8/31/90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 6.2 GALLONS

TOTAL GALLONS PUMPED: 195 TOTAL WELL VOLUMES PUMPED: 31.4

INITIAL pH: 8.5 FINAL pH: 8.2

INITIAL CONDUCTIVITY ($\mu S/cm$): 500 FINAL CONDUCTIVITY ($\mu S/cm$): 735

DESCRIPTION OF INITIAL TURBIDITY: Milky

DESCRIPTION OF FINAL TURBIDITY: Muddy

FINAL MEASURED TURBIDITY: 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: 8.5 feet from ground surface

DEVELOPMENT OBSERVATIONS

OVA tests were fine no odor or volatiles found coming from well, barrels,
or breathing zone.

OBSERVER SIGNATURE/DATE

D. Charles Lytle 8/27/90
D. Charles Lytle

ERC / EDGE
Environmental
and Energy
Services Co.

WELL NO. 1097

LOCATION: WAG9

DATE: 8/22/90

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 6.2 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCT- IVITY (uS)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
8/22/90	0900	15	Milky	---	8.5	500	15	2.4	
8/22/90	1430	55	Cloudy	---	8.6	699	70	11.3	
8/23/90	0800	15	Muddy	---	8.4	678	85	13.7	
8/23/90	1430	20	Muddy	---	8.5	654	105	16.9	
8/24/90	0800	10	Muddy	---	8.4	671	115	18.5	
8/24/90	1330	20	Muddy	---	8.3	691	135	21.7	
8/27/90	1330	30	Muddy	---	8.2	787	165	26.6	
8/28/90	1400		Muddy	---	8.1	746			
8/30/90	1400	10	Muddy	---	8.2	724	175	28.2	
8/31/90	1400	20	Muddy	100 NTU's	8.2	735	195	31.4	
RESULTS AT END OF DEVELOPMENT			Muddy	100 NTU's	8.2	735	195	31.4	

COMMENTS

Water would not clear up, remains muddy, had to pass with 31.4 well volumes. Well was a good recharger and producer.

OBSERVER SIGNATURE/DATE

D. Charles Lytle 8/27/90
D. Charles Lytle

INFORMATION

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.: 1097

DATE OF TEST: 11-1-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: WAG-9

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 = 12.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 10.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 9.60 FEET
THICKNESS OF SATURATED AQUIFER ZONE = 10.00 FEET
DEPTH TO STATIC WATER LEVEL BELOW REF. POINT = .20 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)

1.0040
1.0236

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	2.710	2.510
20.00	2.460	2.260
30.00	2.200	2.000
40.00	1.980	1.780
50.00	1.800	1.600
60.00	1.630	1.430
75.00	1.420	1.220
90.00	1.240	1.040
105.00	1.100	.900
120.00	.980	.780
150.00	.810	.610
180.00	.740	.540
240.00	.700	.500
300.00	.650	.450
360.00	.620	.420
420.00	.570	.370
480.00	.560	.360
540.00	.530	.330
600.00	.520	.320
720.00	.480	.280
840.00	.480	.280
960.00	.450	.250
1080.00	.450	.250
1200.00	.450	.250
1320.00	.420	.220
1440.00	.420	.220
1560.00	.420	.220
1680.00	.410	.210
1800.00	.360	.160
1920.00	.360	.160
2040.00	.350	.150
2160.00	.350	.150

1221-K-0002

HYDRAULIC CONDUCTIVITY CALCULATIONS

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $8.20\text{E-}07$ FT/SEC = $2.50\text{E-}05$ CM/SEC

TRANSMISSIVITY = $8.20\text{E-}06$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $1.39\text{E-}06$ FT/SEC = $4.24\text{E-}05$ CM/SEC

TRANSMISSIVITY = $1.39\text{E-}05$ FT**2/SEC

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

Reviewed by: Bene J. Bowles Date 1/16/90
Next Level Manager
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 ^{MS} 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 <u>Project Manager</u>	J.A. GREENE	11/19/89
A _____ Other <u>Environmental Compliance</u>	C.E. Nix	10/5/89
R _____ Other <u>Waste Management</u>	C.B. Scott	11/1/89

Is revision of the SAR/OSR required? YES ☒ 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 hydrogeologist.

- 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.

*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.

WAG 8 GROUNDWATER QUALITY MONITORING
WELLS AS-BUILT COORDINATES

WELL #	NORTHING	EASTING
1087	19,935.31	31,497.73
1088	19,155.72	30,367.64
1089	19,150.16	31,431.76
1090	19,157.68	31,441.95
1091	18,785.40	32,196.40
1092	18,752.78	32,378.53
1093	18,762.57	32,402.19
1094	16,682.85	31,329.16
1095	16,634.40	31,325.24

WAG 9 GROUNDWATER QUALITY MONITORING
WELLS AS-BUILT COORDINATES

WELL #	NORTHING	EASTING
1096	18,657.31	31,549.54
1097	18,408.60	31,508.25

NO REPRESENTATION OR WARRANTY, EXPRESSED OR IMPLIED, IS MADE AS TO THE ACCURACY, COMPLETENESS OR USEFULNESS OF THE INFORMATION OR STATEMENTS CONTAINED IN THESE DRAWINGS, OR THAT THE USE OR DISCLOSURE OF ANY INFORMATION, APPARATUS, METHOD OR PROCEDURE ENCLOSED IN THESE DRAWINGS MAY NOT INFRINGE PRIVATE RIGHTS OF OTHERS. NO LIABILITY IS ASSUMED WITH RESPECT TO THE USE OF, OR FOR DAMAGES RESULTING FROM THE USE OF ANY INFORMATION, APPARATUS, METHOD OR PROCEDURE ENCLOSED IN THESE DRAWINGS. DRAWINGS MADE AVAILABLE FOR INFORMATION TO BIDDER ARE NOT TO BE USED FOR OTHER PURPOSES, AND ARE TO BE RETURNED UPON REQUEST OF THE FORWARDING CONTRACTOR.

B CHANGED TITLE										LGW	CDP	816 91																																															
A REV MON WELLS 1087-1097 TO AS-BUILT STATUS										SKH	AMP	10/8/87																																															
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TOLERANCES UNLESS OTHERWISE SPECIFIED										DES C FOLDEN										10/87									
FRACTIONS XX DECIMALS 2										CHK A PHILLIPS										10/87									
ANGLES BREAK SHARP EDGES MAX FINISH										SECT 311/44 E										12/87									
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WAG 8 & 9 MON WELL LOC MAP										TYPE																																																											
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