ORNL/ER-69

Environmental Restoration Division
ORNL Environmental Restoration Program

**Groundwater Quality Monitoring Well Installation for
Upper Waste Area Grouping 2 at Oak Ridge National
Laboratory, Oak Ridge, Tennessee**

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EXECUTIVE SUMMARY

This report documents the drilling and installation of seven groundwater quality monitoring (GQM) wells on the perimeter of Upper Waste Area Grouping (WAG) 2. Upper WAG 2 is composed of portions of White Oak Creek (WOC), Melton Branch, two of Melton Branch's tributaries, and the floodplains surrounding these water bodies. The WOC section of the subject site begins at the confluence of WOC and Melton Branch and extends 0.62 mile upstream to the 7500 bridge. The Melton Branch portion of the site also begins at the confluence of WOC and Melton Branch and extends eastward 0.88 mile upstream. The wells at Upper WAG 2 were drilled and developed between December 1989 and October 1990. These wells were installed to characterize and assess the WAG in accordance with applicable Department of Energy, state, and Environmental Protection Agency regulatory requirements.

Well design and placement were performed by Martin Marietta Energy Systems, Inc., (Energy Systems) geologic staff and their subcontractors. The wells were drilled, installed, and developed by 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 was provided by Energy Systems staff or their subcontractors.

The wells at Upper WAG 2 were drilled with auger or air rotary rigs. Depending upon the hydrogeologic conditions present at each proposed well location, one of three 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. In order 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 Upper WAG 2. 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 Upper Waste Area Grouping (WAG) 2. 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 Upper WAG 2 were drilled and developed between December 1989 and October 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 UPPER WAG 2

WAG 2 consists of two SWMUs, (1) White Oak Lake and the embayment below White Oak Dam above the Clinch River and (2) WOC and its tributaries and their respective floodplains. These surface water bodies constitute the major drainage system for ORNL and its outlying support facilities. For the sake of better management of data, production of usable graphics, and presentation of concise descriptive information, WAG 2 has been divided into upper and lower sections.

Upper WAG 2 shares boundaries with WAG 1, WAG 4, WAG 5, WAG 7, and WAG 8 [Fig 1, map pocket (MMES map #C3E20004A121, Rev. B)]. It receives drainage from these WAGs and from WAG 9. Each of the above listed WAGs contains SWMUs that have operating histories spanning as much as 40 years. During this 40-year period, surface runoff and groundwater transport of contaminants from the adjoining WAGs have occurred. Many of these contaminants have accumulated within the floodplain and streambed sediments of Upper WAG 2.

In addition to serving as a collection point for the more mobile contaminants, Upper WAG 2 contains two inactive waste management units and one active unit. The oldest inactive waste management unit is the remnants of a diked area at the bottom of a former impoundment. The impoundment was located on the WOC floodplain south of the 7500 bridge and served as an intermediate settling basin for ORNL plant discharges from 1943 to 1944. Late in 1944, the dike failed and the impoundment was drained, but many of the contaminated sediments remain.

The second inactive waste management unit in Upper WAG 2 is a short section of

abandoned intermediate-level liquid waste (ILLW) line that crosses beneath the floodplain. This portion of the ILLW line is located just north of the confluence of WOC and Melton Branch. The short section of line was part of the ILLW delivery system that was extended from the pits and trenches area in WAG 7 to the first hydrofracture site in WAG 5. The line was eventually abandoned in favor of an alternate route, and no leaks are reported to have occurred on this short section of ILLW line.

The only active SWMU in Upper WAG 2 is a short section of ILLW line located about 300 ft east of the confluence of WOC and Melton Branch. This section of ILLW line is part of the alternate route mentioned above. It is used to transfer ILLW to storage tanks at the new hydrofracture facility.

Overall, the contamination in Upper WAG 2 is thought to be derived chiefly from non-point sources in adjoining WAGs. As a result, the distribution of contaminants in Upper WAG 2 is believed to be diffuse, with locally elevated contamination zones resulting from the principal discharge points for surface water and ground water from the adjoining WAGs. Seven monitoring wells were drilled in Upper WAG 2 in the floodplain of White Oak Creek and its tributaries (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 (A, B, and D) were used at Upper WAG 2. These three types are described in Sects. 4.1 through 4.3. 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 Upper WAG 2 wells can be found in the report *Preliminary Geohydrologic Site Characterization and Proposed Water Quality Well Locations for WAG 11 and Upper WAG 2*, ORNL/RAP/Sub-87/SB189/1.² The actual completion data for Upper WAG 2 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 wells 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 was reamed to refusal with a larger auger, and a steel diverter casing is installed. The annulus is grouted up to surface level. The boring is deepened to total depth with a tricone air rotary bit, 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 Upper WAG 2

Well	Depth clean to (ft) ^a	SST casing diam(in.)	Well type	Screened interval (ft)	Water level (ft) ^b
1150	16.0	2	A	5.8–15.8	–5.0
1151	20.0	2	D	4.8–19.8	–2.1
1152	14.9	2	D	4.7–14.7	–5.8
1153	18.0	2	D	7.8–17.8	–4.1
1154	15.3	2	D	5.1–15.1	–3.9
1155	23.0	2	D	12.8–22.8	–6.6
1156	21.3	2	D	11.0–21.0	–7.9

^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 Upper WAG 2 was conducted in accordance with procedures outlined in the document *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. This rating determined the level of personnel training required and health and safety coverage to be used during drilling.

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

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

4. FIELD SUPPORT

The construction contractor Geotek Engineering Company, whose contract began in May 1989, installed the GQM wells in Upper WAG 2. ORNL Engineering administered the drilling contract through Energy Systems Procurement. The management organization chart for the project is in the *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 Service 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 seven GQM wells drilled in Upper WAG 2. These data packages are 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 well. 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 nephelometric turbidity units (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 seven wells in Upper WAG 2, six wells had turbidity ratings of less than or equal to 5 NTUs. The number of well volumes removed ranged from 17.4 to 52.1, with an average of 29.9. 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 when drilling with the air rotary took place. All samples were transferred using chain-of-custody forms, which are included in the data packages. The sampling procedures are explained in ORNL/RAP/LTR-88/28.⁴ Soil samples were collected from each single well and from one well of each well pair. A drilling-water sample was collected from each air-rotary-drilled boring.

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

8. SPECIAL NOTES ON INSTALLATION AND DEVELOPMENT

During the drilling of the GQM wells in Upper WAG 2, wells 1152 and 1156 were determined by HP to be Class II locations (moderate probability of encountering contamination). No measurable RAD over background was encountered at either location.

REFERENCES

1. Engineering Division, *Construction Specifications for Monitoring Wells Installation Construction Project*, Rev. 2, K-4491G-G1, Martin Marietta Energy Systems, Inc., Oak Ridge National Laboratory, Oak Ridge, Tenn., August 1988.
2. Engineering, Design and Geosciences Group, Inc., *Preliminary Geohydrologic Site Characterization and Proposed Water Quality Well Locations For WAG 11 and Upper WAG 2*, ORNL/RAP/Sub/87-SB189/1, 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 1150 is located in Upper WAG 2. It is 750 feet due south of the intersection of Lagoon Road and Melton Valley Road. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 19,298.5495, E 29,620.0985 (X-10 grid) or latitude 35°-55'-05.58" and longitude 84°-18'-56.76". 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 1150 was drilled by Geotek Engineering Company. A Schramm Rotadrill rig was used to drill this boring for monitor well installation under operation of George Akins with the assistance of James Shelton. Drilling commenced on December 14, 1989, and was finished on December 14, 1989. Paragraph 2.4.1 includes a detailed discussion of the well installation and a well schematic is included on the well installation/completion

form. A synopsis of the drilling activity follows. This information was typed directly from field notes and was edited only when necessary for clarification.

12-14-89 The rig was mobilized to the staked location and set up on plastic sheeting. Split Spoon samples were taken from surface to 10.8 feet at refusal. The boring was deepened to 16.3 feet using a 6-inch auger. Set stainless steel casing with sand pack and bentonite seal. The rig was moved from location.

12-15-89 The casing was grouted into place with 1.0 sack of cement.

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

2.0 Technical Information

2.1 Decontamination Procedures

The drilling rig, down hole tools, surface casing, stainless steel screen, stainless steel casing, centralizers, and stainless steel silt trap underwent the cleaning decontamination procedures outlined in the drilling specifications (Release Specific Technical

Directions for Regulatory Compliance Monitoring Wells Phase 1, Oak Ridge National Laboratory, Oak Ridge, W.O. K-4147, April 1987, pgs. 2-4). A checklist of the cleaned materials is included with this data package.

2.2 Geology

The Rome Formation underlies the northern portion of Upper WAG 2 and consists of variegated shale and siltstone with beds of gray, fine grained sandstone. The Conasauga Group underlies the southern portion of Upper WAG 2 and is divided into five members. They are from north to south, the Pumpkin Valley Shale, Rutledge Limestone, Rogersville Shale, Maryville Limestone, and Nolichucky Shale. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strike and dips. The regional strike is 56 degrees northeast with dips of about 30 degrees to the southeast. The White Oak Creek tear fault is in Upper WAG 2. Displacement varies from 40 feet up to 350 feet.

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 soil sample is included with this data package. Soil sample 1150S01 was collected in the split spoon interval from 8.0 feet to 8.5 feet on December 14, 1989.

A bulk density soil sample was collected from the split spoon sample interval from 4.5 feet to 4.8 feet. The sample was measured and weighed, and a bulk density of 2.10 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 16.3 feet. A 2-inch diameter stainless steel screen with threaded bottom cap was installed from 5.8 feet to 16.0 feet. A 2-inch diameter stainless steel casing was installed above the screen from 5.8 feet to 1.74 feet above ground surface. A sand pack was then tremied into the annular space from 4.6 feet to 16.0 feet, with a 1.9-foot bentonite pellet seal poured into the annular space above the sandpack from 2.7 feet to 4.6 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 1150 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 150 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 July 17, 1990, at a depth of 13.6 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 1150 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 1.10×10^{-4} cm/second (shown as permeability on the hydraulic conductivity calculations printout attached) was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

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WELL No. 1150

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>12-14-89</u>	<u>TJ</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>12-14-89</u>	<u>TJ</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>12-14-89</u>	<u>TJ</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>12-14-89</u>	<u>TJ</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>12-14-89</u>	<u>TJ</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>12-14-89</u>	<u>TJ</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u>N/A</u>	<u>N/A</u>

RESULTS: N/A

ADDITIONAL NOTES/OBSERVATIONS: _____

_____
_____
_____
_____

OBSERVER SIGNATURE/DATE

Timothy A. Lee 12-14-89

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WELL No. 1150

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 12-14-89
Timothy A. Lee

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WELL No. 1150

ORNL MONITORING WELL LOG

PAGE 1 OF 2

LOCATION: Upper WAG 2
DRILLER: George Akins
HELPER: James Shelton
DRILL: Schramm Rotadrill

DATE: START: 12-14-89
FINISH: 12-14-89
LOGGED BY: Timothy A. Lee
HEALTH PHYSICIST: Bill Shinpaugh

TYPE DRILLING: Split spoons, augers LUBRICANT TYPE: Green stuff
No. SAMPLES TAKEN: One TYPE: Soil
CONTAINMENT TYPE: Plastic, pan

THICKNESS OF SOIL (REFUSAL DEPTH): 16.3'
DEPTH DRILLED IN ROCK: 0.0'
TOTAL DEPTH OF WELL: 16.3'

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	1.5		Augered	Gravel fill
1.5	3.5		75%	Clay, moderate yellowish brown, medium dense, damp, scattered sandstone, reddish brown
3.5	3.8		90%	Clay, dark yellowish brown, damp, scattered roots and vegetation
3.8	4.4		90%	Clay, dark yellowish orange, dry, plastic, slightly silty, mottled with clay, yellowish gray, dark streaks
4.4	5.5		90%	Clay, dark yellowish brown, damp, loose, slightly silty. Bulk density taken from 4.5' 4.8', Bulk density is 2.10 g/cm ³
5.5	6.1		50%	Clay, dark yellowish brown, wet, slightly silty loose, very soft
6.1	6.6		50%	Clay, light olive gray, moist, loose, soft
6.6	7.5		50%	Clay, moderate yellowish brown, damp, and shale olive gray, iron stained
7.5	9.0	1150S01	90%	Clay, light olive gray, wet, slightly silty
		8.0' - 8.5'		
9.0	9.5		100%	Shale, olive gray to light olive gray, iron stains

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and Energy
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WELL No. 1150

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: George Akins HELPER: James Shelton

EQUIPMENT ☒ 6 INCH AUGER 16.3 L.F.
☐ _____ INCH AUGER _____ L.F.

MATERIALS USED

EST. USED
VOL. VOL.

10.0 FEET OF 2 IN. S.S. SCREEN
5.8 FEET OF 2 IN. S.S. CASING
2.0 2.5 SACKS OF SAND
25.0 37.5 POUNDS OF BENTONITE PELLETS
1.0 1.0 SACKS OF CEMENT
5.0 POUNDS OF POWDERED BENTONITE
8.0 GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

Fractures and irregular boring
diameters

WELL COVER USED

☒ LOCKING STEEL COVER
☐ FLUSH MOUNTED WELL COVER
☐ OTHER

SILT TRAP USED

YES ☒ NO ☐

MONITORING WELL PUMP BASE SET AT 13.6 FEET.

CENTRALIZERS AT 7.0 FEET.
15.0 FEET.
_____ FEET.

NOTE:

ALL DEPTHS ARE MEASURED
FROM GROUND SURFACE
UNLESS OTHERWISE NOTED:

HOLE CLEANED OUT
TO 16.0 FEET
BOTTOM OF BOREHOLE
16.3 FEET

LOCATION WAG2
ORNL GRID COORDINATES
N 19,298.5495
E 29,620.0985
ELEV. GROUND 770.33
ELEV. TOP STAINLESS
STEEL CASING 772.07
DRILLING DATES:
STARTED: 12-14-89
FINISHED: 12-14-89

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

CONCRETE PAD

GROUT SEAL 0.0 TO
2.7 FEET

6 INCH DIAMETER
BOREHOLE

2 INCH DIAMETER STAINLESS

STEEL CASING 1.74 FT. ABOVE

GROUND SURFACE TO 5.8 FT
BELOW GROUND SURFACE

CENTRALIZER (TYP.)

BENTONITE PELLET SEAL
2.7 TO 4.6 FEET

SAND PACK
4.6 TO 16.0 FEET

2 INCH DIAMETER
STAINLESS STEEL 0.010

SLOTTED SCREEN
5.8 TO 15.8 FEET

2 INCH DIAMETER STAINLESS

STEEL SILT TRAP/CAP
15.8 TO 16.0 FEET

TYPE A WELL

NOT TO SCALE

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1150

DATE: 12-14-89

MONITORING WELL MATERIALS
CERTIFICATION

<u>ITEM/MATERIAL</u>	<u>DATE USED</u>	<u>BATCH NUMBER</u>
SAND	12-14-89	1
BENTONITE Pellets	12-14-89	1
BENTONITE Powder	12-14-89	3
STAINLESS STEEL SCREEN (PREPACKAGED ☒ YES ☐ NO)	12-14-89	2
STAINLESS STEEL CASING (PREPACKAGED ☒ YES ☐ NO)	12-14-89	2
STAINLESS STEEL CENTRALIZERS (PREPACKAGED ☒ YES ☐ NO)	12-14-89	2
STAINLESS STEEL CAPS (PREPACKAGED ☒ YES ☐ NO)	12-14-89	2
MONITORING WELL PUMP (PREPACKAGED ☒ YES ☐ NO)	07-17-90	7
GROUT	12-14-89	3
WELL COVERS		
SURFACE CASING	N/A	N/A

COMMENTS:

OBSERVER SIGNATURE/DATE

Timothy A. Lee 12-14-89
Timothy A. Lee

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1150

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>12-14-89</u>	<u>Tbn</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>12-14-89</u>	<u>Tbn</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>07-17-90</u>	<u>DCL</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>12-14-89</u>	<u>Tbn</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 12-14-89
Timothy A. Lee

D. Charles Lytle 07-17-90
D. Charles Lytle

ERCE
Environmental
and Energy
Services Co.

WELL No. 1150
Upper
LOCATION: WAG2

**MONITORING WELL
DEVELOPMENT FORM**

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and pumping

DEVELOPMENT
BEGAN DATE: 7/16/90 TIME: _____

DEVELOPMENT
ENDING DATE: 7/17/90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 4.5 GALLONS

TOTAL GALLONS PUMPED: 150 TOTAL WELL VOLUMES PUMPED: 33.3

INITIAL pH: 8.1 FINAL pH: 8.1

INITIAL CONDUCTIVITY ($\mu S/cm$): 466 FINAL CONDUCTIVITY ($\mu S/cm$): 466

DESCRIPTION OF INITIAL TURBIDITY: Muddy

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: 5.0 feet from ground surface

DEVELOPMENT OBSERVATIONS

_____
_____
_____
_____
_____

OBSERVER SIGNATURE/DATE D. Charles Lytle 7/17/90
D. Charles Lytle

ONE WELL VOLUME = 4.5 GALLONS

COMMENTS	Started out as a very poor producer, then started pumping water on 7/16/90. Had to pass with 33.3 well volumes

INFORMATIONS

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.: 1150

DATE OF TEST: 10-29-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: U. WAG-2

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 = 10.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 11.20 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 = 27

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

SUCCESSIVE COMPUTED
VALUES FOR H0
(FEET)

1.1307
1.1808

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	4.640	3.640
20.00	3.650	2.650
30.00	3.240	2.240
40.00	2.910	1.910
50.00	2.630	1.630
60.00	2.430	1.430
75.00	2.200	1.200
90.00	2.020	1.020
105.00	1.870	.870
120.00	1.750	.750
150.00	1.540	.540
180.00	1.410	.410
240.00	1.260	.260
300.00	1.170	.170
360.00	1.140	.140
420.00	1.120	.120
480.00	1.090	.090
540.00	1.080	.080
600.00	1.060	.060
720.00	1.040	.040
840.00	1.040	.040
960.00	1.040	.040
1080.00	1.020	.020
1200.00	1.020	.020
1320.00	1.020	.020
1440.00	1.020	.020
1560.00	1.010	.010

HYDRAULIC CONDUCTIVITY CALCULATIONS

*****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $3.61\text{E-}06$ FT/SEC = $1.10\text{E-}04$ CM/SEC

TRANSMISSIVITY = $3.61\text{E-}05$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $4.80\text{E-}06$ FT/SEC = $1.46\text{E-}04$ CM/SEC

TRANSMISSIVITY = $4.80\text{E-}05$ 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

1150501

WELL NO. 1150		LOCATION: WAG 2			TYPE: SOIL		
SAMPLER: Timothy G. [Signature] (SIGNATURE)		SAMPLE INTERVAL: 8.0' To 8.5'			DATE: 12-14-89		TIME: 0920
RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECEIVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
Timothy G. [Signature]	12/17/89	1245	ERC	JHS	12/14/89	12:42	

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 1151 is located in Upper WAG 2. It is along the northeast boundary of Upper WAG 2, approximately 250 feet southeast of building 7500. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 18,531.4384, E 31,761.3675 (X-10 grid) or latitude 35°-55'-11.05" and longitude 84°-18'-29.94". 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 1151 was drilled by Geotek Engineering Company. A Schramm Rotadrill rig was used to drill this boring for monitor well installation under operation of George Akins with the assistance of James Shelton. Drilling commenced on December 7, 1989, and was finished on December 12, 1989. Paragraph 2.4.1 includes a detailed discussion of the well installation and a well schematic is included on the well installation/completion

form. A synopsis of the drilling activity follows. This information was typed directly from field notes and was edited only when necessary for clarification.

- 12-07-89 The rig was mobilized to the staked location and set up on plastic sheeting.
- 12-08-89 Split spoon samples were taken from surface to 7.9 feet at refusal. The boring was widened with a 14-inch auger to 3.9 feet and set 10 3/4-inch diverter casing and grouted it into place. the rig was moved from location.
- 12-12-89 The rig was moved to location and set up. The boring was deepened from 7.9 feet to 20.3 feet using a 7 7/8-inch rotary air tricone bit into a containment box. Water was heard flowing into well. Therefore, set 2-inch stainless steel screen and casing with sand pack and bentonite seal. The casing was grouted into place with 1 sack of cement.

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

2.0 Technical Information

2.1 Decontamination Procedures

The drilling rig, down hole tools, surface casing, stainless steel screen, stainless steel casing,

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

2.2 Geology

The Rome Formation underlies the northern portion of Upper WAG 2 and consists of variegated shale and siltstone with beds of gray, fine grained sandstone. The Conasauga Group underlies the southern portion of Upper WAG 2 and is divided into five members. They are from north to south, the Pumpkin Valley Shale, Rutledge Limestone, Rogersville Shale, Maryville Limestone, and Nolickucky Shale. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strike and dips. The regional strike is 56 degrees northeast with dips of about 30 degrees to the southeast. The White Oak Creek tear fault is in Upper WAG 2. Displacement varies from 40 feet up to 350 feet.

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. Soil sample 1151S01 was collected in the split spoon interval from 6.3 feet to 6.6 feet on December 8, 1989. A drill water sample was collected from the water pump on the drill rig on

December 12, 1989. Analytical results for the soil and water samples described above can be obtained from the Remedial Action Program data base at ORNL. Chain of custody forms for these samples are included with this data package.

A bulk density soil sample was collected from the split spoon sample interval from 6.3 feet to 6.6 feet. The sample was measured and weighed, and a bulk density of 2.22 grams/cm³ was calculated.

The Schramm Rotadrill compressed air was sampled with a cloth filter inserted between drill rods on December 12, 1989. 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/augered from ground surface to auger refusal (7.9 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 3.9 feet and a 10 3/4-inch diverter casing was installed and grouted. An 8-inch diameter boring was then drilled with an air rotary tricone roller bit from 3.9 to 20.3 feet. A 2-inch diameter stainless steel screen with welded bottom cap was installed from 4.8 to 20.0 feet. A 2-inch diameter stainless steel casing was installed above the screen at 4.8 feet and

extended 1.80 feet above ground surface. A sandpack was then tremied into the annular space from 3.3 to 20.0 feet, with a 1.6-foot bentonite pellet seal poured into the annular space above the sandpack from 1.7 to 3.3 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 1151 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 495 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 4.0 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 June 22, 1990, at a depth of 18.1 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 1151 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 2.87×10^{-5} cm/second (shown as permeability on the hydraulic conductivity calculations printout attached) was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1151

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>12-8-89</u>	<u>Tm</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>12-8-89</u>	<u>Tm</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>12-12-89</u>	<u>Tm</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>12-8-89</u>	<u>Tm</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>12-8-89</u>	<u>Tm</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>12-8-89</u>	<u>Tm</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u>12-12-89</u>	<u>Tm</u>

RESULTS: Showed no signs of hydrocarbons under ultraviolet light

ADDITIONAL NOTES/OBSERVATIONS: _____
_____
_____
_____
_____

OBSERVER SIGNATURE/DATE Timothy A. Lee 12-12-89

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1151

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 12-7-89
 Timothy A. Lee

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1151

ORNL MONITORING WELL LOG

PAGE 1 OF 2

LOCATION: Upper WAG2
DRILLER: George Akins
HELPER: James Shelton
DRILL: Schramm Rotadrill

DATE: START: 12-8-89
FINISH: 12-12-89
LOGGED BY: Timothy A. Lee
HEALTH PHYSICIST: Ed Turnington

TYPE DRILLING: Split spoon, Auger, Air Rotary LUBRICANT TYPE: Green stuff
No. SAMPLES TAKEN: One soil TYPE: Soil
CONTAINMENT TYPE: Plastic, pan, containment box

THICKNESS OF SOIL (REFUSAL DEPTH): 7.9'
DEPTH DRILLED IN ROCK: 12.4'
TOTAL DEPTH OF WELL: 20.3'

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

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
0.0	1.6		Augered	Gravel fill
1.6	1.8		50%	Gravel fill
1.8	3.6		50%	Clay, dark yellowish brown, slightly silty, damp, plastic, mottled with clay, light gray
3.6	4.1		60%	Clay, dark yellowish brown, slightly silty, damp, plastic, mottled with light gray clay
4.1	4.6		60%	Clay, dark yellowish orange, wet, slightly silty, mottled with clay, grayish orange
4.6	5.6		60%	Shale, moderate yellowish brown, damp, crumbly
5.6	6.0		100%	Clay, dark yellowish orange, moist, plastic dense, mottled with clay light gray, black streaks
6.0	6.6	1151S01	100%	Clay, pale olive, damp, dense, plastic, mottled with clay dark yellowish orange. Bulk density from 6.3' to 6.6' = 2.22 g/cm ³
6.6	7.6		100%	Shale, light olive gray, crumbly, dark streaks
	7.6			First split spoon refusal
7.6	7.9		100%	Shale, limey, medium light gray, medium crystalline
	7.9			Second split spoon refusal and auger refusal

ORNL MONITORING WELL LOG

PAGE 2 OF 2

PAGE 10 OF 21.

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1151

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: George Akins HELPER: James Shelton

EQUIPMENT ☐ 6 INCH AUGER 7.9 L.F.
☐   INCH AUGER   L.F.
☐ 7 7/8 INCH ROTARY 12.4 L.F.

MATERIALS USED

EST. USED VOL. VOL.
15.0 FEET OF 2 IN. S.S. SCREEN
5.3 FEET OF 2 IN. S.S. CASING
4.0 6.0 SACKS OF SAND
50.0 50.0 POUNDS OF BENTONITE PELLETS
0.5 1.0 SACKS OF CEMENT
5.0 POUNDS OF POWDERED BENTONITE
8.0 GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

Fractures and 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 18.1 FEET.

CENTRALIZERS AT 6.0 FEET.
19.0 FEET.
       FEET.

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

LOCATION WAG2
ORNL GRID COORDINATES
N 18.531.4384
E 31.761.3675
ELEV. GROUND 807.45
ELEV. TOP STAINLESS
STEEL CASING 809.25
DRILLING DATES:
STARTED: 12-7-89
FINISHED: 12-12-89

TYPE D WELL

NOT TO SCALE

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1151

DATE: 12-12-89

MONITORING WELL MATERIALS
CERTIFICATION

ITEM/MATERIAL	DATE USED	BATCH NUMBER
SAND	12-12-89	1
BENTONITE Pellets	12-12-89	1
BENTONITE Powder	12-12-89	3
STAINLESS STEEL SCREEN (PREPACKAGED ☒ YES ☐ NO)	12-12-89	2
STAINLESS STEEL CASING (PREPACKAGED ☒ YES ☐ NO)	12-12-89	2
STAINLESS STEEL CENTRALIZERS (PREPACKAGED ☒ YES ☐ NO)	12-12-89	2
STAINLESS STEEL CAPS (PREPACKAGED ☒ YES ☐ NO)	12-12-89	2
MONITORING WELL PUMP (PREPACKAGED ☒ YES ☐ NO)	06-22-90	7
GROUT	12-12-89	3
WELL COVERS		
SURFACE CASING	N/A	N/A

COMMENTS:

OBSERVER SIGNATURE/DATE

Timothy A. Lee 12-12-89
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>12-12-89</u>	<u>Ph</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>12-12-89</u>	<u>Ph</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>06-22-89</u>	<u>DCL</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>12-12-89</u>	<u>Ph</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 12-12-89
Timothy A. Lee

D. Charles Lytle 06-22-90
D. Charles Lytle

ERCE
Environmental
and Energy
Services Co.

WELL No. 1151
Upper
LOCATION: WAG2

**MONITORING WELL
DEVELOPMENT FORM**

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and pumping

DEVELOPMENT
BEGAN DATE: 6/19/90

TIME: _____

DEVELOPMENT
ENDING DATE: 6/22/90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle and Nick Norrod

ONE WELL VOLUME: 9.5 GALLONS

TOTAL GALLONS PUMPED: 495 TOTAL WELL VOLUMES PUMPED: 52.1

INITIAL pH: 8.3 FINAL pH: 8.8

INITIAL CONDUCTIVITY ($\mu S/cm$): 786 FINAL CONDUCTIVITY ($\mu S/cm$): 815

DESCRIPTION OF INITIAL TURBIDITY: Cloudy

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 4.0 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: 2.1 feet from ground surface

DEVELOPMENT OBSERVATIONS

_____
_____
_____
_____
_____

OBSERVER SIGNATURE/DATE D. Charles Lytle 6/22/90
D. Charles Lytle

WELL NO. 1151
LOCATION: Upper WAG2
DATE: 6/19/90

ONE WELL VOLUME = 9.5 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCT- IVITY (U.S./cm)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
6/20/90	1130	122	Cloudy	---	8.3	786	122	12.8	
6/20/90	1330	85	Cloudy	---	8.5	792	207	21.8	
6/21/90	1025	90	Cloudy	---	8.3	763	297	31.3	
6/22/90	1000	90	Clear	14.0	8.7	780	377	39.7	
6/22/90	1400	118	Clear	4.0	8.8	815	495	52.1	
RESULTS AT END OF DEVELOPMENT			Clear	4.0	8.8	815	495	52.1	

Fast recharger and a good producer. Water clean even after surging.
Passed with 4.0 NTU's and 52.1 well volumes. Moved to another hole.

OBSERVER SIGNATURE/DATE D. Charles Lytle 6/22/90
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.: 1151

DATE OF TEST: 10-19-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: U. WAG-2

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 = 7.88 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 15.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 18.50 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)

.5027
.5166

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	2.170	1.170
20.00	1.970	.970
30.00	1.820	.820
40.00	1.730	.730
50.00	1.690	.690
60.00	1.600	.600
75.00	1.550	.550
90.00	1.480	.480
105.00	1.450	.450
120.00	1.420	.420
150.00	1.370	.370
180.00	1.350	.350
240.00	1.260	.260
300.00	1.250	.250
360.00	1.230	.230
420.00	1.200	.200
480.00	1.190	.190
540.00	1.180	.180
600.00	1.140	.140
720.00	1.140	.140
840.00	1.130	.130
960.00	1.100	.100
1080.00	1.090	.090
1200.00	1.090	.090
1320.00	1.080	.080
1440.00	1.060	.060
1560.00	1.060	.060
1680.00	1.060	.060
1800.00	1.060	.060
1920.00	1.070	.070
2040.00	1.060	.060
2160.00	1.060	.060

HYDRAULIC CONDUCTIVITY CALCULATIONS

*****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $9.43\text{E-}07$ FT/SEC = $2.87\text{E-}05$ CM/SEC

TRANSMISSIVITY = $1.41\text{E-}05$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $1.30\text{E-}06$ FT/SEC = $3.96\text{E-}05$ CM/SEC

TRANSMISSIVITY = $1.95\text{E-}05$ 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

1151501

WELL NO.

1151

LOCATION:

WAG 2

TYPE:

SOIL

SAMPLER:

Timothy G. Jones

(SIGNATURE)

SAMPLE INTERVAL:

6.3' - 6.6'

DATE:

12-8-89

TIME:

1115

RELINQUISHED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

RECEIVED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

Timothy G. Jones

12/19

1245

ERC

JHS

12/19/89

12:43

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 1-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

AMPLE
NUMBER

1151401

WELL NO.

1151

LOCATION:

WAG 2

TYPE:

DRILL WATER

SAMPLER:

Justin G. [Signature]

(SIGNATURE)

SAMPLE INTERVAL:

20.3'

DATE:

12-12-89

TIME:

0945

RELINQUISHED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

RECEIVED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

Justin G. [Signature]

12/19/89

1245

ERC

JH S

12/19/89

12:42

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 1152 is located in Upper WAG 2. It is on the east side of Upper WAG 2, approximately 500 feet south of building 7900 in HFIR. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 16,470.8164, E 32,503.0399 (X-10 grid) or latitude 35°-54'-58.20" and longitude 84°-18'-08.51". 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 1152 was drilled by Geotek Engineering Company. A Schramm Rotadrill rig was used to drill this boring for monitor well installation under operation of George Akins with the assistance of James Shelton. Drilling commenced on December 11, 1989, and was finished on December 13, 1989. Paragraph 2.4.1 includes a detailed discussion of the well installation and a well schematic is included on the well installation/completion form. A synopsis of the drilling activity follows. This

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

- 12-08-89 The rig was mobilized to the staked location and set up on plastic sheeting.
- 12-11-89 Split Spoon samples were taken from surface to 9.9 feet. The boring was widened with a 14 1/2-inch auger to 4.2 feet. Set 4.2 feet of decontaminated 10 3/4-inch diverter casing and grouted it into place with cement. The rig was moved from location.
- 12-13-89 The rig was moved to location and set up on plastic. The boring was deepened from 4.2 feet to 15.0 feet using a 7 7/8-inch air rotary tricone bit into a contaminant box. Set 2-inch stainless steel screen and casing with sand pack and bentonite seal.
- 12-14-89 The casing was grouted into place with 1 sack of cement.

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

2.0 Technical Information

2.1 Decontamination Procedures

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

2.2 Geology

The Rome Formation underlies the northern portion of Upper WAG 2 and consists of variegated shale and siltstone with beds of gray, fine grained sandstone. The Conasauga Group underlies the southern portion of Upper WAG 2 and is divided into five members. They are from north to south, the Pumpkin Valley Shale, Rutledge Limestone, Rogersville Shale, Maryville Limestone, and Nolichucky Shale. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strike and dips. The regional strike is 56 degrees northeast with dips of about 30 degrees to the southeast. The White Oak Creek tear fault is in Upper WAG 2. Displacement varies from 40 feet up to 350 feet.

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. Soil sample 1152S01 was collected in the split spoon interval from 6.3 feet to 6.7 feet on December 11, 1989.

A drill water sample was collected from the water pump on the drill rig on December 13, 1989. Analytical results for the samples described above can be obtained from the Remedial Action Program data base at ORNL. The chain of custody forms for these samples are included with this data package.

A bulk density soil sample was collected from the split spoon sample interval from 6.7 feet to 7.0 feet. The sample was measured and weighed, and a bulk density of 2.47 grams/cm³ was calculated.

The Schramm Rotadrill compressed air was sampled with a cloth filter inserted between drill rods on December 13, 1989. 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 (9.9 feet). The air rotary method was required to complete the boring to the specified total well depth. Therefore, a 14.5- inch diameter boring was augered from ground surface to 4.2 feet and a 10 3/4-inch diverter casing was installed and grouted. An 8-inch diameter boring was then drilled with an air rotary tricone roller bit from 9.9 to 15.0 feet. A 2-inch diameter stainless steel screen with threaded bottom cap was installed from 4.7 to 14.9 feet. A 2-inch diameter stainless steel casing was installed above the screen at 4.7 feet and extended 1.80 feet above ground surface. A sandpack was then tremied into the annular space from 2.9 to 14.9 feet, with a 1.5-foot bentonite pellet seal poured into the annular space above the sandpack from 1.4 to 2.9 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 1152 was developed to remove drill cuttings, silt, and other fines. The monitoring 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 161 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 4.0 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 June 22, 1990, at a depth of 13.4 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 1152 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 3.50×10^{-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

PRE-DRILLING TASKS

COMPLIANCE

1. EXCAVATION PERMIT OBTAINED

DATE
12-11-89

INITIALS
TL

2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.

12-11-89

TL

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

N/A

3b. PRE-PACKAGED SCREENS, CASING AND CENTRALIZERS
WERE USED.

12-13-89

TL

4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH
CLEAN POLYETHYLENE.

12-11-89

TL

5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS
ON HAND.

12-11-89

TL

6. POLYETHYLENE COVER IN PLACE OVER HOLE.

12-11-89

TL

7. AIR ROTARY COMPRESSED AIR SAMPLED.

12-13-89

TL

RESULTS: No hydrocarbons detected under ultraviolet light

ADDITIONAL NOTES/OBSERVATIONS: _____

_____
_____
_____
_____

OBSERVER SIGNATURE/DATE

Timothy A. Lee
Timothy A. Lee

12-11-89

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1152

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
Timothy A. Lee

12-11-89

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1152

ORNL MONITORING WELL LOG

PAGE 1 OF 2

LOCATION: Upper WAG2
DRILLER: George Akins
HELPER: James Shelton
DRILL: Schramm Rotadrill

DATE: START: 12-11-89
FINISH: 12-11-89
LOGGED BY: Timothy A. Lee
HEALTH PHYSICIST: Bill Shinpaugh

TYPE DRILLING: Split spoon, auger, air rotary LUBRICANT TYPE: Green stuff
No. SAMPLES TAKEN: One TYPE: Soil
CONTAINMENT TYPE: Plastic, pan, containment box

THICKNESS OF SOIL (REFUSAL DEPTH): 9.9'
DEPTH DRILLED IN ROCK: 5.1'
TOTAL DEPTH OF WELL: 15.0'

DRILLING FLUID SAMPLES:
TYPE: Water DATE: 12-13-89

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
0.0	2.0		Augered	Gravel fill
2.0	4.0		05%	Clay, dark yellowish brown, wet, loose, very soft, roots
4.0	6.0		0%	Wet
6.0	6.7	1152S01	50%	Clay, dusky yellow, wet, soft
		6.3' - 6.5'		
6.7	7.0		50%	Clay, light olive brown, damp, medium stiff, plastic. Bulk density taken from 6.7' to 7.0' is 2.47 g/cm ³
7.0	7.8		50%	Shale, yellowish gray to light brown, iron stains, dry, crumbly
	7.8			First split spoon refusal
7.8	8.7		100%	Shale, yellowish gray to light brown, iron stains, crumbly
	8.7			Second split spoon refusal
8.7	9.9		Augered	Shale, hard
	9.9			Auger refusal
9.9	10.6			** Limestone, hard
10.6	11.0			Limestone, hard
11.0	12.0			Cavity?, soft
12.0	15.0			Limestone, hard

ORNL MONITORING WELL LOG

PAGE 2 OF 2

PAGE 10 OF 21

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1152

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: George Akins HELPER: James Shelton

EQUIPMENT ☐ 6 INCH AUGER 9.9 L.F.
☐ INCH AUGER L.F.
☐ 7 7/8 INCH ROTARY 5.1 L.F.

MATERIALS USED

EST. USED VOL. VOL.
10.0 FEET OF 2 IN. S.S. SCREEN
4.8 FEET OF 2 IN. S.S. CASING
3.0 5.5 SACKS OF SAND
25.0 37.5 POUNDS OF BENTONITE PELLETS
0.5 1.0 SACKS OF CEMENT
5.0 POUNDS OF POWDERED BENTONITE
8.0 GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

Fractures and irregular boring diameters

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

MONITORING WELL PUMP BASE SET AT 13.4 FEET.

CENTRALIZERS AT 6.0 FEET.
15.0 FEET.
FEET.

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

HOLE CLEANED OUT
TO 14.9 FEET
BOTTOM OF BOREHOLE
15.0 FEET

LOCATION WAG2
ORNL GRID COORDINATES
N 16,470.8164
E 32,503.0399
ELEV. GROUND 790.82
ELEV. TOP STAINLESS
STEEL CASING 792.62
DRILLING DATES:
STARTED: 12-8-89
FINISHED: 12-13-89

TYPE D WELL

NOT TO SCALE

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1152

DATE: 12-13-89

MONITORING WELL MATERIALS
CERTIFICATION

<u>ITEM/MATERIAL</u>	<u>DATE USED</u>	<u>BATCH NUMBER</u>
SAND	12-13-89	1
BENTONITE	12-13-89	1
Pellets	12-13-89	3
Powder	12-13-89	2
STAINLESS STEEL SCREEN (PREPACKAGED ☒ YES ☐ NO)	12-13-89	2
STAINLESS STEEL CASING (PREPACKAGED ☒ YES ☐ NO)	12-13-89	2
STAINLESS STEEL CENTRALIZERS (PREPACKAGED ☒ YES ☐ NO)	12-13-89	2
STAINLESS STEEL CAPS (PREPACKAGED ☒ YES ☐ NO)	12-13-89	2
MONITORING WELL PUMP (PREPACKAGED ☒ YES ☐ NO)	06-22-90	7
GROUT	12-14-89	3
WELL COVERS		
SURFACE CASING	N/A	N/A

COMMENTS:

OBSERVER SIGNATURE/DATE Timothy A. Lee 12-13-89

Timothy A. Lee

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1152

POST-WELL COMPLETION
CHECKLIST

		COMPLIANCE DATE	INITIALS
<u>POST-WELL COMPLETION TASKS</u>			
1.	MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	<u>12-11-89</u>	<u>TH</u>
2.	ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>12-11-89</u>	<u>TH</u>
3.	WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>06-22-90</u>	<u>DCL</u>
4.	DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>12-11-89</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
Timothy A. Lee

12-13-89

D. Charles Lytle
D. Charles Lytle

06-22-90

ERCE
Environmental
and Energy
Services Co.

WELL No. 1152
Upper
LOCATION: WAG2

**MONITORING WELL
DEVELOPMENT FORM**

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and pumping

DEVELOPMENT
BEGAN DATE: 6/19/90

TIME: _____

DEVELOPMENT
ENDING DATE: 6/22/90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle and Nick Norrod

ONE WELL VOLUME: 6.6 GALLONS

TOTAL GALLONS PUMPED: 161 TOTAL WELL VOLUMES PUMPED: 24.4

INITIAL pH: 8.0 FINAL pH: 8.5

INITIAL CONDUCTIVITY ($\mu S/cm$): 712 FINAL CONDUCTIVITY ($\mu S/cm$): 670

DESCRIPTION OF INITIAL TURBIDITY: Cloudy

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 4.0 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: 5.8 feet from ground surface

DEVELOPMENT OBSERVATIONS

_____
_____
_____
_____
_____

OBSERVER SIGNATURE/DATE D. Charles Lytle 6/22/90
D. Charles Lytle

DATE/TIME

WELL NO. 1152
LOCATION: Upper WAG2
DATE: 6/19/90

ONE WELL VOLUME = 6.6 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCT- IVITY (µS/cm)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
6/19/90	1130	32	Cloudy	---	8.0	712	32	4.8	
6/19/90	1330	39	Cloudy	---	8.3	713	71	10.8	
6/22/90	1100	90	Clear	4.0	8.5	670	161	24.4	
RESULTS AT END OF DEVELOPMENT			Clear	4.0	8.5	670	161	24.4	

COMMENTS Fast recharger and a good producer. Water clean even after surging.
Passed with 4.0 NTU's and moved to another hole.

OBSERVER SIGNATURE/DATE D. Charles Style 6/22/90
D. Charles Style

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.: 1152

DATE OF TEST: 10-19-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: U. WAG-2

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 = 7.88 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 10.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 12.20 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)

1.9079
1.9504

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	3.920	2.920
20.00	3.790	2.790
30.00	3.620	2.620
40.00	3.480	2.480
50.00	3.370	2.370
60.00	3.260	2.260
75.00	3.120	2.120
90.00	3.000	2.000
105.00	2.880	1.880
120.00	2.780	1.780
150.00	2.600	1.600
180.00	2.460	1.460
240.00	2.240	1.240
300.00	2.070	1.070
360.00	1.970	.970
420.00	1.870	.870
480.00	1.800	.800
540.00	1.730	.730
600.00	1.650	.650
720.00	1.570	.570
840.00	1.510	.510
960.00	1.460	.460
1080.00	1.420	.420
1200.00	1.370	.370
1320.00	1.320	.320
1440.00	1.310	.310
1560.00	1.300	.300
1680.00	1.290	.290
1800.00	1.260	.260
1920.00	1.260	.260
2040.00	1.260	.260
2160.00	1.250	.250

HYDRAULIC CONDUCTIVITY CALCULATIONS

*****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $1.15\text{E-}06$ FT/SEC = $3.50\text{E-}05$ CM/SEC

TRANSMISSIVITY = $1.15\text{E-}05$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $1.64\text{E-}06$ FT/SEC = $4.99\text{E-}05$ CM/SEC

TRANSMISSIVITY = $1.64\text{E-}05$ 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

1152501

WELL NO.

1152

LOCATION:

UPPER WAG 2

TYPE:

SOIL

SAMPLER:

Smith A. 835

(SIGNATURE)

SAMPLE INTERVAL:

6.3' - 6.5'

DATE:

12-11-89

TIME:

0900

RELINQUISHED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

RECEIVED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

Smith C. 724

12/19/89

1245

ERC

JHS

12/19/89

12:44

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

1152W01

WELL NO. 1152 LOCATION: WAG 2 TYPE: DRILL WATER

SAMPLER: Smith G. M. (SIGNATURE) SAMPLE INTERVAL: N/A DATE: 12-13-89 TIME: 1015

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECEIVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
<u>Smith G. M.</u>	12/19/89	1245	ERC	JHS	12/19/82	12:42	

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 1153 is located in Upper WAG 2. It is approximately 500 feet due east of building number 7920. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 17,395.6675, E 33,324.8783 (X-10 grid) or latitude 35°-55'-10.32" and longitude 84°-18'-06.46". 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 1153 was drilled by Geotek Engineering Company. A Schramm Rotadrill rig was used to drill this boring for monitor well installation under operation of George Akins with the assistance of James Shelton and Phil Getsi. Drilling commenced on December 14, 1989, and was finished on December 20, 1989. Paragraph 2.4.1 includes a detailed discussion of the well installation and a well schematic is included on the well installation/completion form. A synopsis of the drilling

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

12-14-89 The rig was mobilized to the staked location and set up on plastic sheeting. Split Spoon samples were taken from the surface to refusal at 5.6 feet. The boring was widened with a 14 1/2-inch auger to 4.1 feet and set 10 3/4-inch decontaminated steel diverter casing. The rig was moved from location.

12-15-89 The diverter casing was grouted into place.

12-20-89 The rig was moved to the location. The boring was deepened to 18.0 feet using a 7 7/8 air rotary tricone bit into a containment box. Set 2-inch stainless steel casing with sand pack and bentonite seal.

12-21-89 The casing was grouted into place with 2 sacks of cement.

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

2.0 Technical Information

2.1 Decontamination Procedures

The drilling rig, down hole tools, surface casing, stainless steel screen, stainless steel casing,

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

2.2 Geology

The Rome Formation underlies the northern portion of Upper WAG 2 and consists of variegated shale and siltstone with beds of gray, fine grained sandstone. The Conasauga Group underlies the southern portion of Upper WAG 2 and is divided into five members. They are from north to south, the Pumpkin Valley Shale, Rutledge Limestone, Rogersville Shale, Maryville Limestone, and Nolichucky Shale. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strike and dips. The regional strike is 56 degrees northeast with dips of about 30 degrees to the southeast. The White Oak Creek tear fault is in Upper WAG 2. Displacement varies from 40 feet up to 350 feet.

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. Soil sample 1153S01 was collected in the split spoon interval from 3.3 feet to 3.6 feet on December 14, 1989. A drill water sample was collected from the water pump on the drill rig on

December 20, 1989. Analytical results for the soil and water samples described above can be obtained from the Remedial Action Program data base at ORNL. Chain of custody forms for these samples are included with this data package.

A bulk density soil sample was collected from the split spoon sample interval from 1.4 feet to 1.7 feet. The sample was measured and weighed, and a bulk density of 2.14 grams/cm³ was calculated.

The Schramm Rotadrill compressed air was sampled with a cloth filter inserted between drill rods on December 20, 1989. The sample was examined with an ultraviolet light for the presence of hydrocarbons. The filter showed no evidence of hydrocarbons.

2.4 Installation and Development

2.4.1 Installation

This was a Type D well. A 6-inch diameter boring was split spooned and augered from ground surface to auger refusal (5.6 feet). The air rotary method was required to complete the boring to the specified total well depth. Therefore, a 14.5- inch diameter boring was augered from ground surface to 4.1 feet and a 10 3/4-inch diverter casing was installed and grouted. An 8-inch diameter boring was then drilled with an air rotary tricone roller bit from 5.6 to 18.0 feet. A 2-inch diameter stainless steel screen with threaded bottom cap was installed from 7.8 to 18.0 feet. A 2-inch diameter stainless steel casing was installed above the screen at 7.8 feet and

extended 1.64 feet above ground surface. A sandpack was then tremied into the annular space from 5.8 to 18.0 feet, with a 2.1-foot bentonite pellet seal poured into the annular space above the sandpack from 3.7 to 5.8 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 1153 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 124 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was 3.0 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on June 26, 1990, at a depth of 16.7 feet below ground surface. These pumps are decontaminated at American Sigma and are sent prepackaged. A copy of the pump certification is kept on file at ORNL.

2.5 Hydraulic Conductivity Testing

Well number 1153 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 5.27×10^{-5} cm/second (shown as permeability on the hydraulic conductivity calculations printout attached) was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1153

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>12-14-89</u>	<u>Ton</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>12-14-89</u>	<u>Ton</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>12-20-89</u>	<u>Ton</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>12-14-89</u>	<u>Ton</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>12-14-89</u>	<u>Ton</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>12-14-89</u>	<u>Ton</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u>12-20-89</u>	<u>Ton</u>

RESULTS: No detectable signs of hydrocarbons under ultraviolet light

ADDITIONAL NOTES/OBSERVATIONS: _____

_____
_____
_____
_____

OBSERVER SIGNATURE/DATE Timothy A. Lee 12-14-89
Timothy A. Lee

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1153

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
Timothy A. Lee

12-14-89

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1153

ORNL MONITORING WELL LOG

PAGE 1 OF 1

LOCATION: Upper WAG2
DRILLER: George Akins
HELPER: James Shelton
DRILL: Schramm Rotadrill

DATE: START: 12-14-89
FINISH: 12-20-89
LOGGED BY: Timothy A. Lee
HEALTH PHYSICIST: Bill Shinpaugh

TYPE DRILLING: Split spoon, Auger, Air Rotary LUBRICANT TYPE: Green stuff
No. SAMPLES TAKEN: One TYPE: Soil
CONTAINMENT TYPE: Plastic, pan, containment box

THICKNESS OF SOIL (REFUSAL DEPTH): 5.6'
DEPTH DRILLED IN ROCK: 12.4'
TOTAL DEPTH OF WELL: 18.0'

DRILLING FLUID SAMPLES:
TYPE: Water DATE: 12-20-89

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
0.0	1.0			Gravel fill
1.0	3.0		75%	Clay, dark yellowish orange, damp, slightly silty, mottled with clay, yellowish gray, dark streaks. Bulk density sample taken 1.4' to 1.7'. Bulk density = 2.14 g/cm ³
3.0	4.1	1153S01	100%	Clay, dark yellowish orange, slightly silty
		3.3' - 3.6'		mottled with clay, yellowish gray, dark streaks
				scattered fragments of sandstone, medium grained
4.1	5.0		100%	Shale, light olive gray, dry, crumbly,
				scattered fragments of sandstone, medium grained, iron stains
5.0	5.6		100%	Shale, light olive gray, dry, crumbly,
	5.6			Split spoon refusal
5.6	6.0		Augered	Shale, olive gray
	6.0			Auger refusal
6.0	18.0			** Shale, moderately soft
	18.0			Total Depth
				** No detailed lithologic descriptions are available from 6.0' to 18.0' due to the use of the containment box.

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1153

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: George Akins

HELPER: James Shelton

EQUIPMENT

☒ 6 INCH AUGER 6.0 L.F.

☐ INCH AUGER L.F.

☒ 7 7/8 INCH ROTARY 12.0 L.F.

MATERIALS USED

EST. USED
VOL. VOL.

10.0 FEET OF 2 IN. S.S. SCREEN

7.8 FEET OF 2 IN. S.S. CASING

3.0 3.5 SACKS OF SAND

50.0 50.0 POUNDS OF BENTONITE PELLETS

1.0 1.5 SACKS OF CEMENT

7.5 POUNDS OF POWDERED BENTONITE

12.0 GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED
VOLUMES AND USED VOLUMES

Fractures and irregular boring

diameters

WELL COVER USED

☒ LOCKING STEEL COVER
☐ FLUSH MOUNTED WELL COVER
☐ OTHER

SILT TRAP USED

YES ☒ NO ☐

MONITORING WELL PUMP BASE SET AT 16.7 FEET.

CENTRALIZERS AT 9.0 FEET.

17.0 FEET.

FEET.

NOTE:

ALL DEPTHS ARE MEASURED
FROM GROUND SURFACE
UNLESS OTHERWISE NOTED:

HOLE CLEANED OUT
TO 18.0 FEET

BOTTOM OF BOREHOLE

18.0 FEET

LOCATION WAG2

ORNL GRID COORDINATES

N 17,395.6675

E 33,324.8783

ELEV. GROUND 800.71

ELEV. TOP STAINLESS

STEEL CASING 802.35

DRILLING DATES:

STARTED: 12-14-89

FINISHED: 12-20-89

LOCKING STEEL COVER

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

CONCRETE PAD

10 3/4 INCH DIVERTER
CASING 0.9 FT. ABOVE
GROUND SURFACE TO
4.1 FT. BELOW GROUND
SURFACE

14 1/2 INCH BOREHOLE
0.0 TO 4.1 FEET

GROUT SEAL 0.0 TO
3.7 FEET

7 7/8 INCH DIAMETER
BOREHOLE

2 INCH DIAMETER STAINLESS
STEEL CASING 1.64 FT. ABOVE
GROUND SURFACE TO 7.8 FT.
BELOW GROUND SURFACE

CENTRALIZER (TYP.)

BENTONITE PELLET SEAL
3.7 TO 5.8 FEET

SAND PACK
5.8 TO 18.0 FEET

2 INCH DIAMETER
STAINLESS STEEL 0.010

SLOTTED SCREEN
7.8 TO 17.8 FEET

2 INCH DIAMETER STAINLESS
STEEL SILT TRAP/CAP
17.8 TO 18.0 FEET

TYPE D WELL

NOT TO SCALE

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1153

DATE: 12-20-89

MONITORING WELL MATERIALS
CERTIFICATION

ITEM/MATERIAL			DATE USED	BATCH NUMBER
SAND			12-20-89	2
BENTONITE	Pellets		12-20-89	1
	Powder		12-21-89	4
STAINLESS STEEL SCREEN	(PREPACKAGED	☒ YES ☐ NO	12-20-89	2
STAINLESS STEEL CASING	(PREPACKAGED	☒ YES ☐ NO	12-20-89	2
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED	☒ YES ☐ NO	12-20-89	2
STAINLESS STEEL CAPS	(PREPACKAGED	☒ YES ☐ NO	12-20-89	2
MONITORING WELL PUMP	(PREPACKAGED	☒ YES ☐ NO	06-26-90	7
			12-21-89	4
GROUT				
WELL COVERS				
SURFACE CASING			N/A	N/A

COMMENTS:

OBSERVER SIGNATURE/DATE

Timothy A. Lee 12-20-89
Timothy A. Lee

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1153

POST-WELL COMPLETION
CHECKLIST

	COMPLIANCE	
	DATE	INITIALS
<u>POST-WELL COMPLETION TASKS</u>		
1. MUD SCRAPED FROM AUGERS, SAMPLERS, AND ALL OTHER EQUIPMENT.	<u>12-14-89</u>	<u>Tbz</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>12-20-89</u>	<u>Tbz</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>06-26-90</u>	<u>DCL</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>12-20-89</u>	<u>Tbz</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 12-20-89
Timothy A. Lee

D. Charles Lytle 06-26-90
D. Charles Lytle

ERCE
Environmental
and Energy
Services Co.

WELL No. 1153
Upper
LOCATION: WAG2

MONITORING WELL
DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and pumping

DEVELOPMENT
BEGAN DATE: 6/22/90

TIME: _____

DEVELOPMENT
ENDING DATE: 6/26/90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 5.6 GALLONS

TOTAL GALLONS PUMPED: 124 TOTAL WELL VOLUMES PUMPED: 22.1

INITIAL pH: 8.2 FINAL pH: 8.5

INITIAL CONDUCTIVITY ($\mu\text{S}/\text{cm}$): 722 FINAL CONDUCTIVITY ($\mu\text{S}/\text{cm}$): 856

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: 4.1 feet from ground surface

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE

D. Charles Lytle 6/26/90
D. Charles Lytle

ONE WELL VOLUME = 5.6 GALLONS

COMMENTS	Slow recovery, easily pumped dry. Pumped more air than water. Water finally cleaned and passed with 3.0 NTU's. Moved to another hole.

MWF09M05.DWG

HYDRAULIC CONDUCTIVITY CALCULATIONS

PROGRAM SLUGT, VERSION 4.1, NOV. 1986

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SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

- (1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967
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OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY
PENETRATING WELLS")

WELL NO.: 1153

DATE OF TEST: 10-29-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: U. WAG-2

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 = 7.88 INCHES
 LENGTH OF SCREEN OR INTAKE PORTION = 10.00 FEET
 DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 15.50 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)

1.7981
1.8495

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	4.710	3.710
20.00	4.320	3.320
30.00	4.020	3.020
40.00	3.740	2.740
50.00	3.560	2.560
60.00	3.340	2.340
75.00	3.090	2.090
90.00	2.890	1.890
105.00	2.700	1.700
120.00	2.570	1.570
150.00	2.340	1.340
180.00	2.170	1.170
240.00	1.900	.900
300.00	1.750	.750
360.00	1.630	.630
420.00	1.560	.560
480.00	1.500	.500
540.00	1.450	.450
600.00	1.370	.370
720.00	1.320	.320
840.00	1.260	.260
960.00	1.230	.230
1080.00	1.200	.200
1200.00	1.180	.180
1320.00	1.150	.150
1440.00	1.150	.150
1560.00	1.130	.130
1680.00	1.130	.130
1800.00	1.100	.100
1920.00	1.100	.100
2040.00	1.100	.100
2160.00	1.090	.090

HYDRAULIC CONDUCTIVITY CALCULATIONS

*****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $1.73\text{E-}06$ FT/SEC = $5.27\text{E-}05$ CM/SEC

TRANSMISSIVITY = $1.73\text{E-}05$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $2.43\text{E-}06$ FT/SEC = $7.42\text{E-}05$ CM/SEC

TRANSMISSIVITY = $2.43\text{E-}05$ 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

PLE
NUMBER

1153W01

WELL NO. 1153	LOCATION: UPPER WAG 2	TYPE: DRILL WATER	
SAMPLER: <i>Timothy A. Jones</i> (SIGNATURE)	SAMPLE INTERVAL: N/A	DATE: 12-20-89	TIME: 1340

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECEIVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
<i>Timothy A. Jones</i>			ERC				

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.
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

1153501

WELL NO.

1153

LOCATION:

WAG 2

TYPE:

Soil

SAMPLER:

Jimothy C. Rogers

(SIGNATURE)

SAMPLE INTERVAL:

3.3' - 3.6'

DATE:

12-14-89

TIME:

1545

RELINQUISHED BY
(SIGNATURE)

DATE:

TIME:

WITH:

RECEIVED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

Jimothy C. Rogers

12/19/89

1245

ERC

JHS

12/19/89

12:44

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

1153W01

WELL NO.

1153

LOCATION:

WAG 2

TYPE:

DRILL WATER

SAMPLER:

Timothy A. Orr

(SIGNATURE)

SAMPLE INTERVAL:

N/A

DATE:

12-20-89

TIME:

1340

RELINQUISHED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

RECEIVED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

Timothy A. Orr

12-20-90

1500

ERC

NE Owen

1/31/90

14:55

ORNL

TYPE OF SAMPLE: ☐ SPLIT SPOON CORES-SOIL

☐ AUGER CUTTINGS-SOIL

☐ AUGER CUTTINGS-ROCK

☐ AIR ROTARY CUTTINGS-ROCK

☒ DRILL WATER (NO AIR IN SAMPLE)

☐ OTHER _____

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

REMARKS:

1.0 General Information

1.1 Well Location

Monitoring well number 1154 is located in Upper WAG 2. It is located in the eastern portion of Upper WAG 2, approximately 200 feet south of HFIR. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 16,191.4921, E 32,693.8687 (X-10 grid) or latitude 35°-54'-56.95" and longitude 84°-18'-04.70". 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 1154 was drilled by Geotek Engineering Company. A Schramm Rotadrill rig was used to drill this boring for monitor well installation under operation of George Akins with the assistance of James Shelton. Drilling commenced on November 30, 1989, and was finished on December 6, 1989. 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.

- 11-30-89 The drill rig was mobilized to the location and set up on plastic sheeting. Split Spoon samples were taken from surface to 5.0 feet. Auger refusal was also at 5.0 feet.
- 12-01-89 The boring was augered from surface to 4.1 feet with a 20-inch auger. Set 4.1 feet of 15 3/4-inch decontaminated diverter casing and grouted it into place. Moved rig from location.
- 12-05-89 The rig was moved to location and set up over hole.
- 12-06-89 Drilled from 5.0 feet to 15.7 feet using a 7 7/8-inch air rotary tricone bit into a containment box. Heard water flowing into hole. Set 15.3 feet of stainless steel casing and screen with a sand pack and bentonite seal. Grouted casing into place with 4 sacks cement.

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

2.0 Technical Information

2.1 Decontamination Procedures

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

2.2 Geology

The Rome Formation underlies the northern portion of Upper WAG 2 and consists of variegated shale and siltstone with beds of gray, fine grained sandstone. The Conasauga Group underlies the southern portion of Upper WAG 2 and is divided into five members. They are from north to south, the Pumpkin Valley Shale, Rutledge Limestone, Rogersville Shale, Maryville Limestone, and Nolichucky Shale. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strike and dips. The regional strike is 56 degrees northeast and dips of about 30 degrees to the southeast. The White Oak Creek tear fault is in Upper WAG 2. Displacement varies from 40 feet up to 350 feet.

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. Soil sample 1154S01 was collected in the split spoon interval from 3.9 feet to 4.2 feet on November 30, 1989. A drill water sample was collected from the water pump on the drill rig on December 6, 1989. Analytical results for the drill water and soil sample described above can be obtained from the Remedial Action Program data base at ORNL. Chain of custody forms for these samples are included with this data package.

A bulk density soil sample was collected from the split spoon sample interval from 3.9 feet to 4.2 feet. The sample was measured and weighed, and a bulk density of 1.94 grams/cm³ was calculated.

The Schramm Rotadrill compressed air was sampled with a cloth filter inserted between drill rods on December 6, 1989. 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 (5.0 feet). The air rotary method was required

to complete the boring to the specified total well depth. Therefore, a 20.0- inch diameter boring was augered from ground surface to 4.1 feet and a 15 3/4-inch diverter casing was installed and grouted. An 8-inch diameter boring was then drilled with an air rotary tricone roller bit from 4.1 to 15.7 feet. A 2-inch diameter stainless steel screen with welded bottom cap was installed from 15.3 to 5.1 feet. A 2-inch diameter stainless steel casing was installed above the screen at 5.1 feet and extended 2.16 feet above ground surface. A sandpack was then tremied into the annular space from 4.3 to 15.3 feet, with a 0.8-foot bentonite pellet seal poured into the annular space above the sandpack from 3.5 to 4.3 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 1154 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 242 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was 1.0 NTU. 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 June 26, 1990, at a depth of 13.9 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 1154 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 4.39×10^{-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 package.

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1154

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>11-30-89</u>	<u>Tom</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>11-30-89</u>	<u>Tom</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>12-6-89</u>	<u>Tom</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>11-30-89</u>	<u>Tom</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>11-30-89</u>	<u>Tom</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>11-30-89</u>	<u>Tom</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u>12-6-89</u>	<u>Tom</u>

RESULTS: No hydrocarbons detected under ultraviolet light

ADDITIONAL NOTES/OBSERVATIONS: _____

_____
_____
_____
_____

OBSERVER SIGNATURE/DATE

Timothy A. Lee 12-1-89

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1154

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

11-30-89

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and Energy
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WELL No. 1154

ORNL MONITORING WELL LOG

PAGE 1 OF 2

LOCATION: Upper WAG2
DRILLER: George Akins
HELPER: James Shelton
DRILL: Schramm Rotadrill

DATE: START: 11-30-89
FINISH: 12-6-89
LOGGED BY: Timothy A. Lee
HEALTH PHYSICIST: Carl Stooksbury

TYPE DRILLING: Auger, Split spoon, Air Rotary LUBRICANT TYPE: Green stuff
No. SAMPLES TAKEN: One TYPE: Soil
CONTAINMENT TYPE: Plastic, pan, containment box

THICKNESS OF SOIL (REFUSAL DEPTH): 5.0'
DEPTH DRILLED IN ROCK: 10.7'
TOTAL DEPTH OF WELL: 15.7'

DRILLING FLUID SAMPLES:
TYPE: Water DATE: 12-6-89

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
0.0	1.5			Gravel fill
1.5	3.5		0%	
3.5	3.6		100%	Gravel fill
3.6	4.4	1154S01	100%	Clay, slightly silty, moderate yellowish brown
		3.9' - 4.2'		with clay, dark yellowish orange. Bulk density
				sample taken from 3.9' to 4.2'. Bulk density
				is 1.94 g/cm ³
4.4	4.7		100%	Clay, very loose moist and shale, moist,
				yellowish brown, crumbly
4.7	5.0		100%	Clay, moderate yellowish brown, moist and shale
				light olive gray, loose
	5.0			Split spoon refusal
	5.0			Auger refusal
5.0	6.5			** Limestone, hard
6.5	7.7			Limestone, shaley, soft
7.7	8.9			Limestone, hard
8.9	9.9			Limestone, shaley, very soft
9.9	10.6			Limestone, hard
10.6	11.6			Limestone, shaley, soft
11.6	11.8			Limestone, hard

ORNL MONITORING WELL LOG

PAGE 2 OF 2

PAGE 10 OF 21

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1154

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: George Akins HELPER: James Shelton

EQUIPMENT ☒ 20 INCH AUGER 4.1 L.F.

☐ _____ INCH AUGER _____ L.F.

☒ 7 7/8 INCH ROTARY 11.6 L.F.

MATERIALS USED

EST. USED
VOL. VOL.

10.0 FEET OF 2 IN. S.S. SCREEN

7.3 FEET OF 2 IN. S.S. CASING

3.0 4.0 SACKS OF SAND

50.0 50.0 POUNDS OF BENTONITE PELLETS

3.0 4.0 SACKS OF CEMENT

20.0 POUNDS OF POWDERED BENTONITE

32.0 GALLONS OF WATER (CEMENTING)

REASON FOR DIFFERENCES BETWEEN ESTIMATED VOLUMES AND USED VOLUMES

Fractures and irregular boring

diameters

WELL COVER USED

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

SILT TRAP USED

YES ☒ NO ☐

MONITORING WELL PUMP BASE SET AT 13.9 FEET.

CENTRALIZERS AT 5.0 FEET.

15.0 FEET.

_____ FEET.

NOTE:

ALL DEPTHS ARE MEASURED
FROM GROUND SURFACE
UNLESS OTHERWISE NOTED:

HOLE CLEANED OUT
TO 15.3 FEET

BOTTOM OF BOREHOLE
15.7 FEET

LOCATION WAG2

ORNL GRID COORDINATES

N 16,191.4921

E 32,693.8687

ELEV. GROUND 787.93

ELEV. TOP STAINLESS

STEEL CASING 790.09

DRILLING DATES:

STARTED: 11-30-89

FINISHED: 12-6-89

LOCKING STEEL COVER

8 INCH DIAMETER

STEEL PROTECTIVE CASING

3.04 FT ABOVE GROUND

TO 2.0 FT BELOW

GROUND SURFACE

CONCRETE PAD

15 3/4 INCH DIVERTER

CASING 0.9 FT ABOVE

GROUND SURFACE TO

4.1 FT. BELOW GROUND

SURFACE

2.0 INCH BOREHOLE

0.0 TO 4.1 FEET

GROUT SEAL 0.0 TO

3.5 FEET

7 7/8 INCH DIAMETER

BOREHOLE

2 INCH DIAMETER STAINLESS

STEEL CASING 2.16 FT. ABOVE

GROUND SURFACE TO 5.1 FT

BELOW GROUND SURFACE

CENTRALIZER (TYP)

BENTONITE PELLET SEAL

3.5 TO 4.3 FEET

SAND PACK

4.3 TO 15.3 FEET

2 INCH DIAMETER

STAINLESS STEEL 0.010

SLOTTED SCREEN

5.1 TO 15.1 FEET

2 INCH DIAMETER STAINLESS

STEEL SILT TRAP/CAP

15.1 TO 15.3 FEET

TYPE D WELL

NOT TO SCALE

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1154

DATE: 12-6-89

MONITORING WELL MATERIALS
CERTIFICATION

ITEM/MATERIAL	DATE USED	BATCH NUMBER
SAND	12-6-89	2
BENTONITE Pellets Powder	12-6-89	1
	12-6-89	3
STAINLESS STEEL SCREEN (PREPACKAGED ☒ YES ☐ NO)	12-6-89	2
STAINLESS STEEL CASING (PREPACKAGED ☒ YES ☐ NO)	12-6-89	2
STAINLESS STEEL CENTRALIZERS (PREPACKAGED ☒ YES ☐ NO)	12-6-89	2
STAINLESS STEEL CAPS (PREPACKAGED ☒ YES ☐ NO)	12-6-89	2
MONITORING WELL PUMP (PREPACKAGED ☒ YES ☐ NO)	06-26-90	7
GROUT S.S.	12-6-89	3
WELL COVERS		
SURFACE CASING	N/A	N/A

COMMENTS:

OBSERVER SIGNATURE/DATE

Timothy A. Lee
Timothy A. Lee

12-6-89

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1154

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>11-30-89</u>	<u>Ph</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>12-6-89</u>	<u>Ph</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>06-26-90</u>	<u>DCL</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>12-6-89</u>	<u>Ph</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
Timothy A. Lee

12-6-89

D. Charles Lytle
D. Charles Lytle

06-26-90

ERCE
Environmental
and Energy
Services Co.

WELL No. 1154
Uppe
LOCATION: WAG2

**MONITORING WELL
DEVELOPMENT FORM**

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and pumping

DEVELOPMENT
BEGAN DATE: 6/21/90 TIME: _____

DEVELOPMENT
ENDING DATE: 6/26/90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 6.2 GALLONS

TOTAL GALLONS PUMPED: 242 TOTAL WELL VOLUMES PUMPED: 39.0

INITIAL pH: 7.8 FINAL pH: 8.1

INITIAL CONDUCTIVITY ($\mu S/cm$): 554 FINAL CONDUCTIVITY ($\mu S/cm$): 542

DESCRIPTION OF INITIAL TURBIDITY: Clear

DESCRIPTION OF FINAL TURBIDITY: Clear

FINAL MEASURED TURBIDITY: 1.0 NTU's

WELL APPROVED BY: R.C. Williams MMES

ODOR
OF WATER: None

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

INITIAL PRE-DEVELOPMENT
WATER DEPTH: 3.9 feet from ground surface

DEVELOPMENT OBSERVATIONS

_____
_____
_____
_____
_____

OBSERVER SIGNATURE/DATE D. Charles Lytle 6/26/90
D. Charles Lytle

DATE/TIME

WELL NO. 1154
LOCATION: Upper WAG2
DATE: 6/21/90

ONE WELL VOLUME = 6.2 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCT- IVITY (U.S./cm)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
6/21/90	0930	60	Clear	7.0	7.8	554	60	9.8	
6/22/90	1400	40	Cloudy	---	8.4	640	100	16.1	
6/25/90	1000	61	Cloudy	---	8.6	595	161	26.0	
6/25/90	1400	32	Slightly Cloudy	---	8.4	555	193	31.1	
6/26/90	0900	29	Slightly Cloudy	---	8.0	536	222	35.8	
6/26/90	1100	20	Clear	1.0	8.1	542	242	39.0	
RESULTS AT END OF DEVELOPMENT			Clear	1.0	8.1	542	242	39.0	

COMMENTS	Good producer, pumped dry several times, but started making more water. Passed with 1.0 NTU's and 39.0 well volumes. Moved to another hole.

OBSERVER SIGNATURE/DATE D. Charles Sytle 6/26/90
D. Charles Sytle

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.: 1154

DATE OF TEST: 10-19-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: U. WAG-2

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 = 7.88 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 10.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 11.70 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)

.7012

.7239

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	4.290	3.290
20.00	3.760	2.760
30.00	3.310	2.310
40.00	2.950	1.950
50.00	2.630	1.630
60.00	2.390	1.390
75.00	2.110	1.110
90.00	1.870	.870
105.00	1.720	.720
120.00	1.570	.570
150.00	1.410	.410
180.00	1.310	.310
240.00	1.210	.210
300.00	1.180	.180
360.00	1.150	.150
420.00	1.130	.130
480.00	1.140	.140
540.00	1.130	.130
600.00	1.100	.100
720.00	1.090	.090
840.00	1.080	.080
960.00	1.080	.080
1080.00	1.100	.100
1200.00	1.090	.090
1320.00	1.090	.090
1440.00	1.100	.100
1560.00	1.070	.070
1680.00	1.080	.080
1800.00	1.080	.080
1920.00	1.080	.080
2040.00	1.070	.070
2160.00	1.060	.060

HYDRAULIC CONDUCTIVITY CALCULATIONS

*****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $1.44\text{E-}06$ FT/SEC = $4.39\text{E-}05$ CM/SEC

TRANSMISSIVITY = $1.44\text{E-}05$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $2.06\text{E-}06$ FT/SEC = $6.27\text{E-}05$ CM/SEC

TRANSMISSIVITY = $2.06\text{E-}05$ 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

1154501

WELL NO.

1154

LOCATION:

WAG 2

TYPE:

Soil

SAMPLER:

Smithy Q. Bras

(SIGNATURE)

SAMPLE INTERVAL:

3.9' - 4.2

DATE:

11-30-89

TIME:

1545

RELINQUISHED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

RECEIVED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

Smithy Q. Bras

12/19/89

1245

ERC

JHS

12/19/89

12:44

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

1154201

WELL NO. 1154 LOCATION: WAG 2 TYPE: DRILL WATER

SAMPLER: Smooty Q Jaz (SIGNATURE) SAMPLE INTERVAL: 8.0' DATE: 12-6-89 TIME: 0825

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECEIVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
<u>Smooty Q Jaz</u>	12/19/89	1245	ERC	<u>JHS</u>	12/19/89	12:42	

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 1155 is located in Upper WAG 2. It is located in the south-central portion of Upper WAG 2. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N16,676.5737, E30,538.5387 (X-10 grid) or latitude 35°-54'-49.08" and longitude 84°-18'-29.75". 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 1155 was drilled by Geotek Engineering Company. A Schramm Rotadrill rig was used to drill this boring for monitor well installation under operation of George Akins with the assistance of James Shelton. Drilling commenced on December 1, 1989, and was finished on December 6, 1989. Paragraph 2.4.1 includes a detailed discussion of the well installation and a well schematic

is included on the well installation/completion form. A synopsis of the drilling activity follows. This information was typed directly from field notes and was edited only when necessary for clarification.

12-01-89 The rig was mobilized to the staked location and set up on a sheet of plastic. Split Spoon samples were taken from the surface to 8.4 feet. The boring was deepened with a 6 inch-auger to refusal at 9.0 feet. The boring was widened from the surface to 4.0 feet using a 20-inch auger. Set 4.0 feet of decontaminated 15 3/4-inch steel casing and grouted it into place.

12-02-89 The rig was moved from location.

12-06-89 The rig was mobilized to the location and set up on the hole. The boring was deepened from 9.0 feet to 23.0 feet using a 7 7/8-air rotary tricone bit. Water was heard flowing into hole. Set 2-inch stainless steel casing with sand pack and bentonite seal.

12-07-89 Grouted casing into place with 3 sacks cement.

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

2.0 Technical Information

2.1 Decontamination Procedures

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

2.2 Geology

The Rome Formation underlies the northern portion of Upper WAG 2 and consists of variegated shale and siltstone with beds of gray, fine grained sandstone. The Conasauga Group underlies the southern portion of Upper WAG 2 and is divided into five members. They are from north to south, the Pumpkin Valley Shale, Rutledge Limestone, Rogersville Shale, Maryville Limestone, and Nolichucky Shale. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strike and dips. The regional strike is 56 degrees northeast with dips of about 30 degrees to the southeast. The White Oak Creek tear fault is in Upper WAG 2. Displacement varies from 40 feet up to 350 feet.

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. Soil sample 1155S01 was collected in the split spoon interval from 5.3 feet to 5.6 feet on December 1, 1989. A drill water sample was collected from the water pump on the drill rig on December 6, 1989. Analytical results for the soil and drill water samples described above can be obtained from the Remedial Action Program data base at ORNL. Chain of custody forms for these soil samples are included with this data package.

A bulk density soil sample was collected from the split spoon sample interval from 5.3 feet to 5.6 feet. The sample was measured and weighed, and a bulk density of 2.03 grams/cm³ was calculated.

The Schramm Rotadrill compressed air was sampled with a cloth filter inserted between drill rods on December 6, 1989. 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 (9.0 feet). The air rotary method was required

to complete the boring to the specified total well depth. Therefore, a 22.0- inch diameter boring was augered from ground surface to 4.0 feet and a 15 1/4-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 23.0 feet. A 2-inch diameter stainless steel screen with welded bottom cap was installed from 12.8 to 23.0 feet. A 2-inch diameter stainless steel casing was installed above the screen at 12.8 feet and extended 1.78 feet above ground surface. A sandpack was then tremied into the annular space from 11.2 to 23.0 feet, with a 1.7 foot bentonite pellet seal poured into the annular space above the sandpack from 9.5 to 11.2 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 1155 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 155 gallons of water had been evacuated and the clarity of the discharge water was approved by the company representative. The final turbidity value measured at completion was 3.0 NTU's. A development form showing the exact method of development and other pertinent data is appended.

2.4.3 Installation of Dedicated Monitoring Well Pump

After the well was developed, a Geoguard Model No. 5614 dedicated monitoring well pump was installed on June 26, 1990, at a depth of 21.3 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 1155 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 3.57×10^{-5} cm/second (shown as permeability on the hydraulic conductivity calculations printout attached) was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1155

PRE-DRILLING CHECKLIST FOR
MONITORING WELLS

PRE-DRILLING TASKS

COMPLIANCE

1. EXCAVATION PERMIT OBTAINED

DATE
12-1-89

INITIALS
TL

2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.

12-1-89

TL

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

N/A

3b. PRE-PACKAGED SCREENS, CASING AND CENTRALIZERS
WERE USED.

12-6-89

TL

4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH
CLEAN POLYETHYLENE.

12-1-89

TL

5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS
ON HAND.

12-1-89

TL

6. POLYETHYLENE COVER IN PLACE OVER HOLE.

12-6-89

TL

7. AIR ROTARY COMPRESSED AIR SAMPLED.

12-6-89

TL

RESULTS: No hydrocarbons detected under ultraviolet light

ADDITIONAL NOTES/OBSERVATIONS: _____

_____
_____
_____
_____

OBSERVER SIGNATURE/DATE

Timothy A. Lee 12-1-89

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1155

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

12-1-89

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1155

ORNL MONITORING WELL LOG

PAGE 1 OF 2

LOCATION: WAG2
DRILLER: George Akins
HELPER: James Shelton
DRILL: Schramm Rotadrill

DATE: START: 12-1-89
FINISH: 12-6-89
LOGGED BY: Timothy A. Lee
HEALTH PHYSICIST: N/A

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

No. SAMPLES TAKEN: One TYPE: Soil

CONTAINMENT TYPE: Plastic, pan, containment box

THICKNESS OF SOIL (REFUSAL DEPTH): 9.0'
DEPTH DRILLED IN ROCK: 14.0'
TOTAL DEPTH OF WELL: 23.0'

DRILLING FLUID SAMPLES:
TYPE: Water DATE: 12-6-89

DEPTH (FEET)		SAMPLE (NUMBER & INTERVAL)	PERCENT RECOVERY (SPLIT SPOONS)	SOIL/BEDROCK DESCRIPTION
FROM	TO			
0.0	1.8			Gravel fill
1.8	3.8		0%	
3.8	4.0		100%	Gravel and clay and organic matter
4.0	5.3		100%	Clay, moderate yellowish brown, slightly silty, plastic, damp, mottled with clay, dark yellowish orange, dark streaks
5.3	5.8	1155S01	100%	Clay, pale yellowish brown, slightly silty, plastic, damp, mottled with clay, dark yellowish orange, dark streaks, Bulk density taken from 5.3' to 5.6'. Bulk density = 2.03 g/cm ³
5.8	6.4	5.3' - 5.6'	75%	Clay, dark yellowish orange, slightly silty, plastic, damp, mottled with clay, dark yellowish brown, dark streaks
6.4	6.6		75%	Chert, moderate yellowish brown
6.6	7.8		75%	Shale, dry, crumbly, dark streaks
7.8	8.4		100%	Shale, dry, crumbly, dark streaks
	8.4			Split spoon refusal
	9.0			Auger refusal
9.0	10.5			** Hard

ORNL MONITORING WELL LOG

PAGE 2 OF 2

** No detailed lithologic descriptions are available from 9.0' to 23.0' due to the use containment box

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1155

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: George Akins HELPER: James Shelton

EQUIPMENT
■ 20 INCH AUGER 4.0 L.F.
■ 6 INCH AUGER 5.0 L.F.
■ 7 7/8 INCH ROTARY 14.0 L.F.

MATERIALS USED

EST. USED VOL. VOL.
10.0 FEET OF 2 IN. S.S. SCREEN
15.0 FEET OF 2 IN. S.S. CASING
3.0 4.0 SACKS OF SAND
50.0 50.0 POUNDS OF BENTONITE PELLETS
3.0 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 and irregular boring diameters

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

MONITORING WELL PUMP BASE SET AT 21.3 FEET.

CENTRALIZERS AT 12.5 FEET.
22.5 FEET.
FEET.

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

HOLE CLEANED OUT
TO 23.0 FEET

BOTTOM OF BOREHOLE
23.0 FEET

LOCATION WAG2
ORNL GRID COORDINATES
N 16,676.5737
E 30,538.5387
ELEV. GROUND 777.11
ELEV. TOP STAINLESS
STEEL CASING 778.89
DRILLING DATES:
STARTED: 12-1-89
FINISHED: 12-6-89

TYPE D WELL

NOT TO SCALE

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1155

DATE: 12-6-89

MONITORING WELL MATERIALS
CERTIFICATION

ITEM/MATERIAL			DATE USED	BATCH NUMBER
SAND			12-6-89	2
BENTONITE Pellets Powder			12-6-89	1
			12-6-89	3
STAINLESS STEEL SCREEN	(PREPACKAGED	☒ YES ☐ NO	12-6-89	2
STAINLESS STEEL CASING	(PREPACKAGED	☒ YES ☐ NO	12-6-89	2
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED	☒ YES ☐ NO	12-6-89	2
STAINLESS STEEL CAPS	(PREPACKAGED	☒ YES ☐ NO	12-6-89	2
MONITORING WELL PUMP	(PREPACKAGED	☒ YES ☐ NO	06-26-90	7
GROUT				
			12-6-89	3
WELL COVERS				
SURFACE CASING			N/A	N/A

COMMENTS:

OBSERVER SIGNATURE/DATE

Timothy A. Lee
Timothy A. Lee

12-6-89

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1155

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>12-6-89</u>	<u>TL</u>
2. ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	<u>12-6-89</u>	<u>TL</u>
3. WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	<u>06-26-90</u>	<u>DCL</u>
4. DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	<u>12-6-89</u>	<u>TL</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
Timothy A. Lee

12-6-89

D. Charles Lytle
D. Charles Lytle

06-26-90

ERCE
Environmental
and Energy
Services Co.

WELL No. 1155
Upper
LOCATION: WAG2

**MONITORING WELL
DEVELOPMENT FORM**

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and pumping

DEVELOPMENT
BEGAN DATE: 6/19/90

TIME: _____

DEVELOPMENT
ENDING DATE: 6/26/90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 7.3 GALLONS

TOTAL GALLONS PUMPED: 155 TOTAL WELL VOLUMES PUMPED: 21.2

INITIAL pH: 8.6 FINAL pH: 8.5

INITIAL CONDUCTIVITY ($\mu S/cm$): 606 FINAL CONDUCTIVITY ($\mu S/cm$): 573

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: 6.6 feet from ground surface

DEVELOPMENT OBSERVATIONS

OBSERVER SIGNATURE/DATE

D. Charles Lytle 6-26-90
D. Charles Lytle

MONITORING WELL DEVELOPMENT PROGRESS

ONE WELL VOLUME = 7.3 GALLONS

DATE	TIME	GALLONS PUMPED	DESCRIPTION OF TURBIDITY	MEASURED TURBIDITY (NTU'S)	pH	CONDUCT- IVITY (uS/cm)	TOTAL GALLONS PUMPED	WELL VOLUMES PUMPED	COMMENTS
6/19/90	1130	46	Cloudy	---	8.6	606	46	6.3	
6/25/90	1300	19	Cloudy	---	8.4	600	65	8.9	
6/25/90	1400	38	Slightly Cloudy	---	8.6	574	103	14.1	
6/26/90	0900	32	Slightly Cloudy	---	8.3	530	135	18.5	
6/26/90	1100	20	Clear	3.0	8.5	573	155	21.2	
RESULTS AT END OF DEVELOPMENT			Clear	3.0	8.5	573	155	21.2	

COMMENTS Pumped dry several times, recharged quickly after setting for a couple of hours. Passed with 3.0 NTU's and 21.2 well volumes. Moved to another hole

OBSERVER SIGNATURE/DATE D. Charles Lytle 6-26-90
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.: 1155

DATE OF TEST: 10-19-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: U. WAG-2

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 = 7.88 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 10.00 FEET
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 14.40 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)

3.4371
3.4800

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	5.130	4.130
20.00	5.030	4.030
30.00	4.920	3.920
40.00	4.820	3.820
50.00	4.740	3.740
60.00	4.670	3.670
75.00	4.540	3.540
90.00	4.420	3.420
105.00	4.300	3.300
120.00	4.200	3.200
150.00	4.000	3.000
180.00	3.820	2.820
240.00	3.480	2.480
300.00	3.240	2.240
360.00	3.010	2.010
420.00	2.810	1.810
480.00	2.650	1.650
540.00	2.520	1.520
600.00	2.370	1.370
720.00	2.190	1.190
840.00	2.040	1.040
960.00	1.900	.900
1080.00	1.790	.790
1200.00	1.690	.690
1320.00	1.630	.630
1440.00	1.570	.570
1560.00	1.530	.530
1680.00	1.500	.500
1800.00	1.460	.460
1920.00	1.450	.450
2040.00	1.400	.400
2160.00	1.360	.360

HYDRAULIC CONDUCTIVITY CALCULATIONS

*****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $1.17\text{E-}06$ FT/SEC = $3.57\text{E-}05$ CM/SEC

TRANSMISSIVITY = $1.17\text{E-}05$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $1.65\text{E-}06$ FT/SEC = $5.04\text{E-}05$ CM/SEC

TRANSMISSIVITY = $1.65\text{E-}05$ 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

1155S01

WELL NO.

1155

LOCATION:

WAG 2

TYPE:

Soil

SAMPLER:

Justin Q. Smith

(SIGNATURE)

SAMPLE INTERVAL:

5.3' - 5.6'

DATE:

12-6-89

TIME:

1230

RELINQUISHED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

RECEIVED BY:
(SIGNATURE)

DATE:

TIME:

WITH:

Justin Q. Smith

12/19/89

1245

ERC

JHS

12/19/89

12:43

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

1155W01

WELL NO. 1155 LOCATION: WAG 2 TYPE: DRILL WATER

SAMPLER: (SIGNATURE) SAMPLE INTERVAL: 13.0' DATE: 12-6-89 TIME: 1305

RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECEIVED BY: (SIGNATURE)	DATE:	TIME:	WITH:
<u> </u>	12/19/89	1245	ERC	JHS	12/19/89	12:42	

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 1156 is located in Upper WAG 2. It is in the southwestern corner of Upper WAG 2, approximately 200 feet north of the New Hydro-fracture facility. The location is shown on ORNL drawing number C3E20004A075. Survey coordinates for this well are N 17,001.9312, E 27,876.1244 (X-10 grid) or latitude 35°-54'-37.11" and longitude 84°-18'-58.85". 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 1156 was drilled by Geotek Engineering Company. A Schramm Rotadrill rig was used to drill this boring for monitor well installation under the operation of George Akins with the assistance of James Shelton. Drilling commenced on 12-12-89 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.

- 12-12-89: The rig was mobilized to the staked location and set up on plastic sheeting. Split spoon samples were taken from the surface to 8.0 feet. The boring was deepened from 8.0 feet to refusal at 9.3 feet using a 6-inch auger. Water could be heard flowing into the well. Set 2-inch stainless steel screen and casing with sandpack and bentonite seal.
- 12-13-89: The casing was grouted into place with 1.0 sack of cement.
- 9-12-90: The protective casing, 2-inch stainless steel screen and riser were pulled in order to deepen the well.
- 9-13-90: The Ingersoll Rand T-4 drill rig and tools were steamcleaned.
- 9-14-90: The rig was mobilized to the well location and set up over #1156. The boring was reamed from 0.0' to 8.5 feet with 14-inch augers. Ten inch surface/diverter casing as set to 7.6 feet and grouted in place.
- 9-19-90: The Ingersoll Rand T-4 was decontaminated and mobilized to the location. Drilled from 7.6 to 21.4 feet with 8-inch tricone bit. Ran in 2-inch stainless steel casing, screen, tremied sand and poured in bentonite. Grouted annulus to surface.

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

2.0 Technical Information

2.1 Decontamination Procedures

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

2.2 Geology

The Rome Formation underlies the northern portion of Upper WAG 2 and consists of variegated shale and siltstone with beds of gray, fine grained sandstone. The Conasauga Group underlies the southern portion of Upper WAG 2 and is divided into five members. They are from north to south, the Pumpkin Valley Shale, Rutledge Limestone, Rogersville Shale, Maryville Limestone, and Nolichucky Shale. These rocks have undergone extensive deformation and contain many folds and faults resulting in varying strike and dips. The regional strike is 56

degrees northeast with dips of about 30 degrees to the southeast. The White Oak Creek tear fault is in Upper WAG 2. Displacement varies from 40 feet up to 350 feet.

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 soil sample is included with this data package. Soil sample 1156S01 was collected in the split spoon interval from 4.3' to 4.8' on 12-12-89.

A bulk density soil sample was collected from the split spoon sample interval from 2.5' to 2.8'. The sample was measured and weighed, and a bulk density of 2.17 grams/cm³ was calculated.

2.4 Installation and Development

2.4.1 Installation

This was a Type D well. The air rotary method was required to complete the boring to the specified total well depth. A 14-inch diameter boring was augered from ground surface to 7.6 feet and 10-inch diverter casing was installed and grouted. An 8-inch diameter boring was then drilled with an air rotary tricone roller bit from 8.5 to 21.4 feet. A 2-inch diameter stainless steel screen with threaded bottom cap was installed from 11.0 to 21.3 feet. A 2-inch diameter stainless

steel casing was installed above the screen at 11.0 feet and extended 2.07 feet above ground surface. A sandpack was then tremied into the annular space from 8.3 to 21.3 feet, with a bentonite pellet seal poured into the annular space above the sandpack from 7.3 to 8.3 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 1156 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 120 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 10/8/90 at a depth of 20.1 feet below ground surface. These

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

2.5 Hydraulic Conductivity Testing

Well number 1156 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 4.22×10^{-5} cm/second (shown as permeability on the hydraulic conductivity calculations printout attached) was calculated using the Bouwer and Rice method. A computer printout of the hydraulic conductivity calculations is included in this data package.

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1156

PRE-DRILLING CHECKLIST FOR
MONITORING WELLS

PRE-DRILLING TASKS

COMPLIANCE

1. EXCAVATION PERMIT OBTAINED

DATE
12-12-89

INITIALS
TJL

2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.

DATE
12-12-89

INITIALS
TJL

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.

DATE
N/A

INITIALS
N/A

3b. PRE-PACKAGED SCREENS, CASING AND CENTRALIZERS
WERE USED.

DATE
12-12-89

INITIALS
TJL

4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH
CLEAN POLYETHYLENE.

DATE
12-12-89

INITIALS
TJL

5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS
ON HAND.

DATE
12-12-89

INITIALS
TJL

6. POLYETHYLENE COVER IN PLACE OVER HOLE.

DATE
12-12-89

INITIALS
TJL

7. AIR ROTARY COMPRESSED AIR SAMPLED.

DATE
N/A

INITIALS
N/A

RESULTS: N/A

ADDITIONAL NOTES/OBSERVATIONS: _____

_____
_____
_____
_____

OBSERVER SIGNATURE/DATE

Timothy A. Lee
Timothy A. Lee

12-12-89

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1156
Deepen

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>9-14-90</u>	<u>MLE</u>
2. ALL EQUIPMENT HAS BEEN CLEANED BEFORE DRILLING.	<u>9-14-90</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>N/A</u>
3b. PRE-PACKAGED SCREENS, CASING AND CENTRALIZERS WERE USED.	<u>9-20-90</u>	<u>THM</u>
4. WORK AREA FOR SAMPLE EXAMINATION COVERED WITH CLEAN POLYETHYLENE.	<u>9-14-90</u>	<u>MLE</u>
5. CLEAN KNIVES, GLOVES, SAMPLE JARS AND LABELS ON HAND.	<u>9-14-90</u>	<u>MLE</u>
6. POLYETHYLENE COVER IN PLACE OVER HOLE.	<u>9-14-90</u>	<u>MLE</u>
7. AIR ROTARY COMPRESSED AIR SAMPLED.	<u>N/A</u>	<u>N/A</u>

RESULTS: _____

ADDITIONAL NOTES/OBSERVATIONS: _____

_____
_____
_____
_____

OBSERVER SIGNATURE/DATE

Michael L. Ebers 9-14-90
Timothy A. Lee 9-20-90

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1156

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

Timothy A. Lee 12-12-89
Timothy A. Lee
Michael L. Ebers 9-14-90
Michael L. Ebers
OBSERVER SIGNATURE/DATE

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 115

ORNL MONITORING WELL LOG

PAGE 1 OF 2

LOCATION: Upper WAG 2
DRILLER: George Akins & Larry Ledbetter
HELPER: James Shelton & Fred Dixon
DRILL: Schramm Rotadrill & Ingersoll Rand
T-4

DATE: START: 12-12-89
FINISH: 9-20-90
LOGGED BY: Timothy A. Lee & Michael
L. Ebers
HEALTH PHYSICIST: Bill Shinpaugh &
Carl Stooksbury

TYPE DRILLING: Split spoon, auger, air rotary LUBRICANT TYPE: Green stuff

No. SAMPLES TAKEN: One TYPE: Soil

CONTAINMENT TYPE: Plastic, pan, containment box

THICKNESS OF SOIL (REFUSAL DEPTH): 9.3'
DEPTH DRILLED IN ROCK: 12.1'
21.4'
TOTAL DEPTH OF WELL: 21.4'

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	2.0		Augered	Gravel fill
2.0	4.0		75%	Clay, dark yellowish orange, medium dense, wet plastic; mottled with clay, yellowish gray; dark streaks, Bulk density taken 2.5 to 2.8' = 2.17 g/cm ³
4.0	6.0	1156S01	85%	Clay, dark yellowish orange, wet, plastic, mottled with clay, yellowish gray, dark streaks; vegetation roots. Scattered cavities throughout
6.0	6.5		60%	Clay, dark yellowish orange, moist, dense, mottled with clay, yellowish gray; dark streaks
6.5	6.7		60%	Cavity, wet
6.7	8.0		60%	Clay, dark yellowish orange, moist, dense; mottled with clay, yellowish gray; dark streaks; roots
	8.0			Split spoon refusal
8.0	9.3		Augered	Shale, limey, medium hard
9.3	12.0			*Shale, hard
12.0	13.0			Limestone, very hard
13.0	21.4			Shale, hard

WELL No. 1156

PAGE 2 OF 2

WELL LOG

Page 11 of 21

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1156

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

EQUIPMENT
■ 14 INCH AUGER 8.5 L.F.
□ _____ INCH AUGER _____ L.F.
■ 8 INCH ROTARY 12.9 L.F.

MATERIALS USED

EST. USED
VOL. VOL.

10 FEET OF 2 IN. S.S. SCREEN
15 FEET OF 2 IN. S.S. CASING
4.2 5.0 SACKS OF SAND
50.0 50.0 POUNDS OF BENTONITE PELLETS
1.6 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

Irregular well diameters

WELL COVER USED

■ LOCKING STEEL COVER
□ FLUSH MOUNTED WELL COVER
□ OTHER

SILT TRAP USED

YES ■ NO □

MONITORING WELL PUMP BASE SET AT 20.1 FEET.

CENTRALIZERS AT 3.0 FEET.
20.0 FEET.
_____ FEET.

NOTE:

ALL DEPTHS ARE MEASURED
FROM GROUND SURFACE
UNLESS OTHERWISE NOTED:

HOLE CLEANED OUT
TO 21.3 FEET

BOTTOM OF BOREHOLE
21.4 FEET

LOCATION Upper WAG 2
ORNL GRID COORDINATES
N 17,001.9312
E 27,876.1244
ELEV. GROUND 754.81
ELEV. TOP STAINLESS
STEEL CASING 756.88
DRILLING DATES:
STARTED: 9-14-90
FINISHED: 9-20-90

TYPE D WELL

NOT TO SCALE

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1156

DATE: 9-20-90

MONITORING WELL MATERIALS
CERTIFICATION

<u>ITEM/MATERIAL</u>			<u>DATE USED</u>	<u>BATCH NUMBER</u>
SAND				
			9-20-90	2
BENTONITE	Pellet Powder		9-20-90	6
			9-20-90	1
STAINLESS STEEL SCREEN	(PREPACKAGED	☒ YES ☐ NO	9-20-90	4
STAINLESS STEEL CASING	(PREPACKAGED	☒ YES ☐ NO	9-20-90	4
STAINLESS STEEL CENTRALIZERS	(PREPACKAGED	☒ YES ☐ NO	9-20-90	4
STAINLESS STEEL CAPS	(PREPACKAGED	☒ YES ☐ NO	9-20-90	4
MONITORING WELL PUMP	(PREPACKAGED	☒ YES ☐ NO	10-8-90	8
GROUT				
			9-20-90	7
WELL COVERS				
SURFACE CASING			N/A	N/A

COMMENTS:

_____
_____
_____
_____
_____
_____
_____
_____

OBSERVER SIGNATURE/DATE

Timothy A. Lee
Timothy A. Lee

9-20-90

ERC / EDGE
Environmental
and Energy
Services Co.

WELL No. 1156

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.	12-12-89 & 9-19-90	<u>Tbz</u>
2.	ALL MUD FROM RIG AND EQUIPMENT SCRAPINGS AND CUTTINGS DISPOSED OF IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED.	12-12-89 & 9-19-90	<u>Tbz</u>
3.	WELL DEVELOPED IN ACCORDANCE WITH THE SPECIFICATION* PROVIDED AND DETAILS OF THE DEVELOPMENT ACTIVITY RECORDED.	10-8-90	<u>DCL</u>
4.	DRILLING SITE PROPERLY CLEANED UP AFTER COMPLETION OF WELL INSTALLATION.	12-12-89 & 9-19-90	<u>Tbz</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

12-12-89 &
9-19-90

D. Charles Lytle

10-8-90

ERCE
Environmental
and Energy
Services Co.

WELL No. 1156
Upper
LOCATION: WAG 2

MONITORING WELL DEVELOPMENT FORM

DEVELOPMENT DETAILS

METHOD OF
DEVELOPMENT: Surging and pumping

DEVELOPMENT
BEGAN DATE: 9-24-90 TIME: _____

DEVELOPMENT
ENDING DATE: 10-8-90

DEVELOPMENT
OBSERVED BY: D. Charles Lytle

ONE WELL VOLUME: 6.9 GALLONS

TOTAL GALLONS PUMPED: 120 TOTAL WELL VOLUMES PUMPED: 17.4

INITIAL pH: 9.4 FINAL pH: 7.8

INITIAL CONDUCTIVITY ($\mu S/cm$): 578 FINAL CONDUCTIVITY ($\mu S/cm$): 810

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: 7.9 feet from ground surface

DEVELOPMENT OBSERVATIONS

Re-drill because well was not producing sufficient water. Deepened hole
to 21.4 feet.

OBSERVER SIGNATURE/DATE

D. Charles Lytle 10-8-90
D. Charles Lytle

ONE WELL VOLUME = 6.9 GALLONS

COMMENTS

D. Charles Lytle 10-8-90
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.: 1156

DATE OF TEST: 10-29-90

PROJECT NO.: E221-002

CLIENT: MMES

SITE LOCATION: U. WAG-2

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 = 15.85 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)

1.2228
1.2640

HYDRAULIC CONDUCTIVITY CALCULATIONS

TIME (SEC)	DEPTH TO WATER (FEET)	HEAD (FEET)
10.00	4.850	3.850
20.00	4.230	3.230
30.00	3.800	2.800
40.00	3.410	2.410
50.00	3.100	2.100
60.00	2.890	1.890
75.00	2.580	1.580
90.00	2.360	1.360
105.00	2.190	1.190
120.00	2.040	1.040
150.00	1.860	.860
180.00	1.700	.700
240.00	1.530	.530
300.00	1.460	.460
360.00	1.390	.390
420.00	1.360	.360
480.00	1.340	.340
540.00	1.310	.310
600.00	1.260	.260
720.00	1.240	.240
840.00	1.230	.230
960.00	1.190	.190
1080.00	1.180	.180
1200.00	1.180	.180
1320.00	1.180	.180
1440.00	1.170	.170
1560.00	1.170	.170
1680.00	1.170	.170
1800.00	1.150	.150
1920.00	1.150	.150
2040.00	1.150	.150
2160.00	1.150	.150

HYDRAULIC CONDUCTIVITY CALCULATIONS

*****

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = $1.38\text{E-}06$ FT/SEC = $4.22\text{E-}05$ CM/SEC

TRANSMISSIVITY = $1.38\text{E-}05$ FT**2/SEC

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = $1.95\text{E-}06$ FT/SEC = $5.95\text{E-}05$ CM/SEC

TRANSMISSIVITY = $1.95\text{E-}05$ 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

1156501

WELL NO. 1156			LOCATION: WAG2			TYPE: SOIL		
SAMPLER: <u>Timothy A. Jones</u> (SIGNATURE)			SAMPLE INTERVAL: 4.3' to 4.8'			DATE: 12-12-89		TIME: 1400
RELINQUISHED BY: (SIGNATURE)	DATE:	TIME:	WITH:	RECEIVED BY: (SIGNATURE)	DATE:	TIME:	WITH:	
<u>Timothy A. Jones</u>	12/19/89	1245	ERC	JHS	12/19/89	12:44		

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: _____
_____
_____
_____
_____

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

Operating Instructions for Handling Cuttings and Water from
 Procedure Title 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: *Gene 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~~ ^{MSB} 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. Hankford	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.

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*Testing for tritium will be done for wells located in areas where tritium contamination is suspected. This decision will be made between RP and EM&C.

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